RANI DURGAWATI UNIVERSITY

Saraswati Vihar, Pachpedi, Jabalpur,

Madhya Pradesh (INDIA) -482001

Department of PG Studies & Research in Biological Sciences

Syllabus of All Programme

INDEX

Syllabus
For
B.Sc. (Hons.)MICROBIOLOGY

THREE YEAR FULL TIME PROGRAMME UNDER CBCS

RANI DURGAVATI UNIVERSITY

JABALPUR-482001

Note: Syllabus applicable for students seeking admission in the B.Sc. (HONS) Microbiology Course from the academic year 2019-2020 onwards

Syllabus For
B.Sc. (Hons.) MICROBIOLOGY
(CBCS Pattern)

ACADEMIC YEAR 2020-2021 Onwards

The B.Sc. (Hons.) Microbiology course would be of three years duration, divided into three parts- Part I, Part II and Part III. Each part would consist of two semesters. Semester I to V would comprise of three theory papers including practicals and one Elective with practical out of two choices, making a total of 20 papers in five semesters. Students will carry out Research work and submit a Dissertation in Semester VI. There would be 12 cores, 8 common (elective) and 4 interdisciplinary papers. The new course will commence from the academic session 2020-21. The syllabus has been prepared keeping in view the unique requirements of B.Sc. (Hons.) microbiology students under CBCS Programme. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline. It reflects the changing needs of the students, pertaining to the fields of Chemistry, Statistics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings. Teaching time allotted for each paper shall be 4 periods for each theory paper and 4 periods for each practical class per week and 1 tutorial period for each paper per week. Each practical batch should not have more than 20 students. Any number exceeding 20 will be divided into two equal batches. This is because microbiology practicals require individual attention for imparting correct and adequate hands – on training to the students.

The six common papers (Cell Biology - I and II, Genetics and Genomics – I and II and Molecular Biology I and II) will be taught by teachers of the department of Biological Sciences. The interdisciplinary courses like Fundamental of Statistics, Basics of Computers, Computational Skills, Chemistry and Technical Writing and Communication in English) will be taught by teachers of the respective departments. One short educational trip will be conducted to industry/national/research institutes in the $5^{th}/6^{th}$ semester to keep the students abreast with latest developments in the field of microbiology.

BACHELOR OF SCIENCE IN MICROBIOLOGY
THREE YEAR FULL TIME PROGRAMME,
PROGRAMME STRUCTURE

PART	SEMESTER	PAPER
PART-I	**Semester-1**	
	UMB 101	Introduction to Microbial World-**SKILL**
	UMB 102	Techniques in Microbiology-**EMPLOYABILITY**
	UMB 103	Chemistry-I- SKILL
	UMB 104	Practical based on UMB 101&102-**SKILL**
	UMB 105	Techniques in Microbiology-**EMPLOYABILITY**
	UMBE 101/ UMBE 102	Communicative English-SKILL / Fundamentals of Statistics-SKILL
	Semester-2	
	UMB 201	Bacteriology-SKILL
	UMB 202	Medical Microbiology- EMPLOYABILITY
	UMB 203	Chemistry-II-SKILL
	UMB 204	Practical based on UMB 201& 202-**EMPLOYABILITY**
	UMB 205	Practical based on UMB 203 & UMBE 201/202-**SKILL**
	UMBE 201/ UMBE 202	Basics of Computers- **EMPLOYABILITY** / Bioanalytical Techniques- **EMPLOYABILITY**
PART II	**Semester-3**	
	UMB 301	Cell Biology-I-**SKILL**
	UMB 302	Phycology & Mycology-**SKILL**
	UMB 303	Virology-**SKILL**
	UMB 304	Practical based on UMB 301& 302-**SKILL**
	UMB 305	Practical based on UMB 303 & UMBE 301/302-**EMPLOYABILITY**
	UMBE 301/ UMBE 302	Molecular Biology-I- **EMPLOYABILITY** / Recombinant DNA Technology-**SKILL**
	Semester- 4	
	UMB 401	Microbial Physiology & Metabolism-**SKILL**
	UMB 402	Genetics & Genomics-I-**SKILL**
	UMB 403	Cell Biology-II-SKILL
	UMB 404	Practical based on UMB 401& 402-**EMPLOYABILITY**
	UMB 405	Practical based on UMB 403 & UMBE 401/402-**SKILL**
	UMBE 401/ UMBE 402	Molecular Biology-II- **EMPLOYABILITY** / Immunology- **EMPLOYABILITY**
PART III	**Semester-5**	
	UMB 501	Food & Dairy Microbiology- **Entrepreneurship**
	UMB 502	Microbial Ecology-**SKILL**
	UMB 503	Industrial Microbiology- **Entrepreneurship**
	UMB 504	Practical based on UMB 501& 502-

	UMB 505 UMBE 501/ UMBE 502	**EMPLOYABILITY** Practical based on UMB 503& UMBE 501/502-**SKILL** Genetics & Genomics-II-**SKILL** Plant Pathology-**SKILL**
	Semester-6 DISSERTATION	**SKILL, EMPLOYABILITY, Entrepreneurship**

(B) SCHEME OF EXAMINATION

FIRST SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UMB 101	Introduction to Microbial World	**3**	**40**	**60**	**100**
UMB 102	Techniques in Microbiology	**3**	**40**	**60**	**100**
UMB 103	Chemistry-I	**3**	**40**	**60**	**100**
II-Practical Core Courses					
UMB 104	Practical based on UMB 101 and UMB 102	**4**	**40**	**60**	**100**
UMB 105	Practical based onUMB103 and UMBE 101/ UMBE 102	**4**	**40**	**60**	**100**
III-Elective Courses (Any one to choose)					
UMBE 101	Communicative English	**3**	**40**	**60**	**100**
UMBE 102	Fundamentals of Statistics				
IV- Skill Development course					
SKILL	Skill Development module 1	**2**	Grade Point will be provided by Skill Development Centre		
Total valid credits		**22**			
(B) Comprehensive viva voce (Virtual credits)		**4**			**50**

SECOND SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UMB 201	Bacteriology	**3**	**40**	**60**	**100**
UMB 202	Medical Microbiology	**3**	**40**	**60**	**100**
UMB 203	Chemistry-II	**3**	**40**	**60**	**100**
II-Practical core courses					
UMB 204	Practical based on UMB 201 and UMB 202	**4**	**40**	**60**	**100**
UMB 205	Practical based on UMB 203 and UMBE 201/ UMBE 202	**4**	**40**	**60**	**100**
III-Elective Courses (Any one to choose)					
UMBE 201	Basics of Computers	**3**	**40**	**60**	**100**
UMBE 202	Bioanlytical Techniques				
IV- Skill Development course					
SKILL	Skill Development module 2	**2**	Grade Point will be provided by Skill Development Centre		
Total valid credits		**22**			
(B) Comprehensive viva voce (Virtual credits)		**4**			**50**

THIRD SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UMB 301	Cell Biology-I	**3**	**40**	**60**	**100**
UMB 302	Phycology & Mycology	**3**	**40**	**60**	**100**
UMB 303	Virology	**3**	**40**	**60**	**100**
II-Practical core courses					
UMB 304	Practical based on UMB 301 and UMB 302	**4**	**40**	**60**	**100**
UMB 305	Practical based on UMB 303 and UMBE 301/ UMBE 302	**4**	**40**	**60**	**100**
III-Elective Courses (Any one to choose)					
UMBE 301	Molecular Biology-I	**3**	**40**	**60**	**100**
UMBE 302	Recombinant DNA Technology				
IV- Skill Development course					
SKILL	Skill Development module 3	**2**	Grade Point will be provided by Skill Development Centre		
Total valid credits		**22**			
(B) Comprehensive viva voce (Virtual credits)		**4**			**50**

FOURTH SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UMB 401	Microbial Physiology & Metabolism	**3**	**40**	**60**	**100**
UMB 402	Genetics & Genomics-I	**3**	**40**	**60**	**100**
UMB 403	Cell Biology-II	**3**	**40**	**60**	**100**
II-Practical core courses					
UMB 404	Practical based on UMB 401 and UMB 402	**4**	**40**	**60**	**100**
UMB 405	Practical based on UMB 403 and UMBE 401 / UMBE 402	**4**	**40**	**60**	**100**
III-Elective Courses (Any one to choose)					
UMBE 401	Molecular Biology-II	**3**	**40**	**60**	**100**
UMBE 402	Immunology				
IV- Skill Development course					
SKILL	Skill Development module 4	**2**	Grade Point will be provided by Skill Development Centre		
Total valid credits		**22**			
(B) Comprehensive viva voce (Virtual credits)		**4**			**50**

FIFTH SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UMB 501	Food & Dairy Microbiology	**3**	**40**	**60**	**100**
UMB 502	Microbial Ecology	**3**	**40**	**60**	**100**
UMB 503	Industrial Microbiology	**3**	**40**	**60**	**100**
II-Practical core courses					
UMB 504	Practical based on UMB 501 and UMB 502	**4**	**40**	**60**	**100**
UMB 505	Practical based on UMB 503 and UMBE 501/ UMBE 502	**4**	**40**	**60**	**100**
III-Elective Courses (Any one to choose)					
UMBE 501	Genetics & Genomics-II	**3**	**40**	**60**	**100**
UMBE 502	Plant Pathology				
IV- Skill Development course					
SKILL	Skill Development module 5	**2**	Grade Point will be provided by Skill Development Centre		
Total valid credits		**22**			
(B) Comprehensive viva voce (Virtual credits)		**4**			**50**

SIXTH SEMESTER

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

PROGRAMME OUTCOME

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in a wide ranging contexts which involve the use of knowledge and skills of Microbiology. Their understanding, knowledge and skills in Microbiology needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.

PROGRAMME SPECIFIC OUTCOMES

A candidate who is conferred an UG (Hons) degree i.e. B.Sc. (Hons) degree in microbiology needs to have acquired/developed following competencies during the programme of the study:

1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.
2. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices
3. Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc.
4. Developed a broader perspective of the discipline of Microbiology to enable him to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.

FIRST SEMESTER

Course Code UMB 101: INTRODUCTION TO MICROBIAL WORLD

Course Objectives: The main objective of this course is to give students an insight into the world of microorganisms. The paper discusses the historical developments and major milestones leading to the development of microbiology as a separate discipline of science. The students will understand the diversity, structure, evolution and impact of microbes in our day to day life and for the sustenance of life on Earth in general.

Course Learning Outcomes: Upon successful completion of the course, the students:

- will be acquainted with the historical account and development of microbiology as a scientific discipline.
- will have gained knowledge on different systems of classification. They will also acquire an overview of acellular and cellular microorganisms.
- will have acquired in-depth knowledge of the diversity, distribution, cell structure, life cycles and economic importance of algae.
- will have gathered detailed information on the diversity, distribution, structure, life cycles and economic importance of fungi.
- will be aware of general characteristics of protozoa and their economic importance.
- will have a broad perspective of the scope of microbiology.

COURSE CONTENTS

UNIT I

History of Development of Microbiology

History- Discovery and Development of Microbial World, Spontaneous generation vs. biogenesis, Fermentation, Germ Theory of Disease , Contribution of following scientists in the field oh=f Microbiology : Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty

UNIT II

Microbial Diversity and Classification

Occurrence, Binomial Nomenclature, Haekel's Classification, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Taxonomy- Principle and its types (Classical Approaches-Numerical, molecular Approach, Chemical, Serological and Genetics), Bacterial taxonomy- Bergey's manual of systematic bacteriology (Eubacteria and Archaebacteria) Difference between prokaryotic and eukaryotic microorganisms

General characteristics of different groups:

A cellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

UNIT III

Viruses

Definition- Virion, prions, viroids and virusoides.

History, general characterstics and Structure, Virus-host (bacteria, animal and plants), Classification, Replication (TMV, poliovirus, T4 and λ phage), lytic and lysogenic cycles.

Bacteria

A General Characterstics- Morpholgical, Chemical , Cultural , Metabolic , Antigenic, very precise account of typical eubacteria, chlamydiae, rickettsiae, mycoplasma, and archaebacteria (extremophiles).

UNIT IV

Algae

History of phycology with emphasis on contributions of scientists; General characteristics of algae including occurrence, Classification, Morphology, Reproduction. Physiology and Cultivation.

UNIT V

Fungi

Historical developments in the field of Mycology, contributions of mycologists. General characteristics of fungi including habitat, distribution, Classification, Morphology, physiology, cultivation and Reproduction.

PRACTICALS

1. Study of the life history of the following scientists and their contributions with the help of their photographs: Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff and Ananda M. Chakraborty.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven) used in the Microbiology laboratory.
3. Study of the following algae by preparing temporary mounts: *Chlamydomonas* and *Spirogyra*.
4. Study of the following fungi by preparing temporary mounts: *Rhizopus* and *Aspergillus*.
5. Study of the following protozoans using permanent mounts/photographs*: Amoeba, Paramecium* and *Giardia.*
6. Study of the following viruses using electron micrographs : TMV, Polio virus, T4 and λ phage.

SUGGESTED READINGS

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4th edition. John and Sons, Inc.
2. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.
4. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
5. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
9. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
10. Vashishta BR. (2005). Algae. 3rd edition. S. Chand and Company Limited, New Delhi.
11. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

FIRST SEMESTER

Course Code UMB 102: TECHNIQUES IN MICROBIOLOGY

Course learning outcomes: Major learning outcome of this course is that students develop a very good understanding of several microbiological techniques and instruments which are commonly used in a microbiology laboratory. The students have learnt-

- Principles which underlies sterilization of culture media, glassware and plastic ware to be used for microbiological work.
- .Principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.
- Handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. They also get introduced a variety of modifications in the microscopes for specialized viewing.
- Several separation techniques which may be required to be handled later as microbiologists.

COURSE CONTENTS

UNIT I

Pure culture techniques-

Definitions- Pure Culture, Auxenic culture, Mixed Culture, isolates, strains, Clone; Koch's postulates, Pure culture techniques; pour plate, streak plate and spread plate method; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.; Techniques for cultivation of Obligate anaerobes (rolling tube and candle jar method).

Control of Microorganisms-

Definitions- Thermal death time, Decimal reduction time, sterilization, Disinfection, antiseptic, Sanitizer, Germicide (Microbicide), Bactericide, Fungicide, Virucide, Sporicide, Bacteriostasis. Control of Microbes-Physical and Chemical Agents with their mode of action and practical applications.

UNIT II

Principle and application of staining techniques-

Definitions-Stain, Dye, Simple Staining, Differential Staining, Negative Stating.

Principle of Staining Techniques- cell wall, capsule, flagella, endospore, cytoplasmic inclusions, acid fast stain, GIEMSA stain and Negative staining.

UNIT III

Instrumentation

Basic Principles, Applications and certain limitations of Instruments- Microscope Resolving power, Numerical Aperture, Magnification.(Bright Field, Dark Field, Fluorescence, phase contrast microscopy, Electron Microscope), pH meter, fluorimeter, colorimeter, Spectrophotometer (visible, UV, infra-red), centrifuge, Oven & Autoclave.

UNIT IV

Principle and application of electrophoresis: Agarose gel electrophoresis, Density gradient gel electrophoresis, capillary electrophoresis, Pulsed field gel electrophoresis, SDS-PAGE, NATIVE-PAGE, Isolectric focusing, 2- D PAGE, Western Blotting, Southern blotting, Northern blotting.

UNIT V

Principles and methods used for analysis biopolymers- X-ray Crystallography, fluorescence, ORD/CD, NMR & ESR spectroscopy; Hydrodynamic methods; Atomic absorption spectroscopy. DNA sequencing, MALDI-TOF, N-terminal sequencing.

SUGGESTED READINGS:

1. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, New York.
3. Talaro K. P. & Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.
4. Potter GWH and Potter GW (1995). Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques, Kluwer Academic Publishers.
5. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.
6. Willard, HH and Merritt LL (1986). Instrumental Methods of Analysis. CBS Publishers and Distributors.
7. Williams, BL. and Wilson, K. (1975). A Biologists Guide to Principles and Techniques of Practical Biochemistry.John Wiley and Sons. Inc., New York.

FIRST SEMESTER

Course Code UMB 103: CHEMISTRY

Course Objective:

- To introduce the basicconcepts and principles of general chemistry.
- To familiarize the students with principles, fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
- Students will be able to explore new areas of research in both chemistry and allied fields of microbiology.

Course Learning Outcomes:

- The students will learn about the principle, methodology, calculation and application involved in quantitative, chemical and spectrophotometric methods.
- The student shall learn the essential concepts of chirality, configuration, isomerism in organic chemistry and nomenclature of isomers. Students will familiarize with the elementary concept of saturated aliphatic hydrocarbons reactions
- The students shall learn about the fundamentals of organic chemistry with references to structure and reactivity, reagents and reactions & reaction and mechanism.
- The students will learn about ionic, covalent bonding in molecules .compare/contrast the properties of molecular and ionic compounds.
- The students will learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances.
- Students will learn the IUPAC nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions.

COURSE CONTENTS

UNIT I

Quantitative methods. Significant figures. Mole concept. Empirical and molecular formula. Molar and molal solutions, mole fraction, ppm and ppb solutions. Stoichiometry and calculations based on it involving acid-base, precipitation, redox, and complex formation reactions. *Chemical methods:* Principle, methodology and calculations involved in for dissolved oxygen (Winkler method), biological oxygen demand, chemical oxygen demand, and hardness of water. Determination of nitrogen in proteins (Kjeldahl method). *Spectrophotometric methods:* Determination of ammonia (by indophenol formation), nitrate (by nitrophenol formation), nitrite (by azo dye formation), and phosphorus (by molybdenum blue formation).

UNIT II

Chemical bonding and molecular structure.

Kossel-Lewis theory, octet rule, electrovalent and covalent bond. Formal charge. Polarity of bonds. The valence shell electron pair repulsion (VSEPR) theory, its postulates and geometry of molecules. Valence bond theory, orbital concept, hybridisation (sp, sp^2, sp^3, sp^3d and sp^3d^2). Molecular orbital theory. Linear combination of atomic orbitals (LCAO). Types and energy level diagram of molecular orbitals. Bond order. Bonding in homonuclear diatomic molecules. Magnetic properties.

UNIT III

Fundamental organic chemistry.

Structure and reactivity. Inductive and electromeric effects. Tautomerism, hyperconjugation and resonance. Intramolecular and intermolecular hydrogen bonding. Structure and stability of carbocations, carbanions and free radicals. Relative strength of organic carboxylic acids, phenols and amines. pKa and pKb values.

Reagents and reactions. Periodic acid, Grignard reagent, ethyl acetoacetate and diethyl malonate.

Reaction and mechanism. Claisen condensation, Benzoin condensation, Perkin reaction, Pinacol-pinacolone rearrangement,

UNIT IV

Stereochemistry of organic compounds.

Conformations. Fisher, sawhorse and Newman structures. IUPAC namenclature of conformational isomers. Conformations and their analysis of ethane, n-butane, cyclohexane and decalins.

Configurations. Chirality. Elements of symmetry. Optical activity, specific rotation. Enantiomers, diastereomers, and meso compounds. Racemic modification. Thereo and erythro compounds. R and S configuration, sequence rules. Geometrical isomerism, E and Z nomenclature.

Stereochemical aspects of chemical reactions. Addition of bromine to Z- and E-butene. E2 reactions.

UNIT IV

Ionic equilibria.

Ostwald dilution law and its experimental verification. Application of Ostwald dilution law. Ionization of water. The pH value, relation between pH and pOH, the pH scale (numerical problems). The salt hydrolysis, and application to (i) salts of strong acids and strong bases, (ii) salts of weak acis and strong bases, (iii) salts of strong acids and weak bases, and (iv) salts of weak acids and weak bases. Hydrolysis constant and degree of hydrolysis.

Buffer solutions. Solubility and solubility product of sparingly soluble salts. Applications of solubility product principle.

PRACTICAL

1. Determination of hardness of water by titration with EDTA.
2. Determination of dissolved oxygen in environmental waters by the Winkler method.
3. Determination of chemical oxygen demand in environmental waters.
4. Determination of strength of a solution of sulphuric acid by titration with sodium hydroxide using pH meter.
5. Determination of ammonia by the indophenol formation, and spectrophotometry.
6. Determination of solubility product of mercuric iodate or lead iodate.

Suggested reference materials

1. Analytical Chemistry, G.D. Christian, John Wiley & Sons (Asia), Singapore
2. Fundamentals of Analytical Chemistry, D.S. Skoog, D.M. West, F.J. Holler and S.R. Cruch, Thomson, Singapore.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. A Guidebook to Mechanism in Organic Chemistry, P.Sykes, Orient Longman, New Delhi.
6. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.

FIRST SEMESTER

Course Code UMBE 101: COMMUNICATIVE ENGLISH

Course Objective- To develop the learner's communication skills in oral, written and interpersonal, by reinforcing the basics of English grammar.

Course Learning outcomes: Students will

- Improved LSRW- listening, speaking, reading and writing skills and the related sub-skills.
- Recognize and use formal elements of organizational communications: Paper writing, reports, proposals, memorandums, letters etc.
- Enhanced vocabulary with right pronunciation and improved accuracy in grammar.
- Effective oral presentations.

COURSE CONTENTS

UNIT I

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing. Speech drills, pronunciation and ascent, stress and intonation.

UNIT II

Writing Skills; Selection of topic, thesis statement, developing the thesis, introductory, developmental, transitional and concluding paragraphs. Articles, parts of speech, tenses, sentence structure, subject- verb agreement, punctuation.

UNIT III

Use of dictionary. Use of words: Diminutives, Homonyms and Homophones. Linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

UNIT IV

Effective writing skills, avoiding common errors. Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, writing assignments.

UNIT V

Purpose and scope of Report, Memo, Agenda and Minutes. Notice, Letters; types and minutes, Manuals.

SUGGESTED READINGS

1. M. Frank. Writing as thinking: A guided process approach, Englewood Cliffs, Prentice Hall Reagents.
2. L. Hamp-Lyons and B. Heasely: Study Writing; A course in written English. For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: A comprehensive grammar of the English language, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: "Technical Report Writing Today" - Biztaantra.

Additional Reference Books

5. Daniel G. Riordan, Steven E. Pauley, Biztantra (2004).: Technical Report Writing Today, 8th edition.
6. Contemporary Business Communication, Scot Ober, Biztantra, 5th Edition (2004).

FIRST SEMESTER

Course Code UMBE 102: FUNDAMENTALS OF STATISTICS

THEORY

UNIT I

Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.

UNIT II

Intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

UNIT III

Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

UNIT IV

Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

UNIT V

Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probability and basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance. Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)

3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

Note: It is desirable that softwares should be used for demonstrating visual, graphical and application oriented approaches.

SECOND SEMESTER
Course Code UMB 201:BACTERIOLOGY

Course Objectives: The main objective of this course is to provide in-depth knowledge of bacterial cell structure, its cultivation, growth and reproduction. Further, it gives insight into bacterial diversity and its significance. It will also give hands on training of basic and very important bacteriological techniques which will give the student a strong base in microbiology.

Course learning Outcomes: Upon successful completion of the course, the student:

Will gain knowledge about morphology, structure and organisation of different cell components and be able to differentiate between cell walls of Gram positive and Gram-negative bacteria, cell walls and cell membranes of archaea and eubacteria. Will also be able to explain gram and acid-fast staining reactions and effect of antibiotics and enzymes on cell wall structure.

Will get familiar with various techniques used for isolation, cultivation and preservation of different types of bacterial cultures. Will gain insight into working and importance of compound microscope.

Will understand nutritional requirements of different types of bacteria and formulation of media for bacterial growth.

Will be able to briefly explain methods of asexual reproduction in bacteria. Will understand different phases of growth curve and be able to define generation time and growth rate.

Can define and differentiate various types of classifications. Will gain insight into techniques used in polyphasic bacterial taxonomy.

Will get acquainted with differences between archaea and eubacteria and can list their important general characteristics along with ecological significance and economic importance.

COURSE CONTENTS

UNIT I

Cell organization

The morphology and fine structure of bacteria. Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.Cell-wall: Composition and detailed structure of gram positive and gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids

Endospore: Structure, formation, stages of sporulation.

UNIT II

Cultivation of Bacteria

Types of growth media (natural, synthetic, complex, enriched, selective media), Anaerobes (Thioglycolate & Anaerobic chamber), liquid shake culture of aerobic bacteria.

Growth and nutrition Definitions- photoautotrophs, photohetrotrophs, chemoautotrophs, chemohetrotrophs, prototrophs and auxotrophs; Nutritional categories among microorganisms Nutritional requirements in bacteria and nutritional categories; The requirements

for carbon, nitrogen and sulphur, growth factors, the role oxygen, Continous cultures, their applications, chemostats and turbidostats.

Reproduction in Bacteria

Definitions- Diauxie growth, synchronous growth, generation time and specific rate growth. Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

UNIT III

Bacterial Systematics

Definitions-Nomenclature, Taxon, identification, phylogenetic, isolate, strain and clone.

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria

UNIT IV

Important archaeal groups

According to Bergey's Manual of Systematic Bacteriology (Second Edition)

Archaebacteria: General characteristics, phylogenetic overview and economic importance of following group belonging to Methanogens, Halophiles and Thermoacidophiles.

UNIT V

Important eubacterial groups

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative:

• **Alpha proteobacteria**

Rickettsia, Coxiella, Rhizobium,

• **Beta proteobacteria**

Neisseria, Burkholderia

• **Gamma proteobacteria**

Enterobacteriaceae family, Pseudomonas

• **Delta proteobacteria**

Myxococcus

• **Epsilon proteobacteria**

Helicobacter, Campylobacter

Gram Positive:

• Low G+ C (Firmicutes)

Mycoplasmas, Clostridium, Lactobacillus, Staphylococcus, Streptococcus, Bacillus.

• High G+C (Actinobacteria)

Arthrobacter, Corynebacterium, Mycobacterium, Streptomyces

PRACTICALS

1. Introduction to light microscope
2. Preparation of different media: synthetic media BG-11, Complex media-nutrient agar, McConkey agar, EMB agar.
3. Simple staining
4. Negative staining

5. Gram's staining
6. Acid fast staining-permanent slide only.
7. Capsule staining
8. Spore staining.
9. Isolation of pure cultures of bacteria by streaking method.
10. Estimation of CFU count by spread plate method.
11. Motility by hanging drop method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2006). Brock Biology of Micro-organisms. 8th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and 9. Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SECOND SEMESTER

Course Code UMB 202: MEDICAL MICROBIOLOGY

Course Objectives: The major objective of this course is to introduce and acquaint the students with the key aspects of medical microbiology related to the diverse microbial pathogens, their virulence mechanisms, diagnostic methods and brief outline of the functional aspects of antimicrobial chemotherapy. The paper deals with the recent development of new molecular diagnostic methods and the global spread and re-emergence of infectious diseases.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have understood the diverse nature of the normal microflora of the body and its significance as well. Student will have also acquainted themselves with the terminology and scientific nomenclature used in describing disease causation and pathogenic features of microbial agents of disease.
- Will have gained an in depth knowledge about the spectrum of diseases caused by bacterial pathogens, and an understanding of the course of disease development and accompanying symptoms. Will become familiar with the methods of transmission, epidemiological aspects as well as prevention and control methods.
- Will become acquainted with the spectrum of diseases caused by viral pathogens. Also will understand the course of disease development and symptoms seen in diseases of different organ systems.
- Will understand the causation of fungal and protozoal diseases and methods of prevention and control.
- Will learn about the current approaches to diagnosis of diseases.

- Will have learnt basic concepts of handling clinical specimens and approaches used to aid in detection/diagnosis of diseases using immunological and molecular biology based methods. Will also understand the mode of action of different antimicrobial agents and concept of antimicrobial resistance.

COURSE CONTENTS:

UNIT-I

Microbial Interactions with Human

Definitions-invasion, infection, pathogen, parasite, pathogenicity, toxigenicity, virulence, exotoxins, enterotoxins, endotoxins and neurotoxins.

Normal microbial population of healthy human body - Skin, mouth, upper respiratory tract, intestinal tract, urino-genital tract, eye.

Harmful Microbial Interactions with Human- Entry of pathogens into the host, types of pathogens, Mechanism of pathogenicity, colonization and growth, Virulence, Virulence factors – exotoxins, enterotoxins, endotoxins, neurotoxins. – avoidance of host defense mechanisms, damage to host cell, Host factors for infection and innate resistance to infection.

UNIT-2

Sample collection, transport and diagnosis

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

Infection- Sources of infection, method of transmission of infection, factors predisposing to microbial pathogenicity and types of infectious disease

Unit 3

Diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control)

Bacterial diseases - *Bacillus anthracis, Corynebacterium diphtheriae, Streptococcus pyogenes, Escherichia coli, Salmonella typhi and paratyphi.*

Viral diseases- Polio, Chicken pox, Herpes, Hepatitis, Rabies, Influenza.

Unit 4

Diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control)

Protozoan diseases- Malaria, Kala-azar, and Toxoplasmosis

Fungal diseases-Different types of mycoses with particular reference to Dermatomycoses and Opportunistic mycoses

UNIT 5 Chemical control of Pathogens

Definition and Classification of antibiotics on the basis of structure and mode of action. Assay of antibiotics, antibiotic spectrum .Naturally produced drugs. Antibiotics produced by bacteria, actinomycetes and fungi used in chemotherapy. Semisynthetic antibiotic. Sulfa drugs their use and mechanism of action. Naldixic acid, nitrofurans, isonicotinic hydrazide, metronidazole.

PRACTICALS

1. To identify pathogenic bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus)* based on cultural, morphological and biochemical characteristics,

Cultural characteristics on nutrient agar and in nutrient broth, Gram characteristic, motility, presence of endospore and capsule, IMViC, TSI, sugar fermentation, nitrate reduction, urease production, oxidase and catalase tests.

2. To study composition and use of important differential media for identification of pathogenic bacteria EMB agar, McConkey agar, TCBS agar and Salmonella-Shigella agar (any two).

3. To perform antibacterial testing by Kirby-Bauer method.

4. To study symptoms of the diseases with the help of photographs Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis, kaposi's sarcoma), dermatomycoses (ring worms), kala-azar

SUGGESTED READINGS

1. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.

4. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.

5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SECOND SEMESTER
Course Code UMB 203: CHEMISTRY

Course Objectives:

- To introduce the basic concepts and principles of general chemistry.
- To familiarize the students with principles, fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
- Students will be able to explore new areas of research in both chemistry and allied fields of microbiology.

Course Learning Outcomes:

1. The students will learn about the energy and electromagnetic spectrum.
2. The student shall learn the principle, theory and applications of UV Visible spectroscopy and Infrared spectroscopy.
3. The students will get knowledge in the field of Electrochemistry special in references with Electrochemical cell, Nerst equation Gibbs energy.
4. The students will learn general structure, configuration and properties of Carbohydrates, Amino acids, Proteins and Peptides.

COURSE CONTENTS

UNIT I

Energy and the electromagnetic spectrum.

Units (wavelength, wavenumber, frequency) and energy of radiation.

UV-Visible spectroscopy.

Theory of electronic spectroscopy. Types of electronic transitions. Allowed and forbidden transitions. Solvent effects on electronic transitions. Beer and Lambert law. Molar absorptivity. Components of UV-Visible spectrophotometer. Application of electronic spectroscopy to conjugated dienes, and α,β-unsaturated carbonyl compounds. Woodward and Fieser rules.

Infrared spectroscopy.

Molecular vibrations, and calculation of vibrational frequencies. Factors affecting vibrational frequency, Vibrational coupling, hydrogen bonding, electronic effects and bond angles. Components of IR spectrophotometer. Interpretation of IR spectra of model organic compounds.

UNIT II

Electrochemistry.

The electrochemical cell. Galvanic and electrolytic cells. Electrode potential and its measurement. Nernst equation. Measurement of equilibrium constant by Nernst equation. Gibbs energy of the reaction. Conductance of electrolytic solutions. Measurement of conductivity of ionic solutions. Molar conductivity. Kohlrausch law of independent migration of ions. Faraday laws of electrolysis.

UNIT III

Carbohydrates.

Classification and general properties of carbohydrates. Osazone formation with phenylhydrazine. Open chain and cyclic structures. Mutarotation. Ascending and descending of monosaccharides. Anomers and epimers. Determination of structure of glucose and fructose. Determination of ring size. Disaccharides and polysaccharides, and general ideas about the structure of sucrose, maltose, lactose, starch and cellulose.

UNIT IV

Amino acids.

Amino acids. General structures. Configuration of amino acids. The zwitter ion, isoelectric point and electrophoresis. Reactions of amino acids, acetylation, esterification and complexation. Ninhydrin test. Synthesis of amino acids by amination of α-haloacids, Gabriel synthesis and diethyl malonate synthesis.

UNIT V

Peptides and proteins.

The peptide bond. General idea about the structure of oxytocin. Primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of proteins by N-terminal (Edmann degradation using 1-fluoro-2,4-dinitrobenzene, and phenylisothiocyanate) and C-terminal (hydrazinolysis) methods. Peptides (up to 3 amino acids) synthesis by N-protection and C-activation methods. Merrifield solid-phase synthesis.

PRACTICAL

1. Interpretation of bands in the pre-recorded standard IR spectra of model organic compounds.
2. Separation of mixture of amino acids (2 or 3 components) by paper chromatography.

3. Preparation of thin layer plates, and separation of organic compounds (coloured and colourless).
4. Preparation of chromatographic column and separation of carotenoids and chlorophyll from spinach.
5. Identification of glucose, fructose, sucrose, lactose and starch by standard chemical tests.
6. Determination of glucose by the Fehling reaction (titration and spectrophotometric methods). Demonstration on the application of glucometer.

Suggested reference materials

1. Organic Spectroscopy, W. Kemp, ELBS, Hampshire, UK.
2. Spectroscopic methods in Organic Chemistry, D.H. Williams and I. Fleming, Tata McGraw-Hill, New Delhi.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.
6. Organic Chemistry, T.W.G. Solomons and C.B. Fryhle, Wiley India, New Delhi.

SECOND SEMESTER
Course Code UMBE201: BASICS OF COMPUTERS

Course Objective:

This is a skill based paper that introduces the students to the basics of computer operations

The student is imparted with knowledge on both hardware and software.

The student has a better understanding on the use of computers for various applications

Course Learning outcomes:

- The students shall learn about the introduction, basics, organization, types and preliminary knowledge of operating systems and system tools.
- Students will get the idea about data representation, networks terminologies, multimedia and its applications.
- Students will getgeneral awareness about the IT Act, system security and preliminary knowledge about the I-Tax, E banking and E reservations.

COURSE CONTENTS

UNIT I

Computer Fundamentals

Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices User Interface with the Operating System, System Tools

UNIT II

Data Representation

Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of bi

UNIT III

Networks terminology

Types of networks, router, **switch, server-client architecture**

Multimedia

Introduction, Characteristics, Elements, Applications

UNIT IV

Problem Solving

Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

UNIT V

General Awareness

IT Act, System Security (virus/firewall etc.) I-Tax, Reservations,Banking

PRACTICALS

1. Defined projects will be done by the students and evaluated by the instructor.
2. Document Preparation
3. Presentation Software
4. Familiarizing with the Operating System, Control Panel, Networking Configuration, Firewall setting
5. Spreadsheet Handing, Working with worksheets, Creating a spreadsheet, entering and formatting information, basic functions and formulas, creating charts, tables and graphs.

SUGGESTED READING

1. V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.
2. Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.
Reference manual for Open Office available at: http://www.openffice.org
Reference manual for Star Office available at: http://www.sun.com/software/staroffice/

SECOND SEMESTER
Course Code UMBE 202: BIOANALYTICAL TECHNIQUES

Course Objectives: The major objective of this paper is to develop understanding of the key concepts of basic as well as some advanced experimental techniques used across biological sciences, with a focus on principle and design of the instruments. This will enable the students to connect between theoretical concepts of these techniques and their immense biological applications in diverse fields.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have identified the principle components of a light microscope, fluorescence microscope, phase contrast microscope, confocal and electron microscope, simultaneously learning about their principles and practical applications in visualizing, identifying and measuring cell, its components and biomolecules. The student will be familiar with staining and preparation of samples for microscopy
- Will have gained an in-depth knowledge of principles and applications of paper chromatography, thin layer chromatography, gel filtration chromatography, ion- exchange chromatography, affinity chromatography, GC, HPLC. This enables the students to apply the acquired knowledge in isolation and separation of biomolecules for analysis.
- Will have learnt basic concepts of various techniques used to resolve and analyze nucleic acids and proteins - agarose gel electrophoresis, native polyacrylamide gel electrophoresis, SDSpolyacrylamide gel electrophoresis, isoelectric focusing, 2D gel electrophoresis, zymogram preparation.
- as well as be able to understand absorption spectra of biomolecules, and will be able to interpret UVvisible and fluorescence spectroscopy outputs.
- Will have clear fundamentals of centrifugation, RCF, sedimentation coefficient, different types of rotors used, principle and working of differential and density gradient centrifugation, preparative and analytical scales of centrifuge, and the specific uses of ultracentrifuge. Students will also be acquainted with limitations of each method.
- Will be introduced to the concepts of advanced techniques like flow cytometry, circular dichroism, surface plasmon resonance and mass spectrometry. Students will also appreciate the applications of these techniques and recent developments that have come about due to these advanced techniques.

COURSE CONTENTS:

Unit- I

Instruments, basic principles and usage:

pH meter- working of pH meter, Types of electrodes,

Centrifuge- Theory of centrifugation, Types of centrifugation, Density gradient centrifugation, Types of centrifuge.

Unit- II

Instruments, basic principles and usage:

Spectrophotometers- Laws of absorption and emission, Visible and UV, IR, Atomic absorption, NMR, X-Ray crystallography.

Unit- III

Chromatography- Paper chromatography, thin layer chromatography, Basic principle of column chromatography, gel filtration, ion exchange chromatography, affinity chromatography, Gas chromatography and its application.

Unit- IV

Electrophoresis – SDS-Polyacrlamide Gel electrophoresis, Agarose Gel electrophoresis, Immuno electrophoresis, Iso electric focusing, MALDI-TOF, ESI.

Unit- V

Radioisotope tracer technique- Introduction, Radioisotopes and Radioactivity, Types of Radioactivity, Isotopic labeling, Autoradiography, Detection and measurement of radioactivity, scintillation counting.

Suggested reading

• Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
• Bioinstrumentation, Webster
• Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
• Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press
• Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.
• NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.
• Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.
• Principles and Practice of Bioanalysis, Richard F. Venn
• Microscopic Techniques in Biotechnology, Michael Hoppert
• Principles of Fermentation Technology, P.F. Stanbury, A. Whitaker, S.J. Hall

THIRD SEMESTER
Course Code UMB 301: CELL BIOLOGY-I

Course Objectives: The major objective of this course is to educate students about the fundamental concepts in eukaryotic cell biology. The students will be taught the latest developments in cell communication, regulation of cell cycle, and modern tools used to study cell biology. Advances in cancer biology including etiology, diagnosis and therapeutics, as well as the basics of stem cell technology and its applications will be covered.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have gained knowledge about features of the cell wall, plasma membrane, cell transport mechanisms and cytoskeleton.

- Will be able to understand the structures and functions of the nucleus and different cell organelles. The structural organization and function roles of chromatin will be learnt.
- Will have understood the mechanisms of protein sorting, intracellular trafficking, protein export.
- Will have gathered understanding of how cells perceive and respond to various signals from within and outside.
- Will have learnt the mechanisms of cell division and the significance of cell cycle and its regulation. Will become familiar with stem cell technology and its applications.
- Will understand the basics of cancer biology including diagnostic techniques and therapy.

COURSE CONTENTS

Unit- I

An Overview of cells: Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Viroids, *Mycoplasma* and *Escherichia coli*:

Unit- II

Composition of cells: Molecules of cells, cell membranes, cell proteins; The Nucleus: Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, transport across Nuclear Envelope. Chromatin: Molecular organization, Nucleolus and rRNA Processing.

Unit- III

Mitochondria, chloroplasts and peroxisomes: Structural organization, Function; Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisome assembly.

Unit- IV

The Endoplasmic reticulum, the Golgi apparatus, Mechanism of vesicular transport, Lysosomes, Cytoskeleton and cell movement, Structure and organization of actin filaments; actin, myosin and cell movement.

Unit- V

Transport process: cell membrane models of membrane structure, membrane proteins and their properties, membrane carbohydrates and their role. Transport across membrane active and passive diffusion, their mechanism.

PRACTICALS

1. Separation of nucleic acid bases by paper chromatography.
2. Microscopy- Theoretical knowledge of Light and Electron microscope.
3. Study of the following techniques through electron / photo micrographs: Fluorescence microscopy,
autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting.

4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

5. Cytochemical staining of DNA-Feulgen.
6. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
7. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
8. Cytochemical staining of Total proteins- Bromophenol blue.
9. Cytochemical staining of Histones -Fast Green.

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

THIRD SEMESTER

Course Code UMB 302: PHYCOLOGY & MYCOLOGY

Course learning outcomes: By the completion of this course the students able to-

- Describe useful and harmful activities of fungi and algae.
- Identify commonly available fungi and algae and their characteristics.
- Discuss how fungi and algae are used as biofertilizers in agriculture and as biopesticides.
- Grow mushroom in the laboratory**.**

Section A: Phycology

UNIT I

Occurrence, Classification and Life cycles of Algae

Study of the following classes with reference to taxonomic groups listed below (occurrence, classification and life cycles):

Rhodophycota; Xanthophycota; Chrysophycota; Phaephycota; Bacillariophycota; Euglenophycota; Chlorophycota; Cryptophycota; Pyrrophycota

UNIT II

General characteristics of Algae

Morphology, algal pigments, motility, reproduction and economic importance (agriculture, biofertilizer, Industrial application of algae, medicinal importance, Nutritional value, environmental implications, algal blooms)

Section B: Mycology

UNIT III

Occurrence, Classification and Life cycles of fungi

Recent advances in fungal classification, General Characteristic, morphology, Ultrastructure, Physiology, Reproduction- asexual and sexual.

UNIT IV

Study of the following classes with reference to the genera listed below (occurrence, classification and life cycles):

a) Chytridiomycetes- Synchytrium
b) Oomycetes- Saprolegnia
c) Zygomycetes- Mucor, Rhizopus
d) Ascomycetes- Schizosaccharomyces, *Saccharomyces*, *Penicillium*, *Neurospora*
e) Deuteromycetes - *Candida*, *Alternaria*, *Aspergillus*
f) Basidiomycetes – *Agaricus*

UNIT V

Molds and their association with other organisms- Lichens, fungi and nematodes, fungi as parasites of insects , mycorrhiza.

Economic importance of fungi with examples in Agriculture, Environment, Industry, Medicine, Food, Biodeterioration (of wood, paper, textile, leather), Mycotoxins (Ch 1 Alexopoulos et al., Ch 5 Sumbali) (6 periods) Lichens: classification, physiology and importance. (Ch 13 Alexopoulos et al., Ch 5 Sumbali) (2 periods)

PRACTICALS

Section A - Phycology

1. Study of the following genera through temporary and permanent slides:

1. Volvox, Coleochaete, Vaucheria, Ectocarpus, Polysiphonia and Nostoc

2. Section B - Mycology

3. Preparation of Potato Dextrose Medium

4. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus and Alternaria*

SUGGESTED READINGS

Section A - Phycology

1. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group, New York.

2. Graham LE, Graham JM and Wilcox LW. (2009). Algae. 2nd edition. Benjamin Cumming, New York.

3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.

4. Kumar HD. (1995). The Text Book on Algae. 4th edition. Affiliated East Western Press.

5. Lee RE. (1999). Phycology. 4th edition. Cambridge Press.

6. Sharma OP. (2005). Textbook of Algae. Tata McGraw Hill Publishing Co. Ltd.

7. Vashishta BR. (2005). Algae. 3rd edition. S. Chand and Company Ltd., New Delhi.

Section B - Mycology

1. Alexopoulos CJ, Mims CW and Blackwell M. (1996). Introductory Mycology. 4th edition. John Wiley and Sons, Inc.
2. DUMBE HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
3. Sumbali G. (2005). The Fungi. 1st edition. Narosa Publishing India House.
4. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
5. Webster J. (1980). Introduction to Fungi. 2nd edition. Cambridge University Press.

THIRD SEMESTER
Course Code UMB 303:VIROLOGY

Course Objectives: The major objective of this course is to acquaint students with the structure of viruses of plants, animals, and bacteria, their genome organization, and replication strategies within the host cell. The student will learn how they evolve, spread and cause disease, and prevention and control methods for the same. The course also includes description of oncogenic viruses and their role in cancers, and emerging viruses in context of threat to public health and their management.

Course Learning Outcomes: Upon successful completion of the course the student

- will have acquired the knowledge in the following areas and:
- Will be able to describe the nature, properties and structure of viruses and will also gain knowledge of taxonomy of different groups of viruses.
- Will be familiar with diversity and multiplication of lytic and lysogenic bacteriophages.
- Will be able to describe different ways of viral transmission, and prominent and unusual genomic features of different viruses with their significance.
- Will understand about the replication strategies, maturation and release of important plant, animal and bacterial viruses.
- Will have gained knowledge about strategies to prevent viral infections: interferons, vaccines and antiviral compounds
- Will understand the concept of oncogenesis, DNA and RNA cancer causing viruses and will learn of newly emerging viruses which have the potential to cause serious threats to public health and have become a global concern.

COURSE CONTENTS

UNIT I Introduction

Definition- viroids, virusoids, satellite viruses and prions. Discovery of viruses, nature and definition of viruses, general properties of viruses - Detection of viruses and antigens in clinical specimens - Serological diagnosis of virus infections. Structure of viruses: Capsid symmetry, enveloped and non-enveloped viruses

Cultivation of viruses. Structure & properties of viroids, prions.

UNIT II

Isolation, purification and cultivation of viruses. Classification and nomenclature of different groups of viruses infecting microbes, plants and animals.

UNIT III

Salient features of viral genome:

Unusual bases (TMV, T4 phage), overlapping genes (ΦX174, Hepatitis B virus), alternate splicing (Picornavirus), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), ambisense genomes (arenavirus), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (influenza virus) and non segmented genomes (picornavirus), capping and tailing (TMV).

UNIT IV

Bacteriophages)

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda and P1 phage), concept of early and late proteins, regulation of transcription in lambda phage and applications of bacteriophages.

UNIT V

Viral multiplication and replication strategies

Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification. Assembly, maturation and release of virions. Concept of defective particles.

PRACTICALS

1. To study structure of important animal viruses (rhabdo, influenza, paramyxo, Hepatitis B & retroviruses) using electron micrographs
2. To study structure of important plant viruses (caulimo, gemini, tobacco ring spot, cucumber mosaic & alpha-alpha mosaic viruses) using electron micrographs
3. To study structure of important bacterial viruses (λ, T4 & φX174) using electron micrographs.
4. Isolation and enumeration of bacteriophages from water/sewage sample using double agar layer technique
5. Isolation and propagation of animal viruses by cell culture and chick embryo techniques
6. Study of cytopathic effects using photographs
7. To perform local lesion technique for assaying plant viruses

SUGGESTED READINGS

1. Dimmock NJ, and Primrose SB. (1994). Introduction to Modern Virology. 4th edition. Blackwell Science Ltd.
2. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition (First Indian reprint 2007), Blackwell Publishing Ltd.
3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
4. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
5. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
6. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
7. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
8. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
9. Bos L. 1999 Plant viruses-A text book of plant virology by. Backhuys Publishers.
10. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

THIRD SEMESTER
Course Code UMBE 301: MOLECULAR BIOLOGY-I

Course Objectives: The major objective of this course is to develop a clear understanding of the basic concepts of molecular biology starting from the structure and function of DNA to its replication. The student will become familiar with the central dogma of molecular biology, and will learn about the conversion of information from DNA to RNA to proteins, by the study of transcriptional and translational processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be acquainted with the structure of various types of DNA and RNA as well as their organization as genetic material in various living organisms.
- Will gain an in-depth knowledge of DNA replication mechanisms in prokaryotes and eukaryotes, enzymes and proteins involved in replication.
- Will have learnt the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved. Will be able to distinguish between the process in prokaryotes versus eukaryotes.
- Will understand the concept of split genes, introns, exons, spliceosomes and alternative splicing besides learning about other processing events like polyadenylation and capping. Will become familiar with RNA interference and its significance, siRNA and miRNA.
- Will get a clear understanding of translational mechanisms in both prokaryotes and eukaryotes along with the inhibitors of protein synthesis.
- Will understand various mechanisms involved in regulation of gene expression in prokaryotes and eukaryotes at the level of transcription, post-transcriptional processes, and modifications in chromatin structure

COURSE CONTENTS

UNIT I.

Nucleic Acids convey Genetic Information

DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

UNIT II

The Structures of DNA and RNA / Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA -- mitochondria and chloroplast DNA.

UNIT III

I. Genome Structure, Chromatin and the Nucleosome

Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes

UNIT IV

The Replication of DNA (Prokaryotes and Eukaryotes)

Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous, RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

UNIT V. The Mutability and Repair of DNA

Definitions, Mutation, muton, replicon, principles of mutation, Replication Errors, DNA Damage, different types of mutations, deletions, duplications, UV induced mutations, repair mechanisms against mutations and their importance.

PRACTICALS

1. Preparation of Polytene chromosome from Chironomous larva/Drosophila larva
2. Demonstration of mammalian sex chromatin.
3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).
4. Perform Southern Blot Hybridization (Restrict DNA for Southern Blot electrophoresis, perform electrophoresis of restricted DNA, perform southern transfer, hybridization and detection of gene of interest)
5. Demonstration of Northern Blotting.
6. Demonstration of Western Blotting.
7. Perform DNA amplification by PCR.
8. Study of semiconservative replication of DNA through micrographs/schematic representations.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

THIRD SEMESTER

Course Code UMBE 302: RECOMBINANT DNA TECHNOLOGY

Course Objectives: The main objective of this paper is to ensure that the student develops a clear comprehension of the concepts of recombinant DNA technology. The student will get acquainted with the tools and techniques used such as the enzymes, vectors, and cloning methods that can be used, and the applications of cloning such as creation of DNA libraries and recombinant products.

A final exercise on a suitable strategy towards developing a genetically modified crop is incorporated to empower the student to apply the knowledge gained**.**

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will get an overview of developments and contributions of scientists in the field of genetic engineering.
- Will get familiarized with basic cloning tools such as enzymes used to manipulate DNA, and cloning vectors.
- Will have learnt various gene delivery methods and basic essential techniques of DNA, RNA and protein analysis.
- Will gather in-depth knowledge of DNA amplification and sequencing methods.
- Will become conversant with construction and screening of genomic and cDNA libraries
- Will become aware of the applied aspects of all major techniques being used for the benefit of humankind in the areas of agriculture and pharmaceuticals. Students will design a strategy outlining all the steps of developing a novel recombinant.

COURSE CONTENTS:

UNIT I

Introduction to basic biotechnology

Milestones in genetic engineering and biotechnology

Tools of recombinant DNA technology

A. Hosts

E. coli strains; Yeast (*Saccharomyces cerevisiae, Pichia pastoris*); Fungi (*Penicillium, Aspergillus*); Mammalian cell lines - names and genotypes

B. Enzymes

Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, BAL31, mung bean nuclease, S1 nuclease

C. Vectors

Cloning Vectors- Definition and Properties. Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, MACs.

D. Mammalian Expression Vectors

SV40, Vaccinia, Retroviral promoter based vectors

UNIT II

Basic DNA Cloning

Simple cloning of DNA fragments, Vectors: Definition and properties. E. coli expression vectors-lac, tac and T7 promoter based vectors. Yeast expression vectors - pET yeast vectors, YIp, YEp and YCp vectors.

Baculovirus based vectors. Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation

Methods of gene delivery in plants and animals

Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery.

UNIT III

Methods of DNA, RNA and Protein analysis and DNA typing

Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display

Amplification of nucleic acids

Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction

UNIT IV

Construction of Genomic and cDNA libraries

Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony, PCR

DNA sequencing and synthesis

Maxam-Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project

UNIT V

Product of DNA technology

Human protein replacements-insulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal, Analysis of biological processes, DNA typing, gene therapy, commercial products.

PRACTICLAS

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
2. Ligation of DNA fragments.
3. Demonstration of PCR.
4. Interpretation of sequencing gel electropherograms.

SUGGESTED READINGS

1. Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press, USA.
2. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
3. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

4. Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM Press Washington D.C.
5. Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill, India.
6. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
7. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008) Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

FOURTH SEMESTER

Course Code UMB 401: MICROBIAL PHYSIOLOGY AND METABOLISM

Course Objectives: The main objective of this course is to give students a comprehensive insight into various aspects of microbial physiology and metabolism. These include transport mechanisms present in microbes for the uptake of nutrients, bacterial growth and factors affecting it, and diverse metabolic pathways existing in microbes for energy production and carbon and nitrogen assimilation. The course will build the strong foundation needed by the students for further studies in the field of microbiology.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have got acquainted with the diverse physiological groups of bacteria/archaea and microbial transport systems.
- Will have an in-depth knowledge of patterns of bacterial growth, bacterial growth curve, calculation of generation time and specific growth rate, and effect of the environment on growth.
- Will understand the variety of pathways used by bacteria for energy generation and conservation during growth on glucose under aerobic and anaerobic conditions.
- Will become conversant with two important fermentation pathways in microbes.
- Will have an added knowledge on the groups and families of chemolithotrophs and phototrophs, based on their ability to extract energy from inorganic compounds and assimilate carbon from CO2.
- Will have learnt about a typical capability of prokaryotes to reduce nitrogen gas to ammonia. Will become familiar with the physiology of nitrogen fixation and assimilation of inorganic nitrogen by bacteria.

COURSE CONTENTS

UNIT I

Microbial Growth

Definition of growth, generation time and specific growth rate. Growth curve, mathematics expression of growth, batch and continuous culture, synchronous growth, diauxie growth curve. Effect of the environmental factors-pH, temperature, osmotic pressure, oxygen and radiation on microbial growth

Nutritional classification of microorganisms based on carbon, energy and electron sources

UNIT II

Metabolite Transport

Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

Temperature- temperature ranges for MICROBIAL growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure.

UNIT III

Chemolithotrophic metabolism

Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens. Phototrophic metabolism

Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Calvin cycle and reductive TCA cycle.

UNIT IV

Enzymes and their regulation

Importance, structure and classification of enzymes. Apoenzyme and cofactors. Mechanism of enzyme action. Activation energy, Lock and key hypothesis, induced fit. Enzyme kinetics and inhibition. Substrate saturation curve, Michaelis-Menten kinetics, Irreversible and reversible inhibition: competitive and non-competitive inhibition. Enzyme regulation. Synthesis: introduction of enzyme induction and repression. Activity: allostery, covalent modification and feedback inhibition.

UNIT V

Microbial Energetics

Concept of aerobic respiration, anaerobic respiration and fermentation. Central metabolic pathways: EMP pathway, ED pathway, PP pathway, and TCA cycle. Components of respiratory chain, and their inhibitors. Oxidative phosphorylation: ATP synthesis and ATP synthase. Uncouplers, inhibitors and ionophores. Chemical coupling, conformational coupling and chemiosmotic hypothesis.

PRACTICALS

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

SUGGESTED READINGS

1. Devlin RM. (1975). Plant Physiology. 3rd edition, Willard Grant Press.
2. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
3. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms. 10th edition. Pearson/Benjamin Cummings.

4. Moat AG and Foster JW. (2002). MICROBIAL Physiology. 4th edition. John Wiley & Sons.
5. Reddy SR and Reddy SM. (2005). MICROBIAL Physiology. Scientific Publishers India.
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
8 Atlas RM. (1989). Microbiology: Fundamentals and Applications. 2nd Edition, MacMillan Publishing Company, New York.
9. Conn EE and Stumpf PK. (1976). Outlines of Biochemistry. John Wiley & Sons.
10. Gallon JR and Chaplin AE. (1987). An Introduction to Nitrogen Fixation. Cassell Education Ltd.
11. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
12. Lehninger A. (1982). Biochemistry. Worth Publ.
13. Moat AG and Foster JW. (2002). MICROBIAL Physiology. John Wiley and Sons.
15. Stryer L. (1988). Biochemistry. Freeman & Co. NewYork.

FOURTH SEMESTER
Course Code UMB-402: GENETICS AND GENOMICS-I

Course Objectives: The major objective of this course is to develop clear understanding of various aspects of microbial genetics and genomes in relation to microbial survival and propagation and to enable students to better understand courses taught later such as recombinant DNA technology and other allied papers.

Course Learning Outcomes: Upon successful completion of the course, the student will have

- Knowledge of Genetic material and genetic recombination.
- Understanding the stages of gene expression: phenomena of cell division.
- Improved understanding of mutation and mutagens.
- Applying the Mendelian principles and its extensions to solve genetic problems

COURSE CONTENTS

UNIT I

Introduction to Genetics

Definition: gene, genome, trait, genetic material, genetic maps, genotype, phenotype. Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Mitosis and Meiosis

Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

UNIT II

The structure of genetic material

The nature of the genetic material, Discovery of DNA and RNA as genetic material, the chemical composition of DNA and RNA, Organization of DNA in chromosomes, Structural characteristics of bacterial and viral chromosomes, DNA replication in prokaryotes and Eukaryotes.

UNIT III

Mendelian Genetics and its Extension

Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.

UNIT IV Mutations

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

UNIT V. Extrachromosomal Inheritance

Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity- Kappa particles in Paramecium.

Quantitative Genetics

Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

PRACTICALS

1. Mendelian laws and gene interaction using Drosophila crosses.
2. Chi-square and probability.
3. Study of Linkage, recombination, gene mapping using marker based data from Drosophila.
4. Study of Human and Phlox/ Allium Karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.
6. Study of Hardy-Weinberg Law using simulations (seeds).

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.

ADDITIONAL READINGS

Both students as well as teachers of genetics can further benefit from knowledge of following topics as given below-

- **Epigenetics-** http://www.nature.com/nrg/focus/epigenetics/index.html
- **Tetrad Analysis in fungi**
- **Centromere Mapping**
- **Cytogenetic Mapping**

FOURTH SEMESTER
Course Code UMB 403: CELL BIOLOGY-II

Course Objective- Provide understanding of regulation of cellular processes, cell signaling and proliferation.

Course Learning Outcomes:-

- Understanding of processes that control eukaryotic cell cycle, cell division and cell death.
- Conceptualized the mechanisms of signal transduction and cell-cell interaction.
- Knowledge of stem cell and their therapeutic uses and limitations.
- Linking the rapid advances in cell biology for a better understanding of diseases like Cancer and its cytology

COURSE CONTENTS

UNIT I

The Plasma Membrane

Structure; Lipid composition and structural organization, classes of lipids, protein interaction within the membranes, trans-membrane proteins and glycolipids. Transport of small molecules, Endocytosis

Cell Wall, **the Extracellular Matrix and Cell Interactions**

Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions.

UNIT II

Cell Signaling

Signaling at the cell surface, Signaling molecules and their receptor; receptor proteins, ligand binding and effector specificity, functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks, conserved intracellular protein functions in signal transduction, appropriate cellular responses.

UNIT III

The Cell Cycle

Eukaryotic Cell Cycle-overview of the cell cycle and its control, Regulation of Cell cycle progression, diverse experimental systems for regulation of cell cycle, Events of Mitotic Phase, Meiosis, Biochemical studies with oocytes, eggs and early embryos.

UNIT IV

Cell Death and Cell Renewal

The birth of cells, cell type specification in yeast, regulation of asymmetric cell division, specification and differentiation of muscles, Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

UNIT V

Cancer

Tumor cells and the onset of cancer, Development and Causes of Cancer, the genetic basis of cancer, Oncogenic mutations in growth promoting proteins, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

PRACTICALS

1. To demonstrate the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
2. Study of polyploidy in Onion root tip by colchicine treatment.
3. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.
4. Study of mitosis and meiosis from permanent slides.
5. Identification and study of cancer cells- Slides/Photomicrographs.

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco

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FOURTH SEMESTER

Course Code UMBE 401: MOLECULAR BIOLOGY-II

Course Objectives - To impart knowledge about the protein synthesis and their mechanisms and regulation within the cell.

Course Learning outcomes –

- Study of RNA polymerase and mechanisms in prokaryotic and eukaryotic cell.
- Study of RNA modification, split genes, RNA splicing, m-RNA transport

- Translation process in prokaryotic and eukaryotic cell.
- Transcription regulation in prokaryotes and eukaryotes and regulatory RNAs.

COURSE CONTENTS

UNIT I.

Mechanism of Transcription

RNA Polymerase and the transcription unit, Transcription in Prokaryotes, Transcription in Eukaryotes

RNA Modifications

Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

UNIT II.

Translation (Prokaryotes and Eukaryotes)

Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependent regulation of mRNA and Protein Stability.

UNIT III

Transcription Regulation in Prokaryotes

Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, regulation of transcription termination.

UNIT IV

Transcription Regulation in Eukaryotes

Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing

UNIT V

Regulatory RNAs

Transcription Regulation in Eukaryotes & Regulatory RNAs: Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and Xinactivation

PRACTICALS

1. Preparation of culture medium (LB) for E.coli (both solid and liquid) and raise culture of *E.coli.*

2. Demonstration of antibiotic resistance. (Culture of E.coli containing plasmid (pUC 18/19) in LB medium with/without antibiotic pressure and interpretation of results).

3. Isolation and quantitative estimation of salmon sperm / calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).

4. To perform Ames test in Salmonella / E.coli to study mutagenicity.

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

FOURTH SEMESTER
Course Code UMBE 402: IMMUNOLOGY

Course Objectives: The major objective of this course is to develop a clear understanding about the host immune system and advances in the field of Immunology. The student will become familiar with the cells, tissues, and organs constituting the immune system and the various mechanisms used to defend host against microorganisms. The student will gain an understanding of the relationship between the immune system, pathogens and the development of immunity, and will learn how the inappropriate immune response can lead to allergy, autoimmunity and other consequences. The course will further the student's understanding of how advances in immunology have changed the face of modern medicine.

Course Learning Outcomes: Upon successful completion of the course, the student

- Will be acquainted with the emergence of immunology and how the immune system protects us from infection through various lines of defense.
- Will have gained an in-depth knowledge of characteristics and functions of the cells of the immune system and the organization of organs of the immune system.
- Can understand the characteristics that make the molecules to act as antigens. The students will also be conversant with the types, properties and functions of antibodies made against the antigens. Will be able to outline the production and use of monoclonal antibodies
- Will understand the cell surface proteins essential for generation of acquired immune response to differentiate self and non-self molecules and the pathways for antigen processing and presentation.
- Will be acquainted with the mechanisms by which the complement system is recruited and enhances (complements) the ability of antibodies and phagocytic cells to clear microbes and damaged cells from an organism, promotes inflammation, and attacks the pathogen's cell membranes.
- Will be acquainted with the generation and the killing mechanisms of humoral and cell mediated immunity. Will have gained in depth knowledge of various immunological techniques. Will be able to outline the immunodeficiency disorders like autoimmunity and hypersensitivity.

COURSE CONTENTS

UNIT I

Introduction

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa.

UNIT II

Immune Cells and Organs

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Antigens

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Antibodies**)**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic,

allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

UNIT III

Major Histocompatibility Complex

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Complement System

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation

UNIT IV

Generation of Immune Response

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Costimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance.

UNIT V

Immunological Disorders and Tumor Immunity

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens.

Immunological Techniques

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR.

PRACTICALS

1. Identification of human blood groups.
2. To perform Total Leukocyte Count of the given blood sample.
3. To perform Differential Leukocyte Count of the given blood sample.
4. To separate serum from the blood sample (demonstration).
5. To perform immunodiffusion by Ouchterlony method.
6. To perform DOT ELISA.
7. To perform immunoelectrophoresis.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

FIFTH SEMESTER

Course Code UMB 501: FOOD AND DAIRY MICROBIOLOGY

Course Objectives: The main objective of this paper is to acquaint students with the role of microorganisms in association with foods, highlighting both their beneficial and harmful activities and their applications in the food industry.

Course Learning Outcomes: On successful completion of the course, the student:

- Will be aware of the possible sources of contamination of foods and the parameters affecting microbial growth in foods.
- Will gain insight into the microbial spoilage of some foods
- Will acquire an in-depth knowledge of various physical and chemical methods used for food preservation. Will be acquainted with microbial production of fermented dairy and non-dairy food products. Will also be able to understand the health benefits of prebiotics, probiotics and synbiotics.
- Will be conversant with some food-borne diseases and will be able to explain methods for detection of food borne pathogens
- Will be able to understand the concept of quality control of food.

UNIT I

Foods as a substrate for microorganisms

Basic concepts and scope of food and dairy microbiology, Study of primary sources of microorganisms in foods,Effect of intrinsic (pH, moisture content) and extrinsic (temperature and relative humidity) factors on microbial growth in various foods.

UNIT II

Microbial Spoilage of foods

Principle, Sources and mechanism of microbiological food spoilage, Study of spoiled fruits, vegetable, bread and eggs, Study of spoilage of milk for acid, gas and proteolysis.

UNIT III

Principles and Methods of food Preservation

Physical (Temperature- pasteurization, , high temperatures, low temperature-freezing, dehydration; appertization, aseptic packaging, ionizing radiation, osmotic pressure) and chemical methods (organic acids, esters, sulphur- dioxide, nitrate, nitrites, salts and high sugar concentration). Comparison of shelf life of pasteurized, UHT milk, raw milk both at low and room temperature, Aseptic packaging – layers of tetra packs and comparison of shelf life of such packaged fruit juices, Study of specimens of various canned foods (vegetables, fruits, pickles etc) and treatments given to them for preservation.

UNIT IV

Microbiology and Process of Fermented Foods

Microbiology of milk, Cheese, Yogurt (curd), Idli, Fermented Food (dosa, sauerkraut, soy sauce and tampeh) Use of starter cultures and preparation of Dahi, To perform various tests such as pH and titratable acidity of various fermented milk products (yogurt) & Probiotic drinks available in the market

UNIT V

Food-Borne Diseases

A brief account on common food–borne diseases (Laboratory testing- causative agents, symptoms, food involved, preventing measures)

Study of food intoxications: *Staphylococcus aureus, Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonella and Shigella*

Food sanitation and control

HACCP, Indices of food sanitary quality and sanitizers

Water Potability

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

PRACTICALS

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any pathogenic bacteria (Staphylococcus or Salmonella) from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

7. Determination of potability and faecal contamination of water samples by presumptive test/MPN test, confirmed and completed tests.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). AntiMICROBIALs in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural AntiMICROBIAL Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The MICROBiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

FIFTH SEMESTER
Course Code UMB 502: MICROBIAL ECOLOGY

Course Objectives: The objective of this paper is to make the students aware of the diverse microbial populations present in different habitats and interaction amongst them. They would also gain knowledge of the nutrient cycling occurring in the ecosystem(s). The students would learn about environmental problems and their management and will motivate them to think of novel ways to solve various environmental problems.

Course Learning Outcomes: After studying this course, the student:

- Will know about the diverse microbial populations present in various natural habitats (different types).
- Would understand the interaction of microbes with both micro and macro-organisms (plants and animals).
- Would become aware of the importance of microbes in any ecosystem with reference to nutrient cycling/ biogeo-chemical cycling.
- Would become familiar with and gain knowledge about the various methods of waste treatment (solid and liquid) and management.
- Would become aware of the degradable properties of a microbial population present in a habitat/ecosystem
- Would gain knowledge of the methods used in testing the potability of water.

COURSE CONTENTS

UNIT I

History, significance and developments in the field of MICROBIAL ecology

Contributions of Beijerinck, Winogradsky, Kluyver, Van Niel, Martin Alexander, Selman A. Waksman, Environmental chemistry, Atmosphereic pollutants, Types of wastes, The Atmosphere, Organization of life, Ecosystems.

UNIT II

Microorganisms & their natural habitats

A. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora

B. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats

C. Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of microbes.

D. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.

E. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

UNIT III

Succession of microbial communities in the decomposition of plant organic matter

Biological Interactions

A. Microbe–Microbe Interactions

Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents

B. Microbe–Plant Interactions

Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic - biofertilizers)

C. Microbe–Animal Interactions

Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont

UNIT IV

Biogeochemical cycles an introduction (Ch 10, 11 Atlas and Bartha)

Carbon cycle:

Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin)

Nitrogen cycle:

Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution.

Phosphorous cycle:

Phosphate immobilization and phosphate solubilization

Sulphur Cycle:

Microbes involved in sulphur cycle

UNIT V

Solid Waste Management

Sources and types of solid waste, methods of disposal of solid waste (incineration, composting, sanitary landfill)

Liquid Waste Management

Composition of sewage; strength of sewage (BOD and COD); Primary, secondary (aerobic – oxidation pond, trickling filter, rotating biological contractor/biodisc system, activated sludge process and anaerobic – septic tank, imhoff tank, anaerobic digestor) and tertiary sewage treatment

Bioleaching

Biodeterioration

MICROBIAL deterioration of metals (corrosion), textile and paper

PRACTICALS

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC)
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Detection (qualitative) of the presence of enzymes (dehydrogenase, amylase, urease) in soil.
5. Isolation of *Rhizobium* from root nodules of legumes
6. Isolation of *Azotobacter/Azospirillum* from soil
7. Isolation of phosphate solubilizers from soil

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Atlas RM. (1989). Microbiology: Fundamentals and Applications. 2nd Edition, MacMillan Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/ Benjamin Cummings.
4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
6. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in MICROBIAL Ecology. Blackwell Scientific Publication, U.K.
7. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
8. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
9. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
10. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

FIFTH SEMESTER

Course Code UMB 503: INDUSTRIAL MICROBIOLOGY

Course Objectives: The major objective of this course is to acquaint students with the various aspects of industrial microbiology, different types of fermentation processes, fermenters designs and operations Students will become familiar with mass scale culturing of microorganisms for industrial production of various biomolecules and /metabolites of industrial interest and different recovery methods in detail. Students will also learn about immobilization of enzymes and their applications.

Course Learning Outcomes: Upon successful completion of the course the student:

Will understand the development and importance of industrial microbiology and will be conversant with different types of fermentation processes in liquid media as well as solid state substrates media.

- Will learn about the design, operation and uses of different types of fermenters of laboratory, pilot and industrial scale.
- Will gain insight into the techniques of isolation, screening, preservation and maintenance of industrially important microbial strains and different types of media used in fermentation processes.
- Will be acquainted with principles of techniques used for the extraction and purification of industrial products produced using microbial fermentation processes.
- Will have gained in-depth knowledge of the principles of microbial production and recovery of industrial products at large scale.
- Will have an understanding of the methods of enzyme immobilization, its advantages, drawbacks and its applications in the industry

COURSE CONTENTS

UNIT I

Introduction to industrial Microbiology

Brief history and developments in industrial Microbiology

Fermentation processes

Definition- Fermentation, respiration, oxidation, prototroph and auxotroph.

Fermenter – types & operation of Bioreactors, physico-chemical standards used in bioreactors, limitations of bioreactors, stages of fermentation processes, Solid substrate fermentation, Fermenters (Stirred tank, bubble columns, airlift). Submerged fermentation, advantages & disadvantages of solid substrate & liquid fermentations.

UNIT II

Control parameters, industrially important strains, media ingredients

Measurement and control of fermentation parameters

Control and monitoring of different parameters in a bioreactor; pH, temperature, dissolved oxygen, foaming and aeration

UNIT III

Isolation of industrially important MICROBIAL strains

Primary and secondary screening, strain development, preservation and maintenance of industrial strains and strain improvement by mutation of gene transfer.

Media and ingredients for industrial fermentations

Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

UNIT IV

Down-stream Processing

extraction, separation, concentration, recovery & purification, operations (organic acids, alcohol, enzymes and vitamins).

Up-stream and Down-stream processing- Industrial production of organic acids- Acetic Acid, Citric acid and lactic acid; alcohol- ethyl alcohol, wine and beer enzymes- α-amylase, protease; antibiotics- penicillin, tetracycline and vitamins- vitamin B12; bioinsecticides (Bt) and Steroid transformations with reference to easily available raw materials.

UNIT V

Enzyme immobilization

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

PRACTICALS

1. MICROBIAL fermentations for the production and estimation (qualitative and quantitative) of:

(a) Enzyme: Amylase

(b) Amino acid: Glutamic acid

(c) Organic acid: Citric acid

(d) Alcohol: Ethanol

(e) Antibiotic: Penicillin

2. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

FIFTH SEMESTER

Course Code UMBE 501: GENETICS AND GENOMICS II

Course Objective- This course aims to provide an insight and understanding on how connection between genes and genomes play a role in genetics and developmental biology.

Course Learning Outcomes:- Student will

- Conceptualize the mechanism of developmental biology and embryonic development of different model organism.
- Analyze and interpret biological and evolutionary problems in terms of genetics and genomics concepts.
- Knowledge of key processes involved in inheritance and expression of gene.

- Understand different biological database that provide information about protein and nucleic acid.

COURSE CONTENTS

UNIT I.

Genetic Analysis and Mapping in Bacteria and Bacteriophages

Conjugation; Transformation; Transduction, Recombination.

Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses

Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in Drosophila; Uses of transposons; Eukaryotic Viruses.

UNIT II

Developmental Genetics and Model System

Study of model systems in developmental genetics- *Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana,* and *Xenopus laevis.*

UNIT III

Genomics, Bioinformatics and Proteomics

Genomes of bacteria, Drosophila and Humans; Human genome project; Evolution and Comparative Genomics. Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification. Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

UNIT IV

Genomic Analysis- Dissection of Gene Function

Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology. Genetics of cancer, Oncogenes, Tumor suppressor genes, Mutator genes.

UNIT V

Population Genetics

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Evolutionary Genetics

Genetic variation and Speciation. Genetic variation in natural population. Changes in the genetic structure of the populations

PRACTICALS

1. Genomic DNA isolation from E.coli (without plasmid).
2. Restriction enzyme digestion of genomic DNA from E.coli.
3. Isolation of plasmid DNA and genomic DNA together from E.coli. and restriction enzyme digestion.
4. Restriction enzyme digestion (EcoRI) of genomic and plasmid DNA (obtained from Expt.3).

5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
6. Construction of Restriction digestion maps from data provided.
7. Demonstration of DNA fingerprinting.

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.
8. Ghosh, Z. and Mallick,V. (2008). Bioinformatics-Principles and Applications. Oxford Univ. Press

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FIFTH SEMESTER
Course Code UMBE 502: PLANT PATHOLOGY

Course Objectives: The main objective of this course is to provide in-depth knowledge of plant diseases, the causes, symptoms, and the biochemical and genetical aspects of host-pathogen interactions. The student will become conversant with various means by which plants can defend themselves and plant diseases can be controlled or prevented. This will enable the student to initiate studies in search of novel and ecofriendly means of disease control which would improve the quality and quantity of crops.

Course Learning Outcomes: Upon successful completion of the course, the student

- Student will know about concept of disease, causal agents of plant diseases, identification methods and management of crop diseases.
- Student will know importance of sign and symptoms for detection of pathogens and disease, integrated methods of disease management, use of biological and chemicals in disease management.
- Students will know various laboratory methods of detection of plant pathogens and evaluation of biological and chemical agents against plant pathogens.
- Student will know plant viruses, important viral diseases of crops, sign and symptoms and management of viral diseases.
- Students will know biological method of plant growth, disease control and conventional and industrial production of bio control agents.
- Students will know principles and utilization of integrated pest management of field crop..

COURSE CONTENTS:

UNIT I

Introduction and History of plant pathology

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton De Bary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

UNIT II

Stages in development of a disease

Infection, invasion, colonization, dissemination of pathogens and perennation.

Plant disease epidemiology

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

UNIT III

Host Pathogen Interaction

A. MICROBIAL Pathogenicity

Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

B. Genetics of Plant Diseases

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.

C. Defense Mechanisms in Plants

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

UNIT IV Control of Plant Diseases

Principles & practices involved in the management of plant diseases by different methods, viz. **regulatory** - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material

cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches

chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals**.**

biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

UNIT V

Specific Plant diseases (Agrios, Singh)

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control

A. Important diseases caused by fungi (9 periods)

- White rust of crucifers - *Albugo candida*

- Downy mildew of onion - *Peronospora destructor*
- Late blight of potato - *Phytophthora infestans*
- Powdery mildew of wheat - *Erysiphe graminis*
- Ergot of rye - *Claviceps purpurea*
- Black stem rust of wheat - *Puccinia graminis tritici*
- Loose smut of wheat - *Ustilago nuda*

B. Important diseases caused by phytopathogenic bacteria (3 periods)

Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus

C. Important diseases caused by phytoplasmas (1 period)

Aster yellow, citrus stubborn

D. Important diseases caused by viruses (2 periods)

Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro

E. Important diseases caused by viroids (1 period)

Potato spindle tuber, coconut cadang cadang

PRACTICALS

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.*

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

SIXTH SEMESTER

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives: The key objective of this paper is to introduce the students to concepts in identification of a research problem and developing a hypothesis. The course will enable students to learn how to carry out survey of literature, perform experiments, and analyse data. The student will learn how to write a scientific project report, and oral presentation of the results.

Course Learning Outcomes:

- Student is able to formulate a hypothesis to be tested.
- Student learns how to collect and read literature related to the hypothesis.
- Student is able to design experiments to test that hypothesis. Student is exposed to the use of a variety of instruments and is able to perform experiments such as making culture media for various microbes, isolating microorganisms from different sources, and identifying the isolated microorganism. Can examine the microorganism's capacity to produce compounds of industrial importance.
- Student learns about ethical issues in conducting research. Student learns how to examine the obtained data and interpret the results.
- Student learns how to discuss their results based on results obtained by other researchers on the same topic.
- Student learns the skill of writing a project report.
- Student learns about ethical issues related to publishing, plagiarism and self-plagiarism.

Syllabus
For
B.Sc. (Hons.)BIOTECHNOLOGY

THREE YEAR FULL TIME PROGRAMME UNDER CBCS

RANI DURGAVATI UNIVERSITY

JABALPUR-482001

Note: Syllabus applicable for students seeking admission in the B.Sc. (HONS) Biotechnology Course from the academic year 2020-2021 onwards

Approved by
Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/2020
Standing committee on **Executive Council on**

Syllabus For
B.Sc. (Hons.) BIOTECHNOLOGY
(CBCS Pattern)

ACADEMIC YEAR 2020-2021 ONWARDS

The B.Sc. (Hons.) Biotechnology course would be of three years duration, divided into six semesters. Semester I to V would comprise of three core theory courses, two core practicals courses and one Elective course out of two choices, making a total of 30 courses in five semesters. Students will carry out Research work and submit a Dissertation in Semester VI. The course will commence from the academic session 2020-21. The syllabus has been prepared keeping in view the unique requirements of B.Sc. (Hons.) Biotechnology students under CBCS Programme. The contents have been drawn to accommodate the widening horizons of the Biotechnology discipline. It reflects the changing needs of the students, pertaining to the fields of Chemistry, Bioinformatics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings. Teaching time allotted for each course shall be 3 hours for each theory course and 4 hours for each practical course per week, and 1 tutorial period for per week. Each practical batch should not have more than 20 students. Any number exceeding 20 will be divided into two equal batches. This is because biotechnology practical's require individual attention for imparting correct and adequate hands – on training to the students. One short educational trip will be planned to industry/national/research institutes in the $5^{th}/6^{th}$ semester to keep the students abreast with latest developments in the field of biotechnology.

BACHELOR OF SCIENCE IN BIOTECHNOLOGY
THREE YEAR FULL TIME PROGRAMME

PROGRAMME STRUCTURE

PART	SEMESTER/ COURSE CODE	COURSE TITLE
PART I	Semester-1	
	UBC 101	Botany
	UBC 102	Microbiology
	UBC 103	Chemistry-I
	UBC 104	Practical Based on UBC 101 & UBC 102
	UBC 105	Practical Based on UBC 103 & UBE 101/ UBE 102
	UBE 101/ UBE 102	Communicative English / Fundamentals of Statistics
	Semester-2	
	UBC 201	Zoology
	UBC 202	Basics of Computers
	UBC 203	Chemistry-II
	UBC 204	Practical Based on UBC 201 & UBC 202
	UBC 205	Practical Based on UBC 203 & UBE 201/ UBE 202
	UBE 201/ UBE 202	Fundamentals of Biochemistry / Bioanalytical Techniques
PART II	Semester-3	
	UBC 301	Cell Biology-I
	UBC 302	Molecular Biology-I
	UBC 303	Recombinant DNA Technology
	UBC 304	Practical Based on UBC 301 & UBC 302
	UBC 305	Practical Based on UBC 303 & UBE 301/ UBE 302
	UBE 301/ UBE 302	Fundamentals of Biophysics / Fermentation Technology
	Semester- 4	
	UBC 401	Immunology
	UBC 402	Cell Biology-II
	UBC 403	Molecular Biology-II
	UBC 404	Practical Based on UBC 401 & UBC 402
	UBC 405	Practical Based on UBC 403 & UBE 401/ UBE 402
	UBE 401/ UBE 402	Genetics and Genomics-I / Bioinformatics
PART III	Semester-5	
	UBC 501	Plant Biotechnology
	UBC 502	Environmental Biotechnology
	UBC 503	Animal Biotechnology
	UBC 504	Practical Based on UBC 501 & UBC 502
	UBC 505	Practical Based on UBC 503 & UBE 501/ UBE 502
	UBE 501/ UBE 502	Entrepreneurship and IPR / Genetics & Genomics-II
	Semester-6	DISSERTATION

SCHEME OF EXAMINATION

FIRST SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 101	Botany	3	40	60	100
UBC 102	Microbiology	3	40	60	100
UBC 103	Chemistry-I	3	40	60	100
II-Practical core courses					
UBC 104	Practical based on UBC 101 and UBC 102	4	40	60	100
UBC 105	Practical based On UBC103 and UBE 101/ UBE 102	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 101	Communicative English	3	40	60	100
UBE 102	Fundamentals of Statistics				
IV- Skill Development course					
SKILL	Skill Development module 1	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		04			50

SECOND SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 201	Zoology	3	40	60	100
UBC 202	Basics of Computers	3	40	60	100
UBC 203	Chemistry-II	3	40	60	100
II-Practical core courses					
UBC 204	Practical based on UBC 201 and UBC 202	4	40	60	100
UBC 205	Practical based on UBC 203 and UBE 201/ UBE 202	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 201	Fundamentals of Biochemistry	3	40	60	100
UBE 202	Bioanalytical Techniques				
IV- Skill Development course					
SKILL	Skill Development module 2	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		4			50

THIRD SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 301	Cell Biology-I	3	40	60	100
UBC 302	Molecular Biology-I	3	40	60	100
UBC 303	Recombinant DNA Technology	3	40	60	100
II-Practical core courses					
UBC 304	Practical basedon UBC 301 and UBC 302	4	40	60	100
UBC 305	Practical based on UBC 303 and UBE 301 / UBE 302	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 301	Fundamentals of Biophysics	3	40	60	100
UBE 302	Fermentation Technology				
IV- Skill Development course					
SKILL	Skill Development module 3	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		4			50

FOURTH SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 401	Immunology	3	40	60	100
UBC 402	Cell Biology-II	3	40	60	100
UBC 403	Molecular Biology-II	3	40	60	100
II-Practical core courses					
UBC 404	Practical based on UBC 401 and UBC 402	4	40	60	100
UBC 405	Practical based on UBC 403 and UBE 401 / UBE 402	4	40	60	100
III-Elective Courses (Any one to choose)					
UBE 401	Genetics and Genomics-I	3	40	60	100
UBE 402	Bioinformatics				
IV- Skill Development course					
SKILL	Skill Development module 4	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
(B) Comprehensive viva voce (Virtual credits)		04			50

FIFTH SEMESTER

CO1: Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**
I-Core Courses					
UBC 501	Plant Biotechnology	3	40	60	100
UBC 502	Environmental Biotechnology	3	40	60	100
UBC 503	Animal Biotechnology	3	40	60	100
II-Practical core courses					
UBC 504	Practical based on UBC 501 and UBC 502	4	40	60	100
UBC 505	Practical based on UBC 503 and UBE 501/ UBE 502	4	40	60	100
III- Elective Courses (Any one to choose)					
UBE 501	Entrepreneurship and IPR	3	40	60	100
UBE 502	Genetics and Genomics-II				
IV- Skill Development course					
SKILL	Skill Development module 5	2	Grade Point will be provided by Skill Development Centre		
Total valid credits		22			
CO2: Comprehensive viva voce (Virtual credits)		4			50

SIXTH SEMESTER

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii)Methodology (iv)Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

PROGRAMME OUTCOMES

The aim of the undergraduate degree in Biotechnology is to make students knowledgeable about the various basic concepts in wide ranging contexts which involve the use of knowledge and skills of living entities and their manipulation. Their understanding, knowledge and skills in emerging biotechnological tools needs to be developed through a thorough teaching learning processes in the class, practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.

PROGRAMME SPECIFIC OUTCOMES

A candidate who is conferred B.Sc. (Hons) degree in Biotechnology needs to have acquired/developed following competencies during the programme of the study:

1. Acquired knowledge and understanding of the biotechnological concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and related areas.

2. Demonstrate key practical skills/competencies in working with various biological entities for study and use in the laboratory as well as outside, including the use of modern molecular assessment and manipulation protocols.

3. Empower the students to undertake advance knowledge about biotechnological protocols and researches.

FIRST SEMESTER

CORE COURSE CODE UBC 101 BOTANY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners in the systematic position, occurrence, morphology, anatomy, development of reproductive structures, affinity and the classification of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

Course Learning Outcomes:

CO1: The student will be able to identify major groups of plants and compare the characteristics of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

CO2: Students will be able to use the evidence based comparative botanical approach to explain the evolution of organism and understand the genetic diversity on the earth.

CO3: Students will be able to understand adaptation, development, behavior, morphology, anatomy and reproduction of different forms of life.

CO4: Demonstrate proficiency in the experimental techniques and methods to study of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

CO5: Students will be able to Understands concepts of Binomial Nomenclature and elementary knowledge of International Code of Botanical Nomenclature. Systematic position, distinguishing characters and economic importance of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms

COURSE CONTENTS

UNIT I

Algae: Fritsch Classification, occurrence, structure, systematic position mode of reproduction and economic importance of the following generaChlamydomonas,,Chara, Sargassum, Polysiphonia, Nostoc.

UNIT II

Fungi: Outlines of classification of fungi, position, occurrence, structure and mode of reproduction in fungi, based on the following representatives:, Eurotium, Morchella, Agaricus and Alternaria, Economic importance of fungi, Lichens: Classification, occurrence, systematic position, mode of nutrition, reproduction and economic importance.

UNIT III

Bryophytes: Outlines of classification and importance of bryophytes, Systematic position occurrence, morphology, anatomy and reproduction in, Marchantia, Anthoceros (Development of Sporophyte only).

UNIT IV

Pteridophytes: Systematic Position, occurrence, morphology, anatomy and development of reproductive structures of Selaginella, Equisetum and Marsilea, Stelar system and its evolution in Pteridophytes, Heterospory and seed habit.

UNIT V

Gymnosperms & Taxonomy of Angiosperms

General characteristics, affinities and classification of Gymnospermsm(Chamberlains' and D.D Pant's classification) Systematic position, occurrence, morphology and development of reproductive structures and Economic importance of the following taxa- Cycas, Pinus, Ephedra, of Cycas, Pinus and Ephedra. Classification as proposed by Bentham and Hooker and Hutchinson, merits, demerits and comparison. Binomial Nomenclature and elementary knowledge of International Code of Botanical Nomenclature.Systematic position, distinguishing characters and economic importance of family: Rutaceae, Cucurbitaceae, Rosaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Lamiaceae, Euphorbiaceae, and Poaceae.

Suggested Readings:

• College Botany Vol. I and II, Ganguli and Kar

• A Text Book of Botany, V. Singh, P.C. Pande & D.K. Jain

• Modern Plant Taxonomy, N.S. Subrahmanyam, Vikas Publishing House.

• A Text Book of Botany, V. Singh, P.C. Pande & D.K. Jain, Rastogi Publication.

• The Algae, V. J. Chapman and D. J. Chapman.

• Introductory Phycology, H. D. Kumar.

• A Text Book of Algae, H. D. Kumar and H.N. Singh.

• Introductory Mycology, Alexopaulos and Mims

• Cryptogamic Botany, G. M. Smith.

• A Text book of Algae, B. R. Vashishtha

• Bryophytes, N. S. Parihar

• Pteridophytes, N. S. Parihar

•An Introduction to Pteridophytes, A. Rashid. Plant Systematics Theory & Practice, Gurcharan Singh, Oxford & IBH Publishing Co.

• Taxonomy, V. Singh & D. K. Jain, Rastogi Publications.

• Botany for degree students – Gymnosperms, P.C. Vashishtha, S. Chand & Co.

• Gymnosperm, S. P. Bhatnagar & A. Moitra, New Age.

• College Botary Vol.2, B.P. Pandey, S. Chand & Co.

• Systematic Botany, S.C. Datta, New Age.

• Text Book of Botany Vol. II. S. N. Pandey, S. P Misra, P. S. Trivedi, Vikas Publishing House.

CORE COURSE CODE UBC 102: MICROBIOLOGY

(COURSE CREDITS = 03)

Course Objectives:

To provide a deep insight into the world of microorganisms, historical developments and major milestones leading to the development of microbiology as a separate discipline of science. The students will be able to understand the diversity, structure, evolution and impact of microbes in our day to day life and for the sustenance of life on Earth in general.

Course Learning Outcomes: Upon successful completion of the course, the students will:

CO1: Be acquainted with the historical account and development of microbiology as a scientific discipline.

CO2: Have gained knowledge on different systems of classification. They will also acquire an overview of acellular and cellular microorganisms.

CO3: Have acquired in-depth knowledge of the diversity, distribution, cell structure, life cycles and economic importance of algae.

CO4: Have gathered detailed information on the diversity, distribution, structure, life cycles and economic importance of fungi.

CO5: Be aware of general characteristics of protozoa and their economic importance and have a broad perspective of the scope of microbiology.

COURSE CONTENTS

UNIT I

History of Development of Microbiology

History- Discovery and Development of Microbial World, Spontaneous generation vs. biogenesis,

Fermentation, Germ Theory of Disease , Contribution of following scientists in the field oh=f Microbiology : Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty

UNIT II

Microbial Diversity and Classification

Occurrence, Binomial Nomenclature, Haekel's Classification, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Taxonomy- Principle and its types (Classical Approaches-Numerical, molecular Approach, Chemical, Serological and Genetics), Bacterial taxonomy- Bergey's manual of systematic bacteriology (Eubacteria and Archaebacteria), Difference between prokaryotic and eukaryotic microorganisms

General characteristics of different groups:

A cellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

UNIT III

Viruses

Definition- Virion, prions, viroids and virusoides. History, general characterstics and Structure, Virus-host (bacteria, animal and plants), Classification, Replication (TMV, poliovirus, T4 and λ phage), lytic and lysogenic cycles.

Bacteria

A General Characterstics- Morpholgical, Chemical , Cultural , Metabolic , Antigenic, very precise account of typical eubacteria, chlamydiae, rickettsiae, mycoplasma, and archaebacteria (extremophiles).

UNIT IV

Algae

History of phycology with emphasis on contributions of scientists; General characteristics of algae including occurrence, Classification, Morphology, Reproduction. Physiology and Cultivation.

UNIT V

Fungi

Historical developments in the field of Mycology, contributions of mycologists. General characteristics of fungi including habitat, distribution, Classification, Morphology, physiology, cultivation and Reproduction.

Practicals

1. Isolation of bacteria and fungi from soil, water and air. Morphological, cultural and biochemical identification.

2. Isolation and identification of pathogenic bacteria from sewage and waste water.

3. Determination of Plague Forming Unit (PFU/ml).

4. Determination of photosynthetic pigments in cyanobacteria.

5. Determination of growth curve and generation time of E. coli

Suggested readings

• Powar C. B. and H. F. Daginawala (2003).General Microbiology Vol.II; Himalaya Publishing House.

• Dubey R. C. and D. K. Maheshwari (2004). A Text book of microbiology, 1st Edition; S. Chand and Company Ltd.

• H.C. Dube (2005)A Textbook of Fungi, Vikas Publishing House.

• A Textbook of Fungi- Vashistha (2003) S. Chand and Company Ltd.

• Davis and Harper, General Microbiology

• Alexopoulos C. J. and C. W. Mims (1996). Introductory Mycology, 4th Edition; John Wiley and Sons, Inc. USA.

• Stanier, R.Y., J.L. Ingraham, M.L. Wheelis and P.R. Painter (1987) Vth edition. General Microbiology, Macmillan Press Ltd.

• Wiestrich G. A. and M. D. Lechtman (1988). Microbiology, 5th Edition; Macmillan Pulishing Company, New York.

• Trivedi, P.C. (2004) 1st Edition. Microbial Biotechnology, Aavishkar Publisher.

• Sharma, P.D. (2005) 2nd Edition. Microbiology, Rastogi Publications.

• Pelczar M. J., E. C. S. Chan and N. R. Krieg (2003) Microbiology, 5th Edition; Tata McGraw Hill Publishing Company , New Delhi

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CORE COURSE CODE UBC 103: CHEMISTRY-I

(COURSE CREDIT= 03)

Course Objectives:

To introduce the basic concepts and principles of general chemistry, and be familiarized with the principles, fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.

Course Learning Outcomes:

CO1: The students will learn about the principle, methodology, calculation and application involved in quantitative, chemical and spectrophotometric methods.

CO2: The student shall learn the essential concepts of chirality, configuration, isomerism in organic chemistry and nomenclature of isomers. Students will familiarize with the elementary concept of saturated aliphatic hydrocarbons reactions

CO3: The students shall learn about the fundamentals of organic chemistry with references to structure and reactivity, reagents and reactions & reaction and mechanism.

CO4: The students will learn about ionic, covalent bonding in molecules .compare/contrast the properties of molecular and ionic compounds.

CO5: The students will learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances, including the IUPAC nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions.

COURSE CONTENTS

UNIT I

Quantitative methods. Significant figures. Mole concept. Empirical and molecular formula. Molar and molal solutions, mole fraction, ppm and ppb solutions. Stoichiometry and calculations based on it involving acid-base, precipitation, redox, and complex formation reactions. *Chemical methods:* Principle, methodology and calculations involved in for dissolved oxygen (Winkler method), biological oxygen demand, chemical oxygen demand, and hardness of water. Determination of nitrogen in proteins (Kjeldahl method). *Spectrophotometric methods:* Determination of ammonia (by indophenol formation), nitrate (by nitrophenol formation), nitrite (by azo dye formation), and phosphorus (by molybdenum blue formation).

UNIT II

Chemical bonding and molecular structure.

Kossel-Lewis theory, octet rule, electrovalent and covalent bond. Formal charge. Polarity of bonds. The valence shell electron pair repulsion (VSEPR) theory, its postulates and geometry of molecules. Valence bond theory, orbital concept, hybridisation (sp, sp^2, sp^3, sp^3d and sp^3d^2). Molecular orbital theory. Linear combination of atomic orbitals (LCAO). Types and energy level diagram of molecular orbitals. Bond order. Bonding in homonuclear diatomic molecules. Magnetic properties.

UNIT III

Fundamental organic chemistry.

Structure and reactivity. Inductive and electromeric effects. Tautomerism, hyperconjugation and resonance. Intramolecular and intermolecular hydrogen bonding. Structure and stability of carbocations, carbanions and free radicals. Relative strength of organic carboxylic acids, phenols and amines. pKa and pKb values.

Reagents and reactions. Periodic acid, Grignard reagent, ethyl acetoacetate and diethyl malonate.

Reaction and mechanism. Claisen condensation, Benzoin condensation, Perkin reaction, Pinacol-pinacolone rearrangement,

UNIT IV

Stereochemistry of organic compounds.

Conformations. Fisher, sawhorse and Newman structures. IUPAC namenclature of conformational isomers. Conformations and their analysis of ethane, n-butane, cyclohexane and decalins.

Configurations. Chirality. Elements of symmetry. Optical activity, specific rotation. Enantiomers, diastereomers, and meso compounds. Racemic modification. Thereo and erythro compounds. R and S configuration, sequence rules. Geometrical isomerism, E and Z nomenclature.

Stereochemical aspects of chemical reactions. Addition of bromine to Z- and E-butene. E2 reactions.

UNIT V

Ionic equilibria.

Ostwald dilution law and its experimental verification. Application of Ostwald dilution law. Ionization of water. The pH value, relation between pH and pOH, the pH scale (numerical problems). The salt hydrolysis, and application to (i) salts of strong acids and strong bases, (ii) salts of weak acis and strong bases, (iii) salts of strong acids and weak bases, and (iv) salts of weak acids and weak bases. Hydrolysis constant and degree of hydrolysis.

Buffer solutions. Solubility and solubility product of sparingly soluble salts. Applications of solubility product principle.

PRACTICAL

1. Determination of hardness of water by titration with EDTA.

2. Determination of dissolved oxygen in environmental waters by the Winkler method.
3. Determination of chemical oxygen demand in environmental waters.
4. Determination of strength of a solution of sulphuric acid by titration with sodium hydroxide using pH meter.
5. Determination of ammonia by the indophenol formation, and spectrophotometry.
6. Determination of solubility product of mercuric iodate or lead iodate.

Suggested reference materials

1. Analytical Chemistry, G.D. Christian, John Wiley & Sons (Asia), Singapore
2. Fundamentals of Analytical Chemistry, D.S. Skoog, D.M. West, F.J. Holler and S.R. Cruch, Thomson, Singapore.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. A Guidebook to Mechanism in Organic Chemistry, P.Sykes, Orient Longman, New Delhi.
6. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.

ELECTIVE COURSE CODE UBE 101: COMMUNICATIONIVE ENGLISH

(COURSE CREDIT= 03)

Course Objectives:

To develop the learner's communication skills in oral, written and interpersonal, by reinforcing the basics of English grammar.

Course learning outcomes: Students will

CO1: Improve LSRW, i.e. listening, speaking, reading and writing skills and the related sub-skills.

CO2: Recognize and use formal elements of organizational communications: Paper writing, reports, proposals, memorandums, letters etc.

CO3: Enhanced vocabulary with right pronunciation and improved accuracy in grammar.

CO4: Effective oral presentations.

COURSE CONTENTS

UNIT I

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing. Speech drills, pronunciation and ascent, stress and intonation.

UNIT II

Writing Skills; Selection of topic, thesis statement, developing the thesis, introductory, developmental, transitional and concluding paragraphs. Articles, parts of speech, tenses, sentence structure, subject- verb agreement, punctuation.

UNIT III

Use of dictionary. Use of words: Diminutives, Homonyms and Homophones. Linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

UNIT IV

Effective writing skills, avoiding common errors. Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, writing assignments.

UNIT V

Purpose and scope of Report, Memo, Agenda and Minutes. Notice, Letters; types and minutes, Manuals.

Suggested reading:

• M. Frank. Writing as thinking: A guided process approach, Englewood Cliffs, Prentice Hall Reagents.

• L. Hamp-Lyons and B. Heasely: Study Writing; A course in written English. For academic and professional purposes, Cambridge Univ. Press.

• R. Quirk, S. Greenbaum, G. Leech and J. Svartik: A comprehensive grammar of the English language, Longman, London.

• Daniel G. Riordan & Steven A. Panley: "Technical Report Writing Today" -Biztaantra.

• Daniel G. Riordan, Steven E. Pauley, Biztantra (2004).: Technical Report Writing Today, 8th edition

• Contemporary Business Communication, Scot Ober, Biztantra, 5th Edition (2004).

ELECTIVE COURSE CODE UBE 102: FUNDAMENTALS OF STATISTICS

(COURSE CREDIT= 03)

Course Objectives:

It aims to students learn the use of basic statistical concepts, methods and principles in the field of biotechnology.

Course Learning outcomes:

CO1: Students understand the importance of Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, and Sample observations. Sequences finite sequences.

CO2: Students understand the intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas. Intuitive idea of discontinuity, continuity and limits.

CO3: Students study the differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

CO4: Student understands the points in plane and space and coordinate form. Examples of matrices of biological sciences

CO5: Students studies about central tendency, Measures of dispersion; skewness, kurtosis. Elementary Probability. Types variable, distribution, and variance. Correlation and Regression.

COURSE CONTENTS

UNIT I

Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.

UNIT II

Intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

UNIT III

Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

UNIT IV

Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

UNIT V

Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probabilityand basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance. Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

Suggested reading

• H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.

• E. Batschelet : Introduction to Mathematics for Life Scientists,S pringer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)

• A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.

• W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

Note: It is desirable that softwares should be used for demonstrating visual, graphical and application oriented approaches.

SECOND SEMESTER

CORE COURSE CODE UBC 201: ZOOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners with the knowledge about systematics and characteristics of animal kingdom by imparting deep understanding about animal physiology through the study of different organ systems and their components.

Course Learning Outcomes:

CO1: Knowledge of classification of each phylum from protozoa to annelida and arthropoda to echinodermata up to class level with examples.

CO2: Understanding of characteristics and systematic position of classes of Chordata.

CO3: Discuss different organ systems- respiration, digestion, excretion, and osmoregulation; the structure and function of the organs related. Understanding of composition, function, formation, clotting mechanism, type of blood cells & blood groups with activity of the heart.

CO4: Conceptualise Nervous system and its components- neuron structure, nerve impulse transmission (Myelinated & Non Myelinated), Neurotransmitters, Muscle-Types, Neuromuscular junction, sliding filament theory. Understanding of metabolism of carbohydrates, fats and proteins; sense organs and endocrine glands.

CO5: Understanding human reproductive system- reproductive organs, female reproductive cycle, implantation, maternal change during pregnancy, labor and physiology of Lactation and methods of birth control.

COURSE CONTENTS

UNIT I

Invertebrata: Classification of the various phyla up to class level with examples Protozoa to Annelida, Arthropoda to Echinoderma.

1. Parasitic Protozoa. Entamoeba histolytica, Plasmodium Trypamosama, Leishmania
2. Canal system in sponges.

UNIT II

General characteristics, systemic position and examples of the following.

1. Agnatha: Hemichordata, Urochordata and Cephalochordata, Cyclostomes.
2. Gnathostomata:

i. Pisces. General characteristics of Pisces, distinguishing features and examples of Elasmoloranchii and Bony fishes (Chondrichthys and Osteichthys). A general idea of biodiversity and biological significance of fishes.

ii. Amphibia. Classification of living amphibia with examples, general characteristics of amphibia and the impact of terrestrialisation.

iii. Reptilia. Classification on the basis of temporal arcades of the skull. Poisonous and non-poisonous snakes, biting mechanism, snake venon and its medicinal importance.

iv. Birds. General characteristics of birds (palaeognathae and Neograthae). Archaeoptry, flightless birds, flight adaptations.

v. Mammals. General organisation of rabbit/rat. General characterists of mammals. Classification of living mannals up to orders. Primate characters and distinguishing characters of Homosapiens, aquatic mannals.

UNIT III

Physiology (with reference to mammals):

1. Respiratory system. Organs and transport of gases.
2. Digestive system. Organs and physiology of digestion, functions of various digestive enzymes.
3. Heart and circulatory system. Structure of the heart and cardiac cycle.
4. Blood. Composition of blood and its functions, clotting of blood, types of blood cells and blood groups.
5. Excretion. Structure of kidney and nephron, physiology and mechanism of urine formation.

UNIT IV

1. Composition of skeltal muscle, types of muscles, neuromuscular function, sliding filament theory of muscle contraction.
2. Structure of neurons, myslinated and non-myslinated nerve fibres, physiology of nerve impulse transmission.
3. Basic idea of intermediatry metabolism.
4. Sense organs. Eye and ear.
5. Endocrine glands. Source and function of various hormones.

UNIT V

Human reproduction:

1. Male and female reproductive organs.
2. Female reproductive cycle and its hormonal control.
3. Fertilisation and implantation of embryo.
4. Maternal changes during pregnancy.
5. Labor, physiology of lactation.

6. Methods of birth control.

Practical

1. Study of various systems in labeo/any fresh water fish, external features, respiratory system, digestive tract, cranial nerves, internal ear in situ.
2. Monsting of placoid and cycloid scale and their study.
3. Study of permanent slides of (mannals) muscles, blood, and T.S. intestine.
4. Study of paramecium and other phyto and zoo plankton form pond water.
5. Study of national parks of M.P.
6. Listing of animals found in and around your house/college/university.

Suggested reference materials

1. R.L. Kotpal. Modern textbook of zoology
2. R.L. Kotpal. Modern textbook of zoology: Vertebrate
3. Dhami & Dhami. Invertebrate zoology
4. Dhami & Dhami. Chordate zoology
5. Jordan & Verma. Invertebrate zoology
6. Jordan & Verma. Chordrate zoology
7. Reena Mathur. Animal behaviour

CORE COURSE CODE UBC 202: BASICS OF COMPUTERS

(COURSE CREDIT= 03)

Course Objectives:

This is a skill based paper that introduces the students to the basics of computer operations through knowledge on both hardware and software. The student has a better understanding on the use of computers for various applications

Course learning outcomes:

CO1: The students shall learn about the introduction, basics, organization, types and preliminary knowledge of operating systems and system tools.

CO2: Students will get the idea about data representation, networks terminologies, multimedia and its applications.

CO3: Students will get general awareness about the IT Act, system security and preliminary knowledge about the I-Tax, E banking and E reservations.

CO4: They learn basics of algorithms and programming.

COURSE CONTENTS

UNIT I

Computer Fundamentals: Introduction to Computers, Characteristics of Computers, Uses of computers, Types and generations of Computers, Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices, User Interface with the Operating System, System Tools

UNIT II

Data Representation: Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of bi. Networks terminology: Types of networks, router, switch, server-client architecture

UNIT III

Multimedia: Introduction, Characteristics, Elements, Applications

UNIT IV

Problem Solving: Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

UNIT V

General Awareness: IT Act, System Security (virus/firewall etc.) I-Tax, Reservations, Banking

Practical

1. Defined projects will be done by the students and evaluated by the instructor.

2. Document Preparation

3. Presentation Software

4. Familiarizing with the Operating System, Control Panel, Networking Configuration,

Firewall setting

5. Spreadsheet Handing, Working with worksheets, Creating a spreadsheet, entering and

formatting information, basic functions and formulas, creating charts, tables and graphs.

Suggested reading

• V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.

• Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.

Reference manual for Open Office available at: http://www.openffice.org

Reference manual for Star Office available at: http://www.sun.com/software/staroffice/

CORE COURSE CODE UBC 203: CHEMISTRY-II

(COURSE CREDIT= 03)

Course Objectives:

It introduces the basic concepts and principles of general chemistry by familiarizing the students with principles, fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry. Students will be able to explore new areas of research in both chemistry and allied fields of microbiology.

Course Learning Outcomes:

CO1: The students will learn about the energy and electromagnetic spectrum.

CO2: The student shall learn the principle, theory and applications of UV Visible spectroscopy and Infrared spectroscopy.

CO3: The students will get knowledge in the field of Electrochemistry special in references with Electrochemical cell, Nerst equation Gibbs energy.

CO4: The students will learn general structure, configuration and properties of Carbohydrates, Amino acids, Proteins and Peptides.

COURSE CONTENTS

UNIT I

Energy and the electromagnetic spectrum.

Units (wavelength, wavenumber, frequency) and energy of radiation.

UV-Visible spectroscopy.

Theory of electronic spectroscopy. Types of electronic transitions. Allowed and forbidden transitions. Solvent effects on electronic transitions. Beer and Lambert law. Molar absorptivity. Components of UV-Visible spectrophotometer. Application of electronic spectroscopy to conjugated dienes, and α,β-unsaturated carbonyl compounds. Woodward and Fieser rules.

Infrared spectroscopy.

Molecular vibrations, and calculation of vibrational frequencies. Factors affecting vibrational frequency, Vibrational coupling, hydrogen bonding, electronic effects and bond angles. Components of IR spectrophotometer. Interpretation of IR spectra of model organic compounds.

UNIT II

Electrochemistry.

The electrochemical cell. Galvanic and electrolytic cells. Electrode potential and its measurement. Nernst equation. Measurement of equilibrium constant by Nernst equation. Gibbs energy of the reaction. Conductance of electrolytic solutions. Measurement of conductivity of ionic solutions. Molar conductivity. Kohlrausch law of independent migration of ions. Faraday laws of electrolysis.

UNIT III

Carbohydrates.

Classification and general properties of carbohydrates. Osazone formation with phenylhydrazine. Open chain and cyclic structures. Mutarotation. Ascending and descending of monosaccharides.

Anomers and epimers. Determination of structure of glucose and fructose. Determination of ring size. Disaccharides and polysaccharides, and general ideas about the structure of sucrose, maltose, lactose, starch and cellulose.

UNIT IV

Amino acids.

Amino acids. General structures. Configuration of amino acids. The zwitter ion, isoelectric point and electrophoresis. Reactions of amino acids, acetylation, esterification and complexation. Ninhydrin test. Synthesis of amino acids by amination of α-haloacids, Gabriel synthesis and diethyl malonate synthesis.

UNIT V

Peptides and proteins.

The peptide bond. General idea about the structure of oxytocin. Primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of proteins by N-terminal (Edmann degradation using 1-fluoro-2,4-dinitrobenzene, and phenylisothiocyanate) and C-terminal (hydrazinolysis) methods. Peptides (up to 3 amino acids) synthesis by N-protection and C-activation methods. Merrifield solid-phase synthesis.

PRACTICAL

1. Interpretation of bands in the pre-recorded standard IR spectra of model organic compounds.
2. Separation of mixture of amino acids (2 or 3 components) by paper chromatography.
3. Preparation of thin layer plates, and separation of organic compounds (coloured and colourless).
4. Preparation of chromatographic column and separation of carotenoids and chlorophyll from spinach.
5. Identification of glucose, fructose, sucrose, lactose and starch by standard chemical tests.
6. Determination of glucose by the Fehling reaction (titration and spectrophotometric methods). Demonstration on the application of glucometer.

Suggested reference materials

1. Organic Spectroscopy, W. Kemp, ELBS, Hampshire, UK.
2. Spectroscopic methods in Organic Chemistry, D.H. Williams and I. Fleming, Tata McGraw-Hill, New Delhi.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.
6. Organic Chemistry, T.W.G. Solomons and C.B. Fryhle, Wiley India, New Delhi.

ELECTIVE COURSE CODE UBE 201: FUNDAMENTALS OF BIOCHEMISTRY

(COURSE CREDIT= 03)

Course objectives:

Student study about the biomolecules participating in different biochemical reactions and processes within the living system. These biochemical processes control and regulated by different enzymes for production of energy in form of ATP.

Course Learning outcomes:

CO1: Study water and their properties, buffers, pH, acid, base, covalent bond and weak bonds, structure of atom.

CO2: Enzyme, classification, structure, activity, inhibition, kinetics, allostoric enzymes etc.

CO3: Structure and chemistry of Carbohydrate, protein, lipid, vitamins, pigments, antibiotics; functions, analysis.

CO4: Biological membranes and Transport: membrane dynamics, solute transport across membranes.

CO5: Biosignaling, signaling in microorganisms and plants, Bioenergetics and Metabolism; bioenergetics and thermodynamics, phosphoryl group transfers and ATP.

COURSE CONTENTS

UNIT I

Basic building blocks: Biochemistry as molecular logic of living beings, Axioms of living matter, Major organic compounds of animate objects a general view. Chemical elements, structure of atoms, molecules and chemical bonds.Ionic, covalent, coordinate and hydrogen bonds. Structure, function and properties of water, Water as universal solvent, Acids, bases and salts, pH and buffers.

UNIT II

Carbohydrates: Classification of carbohydrates. Chemical structure and properties of monosaccharide, disaccharides, oligosaccharides and polysaccharides- Starch, cellulose and glycogen. Lipids: Saturated and unsaturated fatty acids.

UNIT III

Purines and Pyrimidines: structure and properties of Purines and Pyrimidines. Proteins: Structure and Classification of amino acids. Acid –base properties and solubilities. Amino acid sequencing of proteins. Primary, secondary and tertiary structure of proteins.

UNIT IV

Enzymes: General characteristics of enzymes Classification of enzymes, Co-enzymes and cofactors .Kinetics and Mechanism of enzyme action. Competitive and non competitive inhibition. Allosteric regulation of enzymes. Isoenzymes. Factors contributing to catalytic efficiency of enzymes.

UNIT V

Biological membranes and Transport: membrane dynamics, solute transport across membranes.

Biosignaling, signaling in microorganisms and plants, Bioenergetics and Metabolism; bioenergetics and thermodynamics, phosphoryl group transfers and ATP.

Practicals

1. Laboratory Instrument and Definition

2. Quantitative estimation of reducing and non reducing sugars.

3. Detection of water alkalinity and water acidity

4. Separation of amino acid by Paper chromatography and TLC.

5. Verification of Beer's law

6. Identification of biological compound: Carbohydrate (Glucose, fructose, Galatose, Sucrose, Lactose, Maltose), Protein (color reaction and precipitation reaction), Lipid.

Suggested reading

• Analytical Biochemistry 3rd Ed. by Holme, D. J. & Peck, H.

• Basic Concepts in Biochemistry A Student's Survival Guide by Gilbert, H. F.

• Biochemistry (3rd ed. 1994) by Rawn J. D.

• Biochemistry and Molecular Biology of Antimicrobial Drug Action by Franklin, T. J. & Snow, J. A.

• Biochemistry by Champe

• Biochemistry by Todd, W. B., Mason, M., Bruggen, R. V. & Macmillan.

• Biochemistry by Voet & Voet

• Biochemistry by Mathews 3rd Ed.

• Biochemistry The Chemical Reactions of Living Cells 2d Ed Vols 1&2 by Metzler, D. E.

• Biochemistry with Clinical Correlation by Devlin, T. M.

• Biochemistry: (3rd ed. Vol.1, 2, 3, 1993) by Zubay, J.

• Biochemistry2ed by Stryer

ELECTIVE COURSE CODE UBE 202: BIOANALYTICAL TECHNIQUES

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this paper is to develop understanding of the key concepts of basic as well as some advanced experimental techniques used across biological sciences, with a focus on principle and design of the instruments. This will enable the students to connect between theoretical concepts of these techniques and their immense biological applications in diverse fields.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will have identified the principle components of a light microscope, fluorescence microscope, phase contrast microscope, confocal and electron microscope, simultaneously learning about their principles and practical applications in visualizing, identifying and measuring cell, its components and biomolecules. The student will be familiar with staining and preparation of samples for microscopy.

CO2: Will have gained an in-depth knowledge of principles and applications of paper chromatography, thin layer chromatography, gel filtration chromatography, ion-exchange chromatography, affinity chromatography, GC, HPLC. This enables the students to apply the acquired knowledge in isolation and separation of biomolecules for analysis.

CO3: Will have learnt basic concepts of various techniques used to resolve and analyze nucleic acids and proteins - agarose gel electrophoresis, native polyacrylamide gel electrophoresis, SDSpolyacrylamide gel electrophoresis, isoelectric focusing, 2D gel electrophoresis, zymogram preparation.

CO4: Will be able to understand absorption spectra of biomolecules, and will be able to interpret UV-visible and fluorescence spectroscopy outputs.

CO5: Will have clear fundamentals of centrifugation, RCF, sedimentation coefficient, different types of rotors used, principle and working of differential and density gradient centrifugation, preparative and analytical scales of centrifuge, and the specific uses of ultracentrifuge. Students will also be acquainted with limitations of each method.

COURSE CONTENTS

Unit- I

Instruments, basic principles and usage: pH meter- working of pH meter, Types of electrodes, Centrifuge- Theory of centrifugation, Types of centrifugation, Density gradient centrifugation, Types of centrifuge.

Unit- II

Instruments, basic principles and usage: Spectrophotometers- Laws of absorption and emission, Visible and UV, IR, Atomic absorption, NMR, X-Ray crystallography.

Unit- III

Chromatography- Paper chromatography, thin layer chromatography, Basic principle of column chromatography, gel filtration, ion exchange chromatography, affinity chromatography, Gas chromatography and its application.

Unit- IV

Electrophoresis – SDS-Polyacrlamide Gel electrophoresis, Agarose Gel electrophoresis, Immuno electrophoresis, Iso electric focusing, MALDI-TOF, ESI.

Unit- V

Radioisotope tracer technique- Introduction, Radioisotopes and Radioactivity, Types of Radioactivity, Isotopic labeling, Autoradiography, Detection and measurement of radioactivity, scintillation counting.

Suggested reading

• Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

• Bioinstrumentation, Webster

• Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic

• Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press

• Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.

• NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.

• Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.

• Principles and Practice of Bioanalysis, Richard F. Venn

• Microscopic Techniques in Biotechnology, Michael Hoppert

• Principles of Fermentation Technology, P.F. Stanbury, A. Whitaker, S.J. Hall

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THIRD SEMESTER

CORE COURSE CODE UBC 301: CELL BIOLOGY I

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to educate students about the fundamental concepts in eukaryotic cell biology. The students will be taught the latest developments in cell communication, regulation of cell cycle, and modern tools used to study cell biology. Advances in cancer biology including etiology, diagnosis and therapeutics, as well as the basics of stem cell technology and its applications will be covered.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will have gained knowledge about features of the cell wall, plasma membrane, cell transport mechanisms and cytoskeleton.

CO2: Will be able to understand the structures and functions of the nucleus and different cell organelles. The structural organization and function roles of chromatin will be learnt.

CO3: Will have understood the mechanisms of protein sorting, intracellular trafficking, protein export.

CO4: Will have gathered understanding of how cells perceive and respond to various signals from within and outside.

CO5: Will have learnt the mechanisms of cell division and the significance of cell cycle and its regulation. Will become familiar with stem cell technology and its applications, and basics of cancer biology including diagnostic techniques and therapy.

COURSE CONTENTS

Unit- I

An Overview of cells: Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Viroids, *Mycoplasma* and *Escherichia coli*:

Unit- II

Composition of cells: Molecules of cells, cell membranes, cell proteins; The Nucleus: Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, transport across Nuclear Envelope. Chromatin: Molecular organization, Nucleolus and rRNA Processing.

Unit- III

Mitochondria, chloroplasts and peroxisomes: Structural organization, Function; Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisome assembly.

Unit- IV

The Endoplasmic reticulum, the Golgi apparatus, Mechanism of vesicular transport, Lysosomes, Cytoskeleton and cell movement, Structure and organization of actin filaments; actin, myosin and cell movement.

Unit- V

Transport process: cell membrane models of membrane structure, membrane proteins and their properties, membrane carbohydrates and their role. Transport across membrane active and passive diffusion, their mechanism.

Practicals

1. Separation of nucleic acid bases by paper chromatography.

2. Microscopy- Theoretical knowledge of Light and Electron microscope.

3.Study of the following techniques through electron / photo micrographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting.

4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

1. Cytochemical staining of DNA-Feulgen.

2. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).

3. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).

4. Cytochemical staining of Total proteins- Bromophenol blue.

5. Cytochemical staining of Histones -Fast Green.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

CORE COURSE CODE UBC 302: MOLECULAR BIOLOGY I

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to develop a clear understanding of the basic concepts of molecular biology starting from the structure and function of DNA to its replication. The student will become familiar with the central dogma of molecular biology, and will learn about the conversion of information from DNA to RNA to proteins, by the study of transcriptional and translational processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will be acquainted with the structure of various types of DNA and RNA as well as their organization as genetic material in various living organisms.

CO2: Will gain an in-depth knowledge of DNA replication mechanisms in prokaryotes and eukaryotes, enzymes and proteins involved in replication.

CO3: Will have learnt the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved. Will be able to distinguish between the process in prokaryotes versus eukaryotes.

CO4: Will understand the concept of split genes, introns, exons, spliceosomes and alternative splicing besides learning about other processing events like polyadenylation and capping. Will become familiar with RNA interference and its significance, siRNA and miRNA.

CO5: Will get a clear understanding of translational mechanisms in both prokaryotes and eukaryotes along with the inhibitors of protein synthesis, and various mechanisms involved in regulation of gene expression in prokaryotes and eukaryotes at the level of transcription, post-transcriptional processes, and modifications in chromatin structure

COURSE CONTENTS

UNIT I

Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Key

experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

UNIT II

The Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crickhistoric perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology-linking number, topoisomerases; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA – mitochondria and chloroplast DNA.

UNIT III

Genome Structure, Chromatin and the Nucleosome: Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome Chromatin structure-Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes

UNIT IV

The Replication of DNA (Prokaryotes and Eukaryotes): Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous,RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

UNIT V

The Mutability and Repair of DNA: Definitions, Mutation, muton, replicon, principles of mutation, Replication Errors, DNA Damage, different types of mutations, deletions, duplications, UV induced mutations, repair mechanisms against mutations and their importance.

Practicals

1. Preparation of Polytene chromosome from Chironomous larva/Drosophila larva

2. Demonstration of mammalian sex chromatin.

3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).

4. Perform Southern Blot Hybridization (Restrict DNA for Southern Blot electrophoresis, perform electrophoresis of restricted DNA, perform southern transfer, hybridization and detection of gene of interest)

5. Demonstration of Northern Blotting.

6. Demonstration of Western Blotting.

7. Perform DNA amplification by PCR.

8. Study of semi-conservative replication of DNA through micrographs/schematic representations.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition.John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology.VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

• Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)

• 5.Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

CORE COURSE CODE UBC 303: RECOMBINANT DNA TECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The main objective of this paper is to ensure that the student develops a clear comprehension of the concepts of recombinant DNA technology. The student will get acquainted with the tools and techniques used such as the enzymes, vectors, and cloning methods that can be used, and the applications of cloning such as creation of DNA libraries and recombinant products. A final exercise on a suitable strategy towards developing a genetically modified crop is incorporated to empower the student to apply the knowledge gained**.**

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will get an overview of developments and contributions of scientists in the field of genetic engineering.

CO2: Will get familiarized with basic cloning tools such as enzymes used to manipulate DNA, and cloning vectors.

CO3: Will have learnt various gene delivery methods and basic essential techniques of DNA, RNA and protein analysis.

CO4: Will gather in-depth knowledge of DNA amplification and sequencing methods, and become conversant with construction and screening of genomic and cDNA libraries

CO5: Will become aware of the applied aspects of all major techniques being used for the benefit of humankind in the areas of agriculture and pharmaceuticals. Students will design a strategy outlining all the steps of developing a novel recombinant.

COURSE CONTENTS

Unit I

Introduction to basic biotechnology: Milestones in genetic engineering and biotechnology, Tools of recombinant DNA technology, Hosts, E. coli strains; Yeast (Saccharomyces cerevisiae, Pichia pastoris); Fungi (Penicillium, Aspergillus), Mammalian cell lines - names and genotypes, Enzymes Restriction modification systems:Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications, Cloning Vectors- Definition and Properties. Plasmid vectors.

Unit II

Mammalian Expression Vectors: SV40, Vaccinia, Retroviral promoter based vectors, Basic DNA Cloning, Simple cloning of DNA fragments, Vectors: Definition and properties. E. coli

expression vectors-lac, tac and T7 promoter based vectors. Yeast expression vectors, Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation

Unit III

Methods of gene delivery in plants and animals: Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery, Methods of DNA, RNA and Protein analysis and DNA typing: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display

Unit IV

Amplification of nucleic acids: Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction, Construction of Genomic and cDNA libraries, Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR

Unit V

DNA sequencing and synthesis: Maxam-Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project, Product of DNA technology: Human protein replacementsinsulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal

Practicals

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.

2. Ligation of DNA fragments.

3. Demonstration of PCR.

4. Interpretation of sequencing gel electropherograms.

Suggested reading

• Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press, USA.

• Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.

• Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.

• Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM Press Washington D.C.

• Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill, India.

• Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

• Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

• Willey JM, Sherwood LM, and Woolverton CJ. (2008) Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

ELECTIVE COURSE CODE UBE 301: FUNDAMENTALS OF BIOPHYSICS

(COURSE CREDIT= 03)

Course Objectives:

The course aims to refresh knowledge of basic physics and chemistry to empower the learner in applying physical principles in chemical reactions and physiological systems.

Course Learning Outcomes:

CO1: Discuss molecular organization of different levels of protein and molecular structure of water- hydrogen bonds and physical property of water.

CO2: Knowledge of storage, flow of energy and their applications-electrical properties of biological compartments; electrochemical gradients, membrane potential, chemiosmotic hypothesis.

CO3: Application of law of optics in understanding strategies of light reception in microbes, plants and animals, correction of vision faults, generation and reception of sonic vibrations.

CO4: Understanding Neurotrasmitters, Intra and intermolecular interactions in biological system Spatial and charge compatibility as determinant of such interactions by applying laws of electricity.

CO5: Knowledge of principle, design, methods and application of UV spectroscopy; circular Dichroism and optical rotatory dispersion (ORD); Florescence spectroscopy; Infrared spectroscopy; NMR and ESR spectroscopy, Chromatography, Electrophoresis and Centrifugation.

COURSE CONTENTS

UNIT I

Introduction to Biophysics: Molecular organization, different level, organization of proteinprimary, secondary, tertiary and quaternary structure, Biophysics of Water: Molecular structure of water, hydrogen bonds and physical properties of water.

UNIT II

Bio-energetic: Laws of thermodynamics (1st & 2nd laws), electrical properties of biological compartments; electrochemical gradients, membrane potential, chemiosmotic hypothesis.

UNIT III

Energetic of a living body: Primary events in photosynthesis; strategies of light reception in microbes, plants and animals. Correction of vision faults, generation and reception of sonic vibrations.

UNIT IV

Electrical properties of biological compartments: Electricity as a potential signal, Neurotrasmitters, Intra and intermolecular interactions in biological system Spatial and charge compatibility as determinant of such interactions.

UNIT V

Principle, Instrument design, methods and application of UV spectroscopy; circular Dichroism and optical rotatory dispersion(ORD); Flurescence spectroscopy; Infrared spectroscopy; NMR and ESR spectroscopy, Chromatography, Electrophoresis and Centrifugation.

Practicals

1. Meaurement of pH using pH paper and pH meter-minor

2. Centrifugation – cell fractionation and separation of nuclei

3. Colorimetry – (a) Preparation of standard curve and estimate the concentration of solute in an unknown sample, (b) Determination of absorption maxima-minor

4. Chromatography – Determination of Rf value of amino acid and identification of amino acid.

5. Gel electrophoresis – demonstration.

6. Microscopy- Examination and study of parts of compound microscope, Camera lucida and its uses; micrometry- Calibration of microscope using stage and ocular micrometers, measurement of microscopic objects-minor

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ELECTIVE COURSE CODE UBE 302: FERMENTATION TECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course is focused to enhance student's ability to develop skill in the field of commercial production units.

Course Learning Outcomes:

CO1: To understand the basis of fermentation.

CO2: To formulate and design the production media.

CO3: Screening and selection of production strains.

CO4: Operating and supervision of Fermenters.

CO5: Designing of fermentation processes for the products recovery. Knowledge of Biosafety and patent laws

COURSE CONTENTS

UNIT I

Definition, equipments and production process; Fermentation processes, Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations

UNIT II

Bioreactors/fermenters , Components of a typical bioreactor, types of bioreactors-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

UNIT III

Control parameters, industrially important strains, media ingredients Measurement and control of fermentation parameters, Control and monitoring of different parameters in a bioreactor; pH, temperature, dissolved oxygen, foaming and aeration Isolation of industrially important microbial strain, Primary and secondary screening, strain development, preservation and maintenance of industrial strains Media and ingredients for industrial fermentations Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

UNIT IV

Down-stream Processing, Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.

UNIT V

Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses), Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations. Enzyme immobilization, Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

List of Practicals:

1. Comparative analysis of design of a batch and continuous fermenter.

2. Calculation of Mathematical derivation of growth kinetics.

3. Solvent extraction & analysis of a metabolite from a bacterial culture.

4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.).

Suggested Readings

1. Sullia S. B& Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.

2. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.

3. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.

4. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.

5. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.

6. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.

7. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., Aditya Books (P) Ltd. REFERENCE BOOKS:

8. Pauline.M.Doran ., "Bioprocess Engineering Principles";Academic press ..

9. Peter F.Stanbury, Allan Whitaker, "Principles of Fermentation Technology"

10. Michael L.Shuler and Fikret Kargi, "Bioprocess Engineering Basic concepts", Prentice Hall, 1992.

FOURTH SEMESTER

CORE COURSE CODE UBC 401: IMMUNOLOGY (COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to develop a clear understanding about the host immune system and advances in the field of Immunology. The student will become familiar with the cells, tissues, and organs constituting the immune system and the various mechanisms used to defend host against microorganisms.

Course Learning Outcomes: Upon successful completion of the course, the student

CO1: Will be acquainted with the emergence of immunology and how the immune system protects us from infection through various lines of defense. Will have gained an in-depth knowledge of characteristics and functions of the cells of the immune system and the organization of organs of the immune system.

CO2: Can understand the characteristics that make the molecules to act as antigens. The students will also be conversant with the types, properties and functions of antibodies made against the antigens. Will be able to outline the production and use of monoclonal antibodies

CO3: Will understand the cell surface proteins essential for generation of acquired immune response to differentiate self and non-self molecules and the pathways for antigen processing and presentation.

CO4: Will be acquainted with the mechanisms by which the complement system is recruited and enhances (complements) the ability of antibodies and phagocytic cells to clear microbes and damaged cells from an organism, promotes inflammation, and attacks the pathogen's cell membranes.

CO5: Will be acquainted with the generation and the killing mechanisms of humoral and cell mediated immunity. Will have gained in depth knowledge of various immunological techniques. Will be able to outline the immunodeficiency disorders like autoimmunity and hypersensitivity.

COURSE CONTENTS

UNIT I

Introduction: Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa, Immune Cells and Organs: Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs: Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

UNIT II

Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Haptens, Epitopes (T & B cell epitopes); T-dependent and T-independent antigens, Adjuvants, Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

UNIT III

Major Histocompatibility Complex: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways), Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation

UNIT IV

Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells), Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals), Killing Mechanisms by CTL and NK cells, Introduction to tolerance

UNIT V

Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies- Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens, Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR.

List of Practicals

1. Identification of human blood groups.
2. To perform Total Leukocyte Count of the given blood sample.
3. To perform Differential Leukocyte Count of the given blood sample.
4. To separate serum from the blood sample (demonstration).
5. To perform immunodiffusion by Ouchterlony method.
6. To perform DOT ELISA.

7. To perform immunoelectrophoresis.

Suggested reading

• Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.

• Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.

• Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

• Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.

• Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

• Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

CORE COURSE CODE UBC 402: CELL BIOLOGY II

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners by providing understanding of structure and function of cell, its component and transport across various organelles by empowering the learners with different tool and techniques of cell biology. It will provide deep understanding of cellular aspect of mechanism of signal transduction, cell cycle and cancer.

Course Learning Outcomes:

CO1: Understanding of cell structure of prokaryotic and eukaryotic cell, apply knowledge of microscopic techniques for cell study.

CO2: Knowledge of criteria of function integrity and structure of different cell organelles and transport of ions, nutrients and macromolecules across membranes.

CO3: Empowers student to acquire knowledge about signal transduction pathway with understanding of different type of receptors and signaling molecules.

CO4: Conceptualize cell cycle, cell division and cell death. Deep understanding of events of mitosis, apoptosis, embryonic stem cells and therapeutic cloning.

CO5: Empowers student to acquire knowledge about biology of cancer its causes. Understanding of oncogenes, tumor suppressor gene, tumor viruses and molecular approach of cancer treatment.

COURSE CONTENTS

UNIT I

The cell theory and precellular evolution. The Plasma Membrane: Structure; Transport of small molecules, Endocytosis.

UNIT II

Cell Wall, the Extracellular Matrix and Cell Interactions: Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions.

UNIT III

Cell Signaling: Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.

UNIT IV

The Cell Cycle & Cell Death and Cell Renewal: Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization. Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

UNIT V

Cancer: Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

Practicals

1. To demonstrate the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.

2. Study of polyploidy in Onion root tip by colchicine treatment.

3. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.

4. Study of mitosis and meiosis from permanent slides.

5. Identification and study of cancer cells- Slides/Photomicrographs.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

CORE COURSE CODE UBC 403: MOLECULAR BIOLOGY II

(COURSE CREDIT= 03)

Course Objectives:

Student will study about the molecular biology, different biochemical reaction and processes such as transcription and translation within the living system. These biochemical processes control and regulated by different enzymes, inhibitors, activators.

Course Learning outcomes –

CO1: RNA transcription in Prokaryotes and Eukaryotes, transcriptional regulation, RNA splicing and editing, Protein synthesis, ribosome structure and assembly,

CO2: Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependent regulation of mRNA and Protein Stability.

CO3: Transcription Regulation in Eukaryotes mechanisms, Signal integration, combinatorial control, transcriptional repressors, signal transduction, Gene Silencing

CO4: Regulatory RNAs, Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and Xinactivation.

COURSE CONTENTS

UNIT I

Mechanism of Transcription: RNA Polymerase and the transcription unit, Transcription in Prokaryotes and Transcription in Eukaryotes

UNIT II

RNA Modifications: Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

UNIT III

Translation (Prokaryotes and Eukaryotes): Assembly line of polypeptide synthesis ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis, Regulation of translation, Translation-dependent regulation of mRNA and Protein Stability.

UNIT IV

Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons

UNIT V

Transcription Regulation in Eukaryotes & Regulatory RNAs: Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X inactivation

List of Practicals

1. Preparation of culture medium (LB) for E.coli (both solid and liquid) and raise culture of E.coli.

2. Demonstration of antibiotic resistance. (Culture of E.coli containing plasmid (pUC 18/19) in LB medium with/without antibiotic pressure and interpretation of results).

3. Isolation and quantitative estimation of salmon sperm / calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).

4. To perform Ames test in Salmonella / E.coli to study mutagenicity.

SUGGESTED READINGS

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

• Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)

• Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

ELECTIVE COURSE CODE UBE 401: GENETICS & GENOMICS I

(COURSE CREDIT= 03)

Course Objectives:

The major objective of this course is to develop clear understanding of various aspects of microbial genetics and genomes in relation to microbial survival and propagation and to enable students to better understand courses taught later such as recombinant DNA technology and other allied papers.

Course Learning Outcomes: Upon successful completion of the course, the student will have

CO1: Understanding Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. The student will be able to correlate Mendel's ratios through Mitosis and Meiosis.

CO2: Knowledge of Principles and theories of Inheritance, pedigree analysis, extensions of Mendelian Genetics; Incomplete and co dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

CO3: Deep understanding of crossing over and its Cytological and Molecular mechanism. They will be able to measure linkage intensity using Recombination frequency, two factor and three factor crosses, Interference and coincidence. Knowledge of somatic cell genetics an alternative approach to gene mapping.

CO4: Conceptualize types of Mutation, its molecular basis of mutation and detection using Attached X method, DNA repair mechanisms.

CO5: Empowers the student about mechanism of sex Determination: Environmental factors, Barr bodies, Dosage compensation, extra chromosomal Inheritance: Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, maternal effects, Infective heredity- Kappa particles in Paramecium. Understanding of Quantitative Genetics: Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

COURSE CONTENTS

Unit I

Introduction to Genetics: Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Mitosis and Meiosis: Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

Unit II

Mendelian Genetics and its Extension: Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Unit III

Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics an alternative approach to gene mapping.

Unit IV

Mutations: Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

Unit V

Sex Determination: Chromosomal mechanisms, Environmental factors determining sex determination, Barr bodies, Dosage compensation. Extrachromosomal Inheritance: Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity- Kappa particles in Paramecium. Quantitative Genetics: Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

List of Practicals:

- Mendelian laws and gene interaction using Drosophila crosses.
- 2. Chi-square and probability.

ELECTIVE COURSE CODE UBE 402: BIOINFORMATICS

(COURSE CREDIT= 03)

Course Objectives:

Students are empowered to make independent usage of biological databases, understand various retrieval and alignment tools of biological sequences, and apply bioinformatics in different disciplines related to human welfare.

Course learning outcomes:

CO1: Students get familiarized with hardware and software of modern computers. They understand system and application softwares.

CO2: Students are exposed basics of bioinformatics and its tools.

CO3: Students study various biological databases, retrieval of genetic and biomolecular sequences.

CO4: Students learn various retrieval and alignment tools including construction of phylogenetic trees and annotations on sequences.

CO5: Students learn about different techniques and tools of genome analyses and reconstruction of metabolic pathways.

COURSE CONTENTS

Unit I

Computers: General introduction (characteristics, capabilities, generations), software, hardware: organization of hardware (input devices, memory, control unit arithmetic logic unit, output devices); software : (System software; application software, languages -low level, high level), interpreter, compiler, data processing; batch, on-line, real-time (examples from bioindustries; e.g. application of computers in co-ordination of solute concentration, pH, temperature, etc., of a fermenter in operation); internet application.

Unit II

Basic Bioinformatics: Introduction to Internet, Search Engines (Google, Yahoo, Entrez etc)

Unit III

Biological Databases: Sequence databases (EMBL, GenBank, DDBJ, -UNIPROT, PIR, TrEMBL), Protein family/domain databases (PROSITE, PRINTS, Pfam, BLOCK, etc), Cluster databases-An Introduction, Specialised databases (KEGG, etc), Database technologies (Flat-file), Structural databases (PDB)

Unit IV

Phylogenetic Analysis: Trees-splits and metrices on trees, tree interpretation, Distance – additive, ultrameric and nonadditive distances, tree building methods, phylogenetic analysis, parsimony, tree evaluation, maximum likelihood trees – continuous time markov chains, estimating the rate of change, likelihood and trees; analysis software. Annotation, comparison of different methods; ESTs – databases, clustering, gene discovery and identification, and functional classification.

Unit V

Genome analysis: Annotation, comparison of different methods; ESTs – databases, clustering, gene discovery and identification, and functional classification. Reconstruction of metabolic pathways; Genome analysis, genome anatomy, genome rearrangements with inversions, signed inversions, identification and functional classification.

Suggested reading

• Computer Science, J.G. Brookshear, Pearson, Addison Wesley

• Introduction to Bioinformation – T.Attawood

• A book on C by Kelley : Programming in C, Addison-Wesley Publishing

• Introduction to C++ for Engineers and Scientists, Prentice-Hall

• Schaum's Outline of Introduction of Computer Science, P. Cushman and R. Mata-Toledo, McGraw Hill Trade

• Bioinformatics – Managing Scientific Data, Zoe' Lacroix and Terence Critchlow

• Bioinformatics – Sequence, Structure and Databanks, Des Higgins & Willie Taylor

• Structural Bioinformatics, Philip E. Bourne, Helge Weissig 2003

• Statistical Methods in Bioinformatics: An Introduction, G.R. Grant, W.J. Ewens, Springer

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FIFTH SEMESTER

CORE COURSE CODE UBC 501: PLANT BIOTECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to impart understanding of the concepts, principles and techniques of plant tissue culture.

Course Learning Outcomes:

CO1: Recall terms, definitions and history of in vitro cultures in our country. Describe embryo and endosperm culture, embryo rescue after wide hybridization and its applications.

CO2: Knowledge of processes of plant regeneration under in vitro conditions and their practical application – organogenesis, somatic embryogenesis, meristem, Shoot tip culture and haploids.

CO3: Conceptualize protoplast isolation, culture and various steps in the regeneration of protoplasts.

CO4: Discuss various methods for fusing protoplasts- chemical and electrical. Define Cybrids and its application.

CO5: List use of plant cell, protoplasts and tissue culture for genetic manipulation of plants and practical application of genetic transformation. Understanding of Tumor formation on plants using A.tumefaciens (Monocots vs. Dicots).

COURSE CONTENTS

UNIT I

Terms and definitions. Beginning of in vitro cultures in our country (ovary and ovule culture, in vitro pollination and fertilization. Embryo culture, embryo rescue after wide hybridization, and its applications, Endosperm culture and production of triploids.

UNIT II

Introduction to the processes of embryogenesis and organogenesis and their practical applications: Micropropagation, axillary bud, shoot-tip and meristem culture. Haploids and their applications. Somaclonal variations and applications (Treasure your exceptions).

UNIT III

Introduction to protoplast isolation: Principles of protoplast isolation and applications, testing of viability of isolated protoplasts. Various steps in the regeneration of protoplasts.

UNIT IV

Introduction of somatic hybridization: Various methods for fusing protoplasts, chemical and electrical. Cybrids- definition and application.

UNIT V

Use of plant cell, protoplasts and tissue culture for genetic manipulation of plants: Introduction to A. tumefaciens. Tumor formation on plants using A.tumefaciens (Monocots vs. Dicots), Practicalapplication of genetic transformation.

Suggested reading

• An Introduction to Plant Tissue Culture, M.K. Razdan, Oxford and IBH Publishing

• Experiments in Plant Tissue Culture, J.H. Dodds and L.K. Roberts, Cambridge University Press

• Plant Biotechnology and Transgenic Plants, K.M.O. Caldenty, W.H. Barz and H.L. Wills, Marcel Dekker

• Plant Biotechnology, J. Hammond, P. McGarvy and V. Yusibov, Springer Verlag.

• Plant Cell & Tissue Culture for the production of Food Ingredients, T-J Fu, G. Singh and W.R. Curtis, Kluwer Academic/Plenum Press

• Plant Tissue Culture: Theory & Practice, S.S. Bhojwani and M.K. Razdan, Elsevier Health Sciences

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CORE COURSE CODE UBC 502: ENVIRONMENTAL BIOTECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners with the basic concepts of the environmental components, pollution and its types, energy resources, global environmental issues, treatment of the municipal solid and liquid wastes, EIA and the basic concepts of the biofertilizers and biopesticides.

Course Learning Outcomes:

CO1: Deep understanding of existing and emerging technologies dealing with management of environmental quality and pollution.

CO2: Empowers the students with the knowledge of municipal solid and liquid waste treatments, Classification of Wastes.

CO3: Students will able to learn about the renewable and non-renewable energy resources and clean fuel technologies.

CO4: Students will be able to understand EIA and environmental audit.

CO5: Conceptual understanding of global environmental problems- ozone depletion, UV-B greenhouse effects and global warming, acid rain, and their impacts and biotechnology approaches for management.

COURSE CONTENTS

UNIT I

Environmental components, Environmental pollution and its types, Non-renewable and renewable energy resources. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT II

Conventional fuels and their major impacts: Global warming and greenhouse effect, Global Ozone Problem, Acid rain, Eutrophication, Biomagnification, Concept of clean fuel technology: Biomass energy and biofuels

UNIT III

Biodegradation and bioremediation of major pollutants, Biomineralisation: Use of microbial technology for mining

UNIT IV

Treatment of municipal solid and liquid wastes, Environmental impact assessment and

Environmental audit

UNIT V

Bioassessment of Environmental Quality, Biofertilizers and Biopesticides

Suggested reading

• Environmental Science, S.C. Santra

• Environmental Biotechnology, Pradipta Kumar Mohapatra

• Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and

Jesef Winter

• Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

• Agricultural Biotechnology, S.S. Purohit

• Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John

F.T. Spencer

• Introduction to Environmental Biotechnology, Milton Wainwright

• Principles of Environmental Engineering, Gilbert Masters

• Principles of fermentation Technology, Salisbury, Whitaker and Hall

• Industrial Microbiology – Cassida

• Agricultural Biotechnology – S.S. Purohit

• Wastewater Engineering – Metcalf & Eddy.

CORE COURSE CODE UBC 503: ANIMAL BIOTECHNOLOGY

(COURSE CREDIT= 03)

Course Objectives:

The course aims to empower the learners with the concepts of culture, preservation, maintenance, production of animal cells and application of stem cells.

Course Learning Outcomes:

CO1: Deep understanding of animal cell culture substrate, culture media, preservation and maintenance of cell lines.

CO2: Empowers the students with the knowledge of production of monoclonal antibodies, and bioreactors for large scale culture of cells.

CO3: Students learn different growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, and erythropoietin).

CO4: Knowledge of transgenic animals, in vitro fertilization and embryo transfer.

CO5: Conceptual understanding of Transplantation, Stem cells and its application.

COURSE CONTENTS

Unit I

Introduction of animal cell culture substrate, culture media, preservation and maintenance of cell lines.

Unit II

Production of monoclonal antibodies, Bioreactors for large scale culture of cells.

Unit III

Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin).

Unit IV

Transgenic animals, In-vitro fertilization and embryo transfer.

Unit V

Transplantation, Stem cells and its application,

Suggested reading

• Culture of Animal Cells, R.I Freshney, Wiley-Leiss.

• Animal Cell Culture – A Practical approach, J.R.W. Masters, Oxford.

• Animal Cell Culture Techniques, M. Clynes, Springer Verlag.

• Cell Culture Lab Fax, M. Butler and M. Dawson, Bios scientific Publications Ltd.

• Cell Growth and Division – A Practical approach, R. Basega, IRL Press.

• Comprehensive Biotechnology, Moo-Young, Alan T. Bullm Howard Dalton, Panima Publication.

ELECTIVE COURSE CODE UBE 501: ENTREPRENEURSHIP & IPR

(COURSE CREDIT= 03)

Course Objectives:

The course imparts necessary knowledge and skills required for organizing and carrying out entrepreneurial activities, developing the ability of analyzing and understanding business situations.

Course Learning Outcomes:

CO1: Understanding entrepreneurship, human behavior, business ethics, performance appraisal and (SWOT) analysis

CO2: Knowledge of Market survey techniques with principles of product selection and development.

CO3: Deciphering marketing and sales management; its characteristics and techniques.

CO4: Understanding financial – institutions, incentives and statements; books of accounts.

CO5: Application of technical feasibility of project, plant layout and process planning of product. QC, CPM, PERT for establishing SSI.

COURSE CONTENTS

Unit I

Need, scope and characteristics of entrepreneurship management of self and understanding human behaviour, business ethics, performance appraisal, and (SWOT) analysis.

Unit II

Market survey techniques, Criteria for the principles of product selection and development.

Unit III

Marketing & Sales Management- (a) Nature of product and market strategy (b) Packaging and advertising (c) After Sales Service (d) Pricing techniques.

Unit IV

Financial institutions, financial incentives, books of accounts and financial statements.

Unit V

Technical feasibility of the project, plant layout & process planning for the product, Quality Control, Critical Path Method (CPM) and Project Evaluation Review Techniques (PERT) as planning tools for establishing SSI.

Suggested reading

• Entrepreneurship: New Venture Creation, David H. Holt

• Patterns of Entrepreneurship : Jack M. Kaplan

• Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.

ELECTIVE COURSE CODE UBE 502: GENETICS & GENOMICS II

(COURSE CREDIT= 03)

Course Objectives:

This course aims to provide an insight and understanding of functional genomics, system biology, population genetics, and developmental biology. This course also introduces learners to bioinformatics.

Course Learning Outcomes:

CO1: Knowledge of genetic analysis and mapping in Bacteria and Bacteriophages.

CO2: Understanding of transposable element; prokaryotic, composite. Eukaryotic and uses of transposons.

CO3: Conceptualize the mechanism of developmental biology and embryonic development of different model; Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana, and Xenopus laevis.

CO4: Understand different biological database that provide information about protein and nucleic acid, sequence similarity and alignment; Gene feature identification. Understanding of Gene Annotation and analysis of transcription and translation; Post-translational analysis and Protein interaction.

CO5: Knowledge of genetic analysis, system biology, functional genomics, forward and reverse genetics. Understanding of population and evolutionary genetics.

COURSE CONTENTS

Unit I

Genetic Analysis and Mapping in Bacteria and Bacteriophages: Conjugation; Transformation; Transduction, Recombination.

Unit II

Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses: Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in Drosophila; Uses of transposons; Eukaryotic Viruses.

Unit III

Developmental Genetics and Model System: Study of model systems in developmental genetics- Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana, and Xenopus laevis.

Unit IV

Genomics, Bioinformatics and Proteomics: Genomes of bacteria, Drosophila and Humans; Human genome project; Evolution and Comparative Genomics. Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification. Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

Unit V

Genomic Analysis- Dissection of Gene Function: Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology. Population Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.Evolutionary Genetics: Genetic variation and Speciation.

Practicals

1. Genomic DNA isolation from E.coli (without plasmid).

2. Restriction enzyme digestion of genomic DNA from E.coli.

3. Isolation of plasmid DNA and genomic DNA together from E.coli. and restriction enzyme digestion.

4. Restriction enz yme digestion (EcoRI) of genomic and plasmid DNA (obtained from Expt.3).

5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.

6. Construction of Restriction digestion maps from data provided.

7. Demonstration of DNA fingerprinting.

Suggested reading

• Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

• Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

• Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

• Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.

• Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant

DNA. ASM Press, Washington

• Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

• Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.

• Ghosh, Z. and Mallick,V. (2008). Bioinformatics-Principles and Applications. Oxford

SIXTH SEMESTER

(A) DISSERTATION	CREDITS	MAXIMUM MARKS
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:

The key objective of this semester is to introduce the students to concepts in identification of a research problem and developing a hypothesis. The course will enable students to learn how to carry out survey of literature, perform experiments, and analysis of data. The student will learn how to write a scientific project report, and oral presentation of the results.

Course Learning Outcomes:

CO1: A student is able to formulate a hypothesis to be tested and learns how to collect and read literature related to the hypothesis.

CO2: Student is able to design experiments to test that hypothesis. Student is exposed to the use of a variety of instruments and is able to perform experiments such as making culture media for various biological organisms, its isolation from different sources, and examine its capacity to produce compounds of industrial importance.

CO3: Student learns about ethical issues in conducting research. Student learns how to examine the obtained data and interpret the results; and learns how to discuss their results integrating with earlier relevant researches.

CO4: Student learns the skill of writing a project report and its effective presentation before peers.

CO5: Student learns about ethical issues related to publishing, plagiarism and self-plagiarism.

RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR
SYLLABUS PRESCRIBED FOR THE DEGREE OF THE MASTER OF SCIENCE IN BIOSCIENCE IN UNIVERSITY TEACHING DEPARTMENT
(Academic Session 2020-2021 & Onwards)
[PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM - ORDINANCE 222]

This brochure of the programme for the M.Sc. degree in Bioscience consists of six parts, viz., (A) Information from the relevant Ordinance(s) / Statutes, (B) Programme Objective (C) Programme Outcomes (D) Programme Specific Outcomes (PSOS) (E) Scheme of examination and (F) Courses of study.

A. INFORMATION FROM THE RELEVANT ORDINANCE (S)/STATUTES

1. DURATION OF THE COURSE

M.Sc. Bioscience will be a full time two-year programme to be covered in four semesters, each of six months duration. The first year of the programme will complete the I and II semesters, and the second year will complete the third and fourth semesters. The maximum duration of the programme shall be twice of the minimum duration of the programme, i.e. four years.

2. ADMISSION TO THE COURSE

The number of seats shall be in accordance with the directives by the University. A candidate, who after having secured the B.Sc. degree with at least 50 % marks from a recognized university with a subject of Life Science, shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to guidelines from the University and Government of Madhya Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester.

3. TUITION AND OTHER FEES

The admitted candidate shall pay the course fee in addition to the tuition fee and such other fees as prescribed by the University.

4. PROGRAM OF THE STUDY

The semester will consist of 16-18 weeks of academic work. One credit is equivalent to one hour (60 minutes) of teaching (lecture or tutorial) or two hours (120 minutes) of practical work/field work per week throughout a semester. The credits associated with the courses will be valid credits, while credits associated with comprehensive viva voce will be virtual credits. In the end term examination there will be **three components, namely Core Courses, Elective Courses and Skill Development Course,** except for the 4th semester where every student will carry out and submit a **dissertation**

The syllabus for the theory and practical examination will be prescribed by the Board of Studies in Bioscience, R.D. University, Jabalpur.

5. CONTINUOUS EVALUATION

During the semester, a teacher offering the course will do the continuous evaluation of the student at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and the third may be written test/quiz/seminar/assignment. Marks obtained in two best tests out of three will be awarded to the student.

6. ATTENDANCE

The student whose attendance is less than 75 % will not be allowed to appear in the end semester examination and he/she will be declared fail in that semester.

7. END SEMESTER EXAMINATION

There shall be end semester examination at the end of first, second & third semester. The semester examination will be held every year normally in December and June or on the dates declared in the academic calendar of the University. A student proceeding to appear in end semester examination will submit through the Head of the Department his / her application on the prescribed form along with required examination fee, etc. to the Registrar of the University. Every student will appear in four respective theory papers and two combined practical examinations in first, second, & third semesters except for the fourth semester. In the fourth semester, every student will be allotted dissertation work in lieu of four theory papers. Allotment of the dissertation will be done by a committee comprising of the Dean of Faculty of Life Science, Head of Department of Biological Science, one Professor and one Associate Professor of the Department by rotation according to seniority. The dissertation may be undertaken in UTD or in any of the National Laboratories/ Institute/ Universities/ Government approved Companies/ Industries. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his/her dissertation work.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

8. CONDITION FOR A PASS

For each course, each student has to appear in at least two tests and end semester examination, otherwise the student will be awarded "Ab" grade. The total marks obtained in end-semester examination, and best of two tests under continuous evaluation will decide the grade in that course. In addition, student also has to get valid credits for Skill development modules' courses and Virtual credits and grades for Comprehensive viva-voce. The grading will be made on 10-point scale as follows:

Letter Grade	Grade Points	Description	Range of Marks (%)
O	10	Outstanding	90-100
A+	9	Excellent	80-89
A	8	Very Good	70-79
B+	7	Good	60-69
B	6	Above Average	50-59
C	5	Average	40-49
P	4	Pass	35-39
F	0	Fail	0-34
Ab	0	Absent	Absent

For passing the examination in each semester, a candidate must have secured a minimum of 35% marks ("P" Grade: 4 Grade Points) in the course. If the marks obtained by the student in a course are less than the minimum cut-off percentage of marks, then "F" Grade will be awarded. If a student obtains "F" or "Ab" Grade in any course, he/she will be treated to have failed in the course. He/she has to reappear in the examination of the course as and when conducted or arranged by the UTD. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course.

The theoretical, practical and skill development courses can be repeated whenever offered or arranged by the UTD but within maximum duration of the programme. He/she can avail multiple repeat attempts to pass the course. The student will be promoted to the next

semester if he/she secures at least 12 valid credits in a semester. In case the student secures less than 12 valid credits in any semester, then the student will be asked to repeat entire semester and that semester will be treated as zero semester.

The decision of the teacher regarding the evaluation and the grade shall be final. However, a student submits in writing for review of his Marks/Grade to the Head/Director who will place the case before the board of comprehensive viva voce. The decision of the board will be final. Result of review will be declared by the concerned Head/Director. Review is effective only when grade improves. Review will be allowed only if –

- The prescribed fee is paid.
- The candidate applies within 7 days of the declaration of the grade in that course.

There will be no provision for revaluation. However the candidates can apply for Re-totaling in one course per semester.

9. In matters not covered under this Ordinance, general rules of the University shall be applicable.

10. In case of any dispute/ambiguity, the ruling of the Vice-Chancellor shall be final and binding.

B.PROGRAMME OBJECTIVES

C. PROGRAMME OUTCOMES

D. PROGRAMME SPECIFIC OUTCOMES (PSOS)

E. SCHEME OF EXAMINATION

SEMESTER I

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks			
Course Code	Course Title		Continuous Evaluation	End Semester Exam	Total	
I Core courses						
BSC101	Biological Diversity of Viruses, Bacteria and Fungi	**3**	**40**	**60**	**100**	**SKILL**
BSC102	Developmental Biology (Animal)	**3**	**40**	**60**	**100**	**SKILL**
BSC103	Basic Ecology	**3**	**40**	**60**	**100**	**SKILL**
BSC104	Practical based on BSC101 & BSC102	**4**	**40**	**60**	**100**	**SKILL**
BSC105	Practical based on BSC103 & BSE101/ BSE102	**4**	**40**	**60**	**100**	**SKILL**
II Electives courses (Any one to choose)						
BSE101	Biomolecules	**3**	**40**	**60**	**100**	**SKILL**
BSE102	Bioenergetics and Intermediary Metabolism					**SKILL**
III Skill Development course						
BSS101	Skill Development module 1	**2**	**Grade Point will be provided by Skill Development Centre**			**SKILL**
Total valid credits		**22**				

(B) Comprehensive viva voce (virtual credits)	**4**		**50**	

SEMESTER 5

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks			
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**	
I Core courses						
BSC201	Taxonomy of Angiosperms	**3**	**40**	**60**	**100**	**SKILL**
BSC202	Biostatistics and Computer Applications	**3**	**40**	**60**	**100**	**SKILL**
BSC203	Practical based on BSC201 & BSC202	**4**	**40**	**60**	**100**	**SKILL**
BSC204	Practical based on BSE201/ BSE202/ BSE203 (Any Two courses)	**4**	**40**	**60**	**100**	**SKILL**
II Electives courses (Any two to choose)						
BSE201	Biology of the Immune System	**3**	**40**	**60**	**100**	**SKILL**
BSE202	Resource utilization and conservation	**3**	**40**	**60**	**100**	**Enterpreneurship**
BSE203	Microbial Metabolism					**SKILL**
III Skill Development course						
BSS201	Skill Development module 2	**2**	**Grade Point will be provided by Skill Development Centre**			**SKILL**
Total valid credits		**22**				

(B) Comprehensive viva voce (virtual credits)	**4**		**50**	

SEMESTER 6

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks			
Course Code	**Course Title**		**Continuous Evaluation**	**End Semester Exam**	**Total**	
I Core courses						
BSC301	Plant Physiology	**3**	**40**	**60**	**100**	**SKILL**
BSC302	Genetics & Molecular Biology	**3**	**40**	**60**	**100**	**Employbility**
BSC303	Animal Physiology	**3**	**40**	**60**	**100**	**SKILL**
BSC304	Practical based on BSC301 & BSC302	**4**	**40**	**60**	**100**	**SKILL**
BSC305	Practical based on BSC303 & BSE301/ BSE302/ BSE303/ BSE304	**4**	**40**	**60**	**100**	**SKILL**
II Electives courses (Any one to choose)						
BSE301	Advanced Molecular Biology	**3**	**40**	**60**	**100**	**Employbility**
BSE302	Agricultural Microbiology					
BSE303	Bioprocess Engineering and Technology					
BSE304	Biotechnology					
III Skill Development course						
BSS301	Skill Development module 3	**2**	**Grade Point will be provided by Skill Development Centre**			**SKILL**
Total valid credits		**22**				

(B) Comprehensive viva voce (virtual credits)	**4**		**50**	

*Both (A – Core courses; One/Two Elective course(s) and Skill Development modules) & (B) are compulsory components of a semester. The grades awarded in the comprehensive Viva-voce shall be shown separately in the Grade Sheet.

SEMESTER IV

(A) DISSERTATION	Credits	Maximum Marks		
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**	**SKILL Employbility Enterpreneurship**	
B. Viva-Voce EXTERNAL		**50**		
C. Viva-Voce INTERNAL		**50**		
Total		**400**		

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

F. COURSES OF STUDY

FIRST – SEMESTER

COURSE CODE BSC101: BIOLOGICAL DIVERSITY OF VIRUSES, BACTERIA AND FUNGI
(COURSE CREDITS = 03)

Course Objective- The course aims to empower the learner with knowledge pertaining to the world of microorganisms; techniques for cultivation and their economic importance. It also aims to enable understanding of the habitat, structure, reproduction and classification of bacteria, viruses and fungi.

Course Learning Outcomes:

CO1: Conceptualize the history and scope of microorganisms with emphasis on origin and general features of prokaryotes and eukaryotes. Learners will be able to understand the status and economic importance of microorganisms in agriculture, industry and medicine.

CO2: Knowledge of basic techniques of staining, isolation, enumeration, maintenance and preservation of microbial culture; with understanding of composition of different culture media and nutritional requirement of microorganisms.

CO3: Empowers the student to acquire knowledge about the habitat, structure, reproduction, biochemical characterization and Classification of Bacteria, Cyanobacteria and Actinomycetes.

CO4: Understanding of the structure, multiplication and classification of viruses, Scrapie Virosoids, Prions and Viroids ; general account of Rickettsiae, Chlamydiae and Mycoplasma.

CO5: Knowledge of habitat, structure, reproduction and classification of fungi.

COURSE CONTENTS

UNIT I

History, Development and scope of microbiology, Origin and evolution of microorganisms, General features of prokaryotes and eukaryotes, Status of microorganisms in the living world, Economic significance of microorganisms in agriculture, Industry and medicine.

UNIT II

Basic principles of sterilization and disinfection, Nutritional requirement of microorganisms, Composition of common culture media, Methods of isolation and enumeration of microorganisms from soil, Water and air, Enrichment technique, Maintenance and preservation of microbial cultures, Staining techniques.

UNIT III

Habitat, Structure, Reproduction, Biochemical characterization and outline Classification of Bacteria (only major categories), Cyanobacteria and Actinomycetes.

UNIT IV

Structure, Multiplication and outline classification (major categories only) of viruses, Scrapie Virosoids, Prions and Viroids, General account of *Rickettsiae*, *Chlamydiae* and *Mycoplasma.*

UNIT V

Habitat, Structure, Reproduction and outline classification (major categories only) of fungi

Books Recommended

- Mandahar C. L. (1978) Introduction to Plant Viruses.
- Clifton A. (1958) Introduction to the Bacteria.

- Dubey, R. C. & Maheshwari, D. K. 2005: A Text Book of Microbiology, S. Chand Publisher, New Delhi.

COURSE CODE BSC102: DEVELOPMENTAL BIOLOGY (ANIMAL) (COURSE CREDITS = 03)

Course Objective: The syllabus of Developmental Biology is structured analytically to enable students to learn the structure and function of male and female reproductive organs, tissues and cells, and processes of their development. Further, the process of fertilization and development of fertilized egg into full individual is also dealt with in this course.

Course Learning Outcomes

- Enabling students to understand the process of development of male and female gonads including ultrastructural details of the reproductive tissues and cells.
- The students also learn the process of fertilization including initial changes in an ovum in terms of various planes of cleavages and their significance in eventual development of individuals, taking some examples of Annelids and Mollusks.
- The students are also made acquainted with initial process of embryogenesis; gastrulation and organogenesis taking some animal models.
- The fetus development is the next component with which students are versed with. The placental development and various types of mammalian placenta is also included.
- The students learn various aspects of metamorphosis and organogenesis with respect to life cycle transformations in insects and amphibians.

COURSE CONTENTS

UNIT I

Gametogenesis, Male and Female gonads, Spermatogenesis, Formation of spermatids, Spermiogenesis, Factors controlling the spermatogenesis, Ultra structure of male gametes, Oogenesis, Previtellogenesis post Vitellogenesis, Ultra structure of female gametes.

UNIT II

Fertilization, Types and mechanism acrosome reaction and penetration of sperm, Activation of ovum, Significance of fertilization, Cleavage & its various types, Planes of cleavage, cell lineage with examples from Annelida & Mollusca.

UNIT III

Gastrulation, Types and morphodynamic of gastrulation with examples from *Amphioxus* & Frog, Organogenesis (Brain and Heart only) of Frog, Embryonic induction brief idea.

UNIT IV

Foetal membranes**,** their formation, functions & fate, Placentation in mammals, Types and classification of Placentae.

UNIT V

Metamorphosis, Physiology and biochemistry of metamorphosis in insects & amphibian, regeneration of limb.

COURSE CODE BSC103: BASIC ECOLOGY (COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the students in the field of ecology with special reference to components, biogeochemical cycles, development and stability of the ecosystem along with the concept, analysis of the community and the biodiversity.

Course Learning Outcomes:

CO1: The student will able to get the huge knowledge of population ecology.
CO2: Students will be able to study the concept, organization and study of the community with the concept of niche and biodiversity.
CO3: Students will be able to understand the vegetative organization in community. Students will get to know about how changes take place during ecological succession.
CO4: Student will have developed knowledge about structure and function of ecosystem. They also will understand about biogeochemical cycle in environment and its role.
CO5: Demonstrate proficiency in the experimental techniques and methods to study the ecosystem.

COURSE CONTENTS

UNIT – I

Ecology & ecosystem: Definitions, Organization and components, Population ecology density & distribution, Natality, Mortality, Survivorship curves, Age structure & pyramids, Fecundity schedules, Life tables, Population growth exponential and logistic curves, Intra specific competition and self regulation, r-and k-strategists.

UNIT – II

Community organization: Concepts of community and continuum, Analysis of community analytical and synthetic characters, Community coefficients and indices of diversity, interspecific association negative and positive associations, Concept of ecological niche, Concepts of biodiversity.

UNIT- III

Ecosystem development and stability: Temporal changes cyclic and non cyclic, Succession processes & types, Mechanism of succession facilitation, Tolerance and inhibition models, Concept of climax persistence resilience and resistance, Ecological perturbation natural and anthropogenic, Ecosystem restoration.

UNIT – IV

Fate of energy in ecosystems: Trophic organization and structure, Food chains & webs, energy flow pathways, Ecological efficiencies consumption, assimilation and production trophic, Primary production methods of measurement, Global patterns, Limiting factors.

UNIT – V

Fate of matter in ecosystems: Recycling pathways, Relationship between energy flow and recycling pathways, Nutrient exchange and cycling, Global biogeochemical cycles of C, N, P and S, Physical, chemical and Biological characteristics of soil.

Books Recommended

- Ecology Principles and Applications 2nd Edition J.L. Chapman 1999.
- Ecology and quality of our environment 2nd Edition C.H. Southwick 1976.
- M. P. Singh, S. Chinnamani R.N. Trivedi (1993) forestry & environment.
- E. J. Koromand. (1996) Concept of Ecology.

COURSE CODE BSC104: PRACTICAL BASED ON COURSE CODE BSC101 & COURSE CODE BSC102 (COURSE CREDITS = 04)

Suggested list of practicals (Course Code BSC101)

1. To prepare liquid and solid media for the growth of microorganisms.

Nutrient broth
NAM
PDA

2. To isolate pure culture of microorganism by using different inoculation methods.
   Streaking
   Spreading
3. Isolation and identification of fungi from given water sample.
4. Isolation and identification of fungi from given soil sample.
5. Isolation and identification of fungi from given air sample.
6. Isolation and identification of bacteria from soil and water sample.
7. Isolation and identification of microorganisms on some selective media by given soil and water sample.
   MacConkey
   EMB
   XLD
8. Microscopic identification of different Cyanobacterial cultures.
9. To isolate bacteriophages from sewage.

Suggested list of practicals (Course Code BSC102)

1. To study spermatogenesis and oogenesis in any vertebrate animal
2. To prepare and investigate slides of gametes.
3. To study the developmental stages of frog (Egg, Blastula, Gastula and Tadpole).
4. To study the structure of Hen egg.
5. To study the embryological stages of slides of chick (Primitive Streak, 16, 24, 36, 48, 56, 72 and 96 hour stages W.M.).
6. To study the embryo through window preparation in fertilized Hen egg.

COURSE CODE BSC105: PRACTICAL BASED ON COURSE CODE BSC103& BSE101 / BSE102 (COURSE CREDITS = 04)

Suggested list of practicals (Course Code BSC103)

1. To determine the minimum area of quadrat for phytosociological analysis of grassland.
2. To determine frequency, density and abundance of different species in the grassland.
3. To determine minimum number of quadrats for sampling of grassland.
4. To compare community structure of different forest.
5. To determine the pH of water sample.
6. To determine homogeneity and heterogeneity of grassland vegetation.
7. To determine the trophic state of alkalinity of water body.
8. To determine the pH of soil samples.
9. To calculate Simpson's indices of diversity of grassland vegetation.
10. To calculate Shannon-Wiener indices of diversity of grassland vegetation.

LIST OF ELECTIVE PAPERS

COURSE CODE BSE101 : BIOMOLECULES (COURSE CREDITS = 03)

Course Objective: The syllabus of Biomolecules is structured finely to make the students understand the structure and various principles dealing with the working of biomolecules and their mutual interactions to support the life system.

Course Learning Outcomes

- Enabling students to understand the importance of water in maintaining the various biochemical reactions such as buffering, phosphorylation, oxidation-reduction etc.
- The students learn the principle of working of enzyme and the process of enzymology, that is, how the enzymes work and where the active sites play a key role.
- The students also learn the basic and functional structures of all the biomolecules in detail.
- The inter-relationships and communication between the biomolecules is a major part of signal transduction. The students become well versed with this mode of biological process.
- The students learn various techniques such as chromatography, spectroscopy and electrophoresis to understand the purity of biomolecules and their analytical properties for further application.

COURSE CONTENTS

UNIT I

Structure of water and its solvent properties, Acid- bases, pH and buffer, Bi and polyprotic buffer. Free energy and spontaneity of reactions, ATP and other phosphorylated compound with their free energy of hydrolysis, Phosphoryl group transfer, Biological oxidation reductions reaction, Coupled reaction and oxidative phosphorylation, Inhibitors and uncouplers.

UNIT II

Enzyme classification, Specificity, Active site, Enzyme kinetics, Michealis Menton equation, Determination of kinetic parameters, Bi-substrate reaction and their kinetics, Enzyme inhibition and kinetics, Allosteric enzyme. Kinetics and Allosteric regulation of phosphofructo kinase

UNIT III

Structure and chemistry of macromolecules, Proteins, Carbohydrates and Lipids, Protein folding, Structure and chemistry of bimolecules such as antibiotics, Pigments, Vitamins as coenzymes, Lipid analysis by GLC and Mass Spectrometry, Oligosaccharide and Polysaccharide analysis.

UNIT IV

Biosignaling molecular mechanism of signal transduction, Gated ion channels, Nicotinic acetyl choline receptor, Receptor enzyme, The insulin receptor, G- proteins and cyclic AMP membrane transport, Biomembrane, Nutrient transport across membranes, Active and passive diffusion, Symport, Antiport and uniport, Na^+ K^+ pumps and their metabolic significance.

UNIT V

Chromatographic technique, Paper and TLC , Gel filtration, Ion exchange, Affinity, HPLC, SDS, PAGE, Isoelectric focusing, Western blotting, Protein sequencing, Mass spectrometry, MALDI , TOF, MS.

Books Recommended

J. L., Jain, Sanjay, and Jain Nitin, (1979) Fundamentals of Biochemistry (6th revised Edition). S. Chand & Co. Ltd. New Delhi.

Buchanan . B.B. Gruissem, W. and Jones .R.L. (2000) Biochemistry and Molecular Biology of Plants , American Society of Plant Physiologists, Maryland ,USA.

Albert L. lehninger, Davis L. Nelson, Michael M. Cox. (2004) Lehninger Principles of Biochemistry.
Lea P.J. and Leegood ,R.C. (1999) Plant Biochemistry and Molecular Biology (2 nd Edition) John Wiley and Sons. Chichester, England
Berg Jeremy, Tymoczko John, Stryer Lubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.
Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.
Dawes Edwin A. (1972) Quantitative Problems in Biochemistry, Churchill Livingston, Edinburgh.
Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press. 5. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.
Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.
Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.
Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.
Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.
Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.
Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.
White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.
White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.
Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

Suggested list of practicals (Course Code BSE101**)**

1. To study working of weighing balance.
2. To study the working of pH meter.
3. To determine the pKa value of acetic acid by pH titration method.
4. Preparation of acetate buffer at pH=5.
5. Prepare Phosphate buffer at pH=8.
6. To prepare tris buffer at pH=9.
7. Estimation of protein by Lowry method.
8. Chromatographic separation by paper and thin layer Chromatography.
9. To determine pKa value of glycine.
10. Determine the absorption maxima of Potassium dichromate.
11. To prove the validity of Beer-Lambert's law.
12. Qualitative assessment of carbohydrate.
13. Qualitative assessment of lipids.
14. Qualitative assessment of proteins.
15. To prepare standard curve of glucose by anthrone method.
16. To determine the Km and Vmax of amylase enzymes.
17. To study the effect of substrate concentration on enzyme activity.
18. To study the effect of temperature on enzyme activity.

COURSE CODE BSE102: BIOENERGETICS AND INTERMEDIARY METABOLISM (COURSE CREDITS = 03)

Course objectives – Learners obtain the knowledge about the bioenergetics and intermediary metabolism within the living system for production of energy in form of ATP and different biomolecules, participate in different metabolic pathway.

Course learning outcomes –

CO1: Learners will understand the concepts of bioenergetics, mitochondrial respiratory chain, cytochromes characterization and Oxidative phosphorylation.

CO2: Students will get huge knowledge of cell transport systems, influx and efflux mechanisms, symport, antiport, uniport,

CO3: Students will learn about the carbohydrate metabolism; glycolysis, TCA cycle, energy generation, energy rich bonds, biosynthesis of sugars, HMP shunt and alternate pathways.

CO4: Students will learn about lipid metabolisms; fatty acid synthesis and oxidation, triglycerol, steroids and terpenes.

CO5: Students will understand about the amino acid and nucleic acid biosynthesis, degradation, regulation, urea cycle, inhibitors and inborn error metabolism.

COURSE CONTENTS

UNIT I

Bioenergetics: energy transformation, biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes; free energy changes and redox potentials, phosphate potential, ion and proton electrochemical potentials, membrane potentials, chemo-osmotic theory; ion transport across energy transducing membranes, influx and efflux mechanisms, transport and distribution of cations, anions and ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

UNIT- II

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization; the Q cycle and the stoichiometry of proton extrusion and uptake. Oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes. ATP synthetase complex, microsomal electron transport.

UNIT- III

Carbohydrates: glycolysis, citric acid cycle- its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway, alternate pathways of carbohydrate metabolism, gluconeogensis, inter-conversions of sugars, biosynthesis of glycogen, starch and oligosaccharides.

UNIT- IV

Lipids: fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthase; fatty acid oxidation: α, β, oxidation and lipoxidation; lipid biosynthesis: of triacylglycerols, phosphoglycerides and sphingolipids, biosynthetic pathways for terpenes and steroids.

UNIT- V

Amino acids and nucleic acids: biosynthesis and degradation of amino acids and their regulation, specific aspects of amino acid metabolism, urea cycle and its regulation, in-born errors of amino acid metabolism; Nucleic acids: degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide biosynthesis, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis.

Books recommended

M.M. Cox and D.L. Nelson (2008) Lehninger Principals of Biochemistry W.H. Freeman & Company
Otto Hoffmann-Ostenhof (2008) Intermediary metabolism; *Van Nostrand Reinhold (USA)*.
P.H. Clarke (1978) Intermediary metabolism; *John Wiley & Sons Ltd Hoboken, New Jersey (United States)*.
Alexander Lowen (1994) Bioenergetics; *Penguin/Arkana Books USA*.
David G. Nicholls and Stuart Ferguson (2013) Bioenergetics; *Academic Press Elsevier United States*.

Suggested list of practicals (Course Code BSE102**)**

1. 1. To prepare acetate buffer of pH4.7.
2. To perform carbohydrate tests of manosaccharides, polysaccharides, disaccharides.
3. To determine protein of unknown sample by Lowry method.
4. To perform the detection of lipid in the given sample

COURSE CODE – BSS101: SKILL DEVELOPMENT MODULES 1
(COURSE CREDITS = 02)
PERSONALITY DEVELOPMENT- MODULE- 1 (Semester-1) Hrs.-30

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet	**1**
02	Role and Impact of Personality	Group Activity	**1**
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	**2**
04	Listening and Caring	Group Activity	**1**
05	The Art of Communication	Worksheet	**1**
06	Different level of Effective Communication	Worksheet	**1**
07	Professional Communication P-A-C	Worksheet	**1**
08	Rules of Professional Communication	Group Activity	**1**
09	Body Language - 1	Worksheet	**1**
10	Language Lab	Worksheet	**1**
11	Thought Process - 1	Worksheet	**1**
12	Interpersonal Skills	Worksheet	**1**
13	Observation & Imagination Power	Group activity	**1**
14	Creativity	Group Activity	**1**
15	Extempore - 1	Group activity	**1**
16	Extempore - 2	Group Activity	**1**
17	Presentation Skills	Worksheet	**2**
18	How to Draw the Attention of Audience	Worksheet	**1**
19	Steps of Effective Presentation	Worksheet	**1**
20	Prioritizing Matrix	Worksheet	**1**
21	Leadership Quality	Group activity	**1**
22	SWOT Analysis	Worksheet	**1**
23	Interview Skills	Lecture	**2**
24	Group Discussion	Group Activity	**2**
25	Resume Preparation	Group Activity	**1**

SECOND - SEMESTER

COURSE CODE BSC201: TAXONOMY OF ANGIOSPERMS (COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with the knowledge of the terms, theories, conventional and modern methods and practices of taxonomy of flowering plants, focusing on the local plant species. It also aims to create awareness about the plants used by tribals of MP.

Course Learning Outcomes:

CO1: Understanding principles of biodiversity and its conservation. Gaining insight into the rules of nomenclature, adaptive features of ICBN and different classification systems.

CO2: Learning and applying different techniques of identification, documentation of plants and role of computer in database identification. They will know how to prepare herbarium and use of keys to identify floras.

CO3: Knowledge of modern taxonomy and its application in taxonomic evidences from anatomy, embryology palynology, cytology, secondary metabolites. Understanding numerical taxonomy OUT's coding.

CO4: Empowers student to recognize, collect and compare the plants of the given fourteen angiosperm families. Learners will be able to describe the plant specimen with taxonomical terms, floral formula and diagrams.

CO5: Acknowledge the economic uses of plants in modern society. An increased awareness and appreciation of plants & plant products encountered used by tribes of MP. Knowledge of important families of useful plants, the parts used and active biomolecules present in medicinal plants.

COURSE CONTENTS

UNIT I

Principles of Biodiversity & its conservation, Concept of systematic, Identification & nomenclature with special reference to International code of Botanical nomenclature. Taxonomic Category species, Genus & family, Angiosperm classification systems (Bentham & Hooker & Hutchinson).

UNIT II

Herbarium, Herbarium Techniques, Role of botanical gardens, Documentation (Floras, Monographs, Journals, Manuals, Abstracts, Indices & Dictionaries), Keys for identification of plants single access and multi-access, Role of computers and Database in identification.

UNIT III

Modern Taxonomy, Supportive evidence from Anatomy, Embryology, Palynology, Cytology, Phytochemistry including secondary metabolites, Numerical Taxonomy OUT'S coding, Cladistics.

UNIT IV

Comparative study of Angiosperm families, Rannunculaceae & Magnoliaceae, Papaveraceae & Capparidaceae, Oxalidaceae & Meliaceae, Combretaceae & Lytheraceae Rubiaceae & Asteraceae, Convolvulaceae & Lamiaceae, Gramineae & Orchidaceae.

UNIT V

Importance and nature of plants & their products, Industrial plants, Shisham (*Dalbergia sisoo*), Sagon (*Tectona grandis*), Rubber plant (*Ficus elastica*) Cotton plants (*Gossypium hirsutum*), Semal (*Bombex ceiba*), Flax (*Glycine max*), Kattha (*Acacia catechu*), Neel (*Indigofera tinctoria*), Sindoor (*Melilotus alba*).

Drug Plants, Ashwagandha (*Withania somnifera*), Sarpgandha (*Rauwolfia serpentina*), Adhusa (*Adhatoda vasica*), Amla (*Emblica officinalis*), Neem (*Azadirachta indica*), Punarnava (*Boerhaavia diffusa*) safed musli.
Food Plants, Wheat (*Triticum aestivum*), Rice (*Orriza sativa*), Maize (*Zea mays*), Arhar (*Cajanus cajan*), Chana (*Cicer aurientinum*), Onion (*Allium cepa*) Clove (*Piper longum*) Turmeric (*Curcuma domestica*), Mustard (*Brassica compestris*), Groundnut (*Arachis hypogea*).
Ethnobotany, Plants used by tribals of M.P., Sitaphal, Champa, Bel, Ber, Sal, Achar, Palash, Kachnar, Siris, Arjun, Harra, Bahera, Mehndi, Mahua, Tendu, Latjira, Gular, Anar, Datura.

Books recommended

- Davis P. R. and Heywood V. M. (1973) Principles of Angiosperm Taxonomy.
- Eames A. I. (1961) Morphology of Angiosperms.
- Naik V. N. (1984) Taxonomy of Angiosperms.

COURSE CODE BSC202: BIOSTATISTICS AND COMPUTER APPLICATIONS (COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with tools and techniques in collection, collation, summarization and interpretation of data along with various experimental designs and bioinformatics.

Course Learning Outcomes:

CO1: Proficiency of students in various techniques of collection, collation, summarization and presentation of data. They could learn basic concepts of probability and probability distribution functions along with applications.
CO2: Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.
CO3: Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.
CO4: Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.
CO5: Empowers students to utilize software packages in digital analysis and processing of biological data. Integrate informatics with biology through data submission protocols, sequence alignment and searches, annotations and possible applications in human health and welfare.

COURSE CONTENTS

UNIT I

Importance and scope of statistics in experimentation, Measure of central tendency arithmetic, Geometric and harmonic means, Measure of dispersion variance, Standard deviation, Coefficient of variation, Confidence limits of population mean.

UNIT II

Elements of probability**,** Statistical and Mathematical definitions, Probability distribution function: Normal, Binomial and Poisson distribution.

UNIT III

Tests of significance, Hypothesis and errors, ‘t’ test, Population mean equals a specified value, Test of the equality of two means (Independent samples & Equal variances), Test of

the equality of two means (Paired samples), 'F'- test, One way analysis of variance (Sample sizes, Equal and Unequal).

UNIT IV

Chi-square statistics**,** Test of goodness of fit and test of independence of factors, Simple correlation coefficient, Significance tests, linear regression equation and diagram regression coefficient, Standard error, Significance tests.

UNIT V

History and development of computers, Hierarchy of computers, Computer hardware components and functional structures, Computers software: system and application software.

Books recommended

- B. L. Agarawal, Text Book of Biostatistics.

COURSE CODE BSC203: PRACTICAL BASED ON COURSE CODE BSC201 & BSC202 (COURSE CREDITS = 04)

Suggested list of practicals (Course Code BSC201)

1. List of Families

   Rananculaceae – *Delphinium ajacis*
   Asclepidiaceae – *Calotropis procera* (Aak)
   Papaveraceae – *Argemone maxican*
   Orchidaceae – *Zeuxine stratecemitica*
   Rubiaceae – *Ixora coccinea* (Rukmani)
   Lamiaceae – *Ocimum sanctum* (tulsi)
   Poaceae (Gramineae) – *Triticum aestivum*
   Asteraceae (Compositeae) – *Helianthus annus*
   Combretaceae – *Quinsqualis indica*
   Magnoliaceae – *Michelia champaca Linn*.
   Convolvulaceae – *Convolvulus microphyllus*
   Capparidaceae – *Cleome gynandra* (Hut-hul)
   Meliaceae – *Azadirachta indica* (Neem)

2. Plant of ethnomedicinal importance –

   Arjun (*Terminalia arjuna*)
   Harra (*Terminalia chebula*)
   Clove (*Syzygium aromatium*)
   Mehndi (*Lawsonia inermis*)
   Neem (*Azadirachta indica*)
   Amla (*Emblica officinalis*)
   Onion (*Allium cepa*)
   Ashwagandha (*Withania somnifera*)
   Sarpagandha (*Rauvolfia serpentina*)
   Bahera (*Terminalia bellerica*)

Suggested list of practicals (Course Code BSC202)

1. To find the pH of the various sample of soil by pH meter.
2. To determine the presence of carbonate in different soil mixtures.
3. To determine the presence of phosphate in soil and water sample.
4. To determine the presence of nitrate in mixture sample.
5. To determine the presence of nitrate in mixture sample.

6. To determine frequency, density and abundance of herbaceous species from local garden.
7. To determine the biomass of plant vegetation.
8. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

COURSE CODE BSC204: PRACTICAL BASED ON COURSE CODE BSE201 / BSE202 / BSE203 ANY TWO (COURSE CREDITS = 04)

LIST OF ELECTIVE PAPERS

COURSE CODE BSE201: BIOLOGY OF THE IMMUNE SYSTEM (COURSE CREDITS =03)

Course Objectives: The objective of this course is to understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body. It would also make the students understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be able to understand the fundamental bases of immune system and immune response .
- Will be able to gather information about the structure and organization of various components of the immune system .
- Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity.
- Will be able to understand the operation and the mechanisms which underlie the immune response .
- Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

COURSE CONTENTS

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

UNIT-II

Antibody structure and function; antigen-antibody interactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. Blymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells. Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiences, hybridoma technology and monoclonal antibodies.

Recommended Books:

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A. Osbarne. (Freedom)
2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of immunology, William Paul.
4. Immunology, Roitt and others.

Suggested list of practicals (Course Code BSE201**)**

1. To perform test for antibiotics sensitivity by disc method.
2. To determine the minimum inhibitory concentration of given antibiotics.
3. Preparation of blood smear.
4. To isolate serum from blood plasma.
5. To perform agglutination reaction to identification of blood group.

COURSE CODE BSE202: RESOURCE UTILIZATION AND CONSERVATION (COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with knowledge pertaining to world biomes, resources, conservation, sustainable development, pollution and its management, and remote sensing in management of earth resources.

Course Learning Outcomes:

CO1: Deep understanding of distribution, structure and function of various aquatic and terrestrial biomes.

CO2: Learn definitions, types and utilities of biodiversity along with threats along their applications in management and sustainable development of resources from various biomes.

CO3: Empowers students to apply in-situ and in-vitro techniques in conservation of aquatic and terrestrial resources in real time.

CO4: Understands concepts of pollution of different environments and can monitor and treat pollution loads in artificial and natural ecosystems; and appreciate nuances of industrial, societal and urban pollutions.

CO5: Gains insight knowledge about remote sensing of earth resources along with platforms, sensors and scanners, visual and digital interpretation of remotely sensed data.

COURSE CONTENTS

UNIT – I

Major Biomes of the world, Tropical rain & Seasonal Forests, Temperate rain & Seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic Ecosystems wetlands, Lakes & Ponds Streams & Rivers, Marine & Estuarine habitats.

UNIT – II

Resource utilization**,** Status & Utilization of Biodiversity, Sustainable development resources from forest, Grassland and aquatic habitats, Food forage, Fodder, Timber & Non-wood forest products, Threats to quality & quantity of Resources due to overexploitation. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT –III

Strategies for conservation of resources: Classifications of resources, Principles of conservation, *In-situ* conservation sanctuaries, National parks, Biosphere reserves for wildlife conservation, Habitat conservation practices of conservation for forests ranges, Soil and water.

UNIT – IV

Air, Water and Soil pollution**,** Kinds, Sources, Quality parameters, Effects on structure & function of ecosystems, Management of pollution, Bioremediation, Climate changes sources, Trends & role of greenhouse gases, Effect of global warming on climate, Ecosystem processes & Biodiversity, Ozone layer & Ozone hole.

UNIT – V

Resource monitoring, Remote sensing concepts & Tools, Satellite remote sensing basics sensors, Visual & digital interpretation, EMR bands and their applications, Indian remote sensing program, Thematic mapping of resources, Application of remote sensing in Ecology &Forestry.

Books recommended

- Chopra R. N. (1933) Indigenous Drugs of India.
- Hayes W. B. (1953) Fruit Growing in India.
- Atkinson E. T. (1980) Economic Botany of Himalayan Regions.

Suggested list of practicals: COURSE CODE BSE202
(**Resource Utilization and Conservation)**

9. To find the pH of the various sample of soil by pH meter.
10. To determine the presence of carbonate in different soil mixtures.
11. To determine the presence of phosphate in soil and water sample.
12. To determine the presence of nitrate in mixture sample.
13. To determine the presence of nitrite in mixture sample.
14. To determine frequency, density and abundance of herbaceous species from local garden.
15. To determine the biomass of plant vegetation.
16. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

COURSE CODE BSE203: MICROBIAL METABOLISM
(COURSE CREDITS = 03)

Course Objectives: The course aims to empower the learners by the study of metabolic and biochemical processes within the microbial cell for their life.

Course Learning Outcomes:

CO1: The student will able to get the huge knowledge about microbial growth, measurement, growth curve, types of growth and effect of environmental factors.

CO2: Students will understand the process of Chaemolithotrophy, Methanogenesis, photosynthetic and accessory pigments, oxygenic and anoxygenic photosynthesis, electron transport, generation of ATP and fixation of carbon dioxide.

CO3:.Learners will gain the idea about respiratory metabolism EMP, ED, glyoxalate pathway, TCA cycle, phosphorylation, Pasteur Effect and fermentation.

CO4: Student will know about assimilation of nitrogen, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

CO5: Students will understand the microbial development, sporulation and morphogenesis and organization of microbes.

COURSE CONTENTS

UNIT-I

Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

UNIT-II

Chaemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis. Electron transport- photoautotrophic generation of ATP, fixation of CO2- Calvin cycle, reverse TCA, carbohydrate anabolism.

UNIT-III

Respiratory metabolism: Embden Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates-homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

UNIT-IV

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

UNIT-V

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Dormancy. Endospore-structure, properties and germination.

List of Recommended Books

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009.

Suggested list of Practicals (Course CODE BSE203**: Microbial Metabolism)**

1. Determination of Bacterial growth by turbidity measurements (spectrophotometric method).
2. Study of effect of temperature on growth of bacteria.
3. Study of effect of pH on growth of Bacteria.
4. Isolation of rhizobia from root nodules.
5. Slide culture technique for studying morphology and molds.

COURSE CODE BSS201: SKILL DEVELOPMENT MODULES 2
(COURSE CREDITS = 02)
SOFT SKILLS DEVELOPMENT MODULE-2 (Semester- 2) Hrs. 30

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet/ lecture	**02**
02	Role and Impact of Personality	Group Activity/ lecture	**01**
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	**02**
04	Importance of characteristics and Traits	lecture/Group Activity	**02**
05	Empowerment of Internal and external traits	lecture	**02**
06	Definition of Personality	Lecture	**02**
07	Power of Self	Lecture	**03**
08	Path to Improve Personality	lecture/Group Activity	**03**
09	Body Language - 1	Worksheet	**02**
10	Grooming Yourself	Lecture	**02**
11	IQ / EQ / MQ / SQ	lecture	**02**
12	Disposition of Body in various aspects	Group Activity	**03**
13	Getting desired output	Group Activity	**02**
14	Post Assessment of Personality	Group Activity	**02**

THIRD SEMESTER

COURSE CODE BSC301: PLANT PHYSIOLOGY
(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with basic principles of plant functions such as mechanism of the transport of the water inorganic and organic substances, metabolism (photosynthesis and respiration), secondary products, plant hormones, cell and stress physiology, principles of growth & development.

Course Learning Outcomes:

CO1: The student will able to get the huge knowledge about pathways of water through xylem and phloem. Know about the requirement of mineral nutrition for plant growth.

CO2: Students will understand the process of Photosynthesis, Respiration and Nitrogen metabolism.

CO3: Learners will gain the idea about Stress physiology – Responses of plants to biotic and abiotic stresses, biological clock and the photoperiodism.

CO4: Student will know about the Plant Growth hormones (Auxins, Gibberellins. Cytokinins, Ethylene), they understand the biosynthesis of phenolic acids, alkaloids.

CO5: Demonstrate proficiency in the experimental techniques and methods to study the plant physiology.

COURSE CONTENTS

UNIT I

Mechanism of transport of water inorganic and organic substances, Source and sink relationship, Fundamentals of Enzymology, General aspects, Allosteric mechanism, Active sites, Michaelis Menten equation Cooperativity.

UNIT II

Photosynthesis in plants, Pigments, Photosystem I and II, Mechanism of quantum capture and energy transfer between photosystems, Reduction of CO_2, C_3, C_4 and CAM metabolism , photorespiration and its signification.

UNIT III

Overview of plant respiration, Glycolysis, TCA cycle, Electron transport and ATP synthesis, Pentose phosphate pathway, Glyoxylate cycle.

UNIT IV

Plant hormone, Mode of action of auxins, Gibberellins, Cytokinin, Ethylene, Abscissic acid, Special features of secondary plant metabolites, Biosynthesis and functions of phenolic acids, Alkaloids.

UNIT V

Stress physiology, Water deficit and drought resistance, Temperature stress, Salinity stress metal toxicity, Biological clock and its regulation, Photoperiodism and floral induction.

Books recommended

- Buchanan. B.B. Gruissem, W and Jones. R.L. (2000) Biochemistry and Molecular Biology of plants. American society of plant physiologists, Maryland USA.
- Galston, A.W. (1989) Life processes in plants. Physiology, John wiley and sons Inc new. York USA.
- Hopking W.G. (1995) Introduction to plant physiology John wiley and sons Inc.New York USA.
- Nobel P.s. (1999) Physiochemical and Environmental plan Physiology.
- Taiz .L.and Zeiger, E. (1998) plant physiology (2nd Edn) Sinayer E. Associates Inc. publishers. Massachusetts, USA.

COURSE CODE BSC302: GENETICS & MOLECULAR BIOLOGY (COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners by providing insight into various molecular biological processes of DNA replication, transcription and translation. Molecular biology of recombination, synthesis and processing of various RNA molecules are discussed. Further the course provides deeper understanding of regulation of gene expression in various organisms.

Course Learning Outcomes:

CO1: Understanding of DNA as the genetic material and its types. Knowledge of chromatin organization, euchromatin, heterochromatin, C value paradox and restriction mapping.

CO2: Knowledge of Mutation, its kind and mechanism of DNA repair system.

CO3: Conceptualize different aspects of genetics of microorganism with deep understanding of molecular mechanism of recombination, role of Rec ABC&D, linkage and crossing over.

CO4: Empowers student to acquire knowledge about different enzymes of DNA replication, transcription and translation. Deep understanding of DNA and RNA sequencing methods, process of transcription and post transcriptional processing.

CO5: Gains insight into the process of translation and gene expression in prokaryotes and eukaryotes by understanding different types of RNA, translational factors, concept of operon ; lac and tryptophan and different models of gene expression in eukaryotes.

COURSE CONTENTS

UNIT I

Nucleic acid as genetic material (experimental proof) DNA structure A, B & Z forms. Chromosome structure & chromatin organization, Euchromatin & Heterochromatin different models, Nuclear DNA content, C-value paradox, Cot curves, Restriction mapping, Concept & techniques, *In-situ* hybridization.

UNIT II

Spontaneous & induced mutations, Physical & chemical mutagens types of mutations, Molecular mechanism of mutation, forward, back, Missense, Nonsense, Frameshift and suppresser mutations, Mutations induced by transposons, Site directed mutagenesis, Mechanism of DNA damage & repair , Photorepair, Excision or dark repair,

UNIT III

Genetics of microorganisms, Transformation, Conjugation & transduction in bacteria, Conjugation mapping, Molecular mechanism of recombination, Role of Rec ABC&D, general & site specific recombination, Independent assortment, Linkage and crossing over.

UNIT IV

DNA & RNA sequencing, Different methods, DNA replication, DNA polymerases, Topoisomerases, Ligases, Gene transcription, RNA polmersases, Promoters, Transcription factors, Mechanism of transcription, Chain initiation, Elongation, & termination, Post transcriptional processing of RNA, Capping, Adenylation & splicing, Introns & Exons

UNIT V

Translation of messenger RNA into proteins, Structure & role of t- RNA & ribosomes, Different factors (I, EFTs, RFs), Protein chain initiation, Elongation & termination, Inhibitors of protein synthesis, *In vitro* protein synthesis, Gene expression in prokaryotes, Operon concept, Inducer, Repressor, Co-repressor, c-AMP / CRP, co-induction & co-repression . Regulation of lac operon & Tryptophan operons, Attenuation Gene expression in eukaryotes, Britton and Davidson's, Gene battery model , HCP / NHCP Hormones

Books recommended

- Bray, Lewis Ralf, Roberts and Watson (1983) Molecular Biology of the Cell.

- Schwer M. A. (1989) Methods in Plant Molecular Biology.
- Wolf S. L. (1993) Molecular and Cellular Biology.
- Shaw C. H. (Ed.) (1988) Plant Molecular Biology – A Practical Approach.
- Clug & Cummings: Essential of Genetics.

COURSE CODE BSC303: ANIMAL PHYSIOLOGY (COURSE CREDITS = 03)

Course Objective: The course of Animal Physiology deals extensively with the physiology of the vital organs of vertebrates and invertebrates. These include structure and function of blood and lymph, and the process of digestion, excretion, nerve and muscle functions.

Course Learning Outcomes

- The students learn the nutritional pattern in animals in relation to hormonal and enzymatic regulation of digestion with reference to homeostasis.
- Blood and lymph – their structure and function related to gas exchange, ion transport and clotting and defense is dealt in good detail.
- The students are also made acquainted with the very importance of muscles in relation to structure, function and physiology. Further, the neuromuscular interconnection and basic role of neuronal tissue at different level is elaborately dealt with here.
- The complete physiology of invertebrate and vertebrate excretion system is learnt by the pupil.

COURSE CONTENTS

UNIT I

Nutritional patterns in animals, Types of nutrition, Modes of ingestion and mechanism of feeding in various groups of animals, Digestion, Intracellular and extracellular, Enzyme action and hormonal regulation of digestion, Concept of homoeostasis.

UNIT II

Blood, Composition and functions, Coagulation, Blood groups and transfusion, characteristics of hemoglobin.

UNIT III

Lymphatic system, Various types of leucocytes and their role, Immunity, Innate and acquired, Antigen and antibody response, Transport of respiratory gases in the body chloride bicarbonate shift.

UNIT IV

Muscles, Various types, Structure and functions, Molecular mechanism of muscle contraction, Muscle tone, Muscle fatigue, Rigor mortis, Structure of neuron, Membrane and action potential origin and propagation of nerve impulse, Synaptic transmission, Neuromuscular junction, Reflex action.

UNIT V

Excretion in invertebrates, Flame cells and malpighian tubules, Excretion in vertebrates, structure of nephron, Mechanism of urine formation with details of ultrafiltration and counter current mechanism, Functions of renal tubules.

COURSE CODE BSC304: PRACTICAL BASED ON COURSE CODE BSC301 & CODE BSC302 (COURSE CREDITS = 04)

Suggested list of practicals (Course Code BSC301)

1. To measure D.P.G. (Diffusion Pressure Deficit) of Potato cells.
2. To prepare molar, Molal & normal solution (100ml) of NaCl and Sucrose.
3. To determine the incipient plasmolysis of cells under different concentration of sucrose solution.
4. Extraction and separation of the chlorophyll pigments from spinach leave by solvent extraction method.
5. Extraction and separation of the chlorophyll pigment from spinach leave by paper chromatography.
6. Separation of anthocyanin pigment by Paper Chromatography.
7. Extraction and separation of chlorophyll pigments from spinach leaves by Spectrophotometer.
8. To determine the stomatal index in different plant species.

Suggested list of practicals (Course Code BSC302)

1. Staining technique for chromosomes preparation in plant (onion plant) and animal cell.
2. To study the mitotic stages in the root of anion (*Allium cepa*) and to calculate the mitotic index.
3. To study the pollen sterility and fertility in buds of *tradeschantia*.
4. To study the effect of UV rays on E.coli.
5. To study the effect of dark and light treatment in DNA repair in *E. coli.*

COURSE CODE BSC305: PRACTICAL BASED ON COURSE CODE BSC303 & CODE BSE301 / BSE302 / BSE303 / BSE304 (COURSE CREDITS = 04)

LIST OF ELECTIVE PAPERS

COURSE CODE BSE301: ADVANCED MOLECULAR BIOLOGY (COURSE CREDITS = 03)

Course Objectives : This course combines special set of tutorials centered around research activities in molecular biology with practical exercises and/or laboratory placements. The content is designed to provide students with a perspective of how cutting edge molecular biology principles and techniques are applied to major research questions. This course will illustrate that cross disciplinary approaches are essential in modern research.

Course Learning Outcomes

- To understand key principles of how cells work, including gene regulation, protein synthesis and signal transduction.
- To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand the key principles of Molecular Biology.
- To read, interpret and discuss major contributions to Molecular Biology research published in scientific research literature.
- To develop effective, creative and innovative solutions, both independently and cooperatively, to current and future research problems in Molecular Biology.

COURSE CONTENTS
UNIT I

Recombinant DNA technology I: methods of creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, selection screening construction of DNA library.

UNIT II

Recombinant DNA Technology II: Use of cloned gene, sub-cloning; recombinant proteins production in bacteria, site-directed mutagenesis, RFLP, PCR, DNA-fingerprinting, antisense-RNA technology, chromosomal walking.

UNIT III

Hybridoma technology: monoclonal antibodies mycelium cell infusion selection of hybridomas, protoplast fusion and HAT-medium screening assay purification and application of monoclonal antibodies.

UNIT IV

Cell and tissue culture: micropropagation, somatic cell culture, somoclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and methods), production of transgenic plant and animal; production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture application.

UNIT V

Fermentation technology: continuous and batch type culture techniques, principle types of Fermenters, general design of fementors. Fermentation processes, brewing manufacture of antibiotics, production of single cell protein. Application of genetic and molecular biology procedures in strain improvement.

Books recommended

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8.Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown

Suggested list of practicals (Course CODE BSE301**)**

1. To isolate genomic DNA from fungi by LETS methods.
2. To determine the quantity and quality of the isolated fungal DNA.
3. To determine the agarose gel electrophoresis of the isolated fungal DNA.
4. To isolate plasmid DNA from bacteria by quick method.
5. To purify the DNA from agarose gel.
6. To study the Thermal cycler.
7. To study the gel documentation system.

COURSE CODE BSE302: **AGRICULTURAL MICROBIOLOGY**
(COURSE CREDITS = 03)

Course Objectives: To make students aware about agricultural technique, crop diseases, soil health, composting, agriculture losses, pest management, green revolution and agricultural biotechnology.

Course Learning Outcomes

- Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.
- Critically discuss the need for agricultural microbiology and explain their limitations.
- Clarify application of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.
- Analyse various aspects of N_2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.
- Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

COURSE CONTENTS

UNIT – I

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

UNIT – II

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

UNIT – III

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little left of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

UNIT – IV

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements, constraints

UNIT – V

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel.

List of Recommended Books

1. Soil microbiology by Subba Rao
2. Soil and microbes by Waksman and Starkey.
3. Plant pathology by Mehrotra.
4. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
5. Microbiology by S.S. Purohit.

Suggested list of Practicals (Course CODE BSE302**: Agricultural Microbiology)**

1. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
2. Isolation of fungi from soil by warcup's method.
3. Isolation of azotobacter species from soil.
4. Isolation of microorganism from rhizosphere.
5. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression method.
6. Plant diseases – leaf curl of papaya, rust of wheat, citrus canker, red rot of sugarcane. Study of weeds- Parthenium, water hyacinth.

COURSE CODE BSE303: BIOPROCESS ENGINEERING AND TECHNOLOGY (COURSE CREDITS = 03)

Course Objectives: The course will enable students to apply the learning of microbiology concepts toward the exploitation of microbial population for industrial and human benefits. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant microbial products and therapeutic proteins. The course aims to provide instruction in the general principles of food microbiology, the biology and epidemiology of food borne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses and Understand food spoilage microorganisms; the microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have gained insight on industrially important microbes, recent developments in fermentation processes and various optimization strategies at fermenter level.
- Understands the concept of sterilization methods and principles of batch and continuous processes.
- Attains knowledge about designing of industrial strains and various media optimization strategies .
- Learns about the design, types of fermenters and various critical components of bioreactors
- Is able to describe control parameters, fluid rheology and process constraints in a large scale bioreactor
- Gets introduced to various strategies of product recovery from a fermentation broth . Acquires knowledge about various industrially relevant microbial products and their production process
- Understand the principles of microorganisms during various food-processing & preservation steps.
- Comprehend the interactions between microorganisms and the food environment, and factors influencing their growth and survival.

COURSE CONTENTS

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B12, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

Recommended Books:

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.
4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.
5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.
8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.
9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.
10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

Suggested list of Practicals (Course **CODE** BSE303)

1. Isolation of micro-organism from canned food.
2. Isolation of bacteria and fungi from spoiled bread.
3. Quantitative test of milk by resazurin test.
4. Quantitative estimation of Amylase production.
5. Isolation of lipase producing bacteria from soil.
6. Isolation of phosphate solubilizing/producing bacteria from soil**.**
7. Estimation of antibiotic property of bacteria.

COURSE CODE BSE304: BIOTECHNOLOGY
(COURSE CREDITS = 03)

Course Objectives: The course will help students to understand various applications of microbes for the development of various products of agriculture, industrial and clinical application. The knowledge of recombinant technology, bioreactors and optimization strategies will be beneficial in development of production processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will learn about various industrially relevant microbial products and their production process, role of biotechnology in environment management.
- Acquires knowledge about strains development, selection of hyper producers, microbial products, metabolic engineering and various industrial relevant microbial products and their production process Learns about the designing of recombinant heterologous expression systems such as E. coli, yeast, mammalian and insect cells.
- Learns about sterilization at reactor scale and different types of sterilization strategies
- Attains knowledge about designing large scale industrial processes and types of cultivation strategies Understands the concept of recombinant biomolecules, therapeutic proteins, vaccines, antibodies, bio-pesticides, bio-fertilizers, and probiotics .
- Understands different types of regulatory approvals required for drug development and difference between biologics, biosimilars and biobetters

COURSE CONTENTS

UNIT I

Biotechnology an Overview, Definition, Perspective and scope of biotechnological processes and products, Biotechnology and Ethics, Introduction, Medical and chemical Biotechnology, Agriculture and Food, Energy and environment and human, Bioethics, Facing problem and finding solutions, Regulating the use of biotechnology, Patenting biotechnology inventions.

UNIT II

Genetic Engineering and gene cloning, Introduction of genetic engineering procedure, restriction endonuclease, cloning vehicle, Vectors for animals and plants, Insertion of DNA molecule in to a vector, Direct transformation, Isolation and cloning, Transformation and growth of cells, Selection and screening of particular recombinants, Genomic library, sequencing of DNA, Gene identification and mapping, Analysis of expression of cloned genes, Polymerase chain reaction, Monoclonal Antibodies.

UNIT III

Plant cell and tissue cultures, Culture techniques, Protoplast fusion, Direct gene transfer, Microinjections, Nuclear transplantation, Plastid and mitochondrial genes, production of secondary metabolites by immobilized plant cell, Development of disease resistant, herbicide resistant, Salt & drought resistant plant varieties, Microbial Toxins, Introduction, Toxins gene isolation, Genetic engineering of *B. thuringiensis* strains, *Baculovirus* as biocontrol agents.

UNIT IV

Culturing microorganisms for the production of biomass, Production of microbial (Bacterial, Cyanobacterial and Fungal) products, Batch culture, Continuous culture, Fed-batch culture, Mass culture, Use of culture system for the production of microbial products, Production of cyanobacterial biomass for food, Feed and health care products, Improvement of microbial strains for industry, Agriculture, Immobilization of microbial cells and enzyme and its applications.

UNIT V

Strain improvement, bioreactor design, Reactor types, Application of immobilized cells and enzyme, improvement in bioreactor to control environment of process organism. use of microorganisms in pollution control, Waste treatment, Bioremediation, Biological removal of eutrophic nutrients, Heavy metals, Toxic chemicals (Herbicide, Insecticide and Fungicide and Other Toxicants) from waste water and industrial effluents, Utilization of waste water for the

production of food and feed, Biodegradation, Bioleaching of metals, Application of microorganisms from environment

Books recommended

- Haekett P. B., Fuchs J. A. and Mesing J. W. (1988) An Introduction to Recombinant DNA techniques – basic experiments in gene manipulation.
- Glck B. R. and Thompson J. E. (1993) Methods in Plant Molecular Biology and Biotechnology.
- Bjorn Kristiansen, (2012) Basic Biotechnology third Edition.

Suggested list of practicals (Course CODE BSE304**)**

1. Demonstration:-
   PCR
   Spectrophotometer
   pH meter
   Centrifuse
   Photomicrographic Camera
2. To prepare the media for plant tissue culture.
3. Isolation of pathogenic fungi from infected plants/Disease plants (Leaf/ Stem/ root)
4. Identification of unknown microorganism from given plates.
5. Preparation of tissue culture media.

COURSE CODE BSS301: SKILL DEVELOPMENT MODULES 3
(COURSE CREDITS = 02)
ENTREPRENEURSHIP DEVELOPMENT PROGRAME AGENDA (Semester-3)
TIME - 30 Hrs

1. **ORIENTATION PROGRAM FOR ENTREPRENEURSHIP**
2. **WHAT IS ENTREPRENEURSHIP**
   - **Definition of Entrepreneurship**
   - **Be a Successful Entrepreneurship**
3. **TYPE OF ENTREPRENEURSHIP**
   - **Manufacturing**
   - **Trading**
   - **Service Provider**
4. **NEED TO BE SUCCESSFUL ENTREPRENEURSHIP**
   - **Knowledge - About work and Concern**
   - **Information - About sources/ market/ Customer's**
   - **Assets - About Technology, Place, Man power and money**
5. **CHOOSING A BUSINESS -**
   - **Micro Scale Unit** **Small Scale Unit**
   - **Large Scale Unit** **Mega Scale Unit**
6. **MARKETING and DISTRIBUTION**
   - **Definition and Type of Marketing**
   - **About Sales and Marketing**
   - **Distribution channels**
7. **PRODUCT DESIGNING / BRANDING / MERCHANDIZING**

Research and Development

8. FINANCIAL FLUENCY, PLANNING AND LEGAL ASPECTS

Taxation

Rules and norms of the Govt. to run a business

9. GOVERMENT SCHEMES AND ASSISTENCE

About financial loan / Place/ Training / Subsidy…..etc

10. INDUSTRY VISITS.

FOURTH SEMESTER
(COURSE CREDITS 18)

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:
The primary object of this course is to expose the student to research culture and technology. The student learns how to choose a research problem, plan and perform experiments, collect data, and analyze the data qualitatively and quantitatively. The student gets trained in presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently.

Course Learning Outcomes:

- Student is able to conceive a problem based on current published research.
- Student is able to carry out comprehensive survey of literature on the topic of research
- Student is able to make culture media for various microbes
- Student is able to isolate microorganism from different environmental/ food sources
- Student is able to identify the isolated microorganism using biochemical and molecular methods Student is able to assess the microorganism's ability to produce various enzymes
- Student becomes well-versed in different enzymatic assay systems
- Student learns correct handling and use of instruments
- Student learns correct handling of reagents and chemicals
- Student learns how to execute experiments correctly.
- Student learns the importance of including controls in all experiments
- Student learns how to plot the results.
- Student learns how to analyze data, using statistical tools where necessary
- Student learns how to interpret the results from all possible angles.
- Student learns how to present the project in the form of a slide show before and audience of 20-30 people.
- Student is exposed to the science of thesis writing.

RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR

SYLLABUS PRESCRIBED FOR THE DEGREE OF THE MASTER OF SCIENCE IN BIOTECHNOLOGY IN UNIVERSITY TEACHING DEPARTMENT

(Academic Session 2020-2021 & Onwards)

[PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM - ORDINANCE 222]

This brochure of the programme for the M.Sc. degree in Biotechnology consists of six parts, viz., (A) Information from the relevant Ordinance(s) / Statute(s), (B) Programme Objective (C), Programme Outcomes (D), Programme Specific Outcomes (PSOS), (E) Scheme of examination, and (F) Courses of study.

1. INFORMATION FROM THE RELEVANT ORDINANCE (S)/STATUTES

DURATION OF THE COURSE

M.Sc. Biotechnology will be a full time two-year programme to be covered in four semesters, each of six months duration. The I year of the programme will complete the I and II semesters, and the second year will complete the third and fourth semesters. The maximum duration of the programme shall be twice of the minimum duration of the programme i.e. four years.

ADMISSION TO THE COURSE

The number of seats shall be in accordance with the directives by the University. A candidate, who after having secured the B.Sc. degree with at least 50 % marks from a recognized university with a subject of Life Science, shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to guidelines from the University and Government of Madhya Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days.

TUITION AND OTHER FEES

The admitted candidate shall pay the course fee in addition to the tuition fee and such other fees as prescribed by the University.

PROGRAM OF THE STUDY

The semester will consist of 16-18 weeks of academic work. One credit is equivalent to one hour (60 minutes) of teaching (lecture or tutorial) or two hours (120 minutes) of practical work/field work per week throughout a semester. The credits associated with the courses will be valid credits, while credits associated with comprehensive viva voce will be virtual credits. In the end term examination there will be **three components, namely Core Courses, Elective Courses and Skill Development Course,** except for the 4th semester where every student will carry out and submit a **dissertation**.

The syllabus for the theory and practical examination will be prescribed by the Board of Studies in Biotechnology, R.D. University, Jabalpur.

CONTINUOUS EVALUATION

During the semester, a teacher offering the course will do the continuous evaluation of the student at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and the third may be written test/quiz/seminar/assignment for theoretical courses. Marks obtained in two best tests out of three will be awarded to the student.

Approved by
Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/2020
Standing committee on **Executive Council on**

ATTENDANCE

The student, whose attendance is less than 75 %, will not be allowed to appear in the end semester examination and he/she will be declared fail in that semester.

END SEMESTER EXAMINATION:

There shall be end semester examination at the end of first, second & third semester. The semester examination will be held every year normally in December and June or on the dates declared in the academic calendar of the University. A student proceeding to appear in end semester examination will submit through the Head of the Department his / her application on the prescribed form along with required examination fee, etc. to the Registrar of the University. Every student will appear in four respective theory papers and two combined practical examinations in first, second, & third semesters except for the fourth semester. Each student has to appear in end semester examination, otherwise he/she shall be awarded "Ab" grade in that course. In the fourth semester, every student will be allotted dissertation work in lieu of four theory papers. Allotment of the dissertation will be done by a committee comprising of the Dean of Faculty of Life Science, Head of Department of Biological Science, one Professor and one Associate Professor of the Department by rotation according to seniority. The dissertation may be undertaken in UTD or in any of the National laboratories /Institute /Universities /Government approved companies /Industries. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his/her dissertation work.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

CONDITION FOR A PASS:

For each course, each student has to appear in at least two tests and end semester examination, otherwise the student will be awarded "Ab" grade. The total marks obtained in end-semester examination, and best of two tests under continuous evaluation will decide the grade in that course. The grading will be made on 10 –point scale as follows:

Letter Grade	Grade Points	Description	Range of Marks (%)
O	**10**	**Outstanding**	**90-100**
A+	**9**	**Excellent**	**80-89**
A	**8**	**Very Good**	**70-79**
B+	**7**	**Good**	**60-69**
B	**6**	**Above Average**	**50-59**
C	**5**	**Average**	**40-49**
P	**4**	**Pass**	**35-39**
F	**0**	**Fail**	**0-34**
Ab	**0**	**Absent**	**Absent**

For passing the examination in each semester, a candidate must have secured a minimum of 35% marks ("P" Grade: 4 Grade Points) in the course. If the marks obtained by the student in a course are less than the minimum cut-off percentage of marks, then "F" Grade will be awarded. If a student obtains "F" or "Ab" Grade in any course, he/she will be treated to have failed in the course. He/she has to reappear in the examination of the course as and when conducted or arranged by the UTD. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course.

The theoretical and practical courses can be repeated whenever offered or arranged by the UTD but within maximum duration of the programme. He/she can avail multiple repeat attempts to pass the course. The student will be promoted to the next semester if he/she secures at least 12 valid credits in a semester. In case the student secures less than 12 valid credits in any semester, then the student will be asked to repeat entire semester and that semester will be treated as zero semester.

The decision of the teacher regarding the evaluation and the grade shall be final. However, a student submits in writing for review of his Marks/Grade to the Head/Director who will place the case before the board of comprehensive viva voce. The decision of the board will be final. Result of review will be declared by the concerned Head/Director. Review is effective only when grade improves. Review will be allowed only if –

- The prescribed fee is paid.
- The candidate applies within 7 days of the declaration of the grade in that course.

There will be no provision for revaluation. However the candidates can apply for Re-totaling in one course per semester.

In matters not covered under this Ordinance, general rules of the University shall be applicable.

In case of any dispute/ambiguity, the ruling of the Vice-Chancellor shall be final and binding.

2. PROGRAMME OBJECTIVES

The objective of the Master's Program in Biotechnology is to equip the students to gain conceptual and analytical skills about biological materials, biotechnological tools and techniques.

The program emphasizes to apply knowledge acquired about prokaryotic and eukaryotic cellular processes, structural and genetic manipulation of cellular material and processes, and data processing and interpretation techniques.

The imparting of laboratory training for bioassay protocols of biological materials, their manipulative treatments, emerging tissue culture and genetic recombinant techniques, and bioinformatics databases and tools.

Students will be able to address application skills of biotechnological techniques and tools in fields of biomolecules including enzymes, environment, animals, microbes and plants.

3. PROGRAMME OUTCOMES

The Masters in Biotechnology Program will cater to the expanding demand for skilled manpower,

which is equipped with an understanding of modern research protocols and ethics involving both

cellular and molecular materials from biological entities in alleviation and remediation of energy demands, environmental conservation and management, plant health and yield management, human health including emerging epidemic and pandemic disease loads, and synthesis of multi-functional enzymes, organisms and their survival in nature to maintain natural biodiversity and ecological balance.

A M.Sc. Biotechnology student should be able to independent study and researches related to

Isolation of novel biological material, its assay and multiplication, and manipulation.

Application of modern emerging methodological and analytical tools and techniques in qualitative and quantitative assessment of biological materials and processes.

Extraction of biological molecules and sub-molecules and their biochemical, genetic and molecular characteristics and dynamics.

Designing of bioassay experiments, assessment of their outcomes, their modeling and simulation.

Efficient retrieval of information from national and international biological databases, analysis of retrieved information and contribution to new knowledge.

Integration of up- and down-stream processing of bioassay experiments and their analytical and application assessment.

Undertaking of researches involving genomics, metabolomics, and protemics.

Competition at national and international to pursue career in advanced studies in research and industrial establishments.

Independent documentation and communication of scientific results in the public domain as well as peer-reviewed scientific magazines and journals.

Filing of intellectual property rights to national and international registries.

4. PROGRAMME SPECIFIC OUTCOMES (PSOS)

A successful graduate student will be understand and assess variety of biological entities including structure, metabolism and dynamics. The student will be able to design and execute experiments related to Immunology, Molecular Biology, Recombinant DNA Technology, and bioinformatics. He/ She will be able to pursue independent researches in industrial and research establishment by utilizing his/ her analytical and creative biotechnological skills.

5. SCHEME OF EXAMINATION

SEMESTER I

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks			
			Continuous Evaluation	End Semester Exam	Total	
Course Code	**Course Title**					
I Core courses						
BTC101	Cell Biology	**3**	**40**	**60**	**100**	**SKILL**
BTC102	Animal Cell Science and Techniques	**3**	**40**	**60**	**100**	**SKILL**
BTC103	Microbial Physiology	**3**	**40**	**60**	**100**	**SKILL**
BTC104	Practical based on BTC101 & BTC102	**4**	**40**	**60**	**100**	**SKILL**
BTC105	Practical based on BTC103 & BTE101/ BTE102	**4**	**40**	**60**	**100**	**SKILL**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**	**SKILL**
BTE101	Biomolecules					
BTE102	Bioenergetics and Intermediary Metabolism					
III Skill Development course						
BTS101	Skill Development module 1	**2**	**Grade Point will be provided by Skill Development Centre**			**SKILL**
Total valid credits		**22**				

(B) Comprehensive viva voce (virtual credits)	**4**		**50**	

SEMESTER II

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks			
			Continuous Evaluation	End Semester Exam	Total	
Course Code	**Course Title**					
I Core courses						
BTC201	Molecular Biology	**3**	**40**	**60**	**100**	**Employability**
BTC202	Macromolecules & Basic Enzymology	**3**	**40**	**60**	**100**	**Employability**
BTC203	Biostatistics & Computer Application	**3**	**40**	**60**	**100**	**Employability**
BTC204	Practical based on BTC201 & BTC202	**4**	**40**	**60**	**100**	**Employability**
BTC205	Practical based on BTC203 & BTE201/ BTE202/ BTE203	**4**	**40**	**60**	**100**	**Employability**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**	**SKILL**
BTE201	Biology of the Immune System					
BTE202	Resource utilization and conservation					
BTE203	Microbial Metabolism					
III Skill Development course						
BTS201	Skill Development module 2	**2**	**Grade Point will be provided by Skill Development Centre**			**SKILL**
Total valid credits		**22**				

(B) Comprehensive viva voce (virtual credits)	**4**		**50**	

SEMESTER III

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks			
			Continuous Evaluation	End Semester Exam	Total	
Course Code	**Course Title**					
I Core courses						
BTC301	Environmental Biotechnology	**3**	**40**	**60**	**100**	**Employability**
BTC302	Genetic Engineering	**3**	**40**	**60**	**100**	**Employability**
BTC303	Plant Biotechnology	**3**	**40**	**60**	**100**	**Employability**
BTC304	Practical based on BTC301 & BTC302	**4**	**40**	**60**	**100**	**Employability**
BTC305	Practical based on BTC303 & BTE301/ BTE302/ BTE303/ BTE304	**4**	**40**	**60**	**100**	**Employability**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**	**Skill**
BTE301	Advanced Molecular Biology--Skill					
BTE302	Agricultural Microbiology Skill					
BTE303	Bioprocess Engineering and Technology- **Employability**					
BTE304	Biotechnology- **Employability**					
III Skill Development course						
BTS301	Skill Development module 3	**2**	**Grade Point will be provided by Skill Development Centre**			**Skill**
Total valid credits		**22**				

(B) Comprehensive viva voce (virtual credits)	**4**		**50**	

*Both (A – Core courses; One Elective course and Skill Development modules) & (B) are compulsory components of a semester. The grades awarded in the comprehensive Viva-voce shall be shown

Approved by

Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/20220

Standing committee on **Executive Council on**

separately in the Grade Sheet.

SEMESTER IV

(A) DISSERTATION	Credits	Maximum Marks	
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**	**Skill Employability Enterpreneurship**
B. Viva-Voce EXTERNAL		**50**	
C. Viva-Voce INTERNAL		**50**	
Total		**400**	

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

6. COURSES OF STUDY

FIRST – SEMESTER

CORE COURSE CODE BTC101: CELL BIOLOGY

(COURSE CREDITS =03)

Course Objectives:

The course aims to facilitate the learners an in-depth understanding of structure and function of cell, its components and transport across various organelles. Empowering the learners with different tool and techniques of cell biology, it will provide deep understanding of cellular aspect of mechanism of signal transduction, cell cycle and cancer.

Course Learning Outcomes:

CO1: Understanding of structure of prokaryotic and eukaryotic cell, and application of knowledge of microscopic techniques for cell study.

CO2: Knowledge of functional integrity and structure of different cell organelles and transport of ions, nutrients and macromolecules across membranes.

CO3: Knowledge about signal transduction pathway with understanding of different type of receptors and signaling molecules.

CO4: Conceptualization of cell cycle, cell division and cell death. Deep understanding of events of mitosis, apoptosis, embryonic stem cells and therapeutic cloning.

CO5: Knowledge about biology of cancer and its causes. Understanding of oncogenes, tumor suppressor gene, tumor viruses and molecular approach of cancer treatment.

COURSE CONTENTS

UNIT- I

Diversity of cell size and shape, cell theory, cell theory. Structure of prokaryotic and eukaryotic cells, isolation of cells, microscopic techniques for study of cells.

UNIT- II

Cellular organelles, plasma membrane, mitochondria, chloroplast, nucleus their structural organization, transport of nutrients ions and macromolecules across membranes.

UNIT- III

Cell signaling- signaling molecule and their receptors, functions of cell surface receptors, Intracellular signal transduction pathway, signaling networks.

UNIT-IV

The cell cycle and cell death and cell renewal; Eukaryotic cell cycle, Events of mitotic phase, meiosis and fertilization. Programmed cell death, stem cells and embryonic stem cells and therapeutic cloning.

UNIT- V

Cancer: Development and causes of cancer, Tumor Viruses, Oncogenes, Tumor suppressor genes, Cancer treatment- molecular approach.

Recommended Books

1. Molecular Biology of Cell, Alberts, B. et al.
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, DM Prescott, Academic Press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and Inheritance, EB Wilson, MacMilan NewYork.
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.
7. Fertilization, FT Longo, Chapman and Hall.
8. Molecular Biology of Steroid and Nuclear Hormone Receptors, LP Freedman, Birkhuse

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CORE COURSE CODE BTC102: ANIMAL CELL SCIENCE AND TECHNIQUES

(COURSE CREDITS =03)

Course Objectives:

The course aims to empower the learners with knowledge and techniques of Animal cell science for in vitro cell culture and its application in formation of various cell culture products for research laboratory to industrial uses.

Course Learning Outcomes:

CO1: Understanding the basic structure and organization of animal cell; equipment's and materials for animal cell culture technology; primary and established cell lines cultures; introduction and function of the balanced salt solutions and simple growth medium, serum and supplements; role of carbon dioxide in to the culture.

CO2: Learning the different parameters, i.e. viability and cytotoxicity; biology and characterization of the cultured cells and basic techniques of cultured cells like disaggregation of tissue and primary culture; maintenance of cell culture.

CO3: Knowledge about various techniques like Scaling up of animal cell culture, cell synchronization, cell cloning and micro-manipulation, cell transformation.

CO4: Understanding the application of animal cell cultures, stem cell cultures, cell culture based vaccines, somatic cell genetics.

CO5: Conceptualize the application of Organ and histotypic culture, measurement of cell death, apoptosis, three dimensional culture and tissue engineering.

COURSE CONTENTS

UNIT-I

Structure and organization of animal cell; equipments and materials for animal cell culture

technology; primary and established cell lines cultures; introduction to the balanced salt solutions and simple growth medium; brief account of chemical, physical and metabolic functions of different constituents of culture medium; role of carbon dioxide, serum and supplements.

UNIT-II

Serum and protein free defined media and their application, measurement of viability and cytotoxicity; biology and characterization of the cultured cells, measuring parameters of growth; basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.

UNIT-III

Scaling up of animal cell culture, cell synchronization, cell cloning and micro-manipulation, cell transformation.

UNIT-IV

Application of animal cell cultures, stem cell cultures, embryonic stem cells and their applications, cell culture based vaccines, somatic cell genetics.

UNIT-V

Organ and histotypic culture, measurement of cell death, apoptosis, three dimensional culture and tissue engineering.

Recommended Books:

1. Culture of Animal Cells (3rd Edition), R. lan Freshmney. Wiley-Liss.

2. Animal Cell Culture-Practical Approach, (Ed) John R.W. Masters, Oxford.

3. Cell Growth and Division' A Practical Approach. (Ed.) R. Basega, IRL Press.

4. Cell Culture Lab Fax. (Eds). M. Buller & M. Dawson, Bios Scientific Publication Ltd. Oxford.

5. Animal Cell Culture Techniques. (Ed.) Martin Clynes, Springer.

6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods, (Ed.) Jenni P. Mather and David Barnes,

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CORE COURSE CODE BTC103: MICROBIAL PHYSIOLOGY AND GENETICS

(COURSE CREDITS =03)

Course Objectives:

The course aims to study microbial physiological and biochemical processes within the microbial cell for profiling of metabolic pathways and metabolites along with their genetic controls for possible applications in Biotechnology

Course Learning Outcomes:

CO1: Gains insight about growth dynamics, mathematical expression, growth curves and yields, types of growth; effect of environmental factors storage and maintenance of cultures.

CO2: Understanding of concepts of metabolic diversity, including photosynthetic, chemolithotrophic and CO_2 and nitrogen fixation, nitrate and sulfate reduction, fermentation, decomposition, methanogenesis and acetogenesis, hydrocarbon transformation.

CO3: Gains insight knowledge about structural and metabolic diversity of bacteria, viruses, viroids and prions. Prokaryotic cells structure.

CO4: Insight into host-parasite relationship, colonization, types of toxins, and their structures, mode of action, Chemotherapy/antibiotics: antimicrobial agent antibiotics, mode of action, antibiotics resistance.

CO5: Sound knowledge of genes, mutation and mutagenesis; types of mutagens and mutation; Ames test, complementation test, Bacterial genetic recombination, plasmids and transposons; bacterial genetics mapping.

COURSE CONTENTS

UNIT-I

The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; synchronous growth; growth as affected by environmental factors liken temperature, acidity, water availability and oxygen; storage and maintenance of cultures, continuous culture.

UNIT-II

Metabolic diversity among microorganisms, photosynthesis in microorganisms; role of chlorophylls, carotenoids and phycobilins: Calvin cycle; chemolithotrophy; hydrogen-ironnitrite oxidizing bacteria; nitrate and sulfate reduction; Methane fermentation-diversity, syntrophy, role of anoxic decomposition, methanogenesis and acetogenesis; nitrogen fixation; hydrocarbon transformation.

UNIT-III

Structural diversity of bacteria: purple and green bacteria, cyanobacteria, homoacotogenic bacteria, acetic acid bacteria, budding and appendaged bacteria, spirilla, spriochaetes, gliding and sheathed bacteria, pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci, mycobacteria, rickettsias, chlamydias and mycoplasms methanogens; Structural diversity of viruses: bacterial, plant, animal and tumor viruses examples of herpes, pox, adenoviruses, retroviruses, viroids and prions. Prokaryotic cells structure and functions: cell walls of eubacteria; peptidoglycan and related molecules; outer-membrane of gram negative bacteria; cell membrane synthesis; cell inclusions like endospores, gas vesicles etc.

UNIT-IV

Host-parasite relationship: entry of pathogens into the host; colonization types of toxins: exoendo- and entero-toxins and their structures, mode of action, Chemotherapy/antibiotics: antimicrobial agents, sulfa drugs, antibiotics, penicillins and cephalosporins, broad spectrum antibiotics, mode of action, resistance to antibiotics.

UNIT-V

Genes, mutation and mutagenesis; UV and chemical mutagens; types of mutation; Ames test for mutagenesis, complementation test, Bacterial genetic system: transformation, conjugation, transduction, recombination, plasmids and transposons; bacterial genetics map with reference to E. coli.

Recommended Books:

1. General Microbiology, Stanier, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan press Ltd.

2. Brock Biology of Microogranisms, Madigan M.T. Martinko, J.M. and Parker, J. Prentice- Hall.

3. Microbiology, Pelczar, M.J. Jr. Chan E.C.S. and Kreig , N.R. Tata McGraw Hill.

4. Microbial Genetics Maloy, S.R.C Cronan , J.E.Jr. and Frelfelder ,D. Johnos Bartlett Publishers.

5. Microbiology- A Laboratory Manual, Cappuccino, J.G. and Sherman N. Addison Wesley.

6. Microbiological Application: A Laboratory Manual in General Microbiology Benson, H.J, WCB: Wm C. Brown publishers.

CORE COURSE CODE BTC104: PRACTICAL BASED ON COURSE CODE BTC101 & COURSE CODE BTC102 (COURSE CREDITS =04)

Suggested list of Practicals (Course **BTC101**)

1. To determine the bleeding time of human blood by using blotting paper.
2. To perform agglutination reaction for identification of blood group.
3. To determine the clotting time of human blood by using capillary tube.
4. To determine the hemoglobin contain in blood sample.
5. To prepare a blood smear.

Suggested list of Practicals (Course **BTC102**)

1. To clean and re-sterilize glass wares.
2. To perform agglutination reaction for identification of blood droups.
3. To determine the differential count of leucocytes.
4. Isolation of DNA from animal tissue.
5. To count erythrocytes in a given blood samples.
6. To count total leucocytes in given blood samples.

CORE COURSE BTC105: PRACTICAL BASED ON COURSE CODE BTC103 & COURSE CODE BTE101 / BTE102 (COURSE CREDITS =04)

Suggested List of Practicals (Course **BTC103**)

1. To prepare liquid and solid media for the growth of microorganisms.
2. To isolate and identify micro-organisms by serial dilution agar plating method.
3. To isolate bacteria from water sample on XLD, TCBS, Mac Conkey, EMB selective agar medium.
4. To examine bacteria microscopically by Gram' staining.
5. To determine MPN of different water sample.
6. To isolate bacteria from soil sample on XLD, TCBS, MacConkey, EMB selective media by using pore plate & spread plate method.
7. To confirm the presence of coliforms in water samples by using 24 hrs old positive lactose broth culture.
8. Microscopic identification of different cyanobacterial & algal cultures.

ELECTIVE COURSE CODE BTE101 : BIOMOLECULES

(COURSE CREDITS =03)

Course Objective:

Develop a deep understanding about the structure and various principles dealing with the working of biomolecules and their mutual interactions to support the life system.

Course Learning Outcomes:

CO1: Enabling students to understand the importance of water in maintaining the various biochemical reactions such as buffering, phosphorylation, oxidation-reduction, etc.

CO2: The students learn the principle of working of enzyme and the process of enzymology, i.e. how the enzymes work and where the active sites play a key role.

CO3: The students also learn the basic and functional structures of all the biomolecules in detail.

CO4: The inter-relationships and communication between the biomolecules is a major part of signal transduction. The students become well versed with this mode of biological process.

CO5: The students learn various techniques such as chromatography, spectroscopy and electrophoresis to understand the purity of biomolecules and their analytical properties for further application.

COURSE CONTENTS

UNIT I

Structure of water and its solvent properties, Acid- bases, pH and buffer, Bi and polyprotic buffer. Free energy and spontaneity of reactions, ATP and other phosphorylated compound with their free

energy of hydrolysis, Phosphoryl group transfer, Biological oxidation reductions reaction, Coupled reaction and oxidative phosphorylation, Inhibitors and uncouplers.

UNIT II

Enzyme classification, Specificity, Active site, Enzyme kinetics, Michealis Menton equation, Determination of kinetic parameters, Bi-substrate reaction and their kinetics, Enzyme inhibition and kinetics, Allosteric enzyme. Kinetics and Allosteric regulation of phosphofructo kinase

UNIT III

Structure and chemistry of macromolecules, Proteins, Carbohydrates and Lipids, Protein folding, Structure and chemistry of bimolecules such as antibiotics, Pigments, Vitamins as coenzymes, Lipid analysis by GLC and Mass Spectrometry, Oligosaccharide and Polysaccharide analysis.

UNIT IV

Biosignaling molecular mechanism of signal transduction, Gated ion channels, Nicotinic acetyl choline receptor, Receptor enzyme, The insulin receptor, G- proteins and cyclic AMP membrane transport, Biomembrane, Nutrient transport across membranes, Active and passive diffusion, Symport, Antiport and uniport, Na^+ K^+ pumps and their metabolic significance.

UNIT V

Chromatographic technique, Paper and TLC , Gel filtration, Ion exchange, Affinity, HPLC, SDS, PAGE, Isoelectric focusing, Western blotting, Protein sequencing, Mass spectrometry, MALDI , TOF, MS.

Books Recommended

J. L., Jain, Sanjay, and Jain Nitin, (1979) Fundamentals of Biochemistry (6th revised Edition). S. Chand & Co. Ltd. New Delhi.

Buchanan . B.B. Gruissem, W. and Jones .R.L. (2000) Biochemistry and Molecular Biology of Plants , American Society of Plant Physiologists, Maryland ,USA.

Albert L. lehninger, Davis L. Nelson, Michael M. Cox. (2004) Lehninger Principles of Biochemistry.

Lea P.J. and Leegood ,R.C. (1999) Plant Biochemistry and Molecular Biology (2 nd Edition) John Wiley and Sons. Chichester, England

Berg Jeremy, Tymoczko John, Stryer Lubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.

Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.

Dawes Edwin A. (1972) Quantitative Problems in Biochemistry, Churchill Livingston, Edinburgh.

Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press. 5. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.

Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.

Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.

Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.

Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.

Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.

Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.

White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.

White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford

University Press, New York.

Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

Suggested list of Practicals (Course Code BTE101)

1. To study working of weighing balance.
2. To study the working of pH meter.
3. To determine the pKa value of acetic acid by pH titration method.
4. Preparation of acetate buffer at pH=5.
5. Prepare Phosphate buffer at pH=8.
6. To prepare tris buffer at pH=9.
7. Estimation of protein by Lowry method.
8. Chromatographic separation by paper and thin layer Chromatography.
9. To determine pKa value of glycine.
10. Determine the absorption maxima of Potassium dichromate.
11. To prove the validity of Beer-Lambert's law.
12. Qualitative assessment of carbohydrate.
13. Qualitative assessment of lipids.
14. Qualitative assessment of proteins.
15. To prepare standard curve of glucose by anthrone method.
16. To determine the Km and Vmax od amylase enzymes.
17. To study the effect of substrate concentration on enzyme activity.
18. To study the effect of temperature on enzyme activity.

ELECTIVE COURSE CODE BTE102: BIOENERGETICS AND INTERMEDIARY METABOLISM

(COURSE CREDITS = 03)

Course Objective:

It explains the potential role of biomembranes and their extraordinary use in maintaining and regulating all the metabolic cycles taking place inside the cell and outside the cell. These membranes are playing a very crucial role in maintaining the energy dynamics of the cell.

Learning Outcomes:

CO1: Enabling students to understand finely detailed energy dynamics of a biomembrane, the components involved therein and various physiological attributes driven by aforementioned energy transformation.

CO2: The students learn the principle of working of mitochondria as a model of energy transducer with special reference to its membrane associated respiratory processes leading to formation of ATP.

CO3: The students also learn the anabolic and catabolic processes involving carbohydrates in marinating the energy balance of the cell.

CO4: The biosysnthesis of lipids that constitute the biomenbranes is understood at the level of enzymes and pathways.

CO5: The catabolic role of amino acids in the formation of urea and abnormalities due to metabolic errors in these cycles is learnt by students. The synthesis of nucleic acids, the hereditary material, involving purines and pyrimidines is made acquainted to the learners.

COURSE CONTENTS

UNIT I

Bioenergetics: energy transformation, biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes; free energy changes and redox potentials, phosphate potential, ion and proton electrochemical potentials, membrane potentials, chemo-osmotic theory; ion transport across energy transducing membranes, influx and efflux mechanisms, transport and distribution of cations, anions and ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

UNIT- II

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization; the Q cycle and the stoichiometry of proton extrusion and uptake. Oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes. ATP synthetase complex, microsomal electron transport.

UNIT- III

Carbohydrates: glycolysis, citric acid cycle- its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway, alternate pathways of carbohydrate metabolism, gluconeogensis, inter-conversions of sugars, biosynthesis of glycogen, starch and oligosaccharides.

UNIT- IV

Lipids: fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthase; fatty acid oxidation: α, β, oxidation and lipoxidation; lipid biosynthesis: of triacylglycerols, phosphoglycerides and sphingolipids, biosynthetic pathways for terpenes and steroids.

UNIT- V

Amino acids and nucleic acids: biosynthesis and degradation of amino acids and their regulation, specific aspects of amino acid metabolism, urea cycle and its regulation, in-born errors of amino acid metabolism; Nucleic acids: degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide biosynthesis, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis.

Books recommended

M.M. Cox and D.L. Nelson (2008) Lehninger Principals of Biochemistry W.H. Freeman & Company

Otto Hoffmann-Ostenhof (2008) Intermediary metabolism; *Van Nostrand Reinhold (USA).*

P.H. Clarke (1978) Intermediary metabolism; *John Wiley & Sons Ltd Hoboken, New Jersey (United States).*

Alexander Lowen (1994) Bioenergetics; *Penguin/Arkana Books USA.*

David G. Nicholls and Stuart Ferguson (2013) Bioenergetics; *Academic Press Elsevier United States.*

Suggested list of Practicals (Course Code BTE102)

1. To prepare acetate buffer of pH4.7.
2. To perform carbohydrate tests of manosaccharides, polysaccharides, disaccharides.
3. To determine protein of unknown sample by Lowry method.
4. To perform the detection of lipid in the given sample

CORE COURSE CODE BTS101: SKILL DEVELOPMENT MODULES 1

(COURSE CREDITS = 02)

PERSONALITY DEVELOPMENT- MODULE- 1 (Semester-1) Hrs.-30

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet	1
02	Role and Impact of Personality	Group Activity	1
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	2
04	Listening and Caring	Group Activity	1
05	The Art of Communication	Worksheet	1
06	Different level of Effective Communication	Worksheet	1
07	Professional Communication P-A-C	Worksheet	1
08	Rules of Professional Communication	Group Activity	1

09	Body Language - 1	Worksheet	1
10	Language Lab	Worksheet	1
11	Thought Process - 1	Worksheet	1
12	Interpersonal Skills	Worksheet	1
13	Observation & Imagination Power	Group activity	1
14	Creativity	Group Activity	1
15	Extempore - 1	Group activity	1
16	Extempore - 2	Group Activity	1
17	Presentation Skills	Worksheet	2
18	How to Draw the Attention of Audience	Worksheet	1
19	Steps of Effective Presentation	Worksheet	1
20	Prioritizing Matrix	Worksheet	1
21	Leadership Quality	Group activity	1
22	SWOT Analysis	Worksheet	1
23	Interview Skills	Lecture	2
24	Group Discussion	Group Activity	2
25	Resume Preparation	Group Activity	1

SECOND – SEMESTER

CORE COURSE CODE BTC201: MOLECULAR BIOLOGY

(COURSE CREDITS =03)

Course Objectives:

Enables students understand basic properties and application of nucleic acids and functionally associated proteins both in prokaryotic and eukaryotic system.

Course Learning Outcomes:

CO1: The students learn about different models and biochemical processes associated with nucleic acid replication in diverse model organisms.

CO2: The learners get a deep acquaintance with the process of DNA recombination and repair in model organisms.

CO3: The pupils become well versed with the process of DNA-dependent RNA synthesis (transcription) and post-transcriptional modifications thereby generating transfer, messenger and ribosomal RNA. Channelling of specialized proteins to their correct positions is also made aware of.

CO4: Students learn function of cancer-associated and cancer-preventing genes as well as techniques and applications related to ribozymes and antisense RNA.

CO5: Sophisticated techniques related to genome mapping, DNA fingerprinting, genome cloning and recognition of desired genes are elaborated along their applications.

COURSE CONTENTS

UNIT-I

DNA replication: prokaryotic and eukaryotic DNA replication, mechanics of DNA replication enzymes and accessory proteins involved in DNA replication.

UNIT-II

DNA repair and recombination – methyl directed mismatch repair, very short patch repair nucleotide and base excision repair, SOS system. Holliday junction, gene targeting and gene knock-outs, FLP/ FRT Cre/Lox recombination, RecA and other recombinases.

UNIT-III

Transcription and modification in RNA/ protein; prokaryotic and eukaryotic transcription, RNA polymerases, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, 5- Cap formation transcription termination, 3’ – end processing and polyadenylation, splicing, editing, stability and nuclear export of mRNA; post- transcriptional gene silencing, Protein localization; synthesis of secretary and membrane proteins.

UNIT-IV

Oncogenes and tumor suppressor genes: viral and cellular oncogenes, tumor suppressor genes from humans; structure function and mechanism of action of pRB and p53 tumor suppressor proteins. Antisense and ribozyme technology, molecular mechanism of anti- sense molecules, disruption of RNA structure. Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

UNIT-V

Molecular mapping of genome: genetic and physical maps, physical mapping and map- based cloning. Southern and fluorescence in situ hybridization for genome analysis; chromosome micro-cloning; molecular markers in genome analysis: RFLP and RAPD analysis, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal and germplasm maintenance. Genome sequencing and genomic libraries, YAC, BAC libraries, strategies for sequencing genome, packaging, transfection and recovery of clones

Recommended Books:

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.

2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988

3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991

4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.

5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.

6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.

7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.

8.Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995

9. Genomes, T.S. Brown

CORE COURSE CODE BTC202: MACROMOLECULES & BASIC ENZYMOLOGY

(COURSE CREDITS =03)

Course Objective: Students learn about various properties and applications of enzymes and functional proteins both in prokaryotic and eukaryotic systems.

Course Learning Outcomes:

CO1: The students learn the unitary model of functioning of the enzymes and the environmental factors affecting the efficiency of working of the enzyme

CO2: The kinetics of the enzyme leading to catalysis in polar and non-polar environments, and the contribution of metal ions, water, pH, cofactor and coenzyme in overall efficiency of the enzyme is made understood in detail.

CO3: The students become well versed with the selected model enzymes with their regulatory pattern in overall control of anabolic and catabolic pathways.

CO4: The learners get acquainted with the physiological role of the appropriate conformation of macromolecule and assemblies playing a contributing to the efficiency of catalytic proteins.

CO5: Various biochemical techniques related in elucidating the overall structure of the different biomolecules and their specific role in specific conformations is learnt by the students.

COURSE CONTENTS

UNIT- I

- Review of uni-substrate enzyme kinetics and factors affecting the rate of enzyme catalyzed reactions.
- Michealis pH function and their significance.
- Kinetics of Bisubstrate reactions.

UNIT- II

- Enzyme catalysis in solutions- Kinetics and thermodynamic analysis, activation energy and binding energy
- General acid-base catalysis, Covalent catalysis, Metal ion catalysis
- Effect of organic solvents on enzyme catalysis and structure consequence

UNIT- III

- Detailed mechanism of catalysis of serine proteases, Ribronuclease, Triose phosphate isomerase, lysozyme.
- General mechanism of enzyme regulation, feedback inhibition and feed forward stimulation.

UNIT- IV

- Macromolecule and supra molecule assemblies, Glyco-lipid proteins, membrane
- Conformational properties of polynucleotide and polysaccharide
- Protein denaturation and denaturants.

UNIT- V

- Physical techniques in Proteins, Nucleic acid and Polysaccharides: UV-Vis, IR, NMR, Fluorescence Spectroscopy, Ultracentrifugation, Electron Microscopy. Methods for preparing samples and producing contrast replica formation, freez fracture, Shadow-casting positive staining.

CORE COURSE CODE BTC203: BIOSTATISTICS AND COMPUTER APPLICATIONS

(COURSE CREDITS: 3)

Course Objectives:

The course aims to empower the learners with tools and techniques in collection, collation, summarization and interpretation of data along with various experimental designs and bioinformatics.

Course Learning Outcomes:

CO1: Proficiency of students in various techniques of collection, collation, summarization and presentation of data. They could learn basic concepts of probability and probability distribution functions along with applications.

CO2: Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.

CO3: Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.

CO4: Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.

CO5: Empowers students to utilize software packages in digital analysis and processing of biological data. Integrate informatics with biology through data submission protocols, sequence alignment and searches, annotations and possible applications in human health and welfare.

COURSE CONTENTS

UNIT-I

Importance and scope of statistics in biochemical experimentation; Elements of Probability-Mathematical and Statistical definitions; Addition and Multiplication theorems; Probability Distribution Functions – Binomial, Poisson and Normal; Area under normal distribution curve.

UNIT-II

Measures of central tendency: Arithmetic, geometric & harmonic means; Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean. Tests of significance hypotheses and errors; student t statistics- population mean equals a specified value; equality of 2 independent means (equal & unequal variance), equality of 2 means (paired samples).

UNIT-III

Analysis of variance: one-way analysis (sample sizes equal and unequal), completely randomized design; two-way analysis (one observation per cell), randomized block design; multiple comparisons: least significant difference, Duncan's new multiple range test.

UNIT-IV

Linear regression: regression diagram and equation, regression coefficient, standard error, significant tests, prediction of dependent variable from the independent variable; linear correlation- scatter diagram, correlation coefficient, standard error, significance tests; relationship between regression and correlation coefficients; Non parametric tests: Chi-square statistics, test of goodness of fit, test of independence of attributes; standard line interpolation.

UNIT-V

Introduction to Computers: Basic architecture, generations of computer hardware and software; operating systems-WINDOWS and UNIX; system and application software; introduction to internet-LAN, MAN, WAN, Concept of bioinformatics; application of bioinformatics in microbiology.

List of Recommended Books

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.
2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
3. Programming in C by E. Ballaguruswamy
4. How Computers work - 2000. By Ron White. Tech. Media
5. How the Internet Work 2000 by Preston Gralla Tech. Media.
6. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
7. Biostatistics - 7th Edition by Daniel
8. Fundamental of Biostatistics by Khan
9. Biostatistical Methods by Lachin
10. Statistics for Biologist by CampbellR.C. (1974) Cambridge University Press, UK.
11. INTERNET – CDC publication, India.

CORE COURSE BTC204: PRACTICAL BASED ON COURSE CODE BTC201 & COURSE CODE BTC202

(COURSE CREDITS =04)

Suggested list of practicals (Course Code BTC201)

1. Establishment of *E.coli* in EMB media.
2. Establishment of *E.coli* in Luria-Barthetti Broth.
3. To Perform Protein electrophoresis by SDS-PAGE.
4. Isolation of Plasmid DNA from *E. coli*.
5. Isolation of genomic DNA from higher plants.
6. To perform Agarose gel electrophoresis for isolated DNA sample.

Suggested list of practicals (Course Code BTC202)

1. To estimate glucose or fructose concentration by DNS method.
2. To study the effect of temperature on activity of invertase enzyme.
3. To study product inhibition by sucrose and calculation of Km.
4. To study the substrate inhibition and calculation of Km of the enzyme invertase.
5. To study the effect of pH on activity of invertase enzyme.

CORE COURSE BTC205: PRACTICAL BASED ON COURSE CODE BTC203 & BTE201 / BTE202 / BTE203

(COURSE CREDITS =04)

Suggested list of Practical's (Course Code BTC203: Biostatistics and Computer Application)

1. Representation of Statistical data by a) Histograms b) Pie diagrams
2. Testing statistical definition of probability.
3. Testing of the binomial distribution becoming normal distribution at small n, if p=q.
4. Determination of Statistical averages/ central tendencies. a) Arithmetic mean b) Median c) Mode
5. Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation
6. Tests of Significance-Application of following a) Chi- Square test b) t- test c) Standard error
7. Computer operations-getting acquainted with different parts of Computers. [DOS] and basics of operating a computer.
8. Creating files, folders and directories.
9. Applications of computers in biology using MS-Office.
   A] MS-Word B] Excel C] Power Point
10. Creating an e-mail account, sending and receiving mails.
11. An introduction to INTERNET, search engines, websites, browsing and Downloading.

ELECTIVE COURSE CODE BTE201: BIOLOGY OF THE IMMUNE SYSTEM

(COURSE CREDITS =03)

Course Objectives:

Develops deep understanding about the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body, including operational mechanisms underlining the host defense system, allergy and organ transplantation.

Course Learning Outcomes:

CO1: Students will be able to understand the fundamental bases of immune system and immune response.

CO2: Information about the structure and organization of various components of the immune system.

CO3: Students learn the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity.

CO4: Will be able to understand the operation and the mechanisms which underlie the immune response.

CO5: Application of the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

COURSE CONTENTS

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

UNIT-II

Antibody structure and function; antigen-antibody interactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. Blymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells. Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiences, hybridoma technology and monoclonal antibodies.

Recommended Books:

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A.Osbarne. (Freedom)

2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).

3. Fundamentals of immunology, William Paul.

4. Immunology, Roitt and others.

Suggested list of Practicals (Course Code BTE201)

1. To perform test for antibiotics sensitivity by disc method.
2. To determine the minimum inhibitory concentration of given antibiotics.
3. Preparation of blood smear.
4. To isolate serum from blood plasma.
5. To perform agglutination reaction to identification of blood group.

ELECTIVE COURSE CODE BTE202: RESOURSE UTILIZATION AND CONSERVATION

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with knowledge pertaining to world biomes, resources, conservation, sustainable development, pollution and its management, and remote sensing in management of earth resources.

Course Learning Outcomes:

CO1: Deep understanding of distribution, structure and function of various aquatic and terrestrial biomes.

CO2: Learn definitions, types and utilities of biodiversity along with threats along their applications in management and sustainable development of resources from various biomes.

CO3: Empowers students to apply in-situ and in-vitro techniques in conservation of aquatic and terrestrial resources in real time.

CO4: Understands concepts of pollution of different environments and can monitor and treat pollution loads in artificial and natural ecosystems; and appreciate nuances of industrial, societal and urban pollutions.

CO5: Gains insight knowledge about remote sensing of earth resources along with platforms, sensors and scanners, visual and digital interpretation of remotely sensed data.

COURSE CONTENTS

UNIT – I

Major Biomes of the world, Tropical rain & Seasonal Forests, Temperate rain & Seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic Ecosystems wetlands, Lakes & Ponds Streams & Rivers, Marine & Estuarine habitats.

UNIT – II

Resource utilization**,** Status & Utilization of Biodiversity, Sustainable development resources from forest, Grassland and aquatic habitats, Food forage, Fodder, Timber & Non-wood forest products, Threats to quality & quantity of Resources due to overexploitation.

UNIT –III

Strategies for conservation of resources: Classifications of resources, Principles of conservation, *In-situ* conservation sanctuaries, National parks, Biosphere reserves for wildlife conservation, Habitat conservation practices of conservation for forests ranges, Soil and water.

UNIT – IV

Air, Water and Soil pollution**,** Kinds, Sources, Quality parameters, Effects on structure & function of ecosystems, Management of pollution, Bioremediation, Climate changes sources, Trends & role of greenhouse gases, Effect of global warming on climate, Ecosystem processes & Biodiversity, Ozone layer & Ozone hole.

UNIT – V

Resource monitoring, Remote sensing concepts & Tools, Satellite remote sensing basics sensors, Visual & digital interpretation, EMR bands and their applications, Indian remote sensing programme, Thematic mapping of resources, Application of remote sensing in Ecology &Forestry.

Books recommended

- Chopra R. N. (1933) Indigenous Drugs of India.
- Hayes W. B. (1953) Fruit Growing in India.
- Atkinson E. T. (1980) Economic Botany of Himalayan Regions.
- Chapman, J.L. and Reiss, M.J. (1999) Ecology: Principles and Applications.
- Singhal, P.K. and Shrivastava, P. (2004) Challenges in Sustainable Development.
- Odum, E.P. (1971) Fundamentals of Ecology.
- Begon, M., Harper, J.L. and Townsend, C.R. (1986) Ecology: Individuals, Populations and Communities.
- Wetzel, R.G. (1983) Limnology.

Suggested list of Practical's: Course Code BTE202 (Resource Utilization and Conservation)

1. To find the pH of the various sample of soil by pH meter.
2. To determine ground flora in forest ecosystems.
3. To determine IVI of species in forest ecosystmes.
4. To determine the presence of carbonate in different soil mixtures.
5. To determine the presence of phosphate in soil and water sample.
6. To determine the presence of nitrate in mixture sample.
7. To determine the presence of nitrite in mixture sample.
8. To determine frequency, density and abundance of herbaceous species from local garden.
9. To determine the biomass of plant vegetation.
10. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

ELECTIVE COURSE CODE BTE203: MICROBIAL METABOLISM

(COURSE CREDITS: 3)

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation, and to enable students to better understand courses taught later.

Course Learning Outcomes:

CO1: Students become acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.

CO2: They gain an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.

CO3: They learn central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.

CO4: Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.

CO5: They learn basic concepts of enzyme biochemistry, its kinetics and regulation, details of lipid and nucleotide metabolism in *E. coli* and its regulation along with biochemical basis of lipid accumulation in yeasts, and intracellular signaling in bacteria in response to various nutritional and physiological stresses.

COURSE CONTENTS

UNIT-I

Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

UNIT-II

Chaemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis. Electron transport-photoautotrophic generation of ATP, fixation of CO2- Calvin cycle, reverse TCA, carbohydrate anabolism.

UNIT-III

Respiratory metabolism: Embden Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates-homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

UNIT-IV

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

UNIT-V

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Dormancy. Endospore-structure, properties and germination.

List of Recommended Books

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009.

Suggested list of Practicals (Course Code BTE203: Microbial Metabolism)

1. Determination of Bacterial growth by turbidity measurements (spectrophotometric method).
2. Study of effect of temperature on growth of bacteria.
3. Study of effect of pH on growth of Bacteria.
4. Isolation of rhizobia from root nodules.
5. Slide culture technique for studying morphology and molds.

CORE COURSE CODE BTS201: SOFT SKILL DEVELOPMENT MODULES 2

(COURSE CREDITS = 02)

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet/ lecture	02
02	Role and Impact of Personality	Group Activity/ lecture	01
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	02
04	Importance of characteristics and Traits	lecture/Group Activity	02
05	Empowerment of Internal and external traits	lecture	02
06	Definition of Personality	Lecture	02
07	Power of Self	Lecture	03
08	Path to Improve Personality	lecture/Group Activity	03
09	Body Language - 1	Worksheet	02
10	Grooming Yourself	Lecture	02

11	IQ / EQ / MQ / SQ	lecture	02
12	Disposition of Body in various aspects	Group Activity	03
13	Getting desired output	Group Activity	02
14	Post Assessment of Personality	Group Activity	02

THIRD SEMESTER

CORE COURSE CODE BTC301: ENVIRONMENTAL BIOTECHNOLOGY

(COURSE CREDITS: 3)

Course Objectives:

The course aims to empower the learners with the basic concepts of the global environmental issues, biodiversity in India, water pollution and its control, waste water treatment (physical, chemical and biological) and microbial remediation of xenobiotics in the environment.

Course Learning Outcomes:

CO1: Deep understanding of existing and emerging technologies that are important in the area of environment and the principles and techniques which underline the environmental issues including air and water pollution.

CO2: Empowers the students with the knowledge of Domestic waste water treatment, Classification of wastewater treatment (physical, chemical and biological)

CO3: Students learn about concepts of Biodegradation, Biodegradation of hydrocarbon, Measurement of biodegradation. Bioremediation-Concept, Methods of Bioremediation (In-situ and Ex-situ Bioremediation), and Xenobiotic biodegradation.

CO4: Learners will understand the concept of biodiversity: conservation and management, rules and acts.

CO5: Deep understanding of global environmental problems-ozone depletion, UV-B greenhouse effect and acid rain, their impact and biotechnology approaches for management.

COURSE CONTENTS

UNIT-I

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT-II

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health.

UNIT-III

Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processesanaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes form extreme environment.

UNIT-IV

Microbial degradation of xenobiotics in the environment- ecological considerations, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

UNIT-V

Biological N_2 fixation, H2 production, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production). Single cell protein (Spirulina, yeast, mushroom); global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

List of Recommended Books

1. Wastewater Engineering- Treatment, disposal and Reuse. Metcalf and Eddy, Inc,.Tata McGraw Hill, New Delhi.
2. Comprehensive Biotechnology. Vol. 4, M. Moo-young (Ed-in-chief), Pergamon Press, Oxford.
3. Environmental Chemistry, A.K. De. Wiley Eastern Ltd. New Delhi.
4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold

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CORE COURSE CODE BTC302: GENETIC ENGINEERING

(COURSE CREDITS =03)

Course Objectives:

Inculcates deeper insights about genetic engineering concepts, techniques and tools, and its applications in strain improvement, enzyme engineering, metagenomics and transgenic technology.

Course Learning Outcomes:

CO1: Students will understand the core concepts and fundamentals of genetic engineering.

CO2: Develop their competency on different types of strain improvements.

CO3: Analyses of the enzymes and vectors for genetic modification for required productivity.

CO4: Examination of gene cloning and evaluate different methods of gene transfer like metagenomics

CO5: They are able to critically analyze the major concerns and applications of transgenic technology.

COURSE CONTENTS

UNIT-I: Scope of genetic engineering, milestones in genetic engineering; isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separations, cloning, gene expression; cloning and patenting of life forms; genetic engineering guidelines; molecular tools and their applications; restriction enzymes, modification enzymes, DNA and RNA markers; nucleic acid purification, yield analysis. The manufacture, use, import, export and storage of hazardous micro-organisms genetically engineered organisms or cells rules, 1989.

UNIT-II: Nucleic acid amplification and its applications, gene cloning vectors-plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes; restriction mapping of DNA fragments and map construction; nucleic acid sequencing; cDNA synthesis and cloning; mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis; library construction and screening.

UNIT-III: Alternative strategies of gene cloning; cloning interacting genes-two-and three hybrid systems, cloning differentially expressed genes, nucleic acid micro array; site-directed mutagenesis and protein engineering; gene regulation-DNA transfection, Northern blot, primer extension, S1 mapping, RNAse protection assay, reporter assays.

UNIT-IV: Expression strategies for heterologous genes; vector engineering and codon optimization, host engineering; in vitro transcription and translation, expression in bacteria, yeast, insects and insect cells, mammalian cells, plants; processing of recombinant proteins-purification and refolding, characterization of recombinant proteins, stabilization of proteins; phage display.

UNIT-V: T-DNA and transposon tagging; role of gene tagging in gene analysis, identification and isolation of genes through T-DNA or transposon; transgenic and gene knockout technologies targeted gene replacement, chromosome engineering; gene therapy-vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Recommended Books:

1. Molecular cloning: A Laboratory Manual, J. Sambrook , E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.

2. DNA Cloning: A practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.

4. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego,1998.

5. Methods in Enzymology Vol.185 Gene Expression Technology, D.V. Goeddel, Academic Press, Inc. San Diego, 1990.

6. DNA Science. A First Course In Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York,1990.

7. Molecular Biotechnology (2nd Edn.) S.B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.

8. Milestones in Biotechnology, Classic Papers in Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.

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Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/20220

Standing committee on **Executive Council on**

9. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd. Oxford, 1997.

10. Genetic Engineering; An Introduction to gene analysis and exploitation in eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998.

11. Molecular Biotechnology-Glick

12. Pollution control law series; PCLS/02/2010(Sixth Edition)

COURSE CODE BTC303: PLANT BIOTECHNOLOGY

(COURSE CREDITS =03)

Course Objectives:

It aims to enable the learners with the knowledge of the qualitative and quantitative improvements in higher plants through emerging biotechnological tools.

Course Learning Outcomes:

CO1: Understanding of different techniques of *in vitro* culture and media preparation. Concept of totipotency, morphogenesis, organogenesis and somatic embryogenesis.

CO2: Knowledge of protoplast isolation, culture, fusion, somatic hybridization and cybridization.

CO3: Concepts of transgenic plant production through Ri and Ti plasmids and direct methods.

CO4: Concept of chloroplast transformation and its advantages, post harvest technology, and cryopreservation.

CO5: Role of biotechnology in qualitative improvement in plants through herbicide resistance, insect resistance, disease resistance and N_2 fixation. Knowledge of molecular markers: RFLP, PCR, QTL and MAS.

COURSE CONTENTS

UNIT-I: Introduction to plant cell and tissue culture: tissue culture media (composition and preparation), initiation and maintenance of callus and suspension culture. Regeneration through organogenesis and somatic embryo genesis; transfer and establishment of whole plant in soil; embryo culture and embryo rescue; anther, pollen and ovary culture for production of haploid plants and homozygous diploid lines; cryopreservation for germplasm conservation; protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plant; symmetric and asymmetric cybrids; germplasm conservation, virus free plants.

UNIT-II Cloning vector for higher plant transformation: *Agrobacterium tumefaciens* Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes. Viral vectors and their application: direct gene transfer: particle bombardment, electro oration, microinjection: transformation of monocots; transgene stability and gene silencing, selection of clones. Expression of cloned genes: genetic markers, reporter genes, Gus assay.

UNIT-III Application of plant transformation for productivity and performance: herbicide resistance (phosphnoinothricin, glyphosate, sulfonylurea, atrazine), insect resistance (Bt. Endotoxin genes, Non-Bt like proteinase inhibitors alpha amylase inhibitor), virus resistance (Coat protein mediated

protection (CPMP), nucleocapsid gene), disease resistance (anti fungal proteins chitinase, 1-3 beta glucanase, ribosome inactivating proteins (RIP), thionins, pathogenesis related (PR) proteins, nematode resistance, abiotic stress (salt tolerance); post harvest losses, long shelf life of fruits and flowers, use of ACC synthase. polygalacturanase. ACC oxidase, carbohydrate composition and concentration during storage. ADP glucose pyrophosphatase.

UNIT-IV Chloroplast transformation: advantages, vectors, success with tobacco and potato; metabolic engineering and industrial products; plant secondary metabolites, control mechanism and manipulation of phenyl propanoid pathway, Shikimate pathway, alkaloids, industrial enzymes; biodegradable plastics. Polyhydroxybutyrate, therapeutic proteins; lysosomal enzymes, antibodies, edible vaccines purification strategies, oleosin partitioning technology.

UNIT-V Molecular marker- aided breeding RFLP maps. Linkage analysis. RAPD markers. STS, microsatellites, SCAR (sequence characterized amplified region), AFLP, QTL. Molecular assisted selection; arid and semi- arid plant biotechnology, green house and green- home technology.

Recomonded Books:

1. J. Hammond, P. McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer Verlag, 2000.

COURSES OF STUDY IN M. Sc. BIOTECHNOLOGY

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2. T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.

3. H.S. Chawla: Biotechnology in Group Improvement, International Book Distributing Company. 1998.

4. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.

5. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

CORE COURSE CODE BTC304: PRACTICAL BASED ON COURSE CODE BTC301 & COURSE CODE BTC302

(COURSE CREDITS =04)

Suggested list of practicals (Course Code BTC301)

1. Isolation of *Cyanobacteria* (blue green algae).
2. Estimation of nitrate.
3. Estimation of nitrite.
4. Estimation of ammonia.
5. Determination of biological oxygen demand (BOD) of water sample.
6. Determination of chemical oxygen demand (COD) of water sample.
7. To study air born microbes by agar plate technique.
8. To study pollution stress by chlorophyll and carotenoid ratio from algae sample.
9. To study of effect of heavy metal on growth of bacteria.

10. To study of effect of pesticides on the growth of bacteria.

Suggested list of practicals (Course Code BTC302)

1. Isolation of bacterial DNA by quick preparation.
2. To isolate fungal DNA.
3. To perform Agarose gel electrophoresis of isolated DNA.
4. Comments on Electrophoresis.
5. Comments on Gel documentation system.
6. Comments on PCR.

CORE COURSE CODE BTC305: PRACTICAL BASED ON COURSE CODE BTC303 & BTE301 / BTE302 / BTE303 /BTE 304

(COURSE CREDITS =04)

Suggested list of Practicals (Course Code BTC303)

1.To sterilize the equipments required for plant tissue culture.

2.Preparation of media of plant tissue culture and its sterilization.

3.To culture zygotic embryo from *Arachis hypogaea in vitro*.

4.To induce Callus from given ex plants leaf on MS-Media.

5.To study the effect of herbicide on groundnut.

6.To study the effect of salt concentration on embryo culture of Maize.

7.Encapsulation of *Vinca rosea* by sodium alginate.

8. To isolate genomic DNA from leaves of *Vinca rosea*.

9. To confirm the presence of genomic DNA in the sample by agarose gel electrophoresis.

ELECTIVE COURSE CODE BTE301: ADVANCED MOLECULAR BIOLOGY

(COURSE CREDITS = 03)

Course Objectives:

This course combines special set of tutorials centered on research activities in molecular biology with practical exercises and/or laboratory placements. The content is designed to provide students with a perspective of how cutting edge molecular biology principles and techniques are applied to major research questions. This course will illustrate that cross disciplinary approaches are essential in modern research.

Course Learning Outcomes:

CO1: To understand key principles of how cells work, including gene regulation, protein synthesis and signal transduction.

CO2: To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand the key principles of Molecular Biology.

CO3: To read, interpret and discuss major contributions to Molecular Biology research published in scientific research literature.

CO4: To develop effective, creative and innovative solutions, both independently and cooperatively, to current and future research problems in Molecular Biology.

COURSE CONTENTS

UNIT I

Recombinant DNA technology I: methods of creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, selection screening construction of DNA library.

UNIT II

Recombinant DNA Technology II: Use of cloned gene, sub-cloning; recombinant proteins production in bacteria, site-directed mutagenesis, RFLP, PCR, DNA-fingerprinting, antisense-RNA technology, chromosomal walking.

UNIT III

Hybridoma technology: monoclonal antibodies mycelium cell infusion selection of hybridomas, protoplast fusion and HAT-medium screening assay purification and application of monoclonal antibodies.

UNIT IV

Cell and tissue culture: micropropagation, somatic cell culture, somoclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and methods), production of transgenic plant and animal; production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture application.

UNIT V

Fermentation technology: continuous and batch type culture techniques, principle types of Fermenters, general design of fementors. Fermentation processes, brewing manufacture of antibiotics, production of single cell protein. Application of genetic and molecular biology procedures in strain improvement.

Books recommended

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.)

Approved by

Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/20220

Standing committee on **Executive Council on**

VCH Publishers, Inc, New York, 1995

9. Genomes, T.S. Brown

Suggested list of Practicals (Course Code BTE301)

1. To isolate genomic DNA from fungi by LETS methods.
2. To determine the quantity and quality of the isolated fungal DNA.
3. To determine the agarose gel electrophoresis of the isolated fungal DNA.
4. To isolate plasmid DNA from bacteria by quick method.
5. To purify the DNA from agarose gel.
6. To study the Thermal cycler.
7. To study the gel documentation system.

ELECTIVE COURSE CODE BTE302: AGRICULTURAL MICROBIOLOGY

(COURSE CREDIT: 3)

Course Objectives:

To make students aware about agricultural technique, crop diseases, soil health, composting, agriculture losses, pest management, green revolution and agricultural biotechnology.

Course Learning Outcomes

CO1: Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.

CO2: Critically discuss the need for agricultural microbiology and explain their limitations.

CO3: Applications of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.

CO4: Analyses of various aspects of N_2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.

CO5: Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

COURSE CONTENTS

UNIT – I

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

UNIT – II

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

UNIT – III

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little left of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

UNIT – IV

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements, constraints

UNIT – V

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel.

List of Recommended Books

1. Soil microbiology by Subba Rao
2. Soil and microbes by Waksman and Starkey.
3. Plant pathology by Mehrotra.
4. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
5. Microbiology by S.S. Purohit.

Suggested list of Practicals (Course Code BTE302: Agricultural Microbiology)

1. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
2. Isolation of fungi from soil by warcup's method.
3. Isolation of azotobacter species from soil.
4. Isolation of microorganism from rhizosphere.
5. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression method.
6. Plant diseases – leaf curl of papaya, rust of wheat, citrus canker, red rot of sugarcane.

   Study of weeds- Parthenium, water hyacinth.

ELECTIVE COURSE CODE BTE303: BIOPROCESS ENGINEERING AND TECHNOLOGY

(COURSE CREDITS =03)

Course Objectives:

The course will enable students to apply biotechnological concepts in the exploitation of biological organisms for industrial and human benefits. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant biotechnological products and therapeutic proteins.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Insights on industrially important organisms, recent developments in fermentation processes and various optimization strategies at fermenter level. Learns about the design, types of fermenters and various critical components of bioreactors.

CO2: Is able to describe control parameters, fluid rheology and process constraints in large scale bioreactors. Strategies of product recovery from a fermentation broth.

CO3: Understand the significance and activities of microorganisms in food. Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.

CO4: Analyze the importance of microbiological quality control programme's in food production.

CO5: Discuss the microbiology of different types of food commodities. Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food

COURSE CONTENTS

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B12, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of

milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

Recommended Books:

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.

2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.

3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.

4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.

5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.

6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.

7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.

8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.

9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.

10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.

11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

Suggested list of Practicals (Course Code BTE303)

1. Isolation of micro-organism from canned food.
2. Isolation of bacteria and fungi from spoiled bread.
3. Quantitative test of milk by resazurin test.
4. Quantitative estimation of Amylase production.
5. Isolation of lipase producing bacteria from soil.
6. Isolation of phosphate solubilizing/producing bacteria from soil**.**
7. Estimation of antibiotic property of bacteria.

COURSE CODE BTE304: BIOTECHNOLOGY

(COURSE CREDITS = 03)

Course Objectives:

The course will help students to understand various applications of microbes for the development of various products of agriculture, industrial and clinical application. The knowledge of recombinant technology, bioreactors and optimization strategies will be beneficial in development of production processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: **Will learn about industrially relevant microbial products and their production process, role of biotechnology in environment management.**

CO2: Acquires knowledge about strains development, selection of hyper producers, microbial products, metabolic engineering and various industrial relevant microbial products and their production process Learns about the designing of recombinant heterologous expression systems such as *E. coli*, yeast, mammalian and insect cells.

CO3: Learns about sterilization at reactor scale and different types of sterilization strategies.

CO4: Attains knowledge about designing large scale industrial processes and types of cultivation strategies Understands the concept of recombinant biomolecules, therapeutic proteins, vaccines, antibodies, bio-pesticides, bio-fertilizers, and probiotics .

CO5: Understands different types of regulatory approvals required for drug development and difference between biologics, biosimilars and biobetters.

COURSE CONTENTS

UNIT I

Biotechnology an Overview, Definition, Perspective and scope of biotechnological processes and products, Biotechnology and Ethics, Introduction, Medical and chemical Biotechnology, Agriculture and Food, Energy and environment and human, Bioethics, Facing problem and finding solutions, Regulating the use of biotechnology, Patenting biotechnology inventions.

UNIT II

Genetic Engineering and gene cloning, Introduction of genetic engineering procedure, restriction endonuclease, cloning vehicle, Vectors for animals and plants, Insertion of DNA molecule in to a vector, Direct transformation, Isolation and cloning, Transformation and growth of cells, Selection and screening of particular recombinants, Genomic library, sequencing of DNA, Gene identification and mapping, Analysis of expression of cloned genes, Polymerase chain reaction, Monoclonal Antibodies

UNIT III

Plant cell and tissue cultures, Culture techniques, Protoplast fusion, Direct gene transfer, Microinjections, Nuclear transplantation, Plastid and mitochondrial genes, production of secondary metabolites by immobilized plant cell, Development of disease resistant, herbicide resistant, Salt & drought resistant plant varieties, Microbial Toxins, Introduction, Toxins gene isolation, Genetic engineering of *B. thuringiensis* strains, *Baculovirus* as biocontrol agents.

UNIT IV

Culturing microorganisms for the production of biomass, Production of microbial (Bacterial, Cyanobacterial and Fungal) products, Batch culture, Continuous culture, Fed-batch culture, Mass culture, Use of culture system for the production of microbial products, Production of cyanobacterial biomass for food, Feed and health care products, Improvement of microbial strains for industry, Agriculture, Immobilization of microbial cells and enzyme and its applications.

UNIT V

Strain improvement, bioreactor design, Reactor types, Application of immobilized cells and enzyme, improvement in bioreactor to control environment of process organism. use of microorganisms in pollution control, Waste treatment, Bioremediation, Biological removal of eutrophic nutrients, Heavy metals, Toxic chemicals (Herbicide, Insecticide and Fungicide and Other Toxicants) from waste water and industrial effluents, Utilization of waste water for the production of food and feed, Biodegradation, Bioleaching of metals, Application of microorganisms from environment

Books recommended

- Haekett P. B., Fuchs J. A. and Mesing J. W. (1988) An Introduction to Recombinant DNA techniques – basic experiments in gene manipulation.
- Glck B. R. and Thompson J. E. (1993) Methods in Plant Molecular Biology and Biotechnology.
- Bjorn Kristiansen, (2012) Basic Biotechnology third Edition.

Suggested list of practical's (Course Code BTE304)

1. Demonstration:-

   PCR

   Spectrophotometer

   pH meter

   Centrifuge

   Photomicrographic Camera
2. To prepare the media for plant tissue culture.
3. Isolation of pathogenic fungi from infected plants/Disease plants (Leaf/ Stem/ root)
4. Identification of unknown microorganism from given plates.
5. Preparation of tissue culture media.

CORE COURSE CODE BTS301: SKILL DEVELOPMENT MODULES 3

(COURSE CREDITS = 02)

ENTREPRENEURSHIP DEVELOPMENT PROGRAMME AGENDA (Semester-3)

TIME - 30 Hrs

Approved by
Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/20220
Standing committee on **Executive Council on**

ORIENTATION PROGRAM FOR ENTREPRENEURSHIP

1. **WHAT IS ENTREPRENEURSHIP**

   Definition of Entrepreneurship

   Be a Successful Entrepreneurship

2. **TYPE OF ENTREPRENEURSHIP**

   Manufacturing

   Trading

   Service Provider

3. **NEED TO BE SUCCESSFUL ENTREPRENEURSHIP**

   Knowledge - About work and Concern

   Information - About sources/ market/ Customer's

   Assets - About Technology, Place, Man power and money

4. **CHOOSING A BUSINESS -**

   Micro Scale Unit **Small Scale Unit**

   Large Scale Unit **Mega Scale Unit**

5. **MARKETING and DISTRIBUTION**

   Definition and Type of Marketing

   About Sales and Marketing

   Distribution channels

6. **PRODUCT DESIGNING / BRANDING / MERCHANDIZING**

   Research and Development

7. **FINANCIAL FLUENCY, PLANNING AND LEGAL ASPECTS**

   Taxation

   Rules and norms of the Govt. to run a business

8. **GOVERMENT SCHEMES AND ASSISTENCE**

   About financial loan / Place/ Training / Subsidy.....etc

9. INDUSTRY VISITS.

FOURTH SEMESTER

(COURSE CREDITS 18)

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:

The primary object is to expose the students to research culture and technology. They learn how to choose a research problem, plan and perform experiments, collect data, and analyze the data qualitatively and quantitatively. The student gets trained in presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently.

Course Learning Outcomes:

CO1: Student is able to conceive a research problem based on current published researches through comprehensive survey of literature on the topic of research.

CO2: Student is able to plan and design bioassay protocols, to isolate microbes and macrobes from different sources, to identify the isolated organisms using morphological, structural, biochemical and molecular methods.

CO3: Student becomes well-versed in enzymatic, growth and toxicological assay systems through handling, use of instruments, reagents and chemicals, and in execution of experiments independently.

Approved by

Board of Studies in Biotechnology on 15/09/2020, **Faculty of Life Science on** 14/10/20220

Standing committee on **Executive Council on**

CO4: They learn to summarize and present research data by tables and graphs, and statistically analyze and interpret data.

CO5: They are trained to write dissertation (research reports) and present their important findings for peer evaluation. They also learn to publish their research output in peer reviewed journals and magazines.

RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR

SYLLABUS PRESCRIBED FOR THE DEGREE OF THE MASTER OF SCIENCE IN BOTANY IN UNIVERSITY TEACHING DEPARTMENT

(Academic Session 2020-2021 & Onwards)

[PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM - ORDINANCE 222]

This brochure of the programme for the M.Sc. degree in Botany consists of six parts, viz., (A) Information from the relevant Ordinance(s) / Statutes, (B) Programme Objective (C) Programme Outcomes (D) Programme Specific Outcomes (PSOS) (E) Scheme of examination and (F) Courses of study.

A. INFORMATION FROM THE RELEVANT ORDINANCE (S)/STATUTES

1. DURATION OF THE COURSE

M.Sc. Botany will be a full time two-year programme to be covered in four semesters, each of six months duration. The first year of the programme will complete the I and II semesters, and the second year will complete the third and fourth semesters. The maximum duration of the programme shall be twice of the minimum duration of the programme, i.e. four years.

2. ADMISSION TO THE COURSE

The number of seats shall be in accordance with the directives by the University. A candidate, who after having secured the B.Sc. degree with at least 50 % marks from a recognized university with a subject of Life Science, shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to guidelines from the University and Government of Madhya Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester.

3. TUITION AND OTHER FEES

The admitted candidate shall pay the course fee in addition to the tuition fee and such other fees as prescribed by the University.

4. PROGRAM OF THE STUDY

The semester will consist of 16-18 weeks of academic work. One credit is equivalent to one hour (60 minutes) of teaching (lecture or tutorial) or two hours (120 minutes) of practical work/field work per week throughout a semester. The credits associated with the courses will be valid credits, while credits associated with comprehensive viva voce will be virtual credits. In the end term examination there will be **three components, namely Core Courses, Elective Courses and Skill Development Course,** except for the 4th semester where every student will carry out and submit a **dissertation**

The syllabus for the theory and practical examination will be prescribed by the Board of Studies in Botany, R.D. University, Jabalpur.

5. CONTINUOUS EVALUATION

During the semester, a teacher offering the course will do the continuous evaluation of the student at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and the third may be written test/quiz/seminar/assignment. Marks obtained in two best tests out of three will be awarded to the student.

Approved by
Board of Studies in Botany on 15/09/2020, **Faculty of Life Science on** 14/10/2020
Standing committee on **Executive Council on**

6. ATTENDANCE

The student whose attendance is less than 75 % will not be allowed to appear in the end semester examination and he/she will be declared fail in that semester.

7. END SEMESTER EXAMINATION

There shall be end semester examination at the end of first, second & third semester. The semester examination will be held every year normally in December and June or on the dates declared in the academic calendar of the University. A student proceeding to appear in end semester examination will submit through the Head of the Department his / her application on the prescribed form along with required examination fee, etc. to the Registrar of the University. Every student will appear in four respective theory papers and two combined practical examinations in first, second, & third semesters except for the fourth semester. In the fourth semester, every student will be allotted dissertation work in lieu of four theory papers. Allotment of the dissertation will be done by a committee comprising of the Dean of Faculty of Life Science, Head of Department of Biological Science, one Professor and one Associate Professor of the Department by rotation according to seniority. The dissertation may be undertaken in UTD or in any of the National Laboratories/ Institute/ Universities/ Government approved Companies/ Industries. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his/her dissertation work.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

8. CONDITION FOR A PASS

For each course, each student has to appear in at least two tests and end semester examination, otherwise the student will be awarded "Ab" grade. The total marks obtained in end-semester examination, and best of two tests under continuous evaluation will decide the grade in that course. In addition, student also has to get valid credits for Skill development modules' courses and Virtual credits and grades for Comprehensive viva-voce. The grading will be made on 10-point scale as follows:

Letter Grade	Grade Points	Description	Range of Marks (%)
O	**10**	**Outstanding**	**90-100**
A+	**9**	**Excellent**	**80-89**
A	**8**	**Very Good**	**70-79**
B+	**7**	**Good**	**60-69**
B	**6**	**Above Average**	**50-59**
C	**5**	**Average**	**40-49**
P	**4**	**Pass**	**35-39**
F	**0**	**Fail**	**0-34**

Ab	**0**	**Absent**	**Absent**

For passing the examination in each semester, a candidate must have secured a minimum of 35% marks ("P" Grade: 4 Grade Points) in the course. If the marks obtained by the student in a course are less than the minimum cut-off percentage of marks, then "F" Grade will be awarded. If a student obtains "F" or "Ab" Grade in any course, he/she will be treated to have failed in the course. He/she has to reappear in the examination of the course as and when conducted or arranged by the UTD. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course.

The theoretical, practical and skill development courses can be repeated whenever offered or arranged by the UTD but within maximum duration of the programme. He/she can avail multiple repeat attempts to pass the course. The student will be promoted to the next semester if he/she secures at least 12 valid credits in a semester. In case the student secures less than 12 valid credits in any semester, then the student will be asked to repeat entire semester and that semester will be treated as zero semester.

The decision of the teacher regarding the evaluation and the grade shall be final. However, a student submits in writing for review of his Marks/Grade to the Head/Director who will place the case before the board of comprehensive viva voce. The decision of the board will be final. Result of review will be declared by the concerned Head/Director. Review is effective only when grade improves. Review will be allowed only if –

- The prescribed fee is paid.
- The candidate applies within 7 days of the declaration of the grade in that course.

There will be no provision for revaluation. However the candidates can apply for Re-totaling in one course per semester.

9. In matters not covered under this Ordinance, general rules of the University shall be applicable.

10. In case of any dispute/ambiguity, the ruling of the Vice-Chancellor shall be final and binding.

B. PROGRAMME OBJECTIVES

2.1. The objective of the Master's Program in Botany is to equip the students to gain conceptual and analytical skills about morphological, anatomical, physiological, biochemical and cellular aspects of lower and higher plants.

2.2. The program emphasizes to apply knowledge acquired about different taxa of plants for their manipulations, biomolecules and conservation.

2.3. The imparting of laboratory training for bioassay protocols of biological materials, their manipulative treatments, emerging tissue culture and genetic recombinant techniques, and bioinformatics databases and tools.

C. PROGRAMME OUTCOMES

The Masters in Botany Program will cater to the expanding demand for skilled manpower, which is equipped with an understanding of modern research protocols and ethics involving plants and their cellular and molecular materials in conservation of plant biodiversity, environmental

conservation and management, plant health and yield management, and their survival in nature to maintain natural biodiversity and ecological balance.

A M.Sc. Botany student should be able to independent study and researches related to

3.1. Taxonomic identification of plants including their chemotaxonomy, molecular taxonomy and creation of herbaria.

3.2. Application of modern emerging methodological and analytical tools and techniques in qualitative and quantitative assessment of biological materials and processes.

3.3. Extraction of biological molecules and sub-molecules and their biochemical, genetic and molecular characteristics and dynamics.

3.4. Designing of bioassay experiments including ex-situ culture of threatened and important plants for their conservation and variety improvement.

3.5. Undertaking of independent researches involving genomics, metabolomics, and protemics of plant taxa.

3.6. Competition at national and international to pursue career in advanced studies in research and industrial establishments.

3.7. Independent documentation and communication of scientific results in the public domain as well as peer-reviewed scientific magazines and journals.

3.8. Filing of intellectual property rights to national and international registries.

D. PROGRAMME SPECIFIC OUTCOMES (PSOS)

A successful graduate student will be able to identify plants belonging to different taxa and prepare standard herbaria. The student will be able to design and execute experiments related to biochemistry, physiology, genetics and molecular biology of plants. He/ She will be able to pursue independent researches in basic and applied researches in governmental, industrial and private academic and research establishments.

E. SCHEME OF EXAMINATION

SEMESTER I

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
I Core courses					
BOC101	Biology & Diversity of Viruses, Bacteria and Algae	**3**	**40**	**60**	**100**
BOC102	Biological Diversity of Bryophytes, Pteridophytes & Gymnosperms	**3**	**40**	**60**	**100**
BOC103	Basic Ecology	**3**	**40**	**60**	**100**
BOC104	Practical based on BOC101 & BOC102	**4**	**40**	**60**	**100**
BOC105	Practical based on BOC103 & BOE101/ BOE102	**4**	**40**	**60**	**100**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**
BOE101	Biomolecules				
BOE102	Bioenergetics and Intermediary Metabolism				
III Skill Development course					
BOS101	Skill Development module 1	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

SEMESTER 6

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
I Core courses					
BOC201	Taxonomy of Angiosperms	**3**	**40**	**60**	**100**
BOC202	Biology & Diversity of Fungi	**3**	**40**	**60**	**100**
BOC203	Biostatistics & Computer Application	**3**	**40**	**60**	**100**
BOC204	Practical based on BOC201 & BOC202	**4**	**40**	**60**	**100**
BOC205	Practical based on BOC203 & BOE201/ BOE202/ BOE203	**4**	**40**	**60**	**100**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**
BOE201	Biology of the Immune System				
BOE202	Resource utilization and conservation				
BOE203	Microbial Metabolism				
III Skill Development course					
BOS201	Skill Development module 2	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

SEMESTER 7

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
I Core courses					
BOC301	Plant Physiology	**3**	**40**	**60**	**100**
BOC302	Genetics & Molecular Biology	**3**	**40**	**60**	**100**
BOC303	Plant Reproduction and Development	**3**	**40**	**60**	**100**
BOC304	Practical based on BOC301 & BOC302	**4**	**40**	**60**	**100**
BOC305	Practical based on BOC303 & BOE301/ BOE302/ BOE303/ BOE304	**4**	**40**	**60**	**100**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**
BOE301	Advanced Molecular Biology				
BOE302	Agricultural Microbiology				
BOE303	Bioprocess Engineering and Technology				
BOE304	Biotechnology				
III Skill Development course					
BOS301	Skill Development module 3	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

*Both (A – Core courses; One Elective course and Skill Development modules) & (B) are compulsory components of a semester. The grades awarded in the comprehensive Viva-voce shall be shown separately in the Grade Sheet.

SEMESTER IV

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

F. COURSES OF STUDY

FIRST – SEMESTER

CORE COURSE CODE BOC101: BIOLOGY & DIVERSITY OF VIRUSES, BACTERIA AND ALGAE

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with the systematic position, occurrence, morphology, anatomy, and development of reproductive structures, affinity, pathogenicity and the classification of viruses, bacteria and algae.

Course Learning Outcomes:

CO1: Students will be able to understand the structure, identification, nutrition, reproduction and economic importance of bacteria.

CO2: Students will gain the knowledge of isolation and purification, chemical nature, replication and transmission of viruses.

CO3: Students will able to understand the thallus structure, reproduction and economic importance algae.

CO4: Students will learn the botanical approach to explain the evolution of organism and understand the genetic diversity.

CO5: Students will learn the role of algae in the symbiotic associations, soil fertility, crop productivity as well as food, feed, cosmetics & pharmaceuticals.

COURSE CONTENTS

UNIT – I

Archaebacteria and Eubacteria: General account, Ultrastructure, Nutrition and Reproduction, Biology and economic importance. Cyanobacteria salient features and biological importance. Phytoplasma: General characteristics and role in causing plant diseases.

UNIT – II

Viruses: Characteristics and ultra-structure of virions, Isolation and purification of viruses, Chemical nature, Replication, Transmission of viruses, Economic importance. Phycoviruses.

UNIT III

Phycology: Algae in diversified habitat (terrestrial, fresh water, marine), Thallus organization, Cell ultrastructure, Reproduction (vegetative, asexual, sexual), Criteria for classification of algae, Pigments, Reserve food, Flagella classification.

UNIT – IV

Salient features of the following divisions: Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

UNIT – V

Role of algae in symbiotic associations, Fisheries, Algal blooms, Productivity of algae in fresh water and marine environment, Role of algae in soil fertility and crop productivity. Algae as biofertilizer and bioenergy. Role of algae as food, feed, cosmetics, nutraceuticals & pharmaceuticals.

Books Recommended

- Mandahar C. L. (1978) Introduction to Plant Viruses.
- Clifton A. (1958) Introduction to The Bacteria.

- Dubey, R. C. & Maheshwari, D. K. 2005: A Text Book of Microbiology, S. Chand Publisher, New Delhi.
- Morris L. (1986) An Introduction to Algae.
- Round F. E. (1986) The Biology of Algae.
- Kumar H. D. and Singh H. N. (1972) Textbook on Algae.

CORE COURSE CODE BOC102: BIOLOGICAL DIVERSITY OF BRYOPHYTES, PTERIDOPHYTES & GYMNOSPERMS

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners in systematic position, occurrence, morphology, anatomy, and development of reproductive structures, affinity and the classification of bryophytes, pteridophytes and gymnosperms.

Course Learning Outcomes:

CO1: The student will be able to identify major groups and compare the characteristics of plants of bryophytes, pteridophytes and gymnosperms.

CO2: Students will be able to understand botanical approach to explain the evolution of organisms and understand their genetic diversity on the earth.

CO3: Students will be able to understand their adaptation, development, behavior, morphology, anatomy and reproduction, evolution with their transition to land habitat and their economical & ecological importance.

CO4: Demonstrate proficiency in the experimental techniques and methods to study of bryophytes, pteridophytes and gymnosperms

CO5: Students will be able to understand the concepts of Binomial Nomenclature and elementary knowledge of International Code of Botanical Nomenclature and their Systematic position.

COURSE CONTENTS

UNIT I

General characters & Classification of Bryophytes, Comparative morphological & anatomical studies of Gametophytes and Sporophytes of Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales & Funariales . Economic importance of Bryophytes.

UNIT II

General characters & Classification of Pteridophytes, Comparative Morphology, Anatomy and Reproduction in Psilophytales, Psilotales, Lycopodiales, and Sellaginellales. Stelar in system in Pteridophytes.

UNIT III

Morphology,Aanatomy and Reproduction in Equisetales, Ophioglossales, Osmundales & Salviniales.

UNIT IV

Classification of Gymnosperms, Distribution of living Gymnosprms in India, Economic importance of Gymnosperms, Structure & Reproduction in Cycadales and Coniferales with special reference to Cycas, Pinus & Thuja.

UNIT V

Structure & Reproduction in Ephedrales Gnetales & Welwitschiales with special reference to Ephedra , Gnetum & Welwitschia.

Books Recommended

- Parihar N. S. (1991) Bryophyta.
- Parihar N. S. (1996) Biology and Morphology of Pteridophytes.
- Puri P. (1980) Bryophytes.
- Sporne K. K. (1991) Morphology of Pteridophytes.
- Watson E. V. (1964) The Structure and Life of Bryophytes.
- Monographic study of the living Gymnosperms.

CORE COURSE CODE BOC103: BASIC ECOLOGY

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the students in the field of basic ecological principles with special reference to components, biogeochemical cycles, development and stability of the ecosystem, energy flow and matter recycling along with the concept, analysis of the community and its biodiversity.

Course Learning Outcomes:

CO1: The student will able to get the detailed knowledge about population characteristics and dynamics.

CO2: Students will be able to study the concept, organization and dynamics of the community along the concept of niche and biodiversity.

CO3: Students learn about the consequences of artificial or natural disturbances on community development and stability, including the concept of vegetation change and ecosystem restoration.

CO4: Students understand about fundamentals of energy flow in ecosystems, its models, efficiencies and trophic structure..

CO5: Students learn about various recycling pathways of matter in the ecosystems including exchanges and internal cycling processes, and global biogeochemical cycles of carbon, nitrogen, phosphorus and sulfur.

COURSE CONTENTS

UNIT – I

Ecology & ecosystem: Definitions, Organization and components, Population ecology density & distribution, Natality , Mortality, Survivorship curves, Age structure & pyramids, Fecundity schedules, Life tables, Population growth exponential and logistic curves, Intra specific competition and self-regulation, r- and k-strategists.

UNIT – II

Community organization: Concepts of community and continum, Analysis of community analytical and synthetic characters, Community coefficients and indices of diversity, interspecific association negative and positive associations, Concept of ecological niche, Concepts of biodiversity.

UNIT- III

Ecosystem development and stability: Temporal changes cyclic and non cyclic, Succession processes & types, Mechanism of succession facilitation, Tolerance and inhibition models, Concept of climax persistence resilience and resistance, Ecological perturbation natural and anthropogenic, Ecosystem restoration.

UNIT – IV

Fate of energy in ecosystems: Trophic organization and structure, Food chains & webs, energy flow pathways, Ecological efficiencies consumption, assimilation and production trophic, Primary production methods of measurement, Global patterns, Limiting factors.

UNIT – V

Fate of matter in ecosystems: Recycling pathways, Relationship between energy flow and recycling pathways, Nutrient exchange and cycling, Global biogeochemical cycles of C, N, P and S, Physical, chemical and Biological characteristics of soil.

Books Recommended

- J.L. Chapman 1999 Ecology Principles and Applications 2nd Edition.
- C.H. Southwick 1976 Ecology and Quality of Our Environment 2nd Edition .
- M. P. Singh, S. Chinnamani R.N. Trivedi (1993) Forestry & Environment.
- E. J. Kormondy. (1996) Concept of Ecology.

CORE COURSE CODE BOC104: PRACTICAL BASED ON

COURSE CODE BOC101 & COURSE CODE BOC102 (COURSE CREDITS = 04)

Suggested List of Practicals (Course CODE BOC101**)**

Biology & Diversity of Viruses, Bacteria and Algae.

1. To prepare liquid and solid media for the growth of microorganisms (Cyanobacteria, Bacteria & Virus).

   Nutrient broth

   NAM

   BG_{11}
2. To isolate & purify microorganism by pure culture techniques.
3. Morphological study of certain Genera of Algae (Green, Brown, Red & Blue-green)
4. Isolation of Bacteriophages/Cyanophages from water Bodies.
5. To determine Titre Value of Bacteriophages by Double Agar Technique.
6. Isolation and identification of bacteria from soil and water sample.
7. Isolation and identification of microorganisms on some selective media from soil and water sample.

   MacConkey

   EMB

   XLD

8. Microscopic identification of different algal and Cyanobacterial cultures.
9. To identify Gram-positive & Gram-negative bacteria by Gram staining technique.

Suggested List of Practicals (Course CODE BOC102**)**

Biology and Diversity of Bryophytes, Pteridophytes & Gymnosperms

Bryophytes

1. To study the morphological and anatomical characters of given material.

Marchantia

Riccia

Pellia

Anthoceros

Sphagnum

Funaria

Polytrichum

Pteridophytes

2. To study the morphological and anatomical characters of given material.

Lycopodium

Ophioglossum

Marsilia

Selaginella

Psilotum

Osmunda

Equisetum

Gleichenia

Salvinia

Isoetes

Gymnosperms

3. To study the morphological and anatomical characters of given material.

Pinus

Cycas

Thuja

4. To prepare the slides of given material.

T. S stem of *Thuja*

V.S of cone of *Thuja*

T.S stem of *Cycas*

T.S stem of *Araucaria.*

T.S leaf (needle) of *Pinus.*

CORE COURSE CODE BOC105: PRACTICAL BASED ON COURSE CODE BOC103 & COURSE CODE BOE101/ BOE102 (COURSE CREDITS = 04)

Suggested List of Practicals (Course Code BOC103)

Basic Ecology

1. To determine the minimum area of quadrat for phytosociological analysis of grassland.
2. To determine the minimum number of quadrats for phytosociological analysis of grassland.
3. To determine frequency, density and abundance of different species in the grassland.
4. To determine homogeneity and heterogeneity of grassland vegetation.
5. To determine the pH of soil samples.
6. To calculate Simpson's indices of diversity of grassland vegetation.
7. To calculate Shannon-Wiener indices of diversity of grassland vegetation.

ELECTIVE COURSE CODE BOE101: BIOMOLECULES (COURSE CREDITS = 03)

Course Objective: It makes students understand the structure and principles dealing with the working of biomolecules and their mutual interactions to support the life system.

Course Learning Outcomes

CO 1: Enabling students to understand the importance of water in maintaining the various biochemical reactions such as buffering, phosphorylation, oxidation-reduction etc.

CO 2: The students learn the principle of working of enzyme and the process of enzymology, that is, how the enzymes work and where the active sites play a key role.

CO 3: The students also learn the basic and functional structures of all the biomolecules in detail.

CO 4: The inter-relationships and communication between the biomolecules is a major part of signal transduction. The students become well versed with this mode of biological process.

CO 5: The students learn various techniques such as chromatography, spectroscopy and electrophoresis to understand the purity of biomolecules and their analytical properties for further application.

COURSE CONTENTS

UNIT I

Structure of water and its solvent properties, Acid- bases, pH and buffer, Bi and polyprotic buffer. Free energy and spontaneity of reactions, ATP and other phosphorylated compound with their free energy of hydrolysis, Phosphoryl group transfer, Biological oxidation reductions reaction, Coupled reaction and oxidative phosphorylation, Inhibitors and uncouplers.

UNIT II

Enzyme classification, Specificity, Active site, Enzyme kinetics, Michealis Menton equation, Determination of kinetic parameters, Bi-substrate reaction and their kinetics, Enzyme inhibition and kinetics, Allosteric enzyme. Kinetics and Allosteric regulation of phosphofructo kinase

UNIT III

Structure and chemistry of macromolecules, Proteins, Carbohydrates and Lipids, Protein folding, Structure and chemistry of bimolecules such as antibiotics, Pigments, Vitamins as coenzymes, Lipid analysis by GLC and Mass Spectrometry, Oligosaccharide and Polysaccharide analysis.

UNIT IV

Biosignaling molecular mechanism of signal transduction, Gated ion channels, Nicotinic acetyl choline receptor, Receptor enzyme, The insulin receptor, G- proteins and cyclic AMP membrane transport, Biomembrane, Nutrient transport across membranes, Active and passive diffusion, Symport, Antiport and uniport, Na^+ K^+ pumps and their metabolic significance.

UNIT V

Chromatographic technique, Paper and TLC , Gel filtration, Ion exchange, Affinity, HPLC, SDS, PAGE, Isoelectric focusing, Western blotting, Protein sequencing, Mass spectrometry, MALDI , TOF, MS.

Books Recommended

J. L., Jain, Sanjay, and Jain Nitin, (1979) Fundamentals of Biochemistry (6th revised Edition). S. Chand & Co. Ltd. New Delhi.

Buchanan . B.B. Gruissem, W. and Jones .R.L. (2000) Biochemistry and Molecular Biology of Plants , American Society of Plant Physiologists, Maryland ,USA.

Albert L. lehninger, Davis L. Nelson, Michael M. Cox. (2004) Lehninger Principles of Biochemistry.

Lea P.J. and Leegood ,R.C. (1999) Plant Biochemistry and Molecular Biology (2 nd Edition) John Wiley and Sons. Chichester, England

Berg Jeremy, Tymoczko John, Stryer Lubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.

Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.

Dawes Edwin A. (1972) Quantitative Problems in Biochemistry, Churchill Livingston, Edinburgh.

Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press. 5. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.

Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.

Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.

Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.

Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.

Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.

Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.

White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.

White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford

University Press, New York.

Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

Suggested list of practicals (Course Code BOE101**)**

1. To study working of weighing balance.
2. To study the working of pH meter.
3. To determine the pKa value of acetic acid by pH titration method.
4. Preparation of acetate buffer at pH=5.
5. Prepare Phosphate buffer at pH=8.
6. To prepare tris buffer at pH=9.
7. Estimation of protein by Lowry method.
8. Chromatographic separation by paper and thin layer Chromatography.
9. To determine pKa value of glycine.
10. Determine the absorption maxima of Potassium dichromate.
11. To prove the validity of Beer-Lambert's law.
12. Qualitative assessment of carbohydrate.
13. Qualitative assessment of lipids.
14. Qualitative assessment of proteins.
15. To prepare standard curve of glucose by anthrone method.
16. To determine the Km and Vmax od amylase enzymes.
17. To study the effect of substrate concentration on enzyme activity.
18. To study the effect of temperature on enzyme activity.

ELECTIVE COURSE CODE BOE102: BIOENERGETICS AND INTERMEDIARY METABOLISM

(COURSE CREDITS = 03)

Course objectives – Learners obtain the knowledge about the bioenergetics and intermediary metabolism within the living system for production of energy in form of ATP and different biomolecules, participate in different metabolic pathway.

Course learning outcomes –

CO1: Learners will understand the concepts of bioenergetics, mitochondrial respiratory chain, cytochromes characterization and Oxidative phosphorylation.

CO2: Students will get knowledge of cell transport systems, influx and efflux mechanisms, symport, antiport, uniport,

CO3: Students will learn about the carbohydrate metabolism; glycolysis, TCA cycle, energy generation, energy rich bonds, biosynthesis of sugars, HMP shunt and alternate pathways.

CO4: Students will learn about lipid metabolisms; fatty acid synthesis and oxidation, triglycerol, steroids and terpenes.

CO5: Students will understand about the amino acid and nucleic acid biosynthesis, degradation, regulation, urea cycle, inhibitors and inborn error metabolism.

COURSE CONTENTS

UNIT I

Bioenergetics: energy transformation, biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes; free energy changes and redox potentials, phosphate potential, ion and proton electrochemical potentials, membrane potentials, chemo-osmotic theory; ion transport across energy transducing membranes, influx and efflux mechanisms, transport and distribution of cations, anions and ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

UNIT- II

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization; the Q cycle and the stoichiometry of proton extrusion and uptake. Oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes. ATP synthetase complex, microsomal electron transport.

UNIT- III

Carbohydrates: glycolysis, citric acid cycle- its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway, alternate pathways of carbohydrate metabolism, gluconeogensis, inter-conversions of sugars, biosynthesis of glycogen, starch and oligosaccharides.

UNIT- IV

Lipids: fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthase; fatty acid oxidation: α, β, oxidation and lipoxidation; lipid biosynthesis: of triacylglycerols, phosphoglycerides and sphingolipids, biosynthetic pathways for terpenes and steroids.

UNIT- V

Amino acids and nucleic acids: biosynthesis and degradation of amino acids and their regulation, specific aspects of amino acid metabolism, urea cycle and its regulation, in-born errors of amino acid metabolism; Nucleic acids: degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide biosynthesis, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis.

Books recommended

M.M. Cox and D.L. Nelson (2008) Lehninger Principals of Biochemistry W.H. Freeman & Company

Otto Hoffmann-Ostenhof (2008) Intermediary metabolism; *Van Nostrand Reinhold (USA).*

P.H. Clarke (1978) Intermediary metabolism; *John Wiley & Sons Ltd Hoboken, New Jersey (United States).*

Alexander Lowen (1994) Bioenergetics; *Penguin/Arkana Books USA.*

David G. Nicholls and Stuart Ferguson (2013) Bioenergetics; *Academic Press Elsevier United States*.

Suggested list of practicals (Course Code BOE102)

1. To prepare acetate buffer of pH4.7.
2. To perform carbohydrate tests of manosaccharides, polysaccharides, disaccharides.
3. To determine protein of unknown sample by Lowry method.

CORE COURSE CODE BOS101: SKILL DEVELOPMENT MODULES 1

(COURSE CREDITS = 02)

PERSONALITY DEVELOPMENT- MODULE- 1 (Semester-1) Hrs.-30

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet	1
02	Role and Impact of Personality	Group Activity	1
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	2
04	Listening and Caring	Group Activity	1
05	The Art of Communication	Worksheet	1
06	Different level of Effective Communication	Worksheet	1
07	Professional Communication P-A-C	Worksheet	1
08	Rules of Professional Communication	Group Activity	1
09	Body Language - 1	Worksheet	1
10	Language Lab	Worksheet	1
11	Thought Process - 1	Worksheet	1
12	Interpersonal Skills	Worksheet	1
13	Observation & Imagination Power	Group activity	1
14	Creativity	Group Activity	1
15	Extempore - 1	Group activity	1
16	Extempore - 2	Group Activity	1
17	Presentation Skills	Worksheet	2
18	How to Draw the Attention of Audience	Worksheet	1
19	Steps of Effective Presentation	Worksheet	1
20	Prioritizing Matrix	Worksheet	1
21	Leadership Quality	Group activity	1
22	SWOT Analysis	Worksheet	1
23	Interview Skills	Lecture	2
24	Group Discussion	Group Activity	2
25	Resume Preparation	Group Activity	1

SECOND - SEMESTER

COURSE CODE BOC201: TAXONOMY OF ANGIOSPERMS

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with the knowledge about terminologies, theories, conventional and modern methods and practices of taxonomy of flowering plants, focusing on the local plant species. It also aims to create awareness about the plants used by tribals of MP.

Course Learning Outcomes:

CO1: Understanding principles of biodiversity and its conservation. Gaining insight into the rules of nomenclature, adaptive features of ICBN and different classification systems.

CO2: Learning and applying different techniques of identification, documentation of plants and role of computer in database identification. They will know how to prepare herbarium and use of keys to identify floras.

CO3: Knowledge of modern taxonomy and its application in taxonomic evidences from anatomy, embryology palynology, cytology, secondary metabolites. Understanding numerical taxonomy OUT's coding.

CO4: Empowers student to recognize, collect and compare the plants of the given fourteen angiosperm families. Learners will be able to describe the plant specimen with taxonomical terms, floral formula and diagrams.

CO5: Acknowledge the economic uses of plants in modern society. An increased awareness and appreciation of plants & plant products encountered used by tribes of MP. Knowledge of important families of useful plants, the parts used and active biomolecules present in medicinal plants.

COURSE CONTENTS

UNIT-I

Principles of Biodiversity & its conservation, Concept of systematic, Identification & nomenclature with special reference to International code of Botanical nomenclature. Taxonomic Category species, Genus & family, Angiosperm classification systems (Bentham & Hooker & Hutchinson).

UNIT- II

Herbarium, Herbarium Techniques, Role of botanical gardens, Documentation (Floras, Monographs, Journals, Manuals, Abstracts, Indices & Dictionaries), Keys for identification of plants single access and multi-access, Role of computers and Database in identification.

UNIT- III

Modern Taxonomy, Supportive evidence from Anatomy, Embryology, Palynology, Cytology, Phytochemistry including secondary metabolites, Numerical Taxonomy OUT'S coding, Cladistics.

UNIT- IV

Comparative study of Angiosperm families, Rannunculaceae & Magnoliaceae, Papaveraceae & Capparidaceae, Oxalidaceae & Meliaceae, Combretaceae & Lytheraceae Rubiaceae & Asteraceae, Convolvulaceae & Lamiaceae, Gramineae & Orchidaceae.

UNIT V

Importance and nature of plants & their products, Industrial plants, Shisham (*Dalbergia sisoo*), Sagon (*Tectona grandis*), Rubber plant (*Ficus elastica*) Cotton plants (*Gossypium hirsutum*), Semal (*Bombex ceiba*), Flax (*Glycine max*), Kattha (*Acacia catechu*), Neel (*Indigofera tinctoria*), Sindoor (*Melilotus alba*).

Drug Plants, Ashwagandha (*Withania somnifera*),Sarpgandha (*Rauwolfia serpentina*),Adhusa (*Adhatoda vasica*)Amla (*Emblica officinalis*), Neem (*Azadirachta indica*), Punarnava (*Boerhaavia diffusa*) safed musli.

Food Plants, Wheat (*Triticum aestivum*),Rice (*Orriza sativa*) Maize (*Zea mays*), Arhar (*Cajanus cajan*) Chana (*Cicer aurientinum*), Onion (*Allium cepa*) Clove (*Piper longum*) Turmeric (*Curcuma domestica*), Mustard (*Brassica compestris*), Groundnut (*Arachis hypogea*).

Ethnobotany, Plants used by tribals of M.P., Sitaphal, Champa, Bel, Ber, Sal, Achar, Palash, Kachnar, Siris, Arjun, Harra, Bahera, Mehndi, Mahua, Tendu,Latjira, Gular, Anar, Datura.

Books recommended

- Davis P. R. and Heywood V. M. (1973) Principles of Angiosperm Taxonomy.
- Eames A. I. (1961) Morphology of Angiosperms.
- Naik V. N. (1984) Taxonomy of Angiosperms.

CORE COURSE CODE BOC202: BIOLOGY AND DIVERSITY OF FUNGI

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with the knowledge of fungal biodiversity, phylogeny and classification; fungal plant ecology, physiological aspects and nutritional modes of fungi; fungal genetics at classical and molecular level, economic and biotechnological dimension of fungi.

Course Learning Outcomes:

CO1: Understanding general features and status of fungi along with classification, phlogeny fungal physiology, growth and interactions.

CO2: Gaining Insight into the world of fungal diversity by learning Structure, Reproduction, Life cycle and significance of the following representative: I) Gymnomycota II) Mastigomycota III) Amastigomycota

CO3: Identification of fungi from leaf sample and knowledge of Structure, Reproduction, Life cycle and significance of the following representative: I Ascomycotina II Basidiomycotina III Deutromycotina

CO4: Empowers student to understand fungal genetics at classical and molecular level; the fungal holomorph; asexual and sexual reproduction. Understanding variation in fungi; heterokaryosis, parasxuality, homothallisum and Heterothallisum, Mutation, and improvement of strains.

CO5: Acknowledge the economic uses of fungi in modern society. Understanding and applying knowledge of production of alcoholic beverages, Antibiotics, Organic acids, Ergot alkaloids, mushrooms, Myco protein, Mycofoods and role of fungi in agriculture and forestry. Knowledge of mycotoxins and conservation of fungi germplasm.

COURSE CONTENTS

UNIT –I

Status of fungi in the living world, General features of fungi and fungus like organisms, Recent trends in the classification of fungi, Physiology and growth of fungi, Nutritional and environmental factors affecting growth, Saprotrophs, parasites of mutualistic symbionts, Physiology of reproduction in fungi, Phylogeny of fungi.

UNIT – II

Fungal diversity, Major taxonomic groups, Structure, Reproduction, Life cycle and significance of the following representative:

I) Gymnomycota – Cellular slime moulds (*Dictyostelium*), Plasmodial slime moulds (myxomycetes).

II) Mastigomycota- *Coelomomyces, Langenidium, Achlya, Phytophthora, Peronospra, Plasmodiophora*.

III) Amastigomycota – *Zygomycotina – Mucor, Synephalastrum, Blakeslea, Cunninghamella, Entomorphthora*.

UNIT – III

Fungal diversity contd, Structure, Reproduction, Life cycle and significance of the following representative:

I Ascomycotina: *Taphrina, Emericella, Chaetomium, Morchella, Neurospora, Claviceps*.

II Basidiomycotina: *Puccinia, Melampsora, Ustilago, Polyporus, Lycoperdon, Ganoderma*.

III Deutromycotina: *Fusarium, Cercospora, Curvularia, Beauveria, Microsporum, Phoma, Colletotrichum*.

UNIT – IV

Fungal genetics, Life cycle and sexual process in fungi, Structure and organization of fungal genomes (Mitochondrial genes, Plasmids of transposable elements, Virus and viral genes). Genetic variations in fungi nonsexual variations Haploidy, Heterokaryosis, Parasexuality, Sexual variations mating or Breeding systems Homothallisum and Heterothallisum, Mutation, Physiological specialization, Strain improvement.

UNIT – V

Fungi and Biotechnology, Production of alcoholic beverages, Antibiotics, Organic acids, Ergot alkaloids, The cultivation of fungi for food mushrooms and Myco protein, Mycofoods, Role of fungi in agriculture and forestry, Mycorrhizae and their application, Mycopesticides, Mycotoxins, Conservation of fungi germplasm.

Books recommended

- Gaumann G. S. (1952) The Fungi.
- Mehrotra R. S. and Aneja R. S. (1998) An Introduction to Mycology.
- Dayal (1995) Aquatic Fungi of India.
- Wolf F. A. and Wolf F. T. (1947) The Fungi Vol. I and II,
- Thind K. S. (1977) The Myxomycetes of India.
- Ainsworth G. F. and A. S. Sussman. The Fungi Vo. I, II, III, IVA and IVB.

CORE COURSE CODE BOC203: BIOSTATISTICS AND COMPUTER APPLICATIONS

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with tools and techniques in collection, collation, summarization and interpretation of data along with various experimental designs and bioinformatics.

Course Learning Outcomes:

CO1: Proficiency of students in various techniques of collection, collation, summarization and presentation of data. They could learn basic concepts of probability and probability distribution functions along with applications.

CO2: Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.

CO3: Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.

CO4: Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.

CO5: Empowers students to utilize software packages in digital analysis and processing of biological data. Integrate informatics with biology through data submission protocols, sequence alignment and searches, annotations and possible applications in human health and welfare.

COURSE CONTENTS

UNIT – I

Importance and scope of statistics in experimentation, Measure of central tendency Arithmetic, Geometric and Harmonic means, Measure of dispersion variance, Standard deviation, Coefficient of variation, Confidence limits of population mean.

UNIT – II

Elements of probability**,** Statistical and Mathematical definitions, Probability distribution function: Normal, Binomial and Poisson distribution.

UNIT – III

Tests of significance, Hypothesis and errors, 't' test, Population mean equals a specified value, Test of the equality of two means (Independent samples & Equal variances), Test of the equality of two means (Paired samples), 'F'- test, One way analysis of variance (Sample sizes, Equal and Unequal).

UNIT – IV

Chi-square statistics**,** Test of goodness of fit and test of independence of factors, Simple correlation coefficient, Significance tests, linear regression equation and diagram regression coefficient, Standard error, Significance tests.

UNIT – V

History and development of computers, Hierarchy of computers, Computer hardware components and functional structures, Computers software: system and application software.

Books recommended

1. B. L. Agarawal, Text Book of Biostatistics.
2. Paolo Coletti, Basic Computer Course Book. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.
3. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
4. Programming in C by E. Ballaguruswamy
5. How Computers work - 2000. By Ron White. Tech. Media
6. How the Internet Work 2000 by Preston Gralla Tech. Media.
7. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.

8. Biostatistics - 7th Edition by Daniel
9. Fundamental of Biostatistics by Khan
10. Biostatistical Methods by Lachin
11. Statistics for Biologist by CampbellR.C. (1974) Cambridge University Press, UK.
12. INTERNET – CDC publication, India.

CORE COURSE CODE BOC204: PRACTICAL BASED ON
COURSE CODE BOC201 & COURSE CODE BOC202 (COURSE CREDITS = 04)

Suggested List of Practicals (Course CODE BOC201**)**

Taxonomy of Angiosperms

1. To study the plants of following Families.
   - Rananculaceae – *Delphinium ajacis*
   - Asclepidiaceae – *Calotropis procera* (Aak)
   - Papaveraceae – *Argemone maxican*
   - Orchidaceae – *Zeuxine stratecemitica*
   - Rubiaceae – *Ixora coccinea* (Rukmani)
   - Lamiaceae – *Ocimum sanctum* (tulsi)
   - Poaceae (Gramineae) – *Triticum aestivum*
   - Asteraceae (Compositeae) – *Helianthus annus*
   - Combretaceae – *Quinsqualis indica*
   - Magnoliaceae – *Michelia champaca Linn*.
   - Convolvulaceae – *Convolvulus microphyllus*
   - Capparidaceae – *Cleome gynandra* (Hut-hul)
   - Meliaceae – *Azadirachta indica* (Neem)
2. To study the Ethnomedicinal importance of the following plants–
   - Arjun (*Terminalia arjuna*)
   - Harra (*Terminalia chebula*)
   - Clove (*Syzygium aromatium*)
   - Mehndi (*Lawsonia inermis*)
   - Neem (*Azadirachta indica*)
   - Amla (*Emblica officinalis*)
   - Onion (*Allium cepa*)
   - Ashwagandha (*Withania somnifera*)
   - Sarpagandha (*Rauvolfia serpentina*)
   - Bahera (*Terminalia bellerica*)
3. To prepare the Herbarium of the plants.

Suggested List of Practicals (Course Code BOC202)

Biology and Diversity of Fungi

1. To study the structure of given fungi by using Camera Lucida.
2. To perform micrometry for measurement of fungal spores and sporangia.
3. To study slide culture technique for observing morphology of fungi.
4. Isolation and identification of fungi from infected leaves of different plant parts.
5. Isolation and identification of fungi from air.
6. Classification and characterization of micro-organism

   Alternaria sp.

   Mucor sp.

   Fusarium sp.

   Rhizopus sp.

   Curvularia sp.
7. Morphological study of edible Mushroom.
8. To cultivate Mushrooms as a source of myco-protein.
9. To examine Antibacterial properties of certain fungal species.

CORE COURSE CODE BOC205: PRACTICAL BASED ON

COURSE CODE BOC203 & BOE201/ BOE202/ BOE203 (COURSE CREDITS = 04)

Suggested List of Practicals (Course Code BOC203)

Biostatistics and Computer Applications

1. To find out the average length of the mango leaf by arithmetic, harmonic and geometric mean.
2. To find out the standard deviation and coefficient of variation of the length of leaf.
3. To find out the confidence limit of the length of the leaf.
4. To find out the probability of getting head in 10, 20, 30, 40 & 50 tosses of a fair coin.
5. To test the hypothesis that average pulse rate of biostatistics class students is 72 beats per minute.
6. To calculate the correlation coefficient between length and weight of 10 different pieces of *Parthenium* stem.
7. To find out the prediction or regression equation of the *Parthenium* stem.
8. To study Hardware's & Software's of computer.

ELECTIVE COURSE CODE BOE201: BIOLOGY OF THE IMMUNE SYSTEM

(COURSE CREDITS = 03)

Course objectives:

The course is designed with an objective to enhance students understanding of the biomolecules and the structural organization involved in host individual's immune responses and also the immune mechanisms.

Course Learning Outcomes:

CO1: It will help understanding the structure, types and functions of antigens and immunoglobulins.

CO2: Understand the role of cells and organs in immune system.

CO3: Clinical and sub-clinical practices of collection, transportation and handling of pathological samples in laboratories.

CO4: Practical knowledge of serology.

CO5: Skill as an epidemiologist and adaptation to prophylaxis.

COURSE CONTENTS

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

UNIT-II

Antibody structure and function; antigen-antibody interactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. Blymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells. Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiences, hybridoma technology and monoclonal antibodies.

Recommended Books:

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A.

Osbarne. (Freedom)

2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey

Sunshine (Wiley-Liss).

3. Fundamentals of immunology, William Paul.

4. Immunology, Roitt and others.

Suggested list of practicals (Course Code BOE201)

1. To perform test for antibiotics sensitivity by disc method.
2. To determine the minimum inhibitory concentration of given antibiotics.
3. Preparation of blood smear.
4. To isolate serum from blood plasma.
5. To perform agglutination reaction to identification of blood group.

ELECTIVE COURSE CODE BOE202: RESOURCE UTILIZATION AND CONSERVATION

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with knowledge pertaining to world biomes, resources, conservation, sustainable development, pollution and its management, and remote sensing in management of earth resources.

Course Learning Outcomes:

CO1: Deep understanding of distribution, structure and function of various aquatic and terrestrial biomes.

CO2: Learn definitions, types and utilities of biodiversity along with threats along their applications in management and sustainable development of resources from various biomes.

CO3: Empowers students to apply in-situ and in-vitro techniques in conservation of aquatic and terrestrial resources in real time.

CO4: Understands concepts of pollution of different environments and can monitor and treat pollution loads in artificial and natural ecosystems; and appreciate nuances of industrial, societal and urban pollutions.

CO5: Gains insight knowledge about remote sensing of earth resources along with platforms, sensors and scanners, visual and digital interpretation of remotely sensed data.

COURSE CONTENTS

UNIT – I

Major Biomes of the world, Tropical rain & Seasonal Forests, Temperate rain & Seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic Ecosystems wetlands, Lakes & Ponds Streams & Rivers, Marine & Estuarine habitats.

UNIT – II

Resource utilization**,** Status & Utilization of Biodiversity, Sustainable development resources from forest, Grassland and aquatic habitats, Food forage, Fodder, Timber & Non-wood forest products, Threats to quality & quantity of Resources due to overexploitation. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT –III

Strategies for conservation of resources: Classifications of resources, Principles of conservation, *In-situ* conservation sanctuaries, National parks, Biosphere reserves for wildlife conservation, Habitat conservation practices of conservation for forests ranges, Soil and water.

UNIT – IV

Air, Water and Soil pollution**,** Kinds, Sources, Quality parameters, Effects on structure & function of ecosystems, Management of pollution, Bioremediation, Climate changes sources, Trends & role of

greenhouse gases, Effect of global warming on climate, Ecosystem processes & Biodiversity, Ozone layer & Ozone hole.

UNIT – V

Resource monitoring, Remote sensing concepts & Tools, Satellite remote sensing basics sensors, Visual & digital interpretation, EMR bands and their applications, Indian remote sensing program, Thematic mapping of resources, Application of remote sensing in Ecology &Forestry.

Books recommended

- Chopra R. N. (1933) Indigenous Drugs of India.
- Hayes W. B. (1953) Fruit Growing in India.
- Atkinson E. T. (1980) Economic Botany of Himalayan Regions.
- Chapman, J.L. and Reiss, M.J. (1999) Ecology: Principles and Applications.
- Singhal, P.K. and Shrivastava, P. (2004) Challenges in Sustainable Development.
- Odum, E.P. (1971) Fundamentals of Ecology.
- Begon, M., Harper, J.L. and Townsend, C.R. (1986) Ecology: Individuals, Populations and Communities.
- Wetzel, R.G. (1983) Limnology.

Suggested list of practicals: Course Code BOE202 (Resource Utilization and Conservation)

1. To find the pH of the various sample of soil by pH meter.
2. To determine ground flora in forest ecosystems.
3. To determine IVI of species in forest ecosystmes.
4. To determine the presence of carbonate in different soil mixtures.
5. To determine the presence of phosphate in soil and water sample.
6. To determine the presence of nitrate in mixture sample.
7. To determine the presence of nitrite in mixture sample.
8. To determine frequency, density and abundance of herbaceous species from local garden.
9. To determine the biomass of plant vegetation.
10. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

ELECTIVE COURSE CODE BOE203: MICROBIAL METABOLISM

(COURSE CREDITS = 03)

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation, and to enable students to better understand courses taught later.

Course Learning Outcomes:

CO1: Students become acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.

CO2: They gain an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics

of solute transport.

CO3: They learn central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.

CO4: Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.

CO5: They learn basic concepts of enzyme biochemistry, its kinetics and regulation, details of lipid and nucleotide metabolism in *E. coli* and its regulation along with biochemical basis of lipid accumulation in yeasts, and intracellular signaling in bacteria in response to various nutritional and physiological stresses.

COURSE CONTENTS

UNIT-I

Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

UNIT-II

Chaemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis. Electron transport- photoautotrophic generation of ATP, fixation of CO2- Calvin cycle, reverse TCA, carbohydrate anabolism.

UNIT-III

Respiratory metabolism: Embden Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates- homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

UNIT-IV

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

UNIT-V

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Dormancy. Endospore-structure, properties and germination.

List of Recommended Books

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009.

Suggested list of Practicals (Course CODE BOE203: Microbial Metabolism)

1. Determination of Bacterial growth by turbidity measurements (spectrophotometric method).
2. Study of effect of temperature on growth of bacteria.
3. Study of effect of pH on growth of Bacteria.

4. Isolation of rhizobia from root nodules.
5. Slide culture technique for studying morphology and molds.

CORE COURSE CODE BOS201: SKILL DEVELOPMENT MODULES 2

(COURSE CREDITS = 02)

SOFT SKILLS DEVELOPMENT MODULE-2 (Semester- 2) Hrs. 30

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet/ lecture	02
02	Role and Impact of Personality	Group Activity/ lecture	01
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	02
04	Importance of characteristics and Traits	lecture/Group Activity	02
05	Empowerment of Internal and external traits	Lecture	02
06	Definition of Personality	Lecture	02
07	Power of Self	Lecture	03
08	Path to Improve Personality	lecture/Group Activity	03
09	Body Language - 1	Worksheet	02
10	Grooming Yourself	Lecture	02
11	IQ / EQ / MQ / SQ	Lecture	02
12	Disposition of Body in various aspects	Group Activity	03
13	Getting desired output	Group Activity	02
14	Post Assessment of Personality	Group Activity	02

THIRD SEMESTER

CORE COURSE CODE BOC301: PLANT PHYSIOLOGY

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners with basic principles of plant functions such as mechanism of the transport of the water, inorganic and organic substances, metabolism (photosynthesis and respiration), secondary products, plant hormones, cell and stress physiology, principles of growth & development.

Course Learning Outcomes:

CO1: The student will able to get the huge knowledge about pathways of water through xylem and phloem. Know about the requirement of mineral nutrition for plant growth.

CO2: Students will understand the process of Photosynthesis, Respiration and Nitrogen metabolism.

CO3: Learners will gain the idea about Stress physiology – Responses of plants to biotic and abiotic stresses, biological clock and the photoperiodism.

CO4: Student will know about the Plant Growth hormones (Auxins, Gibberellins. Cytokinins, Ethylene), they understand the biosynthesis of phenolic acids, alkaloids.

CO5: Demonstrate proficiency in the experimental techniques and methods to study the plant physiology.

COURSE CONTENTS

Unit I

Mechanism of transport of water inorganic and organic substances, Source and sink relationship, Mineral nutrition & absoption.

Unit II

Photosynthesis in plants, Pigments, Photosystem I and II, Mechanism of quantum capture and energy transfer between photosystems, Reduction of CO_2 , C_3, C_4 and CAM metabolism , photorespiration and its signification.

Unit III

Overview of plant respiration, Glycolysis, TCA cycle, Electron transport and ATP synthesis, Pentose phosphate pathway, Glyoxalate cycle.

Unit IV

Plant hormone, Mode of action of Auxins, Gibberellins, Cytokinin, Ethylene, Abscissic acid, Special features of secondary plant metabolites, Biosynthesis and functions of phenolic acids, Alkaloids.

Unit V

Stress physiology, Water deficit and drought resistance, Temperature stress, Salinity stress metal toxicity, Biological clock and its regulation, Photoperiodism and floral induction.

Books recommended

- Buchanan. B.B. Gruissem, W and Jones. R.L. (2000) Biochemistry and Molecular Biology of plants.
- Galston, A.W. (1989) Life Processes in Plants. Physiology,
- Hopking W.G. (1995) Introduction to Plant physiology
- Nobel P.s. (1999) Physiochemical and Environmental Plan Physiology.
- Taiz .L.and Zeiger, E. (1998) Plant Physiology (2nd Edition).

CORE COURSE CODE BOC302: GENETICS & MOLECULAR BIOLOGY

(COURSE CREDITS = 03)

Course Objectives:

The course aims to empower the learners insights into various molecular biological processes of DNA replication, transcription and translation. Molecular biology of recombination, synthesis and processing of various RNA molecules are discussed. Further the course provides deeper understanding of regulation of gene expression in various organisms.

Course Learning Outcomes:

CO1: Understanding of DNA as the genetic material and its types. Knowledge of chromatin organization, euchromatin, heterochromatin, C value paradox and restriction mapping.

CO2: Knowledge of Mutation, its kind and mechanism of DNA repair system.

CO3: Conceptualize different aspects of genetics of microorganism with deep understanding of molecular mechanism of recombination, role of Rec ABC&D, linkage and crossing over.

CO4: Empowers student to acquire knowledge about different enzymes of DNA replication, transcription and translation. Deep understanding of DNA and RNA sequencing methods, process of transcription and post transcriptional processing.

CO5: Gains insight into the process of translation and gene expression in prokaryotes and eukaryotes by understanding different types of RNA, translational factors, concept of operon ; lac and tryptophan and different models of gene expression in eukaryotes.

COURSE CONTENTS

Unit I

Nucleic acid as genetic material (experimental proof) DNA structure A, B & Z forms. Chromosome structure & chromatin organization, Euchromatin & Heterochromatin different models, Nuclear DNA content, C-value paradox, Cot curves, Restriction mapping, Concept & techniques, *In-situ* hybridization.

Unit II

Spontaneous & induced mutations, Physical & chemical mutagens types of mutations, Molecular mechanism of mutation, forward, back, Missense, Nonsense, Frameshift and suppresser mutations, Mutations induced by transposons, Site directed mutagenesis, Mechanism of DNA damage & repair , Photo-repair, Excision or dark repair.

Unit III

Genetics of microorganisms, Transformation, Conjugation & transduction in bacteria, Conjugation mapping, Molecular mechanism of recombination, Role of Rec ABC&D, general & site specific recombination, Independent assortment, Linkage and crossing over.

Unit IV

DNA & RNA sequencing, Different methods, DNA replication, DNA polymerases, Topoisomerases, Ligases, Gene transcription, RNA polmersases, Promoters, Transcription factors, Mechanism of transcription, Chain initiation, Elongation, & termination, Post transcriptional processing of RNA, Capping, Adenylation & splicing, Introns & Exons.

Unit V

Translation of messenger RNA into proteins, Structure & role of t- RNA & ribosomes, Different factors (I, EFTs , RFs), Protein chain initiation, Elongation & termination, Inhibitors of protein synthesis, *In vitro*

protein synthesis, Gene expression in prokaryotes, Operon concept, Inducer, Repressor, Co-repressor, c-AMP / CRP, co-induction & co-repression . Regulation of lac operon & Tryptophan operons, Attenuation Gene expression in eukaryotes, Britton and Davidsons, Gene battery model, HCP / NHCP Hormones.

Books recommended

- Bray, Lewis Ralf, Roberts and Watson (1983) Molecular Biology of the Cell.
- Schwer M. A. (1989) Methods in Plant Molecular Biology.
- Wolf S. L. (1993) Molecular and Cellular Biology.
- Shaw C. H. (Ed.) (1988) Plant Molecular Biology – A Practical Approach.
- Clug & Cummings: Essential of Genetics.

CORE COURSE CODE BOC303: PLANT REPRODUCTION & DEVELOPMENT

(COURSE CREDITS = 03)

Course Objectives:

The course aims to provide deeper understanding of various anatomical structures and their functions, several embryological processes including pollen pistil interaction, applied aspects of embryology and seed development.

Course Learning Outcomes:

CO1: Understanding of organization of shoot apical meristem (SAM), differentiation of xylem and phloem; characteristic of wood.

CO2: Learning about the various arrangements of leaf, its growth and differentiation. Learners will also understand various types of epidermal appendages present.

CO3: Knowledge of organization of root apical meristem (RAM), root development and root microbe association.

CO4: Empower students to understand embryology of flowering plants with detail knowledge about the structure of gametes, and the processes of sporogenesis, gametogenesis and embryogenesis.

CO5: Understanding different modes of reproduction, process of fertilization, pollen pistil interaction and significance of seed maturation, dormancy, and germination.

COURSE CONTENTS

UNIT – I

Organization of shoot apical meristem (SAM), Control of tissue differentiation especially Xylem & Phloem, Secretary ducts & Lactifers, Diagnostic features of woods.

UNIT – II

Leaf growth & differentiation, Determination of Phyllotaxy, Differentiation of Epidermis including Stomata, Trichomes, & Mesophyl tissue.

UNIT – III

Root development, Organization of root apical meristem (RAM), Vascular tissue differentiation, Lateral roots, Root hairs, Root microbes interactions.

UNIT – IV

Male gametophyte development , Structure of anther, Microsporogenesis , Pollen germination, Pollination. Female gametophyte development**,** Ovule development, Megasporogenesis organization of embryosac, Endosperm development, storage protein of Endosperm & Embryo.

Approved by
Board of Studies in Botany on 15/09/2020, **Faculty of Life Science on** 14/10/2020
Standing committee on **Executive Council on**

UNIT – V

Reproduction, Vegetative & Sexual reproduction, Pollen Pistel interaction and Fertilization, Double fertilization , Seed germination & Seedling growth, Seed dormancy.

Books recommended

- B. D. Singh 2013 Plant Breeding : Principles & Method.
- Stanley R. G. and E. L. Linkens 1974. Pollen Biology, Biochemistry and Management.
- Nair P. K. K. 1964. Advances in Palynology.

CORE COURSE CODE BOC304: PRACTICAL BASED ON

COURSE CODE BOC301 & COURSE CODE BOC302

(COURSE CREDITS = 04)

Suggested List of Practicals (Course Code BOC301)

Plant Physiology

1. To measure Diffusion Pressure Deficit of Potato cells.
2. To prepare molar, Molal & Normal solution of NaCl and Sucrose.
3. To determine the incipient plasmolysis of cells under different concentration of sucrose solution.
4. Extraction and separation of the chlorophyll pigment from spinach leave by paper chromatography.
5. Separation of anthocyanin pigment by Paper Chromatography.
6. Quantification of pigments from spinach leaves by Spectrophotometer.
7. To determine the stomatal index in different plant species.
8. To study the effect of salt & osmotic stress on plants.

Suggested List of Practicals (Course Code BOC302)

Genetics & Molecular Biology

1. Staining technique for chromosomes preparation in plant (Onion plant) and animal cell.
2. To study the mitotic stages in the root of onion (*Allium cepa*) and to calculate the mitotic index.
3. To study the pollen sterility and fertility in buds of *Tradescantia*.
4. To study the effect of UV rays on *E.coli*.
5. To study the effect of dark and light treatment in DNA repair in *E. coli.*

CORE COURSE CODE BOC305: PRACTICAL BASED ON

COURSE CODE BOC303 & COURSE CODE BOE301/ BOE302/ BOE303/ BOE304

(COURSE CREDITS = 04)

Suggested List of Practicals (Course Code BOC303)

Plant Reproduction & Development

1. Slide :- Amphitropus ovule (T.S.)

   Superficial placentation

   Lilium anthor

Dicot embryo endodermis seed coat

Campylotropous ovule

Lillium Bud (Early anther)

2. To study the structure of given pollen grain (*Tradescantia*) using camera lucida.
3. To measure the size of given pollen grain.

ELECTIVE COURSE CODE BOE301: ADVANCED MOLECULAR BIOLOGY

(COURSE CREDITS = 03)

Course Objectives:

This course combines special set of tutorials centered on research activities in molecular biology with practical exercises and/or laboratory placements. The content is designed to provide students with a perspective of how cutting edge molecular biology principles and techniques are applied to major research questions. This course will illustrate that cross disciplinary approaches are essential in modern research.

Course Learning Outcomes

CO1: To understand key principles of how cells work, including gene regulation, protein synthesis and signal transduction.

CO2: To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand the key principles of Molecular Biology.

CO3: To read, interpret and discuss major contributions to Molecular Biology research published in scientific research literature.

CO4: To develop effective, creative and innovative solutions, both independently and cooperatively, to current and future research problems in Molecular Biology.

COURSE CONTENTS

UNIT I

Recombinant DNA technology I: methods of creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, selection screening construction of DNA library.

UNIT II

Recombinant DNA Technology II: Use of cloned gene, sub-cloning; recombinant proteins production in bacteria, site-directed mutagenesis, RFLP, PCR, DNA-fingerprinting, antisense-RNA technology, chromosomal walking. Bioethics.

UNIT III

Hybridoma technology: monoclonal antibodies mycelium cell infusion selection of hybridomas, protoplast fusion and HAT-medium screening assay purification and application of monoclonal antibodies.

UNIT IV

Cell and tissue culture: micropropagation, somatic cell culture, somoclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and methods), production of transgenic plant and animal; production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture application.

UNIT V

Fermentation technology: continuous and batch type culture techniques, principle types of Fermenters, general design of fementors. Fermentation processes, brewing manufacture of antibiotics, production of single cell protein. Application of genetic and molecular biology procedures in strain improvement.

Books recommended

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.

2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988

3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991

4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.

5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.

6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.

7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.

8.Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.)

VCH Publishers, Inc, New York, 1995

9. Genomes, T.S. Brown

Suggested list of practicals (Course Code BOE301)

1. To isolate genomic DNA from fungi by LETS methods.
2. To determine the quantity and quality of the isolated fungal DNA.
3. To determine the agarose gel electrophoresis of the isolated fungal DNA.
4. To isolate plasmid DNA from bacteria by quick method.
5. To purify the DNA from agarose gel.
6. To study the Thermal cycler.
7. To study the gel documentation system.

ELECTIVE COURSE CODE BOE302: **AGRICULTURAL MICROBIOLOGY**

(COURSE CREDITS = 03)

Course Objectives:

To make students aware about agricultural techniques, crop diseases, soil health, composting, agriculture losses, pest management, green revolution and agricultural biotechnology.

Course Learning Outcomes:

CO1: Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.

CO2: Critically discuss the need for agricultural microbiology and explain their limitations.

CO3: Clarify application of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.

CO4: Analyse various aspects of N_2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.

CO5: Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

COURSE CONTENTS

UNIT – I

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

UNIT – II

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

UNIT – III

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little left of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

UNIT – IV

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements, constraints

UNIT – V

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel.

List of Recommended Books

1. Soil microbiology by Subba Rao
2. Soil and microbes by Waksman and Starkey.
3. Plant pathology by Mehrotra.
4. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
5. Microbiology by S.S. Purohit.

Suggested list of Practicals (Course CODE BOE302**: Agricultural Microbiology)**

1. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
2. Isolation of fungi from soil by warcup's method.
3. Isolation of azotobacter species from soil.
4. Isolation of microorganism from rhizosphere.
5. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression method.
6. Plant diseases – leaf curl of papaya, rust of wheat, citrus canker, red rot of sugarcane.

Approved by
Board of Studies in Botany on 15/09/2020, **Faculty of Life Science on** 14/10/2020
Standing committee on **Executive Council on**

Study of weeds- Parthenium, water hyacinth.

ELECTIVE COURSE CODE BOE303: BIOPROCESS ENGINEERING AND TECHNOLOGY

(COURSE CREDITS = 03)

Course Objectives:

The course will enable students to apply biotechnological concepts in the exploitation of biological organisms for industrial and human benefits. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant biotechnological products and therapeutic proteins.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Insights on industrially important organisms, recent developments in fermentation processes and various optimization strategies at fermenter level. Learns about the design, types of fermenters and various critical components of bioreactors.

CO2: Is able to describe control parameters, fluid rheology and process constraints in large scale bioreactors. Strategies of product recovery from a fermentation broth.

CO3: Understand the significance and activities of microorganisms in food. Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.

CO4: Analyze the importance of microbiological quality control programme's in food production.

CO5: Discuss the microbiology of different types of food commodities. Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food

COURSE CONTENTS

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B12, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

Recommended Books:

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.
4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.
5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.
8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.
9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.
10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

Suggested list of Practicals (Course **CODE** BOE303)

1. Isolation of micro-organism from canned food.
2. Isolation of bacteria and fungi from spoiled bread.
3. Quantitative test of milk by resazurin test.
4. Quantitative estimation of Amylase production.
5. Isolation of lipase producing bacteria from soil.
6. Isolation of phosphate solubilizing/producing bacteria from soil**.**
7. Estimation of antibiotic property of bacteria.

ELECTIVE COURSE CODE BOE304: BIOTECHNOLOGY

(COURSE CREDITS = 03)

Course Objectives:

The course will help students to understand various applications of microbes for the development of various products of agriculture, industrial and clinical application. The knowledge of recombinant technology, bioreactors and optimization strategies will be beneficial in development of production processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Will learn about industrially relevant microbial products and their production process, role of biotechnology in environment management.

CO2: Acquires knowledge about strains development, selection of hyper producers, microbial products, metabolic engineering and various industrial relevant microbial products and their production

process Learns about the designing of recombinant heterologous expression systems such as *E. coli*, yeast, mammalian and insect cells.

CO3: Learns about sterilization at reactor scale and different types of sterilization strategies.

CO4: Attains knowledge about designing large scale industrial processes and types of cultivation strategies Understands the concept of recombinant biomolecules, therapeutic proteins, vaccines, antibodies, bio-pesticides, bio-fertilizers, and probiotics .

CO5: Understands different types of regulatory approvals required for drug development and difference between biologics, biosimilars and biobetters.

COURSE CONTENTS

UNIT I

Biotechnology an Overview, Definition, Perspective and scope of biotechnological processes and products, Biotechnology and Ethics, Introduction, Medical and chemical Biotechnology, Agriculture and Food, Energy and environment and human, Bioethics, Facing problem and finding solutions, Regulating the use of biotechnology, Patenting biotechnology inventions.

UNIT II

Genetic Engineering and gene cloning, Introduction of genetic engineering procedure, restriction endonuclease, cloning vehicle, Vectors for animals and plants, Insertion of DNA molecule in to a vector, Direct transformation, Isolation and cloning, Transformation and growth of cells, Selection and screening of particular recombinants, Genomic library, sequencing of DNA, Gene identification and mapping, Analysis of expression of cloned genes, Polymerase chain reaction, Monoclonal Antibodies.

UNIT III

Plant cell and tissue cultures, Culture techniques, Protoplast fusion, Direct gene transfer, Microinjections, Nuclear transplantation, Plastid and mitochondrial genes, production of secondary metabolites by immobilized plant cell, Development of disease resistant, herbicide resistant, Salt & drought resistant plant varieties, Microbial Toxins, Introduction, Toxins gene isolation, Genetic engineering of *B. thuringiensis* strains, *Baculovirus* as biocontrol agents.

UNIT IV

Culturing microorganisms for the production of biomass, Production of microbial (Bacterial, Cyanobacterial and Fungal) products, Batch culture, Continuous culture, Fed-batch culture, Mass culture, Use of culture system for the production of microbial products, Production of cyanobacterial biomass for food, Feed and health care products, Improvement of microbial strains for industry, Agriculture, Immobilization of microbial cells and enzyme and its applications.

UNIT V

Strain improvement, bioreactor design, Reactor types, Application of immobilized cells and enzyme, improvement in bioreactor to control environment of process organism. use of microorganisms in pollution control, Waste treatment, Bioremediation, Biological removal of eutrophic nutrients, Heavy metals, Toxic chemicals (Herbicide, Insecticide and Fungicide and Other Toxicants) from waste water and industrial effluents, Utilization of waste water for the production of food and feed, Biodegradation, Bioleaching of metals, Application of microorganisms from environment

Books recommended

- Haekett P. B., Fuchs J. A. and Mesing J. W. (1988) An Introduction to Recombinant DNA techniques – basic experiments in gene manipulation.
- Glck B. R. and Thompson J. E. (1993) Methods in Plant Molecular Biology and Biotechnology.
- Bjorn Kristiansen, (2012) Basic Biotechnology third Edition.

Suggested list of practicals (Course Code BOE304)

1. Demonstration:-
   - PCR
   - Spectrophotometer
   - pH meter
   - Centrifuse
   - Photomicrographic Camera
2. To prepare the media for plant tissue culture.
3. Isolation of pathogenic fungi from infected plants/Disease plants (Leaf/ Stem/ root)
4. Identification of unknown microorganism from given plates.
5. Preparation of tissue culture media.

CORE COURSE CODE BOS301: SKILL DEVELOPMENT MODULES 3

(COURSE CREDITS = 02)

ENTREPRENEURSHIP DEVELOPMENT PROGRAME AGENDA (Semester-3)

TIME - 30 Hrs

1. **ORIENTATION PROGRAM FOR ENTREPRENEURSHIP**

2. **WHAT IS ENTREPRENEURSHIP**
   - **Definition of Entrepreneurship**
   - **Be a Successful Entrepreneurship**

3. **TYPE OF ENTREPRENEURSHIP**
   - **Manufacturing**
   - **Trading**
   - **Service Provider**

4. **NEED TO BE SUCCESSFUL ENTREPRENEURSHIP**
   - **Knowledge - About work and Concern**
   - **Information - About sources/ market/ Customer's**
   - **Assets - About Technology, Place, Man power and money**

5. **CHOOSING A BUSINESS -**
   - **Micro Scale Unit** **Small Scale Unit**
   - **Large Scale Unit** **Mega Scale Unit**

6. MARKETING and DISTRIBUTION

Definition and Type of Marketing

About Sales and Marketing

Distribution channels

7. PRODUCT DESIGNING / BRANDING / MERCHANDIZING

Research and Development

8. FINANCIAL FLUENCY, PLANNING AND LEGAL ASPECTS

Taxation

Rules and norms of the Govt. to run a business

9. GOVERMENT SCHEMES AND ASSISTENCE

About financial loan / Place/ Training / Subsidy. ... etc

10. INDUSTRY VISITS.

FOURTH SEMESTER

(COURSE CREDITS 18)

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:

The primary object is to expose the students to research culture and technology. They learn how to choose a research problem, plan and perform experiments, collect data, and analyze the data qualitatively and quantitatively. The student gets trained in presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently.

Course Learning Outcomes:

CO1: Student is able to conceive a research problem based on current published researches through comprehensive survey of literature on the topic of research.

CO2: Student is able to plan and design bioassay protocols, to isolate microbes and macrobes from different sources, to identify the isolated organisms using morphological, structural, biochemical and molecular methods.

CO3: Student becomes well-versed in enzymatic, growth and toxicological assay systems through handling, use of instruments, reagents and chemicals, and in execution of experiments independently.

CO4: They learn to summarize and present research data by tables and graphs, and statistically analyze and interpret data.

CO5: They are trained to write dissertation (research reports) and present their important findings for peer evaluation. They also learn to publish their research output in peer reviewed journals and magazines.

RANI DURGAVATI VISHWAVIDYALAYA, JABALPUR
SYLLABUS PRESCRIBED FOR THE DEGREE OF THE MASTER OF SCIENCE IN MICROBIOLOGY IN UNIVERSITY TEACHING DEPARTMENT
(Academic Session 2020-2021 & Onwards)
[PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM - ORDINANCE 222]

This brochure of the programme for the M.Sc. degree in Microbiology consists of three parts, viz., (A) Information from the relevant Ordinance(s) / Statutes, (B) Scheme of examination and (C) Courses of study.

(A) INFORMATION FROM THE RELEVANT ORDINANCE (S)/STATUTES

1. DURATION OF THE COURSE

M.Sc Microbiology will be a full time two-year programme to be covered in four semesters, each of six months duration. The first year of the programme will complete the I and II semesters, and the second year will complete the third and fourth semesters. The maximum duration of the programme shall be twice of the minimum duration of the programme, i.e. four years.

2. ADMISSION TO THE COURSE

The number of seats shall be in accordance with the directives by the University. A candidate, who after having secured the B.Sc. degree with at least 50 % marks from a recognized university with a subject of Life Science, shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to guidelines from the University and Government of Madhya Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester.

3. TUITION AND OTHER FEES

The admitted candidate shall pay the course fee in addition to the tuition fee and such other fees as prescribed by the University.

4. PROGRAM OF THE STUDY

The semester will consist of 16-18 weeks of academic work. One credit is equivalent to one hour (60 minutes) of teaching (lecture or tutorial) or two hours (120 minutes) of practical work/field work per week throughout a semester. The credits associated with the courses will be valid credits, while credits associated with comprehensive viva voce will be virtual credits. In the end term examination there will be **three components, namely Core Courses, Elective Courses and Skill Development Course,** except for the 4th semester where every student will carry out and submit a **dissertation**.

The syllabus for the theory and practical examination will be prescribed by the Board of Studies in Microbiology, R.D. University, Jabalpur.

5. CONTINUOUS EVALUATION

During the semester, a teacher offering the course will do the continuous evaluation of the student at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and the third may be written test/quiz/seminar/assignment. Marks obtained in two best tests out of three will be awarded to the student.

6. ATTENDANCE

Approved by
Board of Studies in Microbiology on 08/06/2020, **Faculty of Life Science on** 14/10/2020
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The student whose attendance is less than 75% will not be allowed to appear in the end semester examination and he/she will be declared fail in that semester.

7. END SEMESTER EXAMINATION

There shall be end semester examination at the end of first, second & third semester. The semester examination will be held every year normally in December and June or on the dates declared in the academic calendar of the University. A student proceeding to appear in end semester examination will submit through the Head of the Department his / her application on the prescribed form along with required examination fee, etc. to the Registrar of the University. Every student will appear in four respective theory papers and two combined practical examinations in first, second, & third semesters except for the fourth semester. In the fourth semester, every student will be allotted dissertation work in lieu of four theory papers. Allotment of the dissertation will be done by a committee comprising of the Dean of Faculty of Life Science, Head of Department of Biological Science, one Professor and one Associate Professor of the Department by rotation according to seniority. The dissertation may be undertaken in UTD or in any of the National Laboratories/ Institute/ Universities/ Government approved Companies/ Industries. In such cases, there will be two supervisors, one from the parent department and another from the place where the student completes his/her dissertation work.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

8. CONDITION FOR A PASS

For each course, each student has to appear in at least two tests and end semester examination, otherwise the student will be awarded "Ab" grade. The total marks obtained in end-semester examination, and best of two tests under continuous evaluation will decide the grade in that course. In addition, student also has to get valid credits for Skill development modules' courses and Virtual credits and grades for Comprehensive viva-voce. The grading will be made on 10-point scale as follows:

Letter Grade	Grade Points	Description	Range of Marks (%)
O	10	Outstanding	90-100
A+	9	Excellent	80-89
A	8	Very Good	70-79
B+	7	Good	60-69
B	6	Above Average	50-59
C	5	Average	40-49
P	4	Pass	35-39
F	0	Fail	0-34
Ab	0	Absent	Absent

For passing the examination in each semester, a candidate must have secured a minimum of 35% marks ("P" Grade: 4 Grade Points) in the course. If the marks obtained by the student in a course are less than the minimum cut-off percentage of marks, then "F" Grade will be awarded. If a student obtains "F" or "Ab" Grade in any course, he/she will be treated to have failed in the course. He/she has to reappear in the examination of the course as and when conducted or arranged by the UTD. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course.

The theoretical and practical courses can be repeated whenever offered or arranged by the UTD but within maximum duration of the programme. He/she can avail multiple repeat attempts to pass the course. The

student will be promoted to the next semester if he/she secures at least 12 valid credits in a semester. In case the student secures less than 12 valid credits in any semester, then the student will be asked to repeat entire semester and that semester will be treated as zero semester.

The decision of the teacher regarding the evaluation and the grade shall be final. However, a student submits in writing for review of his Marks/Grade to the Head/Director who will place the case before the board of comprehensive viva voce. The decision of the board will be final. Result of review will be declared by the concerned Head/Director. Review is effective only when grade improves. Review will be allowed only if –

- The prescribed fee is paid.
- The candidate applies within 7 days of the declaration of the grade in that course.

There will be no provision for revaluation: However, the candidates can apply for Re-totaling in one course per semester.

9. In matters not covered under this Ordinance, general rules of the University shall be applicable.

10. In case of any dispute/ambiguity, the ruling of the Vice-Chancellor shall be final and binding.

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B. PROGRAM OBJECTIVES

- The objective of the Master's Program in Microbiology is to equip the students to gain bimolecular knowledge and analytical skills at an advanced level.
- The program emphasizes to apply knowledge acquired about prokaryotic and eukaryotic cellular processes, interaction of microorganisms among themselves, with physical and chemical agents and higher order organisms in environment and biological systems to various conditions.
- The laboratory training in addition to theory is included so that the students will acquire the skills to qualify for a broad range of positions in research, industry, consultancy, education and public administration, or for further education in a doctoral program.
- Students will be able to address broad range of fields including biopolymer chemistry, marine biochemistry, environmental biotechnology, food science, microbiology, microbial genetics, molecular biology and systems biology.

C. PROGRAMME OUTCOMES

The Masters in Microbiology Program will address the increasing need for skilled scientific manpower with an understanding of research ethics involving microorganisms to contribute to application, advancement and impartment of knowledge in the field of microbiology and molecular biology globally. The laboratory training will empower them to prepare for careers in broad range fields.
The M.Sc. Microbiology student will have:

- State of art knowledge about various methodological and analytic approaches that are used within the specialization.
- Knowledge of the leading edge in a chosen specialized area of Microbiology, based on own research experience from a master's project and international literature.
- Can compete in national level competitive exams such as NET-JRF or GATE or International exams such as GRE-TOEFEL and can pursue career in higher studies

- In-depth knowledge in the structure of a repertoire of microorganisms, metabolism in the cell, knowledge of the concepts of molecular genetics and biosynthesis of proteins, enzymology, physiology, microbial pathogenicity, environmental and agricultural microbiology, genetic engineering, bioengineering and a good theoretical and practical insight into methods used to obtain this knowledge.
- Demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments.
- Develop ability to independently carry out a complete scientific work process, including the understanding of theoretical background, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.
- Has high competence and multidisciplinary project experience within selected topics related to microbiology and ability to contribute in a multidisciplinary team. Is capable to evaluate methods and results within the field of specialization critically.
- Is able to evaluate and apply relevant theory, methods and analytic approaches within the specialized field of microbiology, including statistical methods.
- Can assess and predict the technological, ethical and social effects of their own work /disciplines and of microbiology.
- Acknowledges health, safety and environment (HSE) issues in handling chemicals and biological materials; understands the environmental impacts associated with the activity; performs risk assessments and is familiar with safety instructions in his/her subject area.
- Can communicate scientific results to the general public and experts by writing well structured reports and contributions for scientific publications and posters, and by oral presentations.

D. PROGRAMME SPECIFIC OUTCOMES (PSOS)

At the end of the two year programme the student will understand and be able to explain different branches of Microbiology such as Bacteriology and Virology. The student will be able to explain about various applications of Microbiology such as Environmental Microbiology, Industrial Microbiology, Food Microbiology, and Microbial Pathogenicity. He/she will be able to design and execute experiments related to Basic Microbiology, Immunology, Molecular Biology, Recombinant DNA Technology, and Microbial Genetics, and will be able to execute a short research project incorporating techniques of Basic and Advanced Microbiology under supervision. The student will be equipped to take up a suitable position in academia or industry, and to pursue a career in research if so desired.

(E) SCHEME OF EXAMINATION:

SEMESTER I

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
I Core courses					
MBC101	Bacteriology **SKILL**	**3**	**40**	**60**	**100**
MBC102	Virology **SKILL**	**3**	**40**	**60**	**100**
MBC103	Mycology **SKILL**	**3**	**40**	**60**	**100**
MBC104	Practical based on MBC101 & MBC102 **SKILL**	**4**	**40**	**60**	**100**
MBC105	Practical based on MBC103 & MBE101/ MBE102 **SKILL**	**4**	**40**	**60**	**100**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**
MBE101	Biomolecules **SKILL**				
MBE102	Bioenergetics and Intermediary Metabolism **SKILL**				
III Skill Development course					
MBS101	Skill Development module 1 **SKILL**	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

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SEMESTER 2

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
I Core courses					
MBC201	Molecular biology and Recombinant DNA Technology **EMPLOYABILITY**	**3**	**40**	**60**	**100**
MBC202	Microbial Genetics **EMPLOYBILITY**	**3**	**40**	**60**	**100**
MBC203	Biostatistics & Computer Application **EMPLOYBILITY**	**3**	**40**	**60**	**100**
MBC204	Practical based on MBC201 & MBC202 **EMPLOYABILITY**	**4**	**40**	**60**	**100**
MBC205	Practical based on MBC203 & MBE201/ MBE202/ MBE203 **EMPLOYABILITY**	**4**	**40**	**60**	**100**
II Electives courses (Any one to choose)		**3**	**40**	**60**	**100**
MBE201	Biology of the Immune System **SKILL**				
MBE202	Resource utilization and conservation **SKILL**				
MBE203	Microbial Metabolism **SKILL**				
III Skill Development course					
MBS201	Skill Development module 2 **SKILL**	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

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SEMESTER 3

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
I Core courses					
MBC301	Environmental Microbiology **SKILL**	**3**	**40**	**60**	**100**
MBC302	Medical Microbiology **EMPLOYABILITY**	**3**	**40**	**60**	**100**
MBC303	Practical based on MBC301 & MBC302 **SKILL**	**4**	**40**	**60**	**100**
MBC304	Practical based on MBE301/ MBE302/ MBE303/ MBE304 (Any Two) **SKILL**	**4**	**40**	**60**	**100**
II Electives courses (Any two to choose)		**3**	**40**	**60**	**100**
MBE301	Advanced Molecular Biology **EMPLOYABILITY**				
MBE302	Agricultural Microbiology **SKILL**	**3**	**40**	**60**	**100**
MBE303	Industrial & Food microbiology **Entrepreneurship**				
MBE304	Microbial Biotechnology **Entrepreneurship**				
III Skill Development course					
MBS301	Skill Development module 3 **SKILL**	**2**	**Grade Point will be provided by Skill Development Centre**		
Total valid credits		**22**			

(B) Comprehensive viva voce (virtual credits)	**4**		**50**

*Both (A – Core courses; One/Two Elective course(s) and Skill Development modules) & (B) are compulsory components of a semester. The grades awarded in the comprehensive Viva-voce shall be shown separately in the Grade Sheet.

SEMESTER 4

(A) DISSERTATION	Credits	Maximum Marks	
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**	**SKILL EMPLOYABILITY ENTREPRENEURSHIP**
B. Viva-Voce EXTERNAL		**50**	
C. Viva-Voce INTERNAL		**50**	
Total		**400**	

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

COURSES OF STUDY IN M.Sc. MICROBIOLOGY
FIRST SEMESTER
COURSE CODE MBC101: BACTERIOLOGY (TOTAL CREDITS: 3)

Course Objectives: The primary objective of the course is to build a strong foundation in the area of bacterial cell structure, division, survival and propagation.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be able to describe the morphological features, cell arrangement and structural components of bacterial cell in detail; will be able to differentiate between Gram-positive and Gram-negative bacteria. Will have gained knowledge about cell wall structure and extracellular appendages in different bacteria and is acquainted with current methodologies available for production of protoplasts, sphaeroplasts and L-forms.
- Will have gathered detailed information regarding bacterial cell division and endospore formation. Can enlist the characteristics of archaea that differentiate it from eubacteria, and will have learnt key features of some model archaeal organisms.
- Can enlist the salient features of the genome organization of E.coli and also the features of the unusual genome organization of selected extremophiles that allow them to survive in harsh environments.
- Understands different secretion systems existing in bacteria for toxins and biomolecules secretion, and their role in bacterial survival and pathogenesis.
- Will have gained in-depth knowledge about density-based signal transduction in bacteria and its significance in competence, sporulation and antibiotic resistance; would know about quorum quenching and its use in developing antimicrobial tools.
- Will have the indepth knowledge of various groups of bacteria with their significane.

COURSE CONTENTS

UNIT-I

History, scope and development of bacteriology, sterilization, isolation, enrichment, pure culture and staining techniques, systematic study of bacteria; morphological, physiological, biochemical and serological studies, genetic characterization, identification & classification chart.

UNIT-II

Habitat, structure, reproduction & classification of bacteria (morphological, biochemical, serological, chemical and molecular aspects), Actinomycetes, Mycoplasma, Rickettsiae, Chlamydiae and their significance.

UNIT-III

The photosynthetic bacteria; cyanobacteria, green bacteria, halobacteria and their economic importance. Methanogenic bacteria and their significance. Chemoautotrophs and Methylotrophs; nitrifying bacteria, sulfur oxidizers, iron bacteria, hydrogen bacteria and their economic importance.

UNIT-IV

Enterobacteriaceae and related organisms, their morphological & physiological characters, genetic interrelationship, taxonomic sub-division & their importance in human health. Myxobacteria, cytophage group, filamentous & gliding chaemoheterotrophs & filamentous sulphur oxidizing bacteria.

UNIT-V

Gram positive spore forming bacteria; unicelluar endospore formers- *Bacillus, Clostridia. Miscellaneous bacteria; lactic acid bacteria, Micrococci, Corynebacteria, Mycobacteria.*

List of Recommended Books

1. Sneath, P.H.A .and R.R. Sokal 1973 Numerical taxonomy .The Principles and Practice of Numerical Classification, San Francisco. W.H. Freeman
2. Sneath, P.H.A 1989 Analysis and Interpretation of sequence data for bacterial Systematic. The view of a Numerical taxonomist .Syst.Appl.Microbiol.12:15-31
3. Tom Parker, M. Lerline, H.Collier,1990,Principles of Bacteriology, Virology and Immunity, VIII Ed.
4. Woese,.C,R 1981 Archeabacteria , Sci. Am. 244:98-122
5. Woese,C.R.,Kandler,O. and M.L.Wheelis 1990 Towards a natural System of organisms: Proposal for the Domains Archea, Bacteria and Eucarya. Proc. Nati, Acad, Sci. ,87: 4576- 4570
6. Woese, C. R 1987 Bacterial evolution, Microbiological Reviews. 51: 221-271
7. Madigan, M. T.,J.M.Mrtinko and J.Parker 2000 Brock Biology of Microbiology IX Ed .Prentice Hall Inter, Inc.
8. Holt, J.G, and N.R.Krieg, 1984-1989 Bergey's Manual of Systematic Bacteriology Ist Ed (Vol 1-4) Williams and Wilkins Co Baltimore,Springer.
9. Holt , J.G, and N.R. Krieg, P.H .A .Sneath, J.T.Staley and J.T. Williums ,1994 Bergey's Manual Determinative Bacteriology IX Ed. Williams and Wilkins Co Baltimore, Springer
10. Garrity George, M. Editor-In Cheaf 2005 Bergey's Manual of Systematic Bacteriology II Ed. (Vol- I-V) .J.Brenner,K.R.Krieg, J.T.Stanly. Editors. Springer-Verlog
11. Garrity, M. George. Winters, B.S.Denise 2001 Taxonomic outline of the prokaryotic genera Bergeys Manual of Systematic Bacteriology. II Ed.
12. Balows, A.A.G. Thuper, M. Dworker, W. Harder, K.Schleifer 1991 The Prokaryotes, Springer,
13. VerlogGunsales and Stainer, The Bacteria I-V vol. Academic press
14. Prescott, L.M., J.P Harley and D.AKlein, 2007 Microbiology VII Ed. Mc Grow Hill,
15. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
16. Stainer General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi
17. Schaechter.R. and Ledenberg.J 2004 The desk encyclopedia of microbiology. Elsevier Acad. Press California.
18. Amann.R. I. Ludwing. W and Schleifer. K .M. 1995 Phylogenetic identification and in detection of individual microbial cell with cultivation. Microbiological Reviews 59, 143-169.
19. Cook .T. 2002 Microbial Biodiversity saving bacteria to save ourselves, Harvard Sci. Review 26-28.
20. Vandanme,D. B.Pot, M.Gillis, P. Devos, K. Kersters and J. Swimgs.1996 Polyphasic taxonomy, a consensus approach to Bacterial Systematic, Microbiological Reviews. 407-438.
21. Bacterial (Prokaryotic) phylogeny web page. 2006, http: www.bacterial phylogeny.com / Index .html.
22. Brun,Y.V. and Schinketes 2000 Prokaryotic developments ASM press
23. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
24. Talaro, K.P. and A. Talaro 1999 Foundations in Microbiology. Mc Graw Hil. Pub.
25. Davies et al.,1990 Microbiology 4thEdition Philadelphia, JB Lippincott

COURSE CODE MBC102: VIROLOGY (TOTAL CREDITS: 3)

Course Objectives: The course will facilitate in understanding of virology by examining common processes and principles in viruses to illustrate viral complexity, to understand viral reproduction. The course will teach the strategies by which viruses spread within a host, and are maintained within populations. It covers the molecular biology of viral reproduction and addresses the interplay between viruses and their host organisms

Course Learning Outcomes: Upon successful completion of the course, the student:

- Is able to describe classification of viruses .
- Is able to describe tools for studying virus structure, process of virus attachment and entry, virus
- assembly and release
- Is able to describe steps in replication of genome of RNA viruses, retroviruses, and DNA viruses Is able to describe steps in virus infection, transmission, patterns of infection, virus virulence, and host defense against virus infection
- Is able to describe methods of making virus vaccines and anti-viral drugs, drivers of virus evolution, and emerging viruses
- Is able to describe unusual infectious agents, virus mediated cellular transformation and oncogenesis.
- Is able to describe evasion strategies used by viruses, and learn to apply their knowledge to investigate virus outbreak **.**

COURSE CONTENTS

UNIT-I

General virology: History and development of virology, origin, distinctive properties, ultrastructure and chemistry of viruses. virus related agents (viroids, prions), significance of viruses.

UNIT-II

General methods for isolation, identification, characterization and cultivation of viruses: Methodology for isolation, adsorption, One-step growth and burst size of virus. Determination of titre value, isolation of phage resistant strain, cultivation and maintenance of plant, animal and bacterial / cyanobacterial viruses. identification of viruses by physical, chemical and serological techniques.

UNIT-III

Bacterial/ cyanobacterial viruses: Structure and multiplication of lytic and lysogenic bacteriophage.Significance of lysogeny. Brief account of M13, Mu, T4 and λ, history, structure, genetics and life cycle of cyanophages, significance of bacteriophages and cyanophages.

UNIT-IV

Plant viruses: classification and nomenclature, structure and multiplication of plant viruses with special reference to TMV, cauliflower mosaic virus, effect of viruses on plants. Some common viral diseases of plants (TMV, CMV, leaf Curl of papaya). Transmission of plant viruses and control of viral diseases of plants.

UNIT-V

Animal viruses: Classification and nomenclature of animal and human viruses. Brief account of Adeno-, Herpes, Hepatitis, HIV and other oncogenic viruses. Prevention, treatment and control of viral diseases. Viral vaccines including DNA vaccines and interferons.

List of Recommended Books

1. Medical Virology 10 Th Edition by Morag C and Tim bury M C 1994. Churchil Livingstone, London.
2. Introduction to Modern Virology 4th Edition by Dimmock N J, Primrose S. B. 1994. Blackwell Scientific Publications. Oxford.

3. Virology 3 rd Edition by Conrat H.F., Kimball P.C. and Levy J.A. 1994. Prentice Hall, Englewood Cliff, New Jersey.
4. Text Book on Principles of Bacteriology, Virology and Immunology Topley and Wilsons 1995.
5. Molecular Biology, Pathogenesis and Control by S.J. Flint and others. ASM Press, Washington, D.C.
6. Applied Virology. 1984. Edited by Edonard Kurstak. Academic Press Inc.
7. Introduction to Modern Virology by Dimmock.
8. Prion diseases by Gaschup, M.H.
9. Clinical virology Manual by Steven, S., Adinka, R.L., Young, S.A.
10. Principles of Virology. 2000 by Edward Arnold.

COURSE CODE MBC103: MYCOLOGY
(TOTAL CREDITS: 3)

Course Objectives: To make the students familiar with basic concepts in mycology (e.g., fungal reproduction, physiology, taxonomy, etc.) to gain an overview of the research field.

Learning outcome:

- Be able to reflect on and formulate research questions relating to mycology and how these concepts apply to their areas of research.
- Be able to become enterpreuners by gainig knowledge about mushroom, biofertilizers etc

COURSE CONTENTS

UNIT-I

Status of fungi in the living world, general features of fungi and fungus like organisms; recent trends in the classification of fungi; physiology and growth of fungi; nutritional and environmental factors affecting growth; saprotrophs, parasites and mutualistic symbionts; physiology of reproduction in fungi, phylogeny of fungi.

UNIT-II

Fungal diversity-major taxonomic group, structure, reproduction, life cycle and significance of the following representatives:

i) Gymnomycota-general account – cellular slime moulds (Dictyostelium), plasmodial slime moulds (Myxomycetes).

ii) Mastigomycota- *Coelomomyces, Lagenidlum, Achlya, Phytophthora, Peronospora, Plasmodiophora.*

iii) Amastigomycota- *Zygomyocotina- Mucor, Syncephalastrum, Blakeclea, Cunninghamella, Entomophthora.*

UNIT-III

Fungal diversity contd. structure, reproduction, life cycle and significance of the following representatives:

i) Ascomycotina- *Taphrina, Emericeilla, Chaetomium, Morchella, Neurospora, Claviceps, Erysiphae.*

ii) Basidiomycotina- *Puccinia, Melamspora, Ustilago, Polyporus, Lycoperdon, Ganoderma.*

iii) Deutromycotina- *Fusarium, Cercospora, Curvularia, Beauveria, Microsporum, Phoma, Collectotrichum.*

UNIT-IV

Fungal genetics:

i) Life cycle and sexual process in fungi; structure and organization of fungal genomes (mitochondrial genes, plasmids and transposable elements, virus and viral genes).

ii) Genetic variations in fungi- nonsexual variations-haploidy, heterokaryosis, parasexuality; sexual variations-mating or breeding systems- homothallism and heterothallism, mutation, physiological specialization; strain improvement.

UNIT-V

Fungi and biotechnology: production of alcoholic beverages, antibiotics, organic acids, ergot alkaloids; the cultivation of fungi for food-mushrooms, myco protein and mycofoods; role of fungi in agriculture and forestry- mycorrhizae and their application, mycopesticides, mycotoxins, conservation of fungal germplasm.

List of Recommended Books

1. Tortora, G.J., Funke, B.R. and Case, C.L. 2001. Microbiology: An Introduction. Addison Wesley Longman, New York.
2. Brock Biology of Microorganisms: by Madigan, Mortinko and Parker (2000), Prentice Hall.

3. Microbiology: by Prescott, L.M., Harley, J.P. and Klein, D.A. (1992). WCB Publishers.
4. Introductory Mycology: by Alexopoulos, C.J. Mims, C.W. and Blackwell, M. (1996). John Wiley & Sons.
5. An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press
6. Alexopoulus, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. John Wiley & Sons, Inc.
7. Mehrotra, R.S. and Aneja, R.S. 1998. An introduction to Mycology. New Age Intermediate Press.
8. 15. Webster, J. 1985. Introduction to Fungi. Cambridge University Press.

COURSE CODE MBC104: PRACTICAL BASED ON COURSE CODE MBC101 & COURSE CODE MBC102 (COURSE CREDITS = 04)

Suggested list of Practicals: (Course Code MBC101**: Bacteriology)**

1. Preparation of different types of media
2. Isolation and enumeration of bacterial and fungal population in air.
3. Enumeration of bacterial population in water.
4. Isolation and enumeration of bacterial and fungal population in soil
5. Demonstration of bacterial motility by Hanging drop technique
6. Staining techniques: i) Gram staining ii) Cell wall staining iii) Endospore staining iv) Flagella staining v) Capsule staining vi) Staining of PHB granules vii) Staining of phosphate granules
7. IMVIC tests (Indole, methyl red, Voges prausker and citrate test)
8. Oxidast test
9. Carbohydrate fermentation & Gas production
10. Catalase test
11. Gelatinase test
12. Caseinase test
13. Amylase test
14. H 2 S production test
15. Nitrate reduction test
16. Litmus milk reactions
17. Urease test
18. Isolation of Bacteria from curd by streaking methods.
19. Determination of bacterial growth by turbidometric method
20. Effect of temperature on bacterial growth.
21. Effect of p H on bacterial growth

Suggested list of Practicals (Course Code MBC102**: Virology)**

1. Estimation of chlorophyll in healthy and viral diseased plants.
2. Study of symptomology of plant, animal and human diseases caused by viruses.
3. Estimation of proteins in healthy and viral diseased plants.
4. Estimation of DNA in healthy and viral diseased plants.
5. Estimation of RNA in healthy and viral diseased plants.
6. Transmission of viruses by grafting.
7. Transmission of viruses by aphids.
8. Sap transmission of plant viruses.
9. Isolation of phages from sewage.
10. Study of Viral diseases- leaf curl of papaya, TMV.

COURSE CODE MBC105: PRACTICAL BASED ON COURSE CODE MBC103 & MBE101/ MBE102 (TOTAL CREDITS = 04)

Suggested list of Practicals (Course code MBC103: Mycology)

1. Isolation of fungi from soil by warcup's method.
2. Isolation of VAM spores from soil.
3. Identification of fungi by slide culture.
4. Preparation of wet mount and Dry mount slide.
5. Measurement of fungal growth by mycelia dry weight estimation.
6. Study of permanent slide of fungi.
7. Lactophenol and cotton blue mounting of fungi.

List of Elective Papers

COURSE CODE MBE101 : BIOMOLECULES

(TOTAL CREDITS =03)

Course objective: The syllabus of Biomolecules is structured finely to make the students understand the structure and various principles dealing with the working of biomolecules and their mutual interactions to support the life system.

Learning outcomes

- Enabling students to understand the importance of water in maintaining the various biochemical reactions such as buffering, phosphorylation, oxidation-reduction etc.
- The students learn the principle of working of enzyme and the process of enzymology, that is, how the enzymes work and where the active sites play a key role.
- The students also learn the basic and functional structures of all the biomolecules in detail.
- The inter-relationships and communication between the biomolecules is a major part of signal transduction. The students become well versed with this mode of biological process.
- The students learn various techniques such as chromatography, spectroscopy and electrophoresis to understand the purity of biomolecules and their analytical properties for further application.

COURSE CONTENTS

UNIT I

Structure of water and its solvent properties, Acid- bases, pH and buffer, Bi and polyprotic buffer. Free energy and spontaneity of reactions, ATP and other phosphorylated compound with their free energy of hydrolysis, Phosphoryl group transfer, Biological oxidation reductions reaction, Coupled reaction and oxidative phosphorylation, Inhibitors and uncouplers.

UNIT II

Enzyme classification, Specificity, Active site, Enzyme kinetics, Michealis Menton equation, Determination of kinetic parameters, Bi-substrate reaction and their kinetics, Enzyme inhibition and kinetics, Allosteric enzyme. Kinetics and Allosteric regulation of phosphofructo kinase

UNIT III

Structure and chemistry of macromolecules, Proteins, Carbohydrates and Lipids, Protein folding, Structure and chemistry of bimolecules such as antibiotics, Pigments, Vitamins as coenzymes, Lipid analysis by GLC and Mass Spectrometry, Oligosaccharide and Polysaccharide analysis.

UNIT IV

Biosignaling molecular mechanism of signal transduction, Gated ion channels, Nicotinic acetyl choline receptor, Receptor enzyme, The insulin receptor, G- proteins and cyclic AMP membrane transport, Biomembrane, Nutrient

transport across membranes, Active and passive diffusion, Symport, Antiport and uniport, Na^+ K^+ pumps and their metabolic significance.

UNIT V

Chromatographic technique, Paper and TLC , Gel filtration, Ion exchange, Affinity, HPLC, SDS, PAGE, Isoelectric focusing, Western blotting, Protein sequencing, Mass spectrometry, MALDI , TOF, MS.

Books Recommended

J. L., Jain, Sanjay, and Jain Nitin, (1979) Fundamentals of Biochemistry (6th revised Edition). S. Chand & Co. Ltd. New Delhi.
Buchanan . B.B. Gruissem, W. and Jones .R.L. (2000) Biochemistry and Molecular Biology of Plants , American Society of Plant Physiologists, Maryland ,USA.
Albert L. lehninger, Davis L. Nelson, Michael M. Cox. (2004) Lehninger Principles of Biochemistry.
Lea P.J. and Leegood ,R.C. (1999) Plant Biochemistry and Molecular Biology (2 nd Edition) John Wiley and Sons. Chichester, England
Berg Jeremy, Tymoczko John, Stryer Lubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.
Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.
Dawes Edwin A. (1972) Quantitative Problems in Biochemistry, Churchill Livingston, Edinburgh.
Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press. 5. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.
Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.
Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.
Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.
Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.
Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.
Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed.. John Wiley and sons New York.
White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.
White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.
Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

Suggested list of practicals (Course Code MBE101**)**

1. To study working of weighing balance.
2. To study the working of pH meter.
3. To determine the pKa value of acetic acid by pH titration method.
4. Preparation of acetate buffer at pH=5.
5. Prepare Phosphate buffer at pH=8.
6. To prepare tris buffer at pH=9.
7. Estimation of protein by Lowry method.
8. Chromatographic separation by paper and thin layer Chromatography.

9. To determine pKa value of glycine.
10. Determine the absorption maxima of Potassium dichromate.
11. To prove the validity of Beer-Lambert's law.
12. Qualitative assessment of carbohydrate.
13. Qualitative assessment of lipids.
14. Qualitative assessment of proteins.
15. To prepare standard curve of glucose by anthrone method.
16. To determine the Km and Vmax od amylase enzymes.
17. To study the effect of substrate concentration on enzyme activity.
18. To study the effect of temperature on enzyme activity.

COURSE CODE MBE102: BIOENERGETICS AND INTERMEDIARY METABOLISM

(TOTAL CREDITS = 03)

Course Objective: The syllabus of Bioenergetics and Intermediary Metabolism Course is structured to explain the potential role of biomembranes and their extraordinary use in maintaining and regulating all the metabolic cycles taking place inside the cell and outside the cell. These membranes are playing a very crucial role in maintaining the energy dynamics of the cell.

Learning outcomes

- Enabling students to understand finely detailed energy dynamics of a biomembrane, the components involved therein and various physiological attributes driven by aforementioned energy transformation.
- The students learn the principle of working of mitochondria as a model of energy transducer with special reference to its membrane associated respiratory processes leading to formation of ATP.
- The students also learn the anabolic and catabolic processes involving carbohydrates in marinating the energy balance of the cell.
- The biosysnthesis of lipids that constitute the biomenbranes is understood at the level of enzymes and pathways.
- The catabolic role of amino acids in the formation of urea and abnormalities due to metabolic errors in these cycles is learnt by students. The synthesis of nucleic acids, the hereditary material, involving purines and pyrimidines is made acquainted to the learners.

UNIT I

Bioenergetics: energy transformation, biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes; free energy changes and redox potentials, phosphate potential, ion and proton electrochemical potentials, membrane potentials, chemo-osmotic theory; ion transport across energy transducing membranes, influx and efflux mechanisms, transport and distribution of cations, anions and ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

UNIT- II

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization; the Q cycle and the stoichiometry of proton extrusion and uptake. Oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes. ATP synthetase complex, microsomal electron transport.

UNIT- III

Carbohydrates: glycolysis, citric acid cycle- its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway, alternate pathways of carbohydrate metabolism, gluconeogensis, inter-conversions of sugars, biosynthesis of glycogen, starch and oligosaccharides.

UNIT- IV

Lipids: fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthase; fatty acid oxidation: α, β, oxidation and lipoxidation; lipid biosynthesis: of triacylglycerols, phosphoglycerides and sphingolipids, biosynthetic pathways for terpenes and steroids.

UNIT- V

Amino acids and nucleic acids: biosynthesis and degradation of amino acids and their regulation, specific aspects of amino acid metabolism, urea cycle and its regulation, in-born errors of amino acid metabolism; Nucleic acids: degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide biosynthesis, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis.

Books recommended

M.M. Cox and D.L. Nelson (2008) Lehninger Principals of Biochemistry W.H. Freeman & Company

Otto Hoffmann-Ostenhof (2008) Intermediary metabolism; *Van Nostrand Reinhold (USA)*.

P.H. Clarke (1978) Intermediary metabolism; *John Wiley & Sons Ltd Hoboken, New Jersey (United States).*

Alexander Lowen (1994) Bioenergetics; *Penguin/Arkana Books USA.*

David G. Nicholls and Stuart Ferguson (2013) Bioenergetics; *Academic Press Elsevier United States*.

Suggested list of practicals (Course Code MBE102)

1. 1. To prepare acetate buffer of pH4.7.
2. To perform carbohydrate tests of manosaccharides, polysaccharides, disaccharides.
3. To determine protein of unknown sample by Lowry method.
4. To perform the detection of lipid in the given sample

COURSE CODE MBS101: SKILL DEVELOPMENT MODULES 1
(TOTAL CREDITS = 02)
PERSONALITY DEVELOPMENT- MODULE- 1 (Semester-1)
Hrs.-30

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet	1
02	Role and Impact of Personality	Group Activity	1
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	2
04	Listening and Caring	Group Activity	1
05	The Art of Communication	Worksheet	1
06	Different level of Effective Communication	Worksheet	1
07	Professional Communication P-A-C	Worksheet	1
08	Rules of Professional Communication	Group Activity	1
09	Body Language - 1	Worksheet	1
10	Language Lab	Worksheet	1
11	Thought Process - 1	Worksheet	1
12	Interpersonal Skills	Worksheet	1
13	Observation & Imagination Power	Group activity	1
14	Creativity	Group Activity	1
15	Extempore - 1	Group activity	1
16	Extempore - 2	Group Activity	1

17	Presentation Skills	Worksheet	2
18	How to Draw the Attention of Audience	Worksheet	1
19	Steps of Effective Presentation	Worksheet	1
20	Prioritizing Matrix	Worksheet	1
21	Leadership Quality	Group activity	1
22	SWOT Analysis	Worksheet	1
23	Interview Skills	Lecture	2
24	Group Discussion	Group Activity	2
25	Resume Preparation	Group Activity	1

SECOND – SEMESTER
COURSE CODE MBC201: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY (TOTAL CREDITS: 3)

Course objective: The aim of the course is to inculcate the vast knowledge of the structure, function and application of genetic material in diverse life forms in performing and regulating the complex biological processes.

Learning outcomes

- Enabling students to understand fundamental processes of nucleic acid multiplication with respect to the intricacy of the enzymes involved and reactions performed.
- The students also learn the specialized in vivo and in vitro models of genome propagation and about chemicals/ physical agents that can prevent the process.
- Once the genetic material is propagated in progeny, how is the genome expressed to RNA by a process, transcription, and how RNA takes its final shapes is being learned in detail.
- There are several inherent mechanisms to control transcription and process thereafter. The learners get acquainted with knowledge of molecules and procedures which switch off/ on gene expression.
- Application of the functional and structural components of flow of information using diverse tools and techniques in genetic important of important life forms is learned in this course.

COURSE CONTENTS

UNIT – I

Nucleic acids as genetic information carriers: DNA structure, melting of DNA; superhelicity in DNA, linking number and topological properties; DNA replication., general principle, various modes of reading, continuous and discontinuous synthesis, asymmetric & dimeric nature of DNA polymerase III & simultaneous synthesis

of DNA leading and lagging strands, polymerase and exonuclease activities, eukaryotic DNA polymerases; Mechanism of action of topoisomerases, ligases.

UNIT – II

Initiation of replication and construction of replication fork in test tube; retroviruses and their unique mode of DNA synthesis; relationship between replication and cell cycle in prokaryotes and eukaryotes; inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization altering DNA structure).

UNIT III

Transcription: general principles, basic apparatus types of RNA polymerase; steps: initiation, elongation and termination, inhibitors of RNA synthesis, polycistronic and monocistronic RNA's; control of transcription by interaction by interaction between RNA polymerases and promoter regions, role of alternate sigma factors; regulation of rRNA and tRNA synthesis; maturation and splicing of mRNA, cutting and modification of tRNA: catalytic RNA, group I and group II splicing.

UNIT – IV

Gene expression in prokaryotes: induction and repression operon concept, regulatory and structural genes, operator, promoter, repressor and co-repressor, catabolite repression, cyclic AMP, CRP/CAP protein, regulation of lactose, tryptophan, histidine and arabinose operons, attenuation regulation. Gene expression in eukaryotes, Britton and Davidson's model of regulation involvement of HCP, NHCP and hormones. Regulation by N protein and nut sites in DNA binding proteins, enhancer sequences and control of transcription. Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp.

UNIT – V

Basic principle of gene cloning, genomic libraries, vectors, strategies of gene cloning using DNA or cDNA inserts, gene expression in recombinants, screening method for recombinant clones, important molecular techniques like Southern Blotting, PCR, RAPD, RFLP, DNA sequencing, and probe hybridization.

List of recommended books

1. Molecular cloning: A Laboratory Manual, J. Sambrook; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. New York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown.

COURSE CODE MBC202: MICROBIAL GENETICS
(TOTAL CREDITS: 3)

Course objectives : understanding the fundamental researches in exploitation and manipulation of microbial genes for the betterment of livelihood and safe environment.

Learning Outcomes : will guide the students in the following perspectives as:

- Better knowledge of DNA and gentic recombination.

- Understanding the mutations and mutagens.
- Designing of vectors and its biotechnological applications.
- Clinical applications and Laboratory technology for designing of vaccines,hormones and immunity boosters.
- Understanding the bioethics and biosafety rules.

COURSE CONTENTS

UNIT-I

Gene as unit of mutation and recombination, molecular mechanism of mutation, mutagens, types of DNA damage (deamination, oxdative damage, alkylation, pyridine dimmers). Spontaneous mutations-origin, suppression of mutation.

UNIT-II

Gene transfer and genetic mapping, transformations, transfection, conjugation and transduction, genetic mapping of E,coli; Molecular aspects of genetic recombination.

UNIT-III

Complementation analysis, cis-trans test, deletion mapping; Benzer's concept of cistron, overlapping genes. DNA repair- photo repair, excision or dark repair, recombinational repair, SOS repair, methyl- directed mismatch repair, very short patch repair.

UNIT-IV

Plasmids. F-factors description and their uses in genetic analysis; R factors, colocin and col factors; plasmids as vectors for gene cloning; replication of selected plasmids; compatibility. Transposons and their uses in genetic analysis, plasmid vectors and bacteriophage vectors.

UNIT-V

Important application of advances in microbial genetics, production of proteins, hormones and design of vaccines: conventional as well as new generation recombinant DNA vaccine, their design and advantages.

List of Recommended Books

1. Microbial Genetics by Maloy ET. Al. 1994. Jones and Bartlett Publishers.
2. Molecular Genetics of Bacteria by J. W. Dale. 1994. John Wiley and Sons.
3. Modern Microbial Genetics. 1991 by Streips and Yasbin. Niley Ltd.
4. Moleculat Biology of the Gene 4th Edition by J.D. Watson, N.H. Hoppkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. 1987, The Benjamin / Cummings Publications Co. Inc. California.
5. Gene VII by Lewin Oxford University Press. 2000.
6. Bacterial and Bacteriophage Genetics. 4 th Editions by Birge.
7. Microbial Genetics by Frefielder. 4th Edition.
8. Organization of Prokayotic Genome. 1999 by Robert L.Charlebois, ASM Publications.
9. DNA repair and mutagenesis. 1995 by Errol C. Friedberg, Graham C. Walker and Wolfram, Siede, ASM Publications.
10. Molecular Genetics of Bacteria, 1997 by Larry, Snyder and Wendy, Champness, ASM Publications.
11. Methods of General and Molecular Bacteriology, 1993. Edited by Philip. Gerhardt, ASM Publications.
12. Recombinant DNA by Watson, J.D.
13. Essentials of Molecular Biology by Malacimski.
14. Mobile DNA II by Nancy Craig, Martin Gellet Allan Lambowitz.

COURSE CODE MBC203: BIOSTATISTICS AND COMPUTER APPLICATION (TOTAL CREDITS: 3)

Course Objectives: The course aims to empower the learners with tools and techniques in collection, collation, summarization and interpretation of data along with various experimental designs and bioinformatics.

Course Learning Outcomes:

- Proficiency of students in various techniques of collection, collation, summarization and presentation of data. They could learn basic concepts of probability and probability distribution functions along with applications.
- Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.
- Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.
- Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.
- Empowers students to utilize software packages in digital analysis and processing of biological data. Integrate informatics with biology through data submission protocols, sequence alignment and searches, annotations and possible applications in human health and welfare.

COURSE CONTENTS

UNIT-I

Importance and scope of statistics in biochemical experimentation; Elements of Probability- Mathematical and Statistical definitions; Addition and Multiplication theorems; Probability Distribution Functions – Binomial, Poisson and Normal; Area under normal distribution curve.

UNIT-II

Measures of central tendency: Arithmetic, geometric & harmonic means; Measures of dispersion: range, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean. Tests of significance hypotheses and errors; student t statistics- population mean equals a specified value; equality of 2 independent means (equal & unequal variance), equality of 2 means (paired samples).

UNIT-III

Analysis of variance: one-way analysis (sample sizes equal and unequal), completely randomized design; two-way analysis (one observation per cell), randomized block design; multiple comparisons: least significant difference, Duncan's new multiple range test.

UNIT-IV

Linear regression: regression diagram and equation, regression coefficient, standard error, significant tests, prediction of dependent variable from the independent variable; linear correlation- scatter diagram, correlation coefficient, standard error, significance tests; relationship between regression and correlation coefficients; Non parametric tests: Chi-square statistics, test of goodness of fit, test of independence of attributes; standard line interpolation.

UNIT-V

Introduction to Computers: Basic architecture, generations of computer hardware and software; operating systems-WINDOWS and UNIX; system and application software; introduction to internet- LAN, MAN, WAN, Concept of bioinformatics; application of bioinformatics in microbiology.

List of Recommended Books

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.

2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
3. Programming in C by E. Ballaguruswamy
4. How Computers work - 2000. By Ron White. Tech. Media
5. How the Internet Work 2000 by Preston Gralla Tech. Media.
6. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
7. Biostatistics - 7th Edition by Daniel
8. Fundamental of Biostatistics by Khan
9. Biostatistical Methods by Lachin
10. Statistics for Biologist by CampbellR.C. (1974) Cambridge University Press, UK.
11. INTERNET – CDC publication, India.

COURSE CODE MBC204: PRACTICAL BASED ON COURSE CODE MBC201 & COURSE CODE MBC202 (TOTAL CREDITS: 04)

Suggested list of Practicals (Course Code MBC201: Molecular Biology and Recombinant DNA Technology)

1. Isolation of genomic DNA.
2. Southern blotting
3. RFLP analysis
4. Isolation of RNA
5. Isolation of poly A+ RNA
6. To study the effect of UV Radition on yeast cell.
7. To study the dark repair mechanism in the UV radiated yeast cell.
8. To study the photo repair mechanism in the UV radiated yeast cell.
9. To perform replica plating of yeast cell.

Suggested list of Practicals (Course Code MBC202: Microbial Genetics)

1. To perform conjugation.
2. To study the effect of UV radiated on Bacterial cells.
3. To study the dark repair mechanism and photo repair mechanism in the UV radiated bacterial cells.
4. To perform replica plating of bacterial cells.
5. To study effect of mutagens (Nitrous acid) on bacterial cells.
6. 1. Purification of chromosomal / plasmid DNA and study of DNA profile:
7. Confirmation of nucleic acid by spectral study.
8. Quantitative estimation by diphenylamine test.
9. DNA denaturation and determination of Tm and G+C content.

COURSE CODE MBC205: PRACTICAL BASED ON COURSE CODE MBC203 & MBE201/ MBE202/ MBE203 (TOTAL CREDITS: 04)

Suggested list of Practicals (Course Code MBC203**: Biostatistics and Computer Application)**

1. Representation of Statistical data by a) Histograms b) Pie diagrams
2. Determination of Statistical averages/ central tendencies. a) Arithmetic mean b) Median c) Mode
3. Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation
4. Tests of Significance-Application of following a) Chi- Square test b) t- test c) Standard error

5. Computer operations-getting acquainted with different parts of Computers. [DOS] and basics of operating a computer.
6. Creating files, folders and directories.
7. Applications of computers in biology using MS-Office.
   A] MS-Word B] Excel C] Power Point
8. Creating an e-mail account, sending and receiving mails.
9. An introduction to INTERNET, search engines, websites, browsing and Downloading.

List of Elective Papers

SECOND – SEMESTER

COURSE CODE MBE201: BIOLOGY OF THE IMMUNE SYSTEM (COURSE CREDITS =03)

Course Objectives: The objective of this course is to understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body. It would also make the students understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be able to understand the fundamental bases of immune system and immune response .
- Will be able to gather information about the structure and organization of various components of the immune system .
- Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity.
- Will be able to understand the operation and the mechanisms which underlie the immune response .
- Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

COURSE CONTENTS

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs, nature and biology of antigens and super antigens.

UNIT-II

Antibody structure and function; antigen-antibody interactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. Blymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells. Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiences, hybridoma technology and monoclonal antibodies.

Recommended Books:

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A.Osbarne. (Freedom)
2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of immunology, William Paul.
4. Immunology, Roitt and others.

Suggested list of practicals (Course Code MBE201**)**

1. To perform test for antibiotics sensitivity by disc method.
2. To determine the minimum inhibitory concentration of given antibiotics.
3. Preparation of blood smear.
4. To isolate serum from blood plasma.
5. To perform agglutination reaction to identification of blood group.

COURSE CODE MBE202: RESOURSE UTILIZATION AND CONSERVATION (COURSE CREDITS = 03)

Course Objectives: The course aims to empower the learners with knowledge pertaining to world biomes, resources, conservation, sustainable development, pollution and its management, and remote sensing in management of earth resources.

Course Learning Outcomes:

- Deep understanding of distribution, structure and function of various aquatic and terrestrial biomes.
- Learn definitions, types and utilities of biodiversity along with threats along their applications in management and sustainable development of resources from various biomes.
- Empowers students to apply in-situ and in-vitro techniques in conservation of aquatic and terrestrial resources in real time.
- Understands concepts of pollution of different environments and can monitor and treat pollution loads in artificial and natural ecosystems; and appreciate nuances of industrial, societal and urban pollutions.
- Gains insight knowledge about remote sensing of earth resources along with platforms, sensors and scanners, visual and digital interpretation of remotely sensed data.

COURSE CONTENTS

UNIT – I

Major Biomes of the world, Tropical rain & Seasonal Forests, Temperate rain & Seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic Ecosystems wetlands, Lakes & Ponds Streams & Rivers, Marine & Estuarine habitats.

UNIT – II

Resource utilization**,** Status & Utilization of Biodiversity, Sustainable development resources from forest, Grassland and aquatic habitats, Food forage, Fodder, Timber & Non-wood forest products, Threats to quality & quantity of Resources due to overexploitation.

UNIT –III

Strategies for conservation of resources: Classifications of resources, Principles of conservation, *In-situ* conservation sanctuaries, National parks, Biosphere reserves for wildlife conservation, Habitat conservation practices of conservation for forests ranges, Soil and water.

UNIT – IV

Air, Water and Soil pollution**,** Kinds, Sources, Quality parameters, Effects on structure & function of ecosystems, Management of pollution, Bioremediation, Climate changes sources, Trends & role of greenhouse gases, Effect of global warming on climate, Ecosystem processes & Biodiversity, Ozone layer & Ozone hole.

UNIT – V

Resource monitoring, Remote sensing concepts & Tools, Satellite remote sensing basics sensors, Visual & digital interpretation, EMR bands and their applications, Indian remote sensing program, Thematic mapping of resources, Application of remote sensing in Ecology &Forestry.

Books recommended

- Chopra R. N. (1933) Indigenous Drugs of India.
- Hayes W. B. (1953) Fruit Growing in India.
- Atkinson E. T. (1980) Economic Botany of Himalayan Regions.

Suggested list of practicals: Course Code MBE202 (Resource Utilization and Conservation)

1. To find the pH of the various sample of soil by pH meter.
2. To determine the presence of carbonate in different soil mixtures.
3. To determine the presence of phosphate in soil and water sample.
4. To determine the presence of nitrate in mixture sample.
5. To determine the presence of nitrite in mixture sample.
6. To determine frequency, density and abundance of herbaceous species from local garden.
7. To determine the biomass of plant vegetation.
8. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

COURSE CODE MBE203: MICROBIAL METABOLISM
(TOTAL CREDITS: 3)

Course Objectives: The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation, and to enable students to better understand courses taught later .

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.
- Will have gained an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.
- Will have learnt central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.
- Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.
- Will have learnt basic concepts of enzyme biochemistry, its kinetics and regulatio
- Will understand details of lipid and nucleotide metabolism in *E. coli* and its regulation along with biochemical basis of lipid accumulation in yeasts.
- Is conversant with intracellular signaling in bacteria in response to various nutritional and physiological stresses.

COURSE CONTENTS

UNIT-I

Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

UNIT-II

Chaemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis. Electron transport- photoautotrophic generation of ATP, fixation of CO2- Calvin cycle, reverse TCA, carbohydrate anabolism.

UNIT-III

Respiratory metabolism: Embden Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates-homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

UNIT-IV

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

UNIT-V

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Dormancy. Endospore-structure, properties and germination.

List of Recommended Books

1. Doelle H.W. 1969. Bacterial Metabolism. Academic Press.
2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.
3. Sokatch JR. 1969. Bacterial Physiology and Metabolism. Academic Press.
4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009.

Suggested list of Practicals (Course Code MBE203: Microbial Metabolism)

1. Determination of Bacterial growth by turbidity measurements (spectrophotometric method).
2. Study of effect of temperature on growth of bacteria.
3. Study of effect of pH on growth of Bacteria.
4. Isolation of rhizobia from root nodules.
5. Slide culture technique for studying morphology and molds.

COURSE CODE MBS201: SKILL DEVELOPMENT MODULES 2 (TOTAL CREDITS = 02)

SOFT SKILLS DEVELOPMENT MODULE-2 (Semester- 2) Hrs. 30

S. No.	Subject	Classroom Activity	Hrs.
01 .	Orientation , Personality Development	Worksheet/ lecture	02
02	Role and Impact of Personality	Group Activity/ lecture	01
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	02
04	Importance of characteristics and Traits	lecture/Group Activity	02
05	Empowerment of Internal and external traits	lecture	02
06	Definition of Personality	Lecture	02
07	Power of Self	Lecture	03
08	Path to Improve Personality	lecture/Group Activity	03
09	Body Language - 1	Worksheet	02
10	Grooming Yourself	Lecture	02
11	IQ / EQ / MQ / SQ	lecture	02
12	Disposition of Body in various aspects	Group Activity	03
13	Getting desired output	Group Activity	02
14	Post Assessment of Personality	Group Activity	02

THIRD SEMESTER
COURSE CODE MBC301: ENVIRONMENTAL MICROBIOLOGY
(COURSE CREDITS: 3)

Course Objectives: The major objective of this paper is to impart knowledge about structure, composition and functioning of microbial communities of diverse environment. The use of microbial population in agriculture, mineral recovery, management of various types of pollutants and conversion processes of various types of wastes into value added products will be discussed.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have an overview of the till date developments in the field of environmental microbiology with special emphasis on the role of microbes in mitigating environment pollution.
- Will have become acquainted with various cultural, biochemical and molecular techniques used in understanding microbial diversity.
- Will be knowledgeable about the diversity, adaptations and biotechnological applications of microbes of extreme environment.
- Will be able to describe the role of soil microbes in nutrient transformation, plant-microbe interactions and biotechnology. Also knows about potability of water and its quality control.
- Understands the role of microbes in management of waste plant biomass and can apply knowledge in designing microbe-based processes for pulp, textile, biofuel and animal feed production industries.
- Is able to describe the role of microbes in solid and liquid waste management, gaining knowledge of various methods employed in sewage treatment and solid waste treatment.
- Understands the role of microbes in bioremediation of environmental pollutants like petroleum hydrocarbons, pesticides, plastic and electronic waste; also understands utility of microbes in mineral and oil recovery.

COURSE CONTENTS

UNIT-I

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT-II

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health.

UNIT-III

Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processesanaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes form extreme environment.

UNIT-IV

Microbial degradation of xenobiotics in the environment- ecological considerations, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

UNIT-V

Biological N_2 fixation, H2 production, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production). Single cell protein (Spirulina, yeast, mushroom); global

environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

List of Recommended Books

1. Wastewater Engineering- Treatment, disposal and Reuse. Metcalf and Eddy, Inc,.Tata McGraw Hill, New Delhi.
2. Comprehensive Biotechnology. Vol. 4, M. Moo-young (Ed-in-chief), Pergamon Press, Oxford.
3. Environmental Chemistry, A.K. De. Wiley Eastern Ltd. New Delhi.
4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold

COURSE CODE MBC302: MEDICAL MICROBIOLOGY (TOTAL CREDITS: 3)

Course Objective : Develop understanding about immune system, antigen antibody interactions. Gain theoretical knowledge of various diseased conditions generated due to interplay of immune system components.

Learning Outcomes

- Discoveries in the field of medical microbiology, microbial flora and human host.
- Study of fungal pathogens and different kinds of infections , laboratory diagnosis.
- Study of immunity, antigen, antibodies and immunological and serological methods.
- Study of pathogenic bacteria and their classification, diseases, diagnosis.
- Study of virus multiplication methods, viral diseases, protozoans diseases.
- Laboratory control, antimicrobial therapy, different kinds of microbial diseases

COURSE CONTENTS

UNIT-I

Early discovery of pathogenic microorganisms; development of bacteriology as scientific disciplines; contribution made by eminent scientists. Normal microbial flora and the human host; role of resident flora; classification of medically important microorganisms, dermatophytes, dimorphic fungi, opportunistic fungal pathogens, laboratory diagnosis of pathogenic fungi.

UNIT-II

Mechanism of pathogenicity, virulence and protection, organs and cells involved in immune system and immune response; antigens, antigenic specificity, antigenic determinants, cellular and humoral basis of immunity: immunoglobulins, antigen and antibody reactions, immunological (serological as well as cellular) methods.

UNIT-III

Classification of pathogenic bacteria- *Staphylococcus, Streptococcus, Pneumococcus, Corynebacteria, Bacillus, Clostridium,* non-sporing anaerobes, organisms belonging to *Enterobacteriaceae*. Vibrios, non-fermenting bacilli, *Yersinia, Haemophilus, Bordetella, Brucella,Mycobacteria, Spirochaetes, Actinomycetes, Ricketisae, Chlamydiae*.

UNIT-IV

Important RNA and DNA viral pathogens; virus host interactions; pox viruses, adenoviruses, picornaviruses, orthomyxoviruses, paramyxoviruses, arboviruses, rhabdoviruses; general properties of pathogenic protozoans and diseases caused by them, slow virus disease.

UNIT-V

Laboratory control of antimicrobial therapy; strategies/ approaches (conventional and modern) in the diagnosis of important disease/ syndrome; meningitis, urinary tract infection, sexually transmitted diseases, pyrexia of unknown origin, wound infection etc.

List of Recommended Books

1. Mims CA (2004). Medical Microbiology, 3rd ed, Mosby
2. Carter JB & Saunders VA (2007) Virology-Principles and Applications, John Wiley and Sons
3. Paniker CKJ (2007). Ananthanarayan and Paniker's Textbook of Microbiology, Orient Longman Pvt. Limited, India.
4. Greenwood D, Slack RCB & Peutherer JF (2006). Medical Microbiology, A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis & Control, Churchill Livingstone, Elsevier, India.
5. Baron EJ, Peterson LR & Finegold SM Mosby (1990). Bailey and Scott's Diagnostic Microbiology

6. Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E & Adelberg EA (2004). Jawetz M & Adelberg's Medical Microbiology, 23rd ed, Lange Publication.
7. Mackie & McCartney Practical Medical Microbiology (1996). Collee JG, Fraser AG, Marmion BP & Simmons A (eds.), Churchill Livingstone,Edinburgh.
8. Zuckerman AJ, Banatwala JE &Pattison JR(2009). Principles & Practice of Clinical Virology, John Wiley & sons Ltd.
9. Brown AE(2005). Benson's microbiological applications, TataMacGrawHill

COURSE CODE MBC303: PRACTICAL BASED ON COURSE CODE MBC301 & COURSE CODE MBC302 (COURSE CREDITS = 04)

Suggested list of Practicals (Course Code MBC301: Environmental Microbiology)

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of dissolved oxygen concentration of water sample.
3. Determination of biological oxygen demand (BOD) of a sewage sample.
4. Determination of the efficiency of removal of air pollutant by using fibrous air filter/Air sampler.
5. Isolation of xenobiotic degrading bacteria by selective enrichment technique.
6. Test for the degradation of aromatic hydrocarbons by bacteria.
7. Survey of degradative of aromatic hydrocarbons by bacteria.
8. Estimation of nitrate, nitrite, and ammonium in drinking water.
9. To study the impact of heavy metals on growth & survival of microbes.
10. To study the impact of pesticides on the growth and survival of microbes.
11. To study the impact of salt and osmotic stress on the growth survival of microbes.
12. To study the biology of N2- fixing microbes/SCP producing microbes.

Suggested list of practicals (Course Code MBC302: Medical Microbiology)

1. Detection of susceptibility to dental caries.
2. Bacteriological examination of skin and throat.
3. Bacteriological examination of urine sample.
4. Viable count of bacteria in urine sample.
5. Dnase agar tests and coagulation test for identification of *Staphylococcus*.
6. Optochin sensitivity test and bile solubility test for Streptococcus.
7. Isolation of enteric pathogens from stool by direct plating method.
8. Determination of minimal inhibitory concentration (MIC) and MBC.
9. Cultivation and enumeration of coliphages from sewage.
10. General tests for identification of bacteria from clinical samples including IMViC test, Carbohydrate fermentation test, Nitrate reduction test, Triple sugar agar test Urease test, Catalase test, Oxidase test.
11. Isolation and characterization of dermatophytes.
12. Study of dimorphic fungi.
13. Study of agglutination reaction by blood grouping.
14. ELISA (to demonstrate immunological reaction by ELISA technique.
15. Double diffusion technique (study of precipitation reation by Ouchterlony Double Diffusion).

COURSE CODE MBC304: PRACTICAL BASED ON COURSE CODE MBE301/ MBE302/ MBE303/ MBE304
(COURSE CREDITS = 04)

List of Elective Papers

THIRD SEMESTER
COURSE CODE MBE301: ADVANCED MOLECULAR BIOLOGY
(TOTAL CREDITS = 03)

Course Objectives : This course combines special set of tutorials centered around research activities in molecular biology with practical exercises and/or laboratory placements. The content is designed to provide students with a perspective of how cutting edge molecular biology principles and techniques are applied to major research questions. This course will illustrate that cross disciplinary approaches are essential in modern research.

Course Learning Outcomes

- To understand key principles of how cells work, including gene regulation, protein synthesis and signal transduction.
- To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand the key principles of Molecular Biology.
- To read, interpret and discuss major contributions to Molecular Biology research published in scientific research literature.
- To develop effective, creative and innovative solutions, both independently and cooperatively, to current and future research problems in Molecular Biology.

UNIT I
Recombinant DNA technology I: methods of creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, selection screening construction of DNA library.

UNIT II
Recombinant DNA Technology II: Use of cloned gene, sub-cloning; recombinant proteins production in bacteria, site-directed mutagenesis, RFLP, PCR, DNA-fingerprinting, antisense-RNA technology, chromosomal walking.

UNIT III
Hybridoma technology: monoclonal antibodies mycelium cell infusion selection of hybridomas, protoplast fusion and HAT-medium screening assay purification and application of monoclonal antibodies.

UNIT IV
Cell and tissue culture: micropropagation, somatic cell culture, somoclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and methods), production of transgenic plant and animal; production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture application.

UNIT V
Fermentation technology: continuous and batch type culture techniques, principle types of Fermenters, general design of fementors. Fermentation processes, brewing manufacture of antibiotics, production of single cell protein. Application of genetic and molecular biology procedures in strain improvement.

Books recommended

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown

Suggested list of practicals (Course Code MBE301)

1. To isolate genomic DNA from fungi by LETS methods.
2. To determine the quantity and quality of the isolated fungal DNA.
3. To determine the agarose gel electrophoresis of the isolated fungal DNA.
4. To isolate plasmid DNA from bacteria by quick method.
5. To purify the DNA from agarose gel.
6. To study the Thermal cycler.
7. To study the gel documentation system.

COURSE CODE MBE302: AGRICULTURAL MICROBIOLOGY (COURSE CREDIT: 3)

Course Objectives: To make students aware about agricultural technique, crop diseases, soil health, composting, agriculture losses, pest management, green revolution and agricultural biotechnology.

Course Learning Outcomes

- Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.
- Critically discuss the need for agricultural microbiology and explain their limitations.
- Clarify application of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.
- Analyse various aspects of N_2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.
- Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

COURSE CONTENTS

UNIT – I

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

UNIT – II

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of

pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

UNIT – III

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little left of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

UNIT – IV

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements, constraints

UNIT – V

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel.

List of Recommended Books

1. Soil microbiology by Subba Rao
2. Soil and microbes by Waksman and Starkey.
3. Plant pathology by Mehrotra.
4. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
5. Microbiology by S.S. Purohit.

Suggested list of Practicals (Course Code MBE302: Agricultural Microbiology)

1. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
2. Isolation of fungi from soil by warcup's method.
3. Isolation of azotobacter species from soil.
4. Isolation of microorganism from rhizosphere.
5. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression method.
6. Plant diseases – leaf curl of papaya, rust of wheat, citrus canker, red rot of sugarcane. Study of weeds- Parthenium, water hyacinth.

COURSE CODE MBE303: INDUSTRIAL & FOOD MICROBIOLOGY (TOTAL CREDITS =03)

Course Objectives: The course will enable students to apply the learning of microbiology concepts toward the exploitation of microbial population for industrial and human benefits. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant microbial products and therapeutic proteins. The course aims to provide instruction in the general principles of food microbiology, the biology and epidemiology of food borne microorganisms of public health significance, including bacteria, yeasts, fungi, protozoa and viruses and Understand food spoilage

microorganisms; the microbiology of food preservation and food commodities; fermented and microbial foods; principles and methods for the microbiological examination of foods; micro biological quality control, and quality schemes.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will have gained insight on industrially important microbes, recent developments in fermentation processes and various optimization strategies at fermenter level.
- Understands the concept of sterilization methods and principles of batch and continuous processes.
- Attains knowledge about designing of industrial strains and various media optimization strategies .
- Learns about the design, types of fermenters and various critical components of bioreactors
- Is able to describe control parameters, fluid rheology and process constraints in a large scale bioreactor
- Gets introduced to various strategies of product recovery from a fermentation broth . Acquires knowledge about various industrially relevant microbial products and their production process
- Understand the principles of microorganisms during various food-processing & preservation steps.
- Comprehend the interactions between microorganisms and the food environment, and factors influencing their growth and survival.
- Understand the significance and activities of microorganisms in food.
- Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.
- Analyze the importance of microbiological quality control programme's in food production.
- Discuss the microbiology of different types of food commodities
- Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food

COURSE CONTENTS

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction.

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B12, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin). Microbes in petroleum industry (oil recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: sources and types of microorganisms in milk, microbial examination of

milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese.

Recommended Books:

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.
4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.
5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.
8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.
9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.
10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.
11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

Suggested list of Practicals (Course **Code MBE303**)

1. Isolation of micro-organism from canned food.
2. Isolation of bacteria and fungi from spoiled bread.
3. Quantitative test of milk by resazurin test.
4. Quantitative estimation of Amylase production.
5. Isolation of lipase producing bacteria from soil.
6. Isolation of phosphate solubilizing/producing bacteria from soil**.**
7. Estimation of antibiotic property of bacteria.

COURSE CODE MBE304: BIOTECHNOLOGY (TOTAL CREDITS = 03)

Course Objectives: The course will help students to understand various applications of microbes for the development of various products of agriculture, industrial and clinical application. The knowledge of recombinant technology, bioreactors and optimization strategies will be beneficial in development of production processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

- Will learn about various industrially relevant microbial products and their production process, role of biotechnology in environment management.
- Acquires knowledge about strains development, selection of hyper producers, microbial products, metabolic engineering and various industrial relevant microbial products and their production process Learns about the designing of recombinant heterologous expression systems such as E. coli, yeast, mammalian and insect cells.
- Learns about sterilization at reactor scale and different types of sterilization strategies
- Attains knowledge about designing large scale industrial processes and types of cultivation strategies Understands the concept of recombinant biomolecules, therapeutic proteins, vaccines, antibodies, bio-pesticides, bio-fertilizers, and probiotics .
- Understands different types of regulatory approvals required for drug development and difference between biologics, biosimilars and biobetters

COURSE CONTENTS

UNIT I

Biotechnology an Overview, Definition, Perspective and scope of biotechnological processes and products, Biotechnology and Ethics, Introduction, Medical and chemical Biotechnology, Agriculture and Food, Energy and environment and human, Bioethics, Facing problem and finding solutions, Regulating the use of biotechnology, Patenting biotechnology inventions.

UNIT II

Genetic Engineering and gene cloning, Introduction of genetic engineering procedure, restriction endonuclease, cloning vehicle, Vectors for animals and plants, Insertion of DNA molecule in to a vector, Direct transformation, Isolation and cloning, Transformation and growth of cells, Selection and screening of particular recombinants, Genomic library, sequencing of DNA, Gene identification and mapping, Analysis of expression of cloned genes, Polymerase chain reaction, Monoclonal Antibodies.

UNIT III

Plant cell and tissue cultures, Culture techniques, Protoplast fusion, Direct gene transfer, Microinjections, Nuclear transplantation, Plastid and mitochondrial genes, production of secondary metabolites by immobilized plant cell, Development of disease resistant, herbicide resistant, Salt & drought resistant plant varieties, Microbial Toxins, Introduction, Toxins gene isolation, Genetic engineering of *B. thuringiensis* strains, *Baculovirus* as biocontrol agents.

UNIT IV

Culturing microorganisms for the production of biomass, Production of microbial (Bacterial, Cyanobacterial and Fungal) products, Batch culture, Continuous culture, Fed-batch culture, Mass culture, Use of culture system for the production of microbial products, Production of cyanobacterial biomass for food, Feed and health care products, Improvement of microbial strains for industry, Agriculture, Immobilization of microbial cells and enzyme and its applications.

UNIT V

Strain improvement, bioreactor design, Reactor types, Application of immobilized cells and enzyme, improvement in bioreactor to control environment of process organism. use of microorganisms in pollution control, Waste treatment, Bioremediation, Biological removal of eutrophic nutrients, Heavy metals, Toxic chemicals (Herbicide, Insecticide and Fungicide and Other Toxicants) from waste water and industrial effluents, Utilization of waste water for the production of food and feed, Biodegradation, Bioleaching of metals, Application of microorganisms from environment

Books recommended

- Haekett P. B., Fuchs J. A. and Mesing J. W. (1988) An Introduction to Recombinant DNA techniques – basic experiments in gene manipulation.
- Glck B. R. and Thompson J. E. (1993) Methods in Plant Molecular Biology and Biotechnology.
- Bjorn Kristiansen, (2012) Basic Biotechnology third Edition.

Suggested list of practical's (Course Code MBE304)

1. Demonstration:-
   PCR
   Spectrophotometer
   pH meter
   Centrifuge
   Photomicrographic Camera
2. To prepare the media for plant tissue culture.
3. Isolation of pathogenic fungi from infected plants/Disease plants (Leaf/ Stem/ root)
4. Identification of unknown microorganism from given plates.
5. Preparation of tissue culture media.

COURSE CODE MBS301: SKILL DEVELOPMENT MODULES 3 (TOTAL CREDITS = 02)

ENTREPRENEURSHIP DEVELOPMENT PROGRAME AGENDA (Semester-3) TIME - 30 Hrs

1. **ORIENTATION PROGRAM FOR ENTREPRENEURSHIP**

2. **WHAT IS ENTREPRENEURSHIP**
   Definition of Entrepreneurship
   Be a Successful Entrepreneurship

3. **TYPE OF ENTREPRENEURSHIP**
   Manufacturing
   Trading
   Service Provider

4. **NEED TO BE SUCCESSFUL ENTREPRENEURSHIP**
   Knowledge - About work and Concern
   Information - About sources/ market/ Customer's
   Assets - About Technology, Place, Man power and money

5. **CHOOSING A BUSINESS -**
   Micro Scale Unit **Small Scale Unit**

Large Scale Unit Mega Scale Unit

6. **MARKETING and DISTRIBUTION**
   - **Definition and Type of Marketing**
   - **About Sales and Marketing**
   - **Distribution channels**

7. **PRODUCT DESIGNING / BRANDING / MERCHANDIZING**
   - **Research and Development**

8. **FINANCIAL FLUENCY, PLANNING AND LEGAL ASPECTS**
   - **Taxation**
   - **Rules and norms of the Govt. to run a business**

9. **GOVERMENT SCHEMES AND ASSISTENCE**
   - **About financial loan / Place/ Training / Subsidy.....etc**

10. **INDUSTRY VISITS**

FOURTH SEMESTER (Total Credit 18)

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:

The primary object of this course is to expose the student to research culture and technology. The student learns how to choose a research problem, plan and perform experiments, collect data, and analyze the data qualitatively and quantitatively. The student gets trained in presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently.

Course Learning Outcomes:

- Student is able to conceive a problem based on current published research.
- Student is able to carry out comprehensive survey of literature on the topic of research
- Student is able to make culture media for various microbes
- Student is able to isolate microorganism from different environmental/ food sources
- Student is able to identify the isolated microorganism using biochemical and molecular methods Student is able to assess the microorganism's ability to produce various enzymes
- Student becomes well-versed in different enzymatic assay systems
- Student learns correct handling and use of instruments
- Student learns correct handling of reagents and chemicals
- Student learns how to execute experiments correctly.
- Student learns the importance of including controls in all experiments
- Student learns how to plot the results.
- Student learns how to analyze data, using statistical tools where necessary
- Student learns how to interpret the results from all possible angles.
- Student learns how to present the project in the form of a slide show before and audience of 20-30 people.
- Student is exposed to the science of thesis writing.

SYLLABUS FOR Ph.D. COURSE WORK
BIOCHEMISTRY

(Under Revised Ordinance [illegible] w.e.f. [illegible])

(Academic Session 2018 [illegible])

SCHEME OF EXAMINATION

Number & Title of the Paper	Credit	End Semester Exam			
		Maximum Marks	Minimum Marks	Total	
PAPER I	4	100	50	100	SKILL
PAPER II	3	100	50	100	SKILL
PAPER III	3	100	50	100	EMPLOYABILITY
PAPER IV	3	100	50	100	EMLOYABILITY
PAPER V	3	100	50	100	SKILL

Note: Aggregate passing marks 55 %.

SCHEME OF EXAMINATION AS APPROVED BY EXECUTIVE COMMITTEE OF THE UNIVERSITY

PAPER - I
RESEARCH METHODOLOGY

Unit - I

Sampling techniques, sterilization technique, various methods for isolation of pure culture, methods for measurement of microbial growth, manipulation of environment, nutritional and genetic characteristics, maintenance and preservation of microbes (pure culture). Introduction to cell & tissue culture. Design & lab setup of tissue culture laboratory. Tissue culture media (Composition preparation). Types of culture.

Unit - II

Chromatographic techniques – Gel filtration, ion exchange chromatography, hydrophobic interaction and reverse phase chromatography, affinity chromatography, gas chromatography, high performance liquid chromatography, fast protein liquid chromatography. Application in separation of proteins.

Unit - III

Molecular Biology and spectroscopic techniques - Comet Assay; Real time PCR, RAPD, RFLP, ARDRA and Fluorescence *in situ* hybridization techniques. Atomic absorption spectroscopy, infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectrometry including ESI MS and MALDI-TOF MS and Applications.

[illegible]

Board of Studies in Biochemistry on 25.06.2018, Faculty of Life Sciences on 28.06.2018

Standing Committee of Academic Council on [illegible], Executive Council on [illegible]

1

applications. Applications exploring various websites and search engines for collecting quality literature and secondary data related to research work.

Unit – V

Data processing, Data mining, Bioinformatics – concept and applications, Biological databases – Primary and Secondary, Sequence Databases (EMBL, GenBank, DDBJ, SWISS-PROT, PIR, TrEMBL), Protein Family Domain Databases (PROSITE, Pfam, PRINTS & SMART), Structure Database (PDB), Tools like BLAST, FASTA and EMBOSS.

PAPER-IV
BIOENERGETICS, ONCOLOGY & PARASITOLOGY

SKILL & EMPLOYABILITY

Unit –I

Structure of atoms, molecules and chemical bonds. Molecular orbitals and covalent bonds, strong vs. weak interactions, stereochemistry and chirality. Water. Van der Waal's, electrostatic, hydrogen bonding and hydrophobic interaction, pH and buffers. Mono- bi- and poly-protic buffers (titration).

Unit –II

Energy Metabolism (Concept of free energy). Thermodynamic principles in biology, energy rich bonds, coupled reactions and oxidative phosphorylation, group transfers, biological energy transducers and bioenergetics.

Unit –III

Structure and organization of membranes, glyco-conjugates and proteins in membrane systems, ion transport, sodium-potassium ATPase, Model membranes and liposomes. Molecular basis of signal transduction in bacteria, plants and animals.

Unit –IV

Biochemistry and molecular biology of cancer: Oncogenes; Chemical carcinogenesis, genetic and metabolic disorders, hormonal imbalances, drug metabolism and detoxification, genetic load and genetic counseling.

Unit –V

Approved by:-
Board of Studies in Bioscience on 25.06.2018, Faculty of Life Science on 25.06.2018
Standing Committee of Academic Council on 19.09.2018, Executive Council on 19.09.2018

applications. Applications exploring various websites and search engines for collecting quality literature and secondary data related to research work.

Unit – V

Data processing, Data mining, Bioinformatics – concept and applications; Biological databases – Primary and Secondary; Sequence Databases (EMBL, GenBank, DDBJ, SWISS-PROT, PIR, TrEMBL); Protein Family/Domain Databases (PROSITE, Pfam, PRINTS & SMART); Structure Database (PDB); Tools like BLAST, FASTA and EMBOSS.

PAPER-IV
APPLIED MICROBIOLOGY

ENTREPRENEURSHIP & EMPLOYABILITY

Unit –I

Sources and characters of industrial microbes, Screening of useful strains; Strain improvement through random mutation (random & rational selection); Role of genetic recombination & genetic engineering in strain improvement.

Unit –II

Fermentation :Principle, Types of Fermentation Metabolisms; Aerobic ,Anaerobic Fermentation Process :Selection of substrate in culture medium, pH, Antifoaming Agents, Air, Steam, Fermentation vessels, Shakers flasks, Type of Fermentations: Solid State Fermentation, Semi continuous Fermentation, Continuous Fermentation, Type of Fermentors: Stirred Tank Fermenters, Air-lift Fermenters, Fixed Bed Fermenters, Tower Fermenters, Batch Culture Fermentation, Fed-batch Culture Fermentation, Fixed volume fed-batch, Variable Volume Fed-Batch,Continuous Culture Fermentation: Chemostat Turbidostat , Sterilization , Product Recovery :Precipitation, Solvent Extraction, Ion Exchange

Unit –III

Production, harvest, recovery, uses and mode of action- enzymes, antibiotics, vitamins (812,82) organic acids (acetic acid, lactic acid, citric acid), alcohol (ethanol), organic solvents (acetone- butanol), amino acids, beverages (beer, wine, brandy), microbial supplements (Lactic acid bacteria) as medicine, biopolymer, biofertilizers, biocides, Sterodi biotransformatoin.

Improvement in production - improved strains by protoplast fusion, recombination, Alteration in metaboilic pathway; immobilization of cells.

Fermented foods, fermented milk, butter & cheese

Unit –IV

Bioremediation: biodegradability of Petroleum hydrocarbons, Halocarbons, Chlorophenols, Nitroaromatics; Applicability of bioremediation: Intrinsic bioremediation, Biostimulation,

Approved by:
Board of Studies in Microbiology on 25/06/2018, Faculty of Life Science on 25/06/2018
Standing Committee of Academic Council on 19/09/2018, Executive Council on 19/09/2018

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Unit – V

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PAPER-IV
ANIMAL PHYSIOLOGY SKILL

Unit –I

Structure & Metabolism of Carbohydrate, fats, & Proteins

Nutritional Pattern, Mechanism of feeding and modes of digestion in various groups of animals. Digestion: Digestive enzymes and their mechanism of action and hormonal regulation of digestion. The sequence of digestion and absorption in mammals. Physiology of respiration, respiratory pigments, oxygen, dissociation curve, chloride shift. Respiratory organs in Invertebrates. Air breathing fishes. Bird respiration, structure of mammalian lungs.

Unit –II

Physiological types of heart structure and working of mammalian heart, cardiac cycle, composition of mammalian blood, coagulation, blood groups and transfusion, characteristics of hemoglobin, functions of plasma proteins, Lymphatic system, various types of leucocytes and their role. Muscles: types, structure and function, Molecular mechanism of muscle contraction, functional architecture of Neuron, membrane and action potential, propagation of nerve impulse, neuro muscular junction, reflex action

Unit –III

Physiology of Excretion in invertebrates, excretion in vertebrates, structure of kidney (nephron), mechanism of urine formation with details of ultra filtration, role of loop of Henle in water conservation.

Osmoregulation – biological Significance of water, body compartment, Osmoregulation in different environment. Invertebrate body fluid regulation. Vertebrate body fluid Regulation. Thermoregulation, temprature as an environmental factor, Thermoregulation among vertebrates.

Unit –IV

applications. Applications exploring various websites and search engines for collecting quality literature and secondary data related to research work.

Unit – V

Data processing, Data mining, Bioinformatics – concept and applications; Biological databases – Primary and Secondary, Sequence Databases (EMBL, GenBank, DDBJ, SWISS-PROT, PIR, TrEMBL), Protein Family/Domain Databases (PROSITE, Pfam, PRINTS & SMART), Structure Database (PDB), Tools like BLAST, FASTA and EMBOSS

PAPER-IV
ENVIRONMENTAL SCIENCE SKILL

Unit –I

Population Ecology: Characteristics, Growth, Self-regulation, fluctuations, r and K strategists; Interactions: Intra- and Inter-specific competitions, Negative relations, Positive relations, Morphological integrations between Mutualists; Community Ecology: characteristics,classification, indices, Super-organismic and Gradient Concepts, Development and Evolution,Climax vs. Relative Stability.

Unit –II

Ecosystems: Components and Processes, Major biomes of the World; Energy Flow: Types, Models, Ecological Pyramids, Ecological Efficiencies; Nutrient Cycling: Exchanges and internal cycling, Recycling pathways, Global Cycles of Carbon, Nitrogen, Phosphorus and Sulfur; Relationship between energy flow and recycling pathways.

Unit –III

Pollution: Concept, Types, Management strategies; Air, Water, Soil and Urban Pollution: Causes, Control, case studies; Waste Management: Disposal, Minimization, Conversion and Treatment; Ozone Holes, Photochemical Smogs, Global Warming.

Unit –IV

Resources: Types, conventional and non-conventional, classification; Conservation: Sustainable Development, in-situ and ex-situ conservation, preservation plots, national parks, sanctuaries, gardens, hot spots; Conservation and Management of resources from forests, ranges, wetlands, freshwater and marine ecosystems;

Unit –V

Approved by:-
Board of Studies in Environmental Science on 25/06/2018, Faculty of Life Science on 25/06/2018
Standing Committee of Academic Council on 19/09/2018, Executive Council on 19/09/2018

applications. Applications exploring various websites and search engines for collecting quality literature and secondary data related to research work

Unit – V

Data processing. Data mining; Bioinformatics – concept and applications; Biological databases – Primary and Secondary; Sequence Databases (EMBL, GenBank, DDBJ, SWISS-PROT, PIR, TrEMBL); Protein Family/Domain Databases (PROSITE, Pfam, PRINTS & SMART); Structure Database (PDB); Tools like BLAST, FASTA and EMBOSS.

PAPER-IV ENTREPRENEURSHIP
PLANTS IN HUMAN WELFARE

Unit –I

Scope of Plants in welfare of society: World biomes, Botanical aspects of National Park & Botanical gardens in India. Plant identification centres, herbaria in India & Documentation (Floras & Monographs).

Unit –II

Importance of food plants: Wheat (*Triticum aestivum*), Rice (*Oryza sativa*) Maize (*Zea mays*), Arhar (*Cajanus cajan*), Chana (*Cicer arietinum*). Plants used in Textile: Cotton (*Gossypium hirsutum*), Semal (*Bombax ceiba*), Jute (*Corchorus capsularis*) , Patsan (*Hibiscus cannabinus*) & Sunnhemp (*Crotalaria juncea*).

Unit –III

Plants used in Dye: Palash (*Butea monosperma*), Henna (*Lawsonia inermis*), Neel (*Indigofera tinctoria*), Katha (*Acacia catechu*), Turmeric (*Curcuma longa*). Plants used in timber: Teak (*Tectona grandis*), Sal (*Shorea robusta*), Beeja (*Pterocarpus marsupium*), Arjun (*Terminalia arjuna*) & Shisham (*Dalbergia sissoo*).

Unit –IV

Plants used in Condiments & Spices: Dalchini (*Cinnamomum zeylanicum*) & Kali mirch (*Piper nigrum*). Plants used in beverages: Coffee (*Coffea arabica*) & Tea (*Camellia sinensis*). Plants used in Oil yielding: Nariyal (*Cocos nucifera*) & Mungphali (*Arachis hypogea*). Plants used in Narcotics: Bhang (*Cannabis sativa*) & Poppy (*Papaver somniferum*). Plants used in Gum: Kullu (*Sterculia urens*) , Gugal (*Commiphora wightii*) & Rubber (*Ficus elastica*). Plants used in Paper & Pulp: Bans (*Dendrocalamus strictus*) & Nilgiri (*Eucalyptus obliqua*).

Unit –V

applications. Applications exploring various websites and search engines for collecting quality literature and secondary data related to research work.

Unit – V

Data processing, Data mining, Bioinformatics – concept and applications. Biological databases – Primary and Secondary, Sequence Databases (ESBI, GenBank, UDBI, SWISS-PROT, PIR, TrEMBL), Protein Family/Domain Databases (PROSITE, Pfam, PRINTS & SMART), Structure Database (PDB), Tools like BLAST, FASTA and EMBOSS.

PAPER IV
APPLIED BIOCHEMISTRY

EMPLOYABILITY

Unit –I

Structure and Function of Proteins and Enzymes: Amino acid and their structural organization, Ramachandran plot, Conformation, Domains, Super secondary structure, Collagen structure, Myoglobin and Haemoglobin quaternary structure.

Biosignaling: General features of signal transduction, G-Protein and Cyclic AMP, Receptor Tyrosine kinases, Gated Ion channel signaling in microorganisms and plants.

Unit –II

Photosynthesis: Photosynthetic membrane and light reactions, General features of Electron transport and photophosphorylation, Photosynthetic carbohydrate synthesis, C_4 and CAM pathways; Plant celluloses and Bacterial peptidoglycans.

Unit –III

Protein Biochemistry: Protein folding, Biophysical and cellular aspects, Molecular chaperons, Chaperonins, Denaturation, Protein-Protein interactions, Physical and chemical methods for their study, Functional proteins: Structure and Drug targets.

Determination of Protein structure: Structural analysis of Proteins by UV- Visible, IR, NMR spectroscopy, Fluorescence spectroscopy, Electron-cryomicroscopy, X-Ray crystallography.

Unit –IV

Purification of Proteins and Enzymes: Extraction methods, Ammonium sulphate fractionation; Purification strategies: Gel filtration chromatography, Ion-Exchange