Department of PG Studies and Research in Biological Science

Programme Offered

1. **B.Sc. (Hons.) BIOTECHNOLOGY**
2. **B.Sc. (Hons.) MICROBIOLOGY**
3. **M.SC. BIOSCIENCE**
4. **M.SC. BIOTECHNOLOGY**

B.Sc. (Hons.) BIOTECHNOLOGY

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 OUTCOMES

PO-1. Graduates should be able to do creative research and develop new technologies in the field of biotechnology, which can contribute to the industry and to academia.

PO-2. Graduates should be able to practice biotechnology engineering in a responsible, professional and ethical manner and implement eco-friendly sustainable technologies for the benefit of industry as well as society.

PO-3. Graduates obtain position in successful career in industry, research institutions, academic, government organizations and entrepreneurship.

PO-4. Graduates to be professionally competent in biotechnology to solve the problems in environmental, food, biochemical and biomedical engineering.

PO-5. Graduate to be able to interact with their peers in industry and society as engineering professionals and leaders to set up technical ambience in the society.

PROGRAMME SPECIFIC OUTCOMES

PSO-1. A candidate who is conferred B.Sc. (Hons) degree in Biotechnology needs to have acquired/developed following competencies during the programme of the study:
PSO-2. Acquired knowledge and understanding of the biotechnological concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and related areas.
PSO-3. Demonstrate key practical skills/competencies in working with various biological entities for study anduse in the laboratory as well as outside, including the use of modern molecular assessment and manipulation protocols.
PSO-4. Empower the students to undertake advance knowledge about biotechnological protocols and researches

SEMESTER I

PAPER I CODE UBC 101 BOTANY

Course Outcomes

CO-1. The student will be able to identify major groups of plants and compare the characteristics of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.
CO-2. Students will be able to use the evidence based comparative botanical approach to explain the evolution oforganism and understand the genetic diversity on the earth.
CO-3. Students will be able to understand adaptation, development, behaviour, morphology, anatomy and reproduction of different forms of life.
CO-4. Demonstrate proficiency in the experimental techniques and methods to study of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.
CO-5. 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.

PAPER 2 CODE UBC 102: MICROBIOLOGY

Course Outcomes

Upon successful completion of the course, the students will

CO-1. Be acquainted with the historical account and development of microbiology as a scientific discipline.
CO-2. Have gained knowledge on different systems of classification. They will also acquire an overview ofacellular and cellular microorganisms.
CO-3. Have acquired in-depth knowledge of the diversity, distribution, cell structure, life cycles and economic importance of algae.
CO-4. Have gathered detailed information on the diversity, distribution, structure, life cycles and economic importance of fungi.
CO-5. Be aware of general characteristics of protozoa and their economic importance and have a broad perspective of the scope of microbiology.

PAPER 3 CODE UBC 103: CHEMISTRY-I

Course Outcomes

CO-1. The students will learn about the principle, methodology, calculation and application involved in quantitative, chemical and spectrophotometric methods.
CO-2. 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
CO-3. The students shall learn about the fundamentals of organic chemistry with references to structure and reactivity, reagents and reactions & reaction and mechanism.
CO-4. The students will learn about ionic, covalent bonding in molecules. compare/contrast the properties of molecular and ionic compounds.
CO-5. 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.

PAPER 4 ELECTIVE COURSE CODE UBE 101: COMMUNICATIONIVE ENGLISH

Course outcomes

Students will

CO-1. Improve LSRW, i.e. listening, speaking, reading and writing skills and the related sub-skills.
CO-2. Recognize and use formal elements of organizational communications: Paper writing, reports, proposals,memorandums, letters etc.
CO-3. Enhanced vocabulary with right pronunciation and improved accuracy in grammar.
CO-4. Effective oral presentations.

PAPER 5 ELECTIVE COURSE CODE UBE 102: FUNDAMENTALS OF STATISTICS

Course outcomes

CO-1. Students understand the importance of Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, and Sample observations. Sequences finite sequences.
CO-2. Students understand the intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas. Intuitive idea of discontinuity, continuity and limits.
CO-3. 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.
CO-4. Student understands the points in plane and space and coordinate form. Examples of matrices of biologicalsciences
CO-5. Students' studies about central tendency, Measures of dispersion; skewness, kurtosis. Elementary Probability. Types variable, distribution, and variance. Correlation and Regression.

SEMESTER II

PAPER 1 CODE UBC 201: ZOOLOGY

Course Outcomes:

CO-1. Knowledge of classification of each phylum from protozoa to Annelida and Arthropoda to Echinodermata up to class level with examples.
CO-2. Understanding of characteristics and systematic position of classes of Chordata.
CO-3. 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.
CO-4. 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.
CO-5. Understanding human reproductive system- reproductive organs, female reproductive cycle, implantation, maternal change during pregnancy, labour and physiology of Lactation and methods of birth control.

PAPER 2 CODE UBC 202: BASICS OF COMPUTERS

Course outcomes

CO-1. The students shall learn about the introduction, basics, organization, types and preliminary knowledge ofoperating systems and system tools.
CO-2. Students will get the idea about data representation, networks terminologies, multimedia and its

applications.

CO-3. Students will get general awareness about the IT Act, system security and preliminary knowledge aboutthe I-Tax, E banking and E reservations.

CO-4. They learn basics of algorithms and programming.

PAPER 3 CODE UBC 203: CHEMISTRY-II

Course Outcomes

CO-1. The students will learn about the energy and electromagnetic spectrum.

CO-2. The student shall learn the principle, theory and applications of UV Visible spectroscopy and Infraredspectroscopy.

CO-3. The students will get knowledge in the field of Electrochemistry special in references withElectrochemical cell, Nerst equation Gibbs energy.

CO-4. The students will learn general structure, configuration and properties of Carbohydrates, Amino acids,Proteins and Peptides.

PAPER 3 ELECTIVE CODE UBE 201: FUNDAMENTALS OF BIOCHEMISTRY

Course outcomes

CO-1. Study water and their properties, buffers, pH, acid, base, covalent bond and weak bonds, structure of atom.

CO-2. Enzyme, classification, structure, activity, inhibition, kinetics, allosteric enzymes etc.

CO-3. Structure and chemistry of Carbohydrate, protein, lipid, vitamins, pigments, antibiotics; functions, analysis.

CO-4. Biological membranes and Transport: membrane dynamics, solute transport across membranes.

CO-5. Biosignalling, signalling in microorganisms and plants, Bioenergetics and Metabolism; bioenergetics andthermodynamics, phosphoryl group transfers and ATP.

PAPER 4 ELECTIVE CODE UBE 202: BIOANALYTICAL TECHNIQUES

Course Outcomes

CO-1. Upon successful completion of the course, the student

CO-2. 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.

CO-3. 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.

CO-4. Will have learnt basic concepts of various techniques used to resolve and analyse nucleic acids and proteins - agarose gel electrophoresis, native polyacrylamide gel electrophoresis, SD polyacrylamide gel electrophoresis, isoelectric focusing, 2D gel electrophoresis, zymogram preparation.

CO-5. Will be able to understand absorption spectra of biomolecules, and will be able to interpret UV-visible andfluorescence spectroscopy outputs.

SEMESTER III

PAPER 1 CODE UBC 301: CELL BIOLOGY I

Course Outcomes

CO-1. Upon successful completion of the course, the student:
CO-2. Will have gained knowledge about features of the cell wall, plasma membrane, cell transport mechanisms and cytoskeleton.
CO-3. 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.
CO-4. Will have understood the mechanisms of protein sorting, intracellular trafficking, protein export.
CO-5. Will have gathered understanding of how cells perceive and respond to various signals from within and outside.

PAPER 2 CODE UBC 302: MOLECULAR BIOLOGY I

Course Outcomes

CO-1. Upon successful completion of the course, the student:
CO-2. 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.
CO-3. Will gain an in-depth knowledge of DNA replication mechanisms in prokaryotes and eukaryotes, enzymesand proteins involved in replication.
CO-4. 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.
CO-5. 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.

PAPER 3CODE UBC 303: RECOMBINANT DNA TECHNOLOGY

Course Outcomes

CO-1. Upon successful completion of the course, the student
CO-2. Will get an overview of developments and contributions of scientists in the field of genetic engineering.
CO-3. Will get familiarized with basic cloning tools such as enzymes used to manipulate DNA, and cloning vectors.
CO-4. Will have learnt various gene delivery methods and basic essential techniques of DNA, RNA and proteinanalysis.
CO-5. Will gather in-depth knowledge of DNA amplification and sequencing methods, and become conversantwith construction and screening of genomic and cDNA libraries.

PAPER 4 ELECTIVE CODE UBE 301: FUNDAMENTALS OF BIOPHYSICS

Course Outcomes

CO-1. Discuss molecular organization of different levels of protein and molecular structure of water- hydrogen bonds and physical property of water.
CO-2. Knowledge of storage, flow of energy and their applications-electrical properties of biological compartments; electrochemical gradients, membrane potential, chemiosmotic hypothesis.
CO-3. 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.
CO-4. Understanding Neurotransmitters, Intra and intermolecular interactions in biological system Spatial and charge compatibility as determinant of such interactions by applying laws of electricity.
CO-5. 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.

PAPER 5 ELECTIVE CODE UBE 302: FERMENTATION TECHNOLOGY

Course Outcomes

CO-1. To understand the basis of fermentation.
CO-2. To formulate and design the production media.
CO-3. Screening and selection of production strains.
CO-4. Operating and supervision of Fermenters.
CO-5. Designing of fermentation processes for the products recovery. Knowledge of Biosafety and patent laws

SEMESTER IV

PAPER 1 CODE UBC 401: IMMUNOLOGY (COURSE CREDIT= 03)

Course Outcomes

CO-1. Upon successful completion of the course, the student
CO-2. Will be acquainted with the emergence of immunology and how the immune system protects us from infection through various lines of defence. 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.
CO-3. 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
CO-4. 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.
CO-5. 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.

PAPER 2 CODE UBC 402: CELL BIOLOGY II

Course Outcomes

CO-1. Understanding of cell structure of prokaryotic and eukaryotic cell, apply knowledge of microscopic techniques for cell study.
CO-2. Knowledge of criteria of function integrity and structure of different cell organelles and transport of ions,nutrients and macromolecules across membranes.
CO-3. Empowers student to acquire knowledge about signal transduction pathway with understanding of different type of receptors and signalling molecules.
CO-4. Conceptualize cell cycle, cell division and cell death. Deep understanding of events of mitosis, apoptosis,embryonic stem cells and therapeutic cloning.
CO-5. Empowers student to acquire knowledge about biology of cancer its causes. Understanding of oncogenes,tumour suppressor gene, tumour viruses and molecular approach of cancer treatment.

PAPER 3 CODE UBC 403: MOLECULAR BIOLOGY II

Course outcomes

CO-1. RNA transcription in Prokaryotes and Eukaryotes, transcriptional regulation, RNA splicing and

editing,Protein synthesis, ribosome structure and assembly,

CO-2. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependentregulation of mRNA and Protein Stability.

CO-3. Transcription Regulation in Eukaryotes mechanisms, Signal integration, combinatorial control,transcriptional repressors, signal transduction, Gene Silencing

CO-4. Regulatory RNAs, Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and Xinactivation.

PAPER 4 ELECTIVE CODE UBE 401: GENETICS & GENOMICS I

Course Outcomes

CO-1. Upon successful completion of the course, the student will have

CO-2. 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.

CO-3. Knowledge of Principles and theories of Inheritance, pedigree analysis, extensions of Mendelian Genetics;Incomplete and co dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effectson phenotypic expression, sex linked inheritance.

CO-4. 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.

CO-5. Conceptualize types of Mutation, its molecular basis of mutation and detection using Attached X method, DNA repair mechanisms.

PAPER 5 ELECTIVE CODE UBE 402: BIOINFORMATICS

Course outcomes

CO-1. Students get familiarized with hardware and software of modern computers. They understand system andapplication software.

CO-2. Students are exposed basics of bioinformatics and its tools.

CO-3. Students study various biological databases, retrieval of genetic and biomolecular sequences.

CO-4. Students learn various retrieval and alignment tools including construction of phylogenetic trees andannotations on sequences.

CO-5. Students learn about different techniques and tools of genome analyses and reconstruction of metabolicpathways.

SEMESTER V

PAPER 1 CODE UBC 501: PLANT BIOTECHNOLOGY

Course Outcomes

CO-1. Recall terms, definitions and history of in vitro cultures in our country. Describe embryo and endospermculture, embryo rescue after wide hybridization and its applications.

CO-2. Knowledge of processes of plant regeneration under in vitro conditions and their practical application –organogenesis, somatic embryogenesis, meristem, Shoot tip culture and haploids.

CO-3. Conceptualize protoplast isolation, culture and various steps in the regeneration of protoplasts.

CO-4. Discuss various methods for fusing protoplasts- chemical and electrical. Define Cyprids and its application.

CO-5. List use of plant cell, protoplasts and tissue culture for genetic manipulation of plants and practical application of genetic transformation. Understanding of Tumour formation on plants using a tumefaciens (Monocots vs. Dicots).

PAPER 2 CODE UBC 502: ENVIRONMENTAL BIOTECHNOLOGY

Course Outcomes

CO-1. Deep understanding of existing and emerging technologies dealing with management of environmentalquality and pollution.
CO-2. Empowers the students with the knowledge of municipal solid and liquid waste treatments, Classificationof Wastes.
CO-3. Students will able to learn about the renewable and non-renewable energy resources and clean fueltechnologies.
CO-4. Students will be able to understand EIA and environmental audit.
CO-5. Conceptual understanding of global environmental problems- ozone depletion, UV-B greenhouse effectsand global warming, acid rain, and their impacts and biotechnology approaches for management.

PAPER 3 CODE UBC 503: ANIMAL BIOTECHNOLOGY

Course Outcomes

CO-1. Deep understanding of animal cell culture substrate, culture media, preservation and maintenance of celllines.
CO-2. Empowers the students with the knowledge of production of monoclonal antibodies, and bioreactors forlarge scale culture of cells.
CO-3. Students learn different growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1,IL-2, NGF, and erythropoietin).
CO-4. Knowledge of transgenic animals, in vitro fertilization and embryo transfer.
CO-5. Conceptual understanding of Transplantation, Stem cells and its application.

PAPER 4 ELECTIVE CODE UBE 501: ENTREPRENEURSHIP & IPR

Course Outcomes

CO-1. Understanding entrepreneurship, human behaviour, business ethics, performance appraisal and (SWOT)analysis
CO-2. Knowledge of Market survey techniques with principles of product selection and development.
CO-3. Deciphering marketing and sales management; its characteristics and techniques.
CO-4. Understanding financial – institutions, incentives and statements; books of accounts.
CO-5. Application of technical feasibility of project, plant layout and process planning of product. QC, CPM,PERT for establishing SSI.

PAPER 5 ELECTIVE CODE UBE 502: GENETICS & GENOMICS II

Course Outcomes

CO-1. Knowledge of genetic analysis and mapping in Bacteria and Bacteriophages.
CO-2. Understanding of transposable element; prokaryotic, composite. Eukaryotic and uses of transposons.
CO-3. Conceptualize the mechanism of developmental biology and embryonic development of different model; Drosophila melanogaster Saccharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana, and Xenopus leaves.
CO-4. Understand different biological database that provide information about protein and nucleic acid, sequencesimilarity and alignment; Gene feature identification. Understanding of Gene Annotation and analysis of transcription and translation; post-translational analysis and Protein interaction.
CO-5. Knowledge of genetic analysis, system biology, functional genomics, forward and reverse genetics.

Understanding of population and evolutionary genetics.

B.Sc. (Hons.) MICROBIOLOGY

PROGRAMMER OUTCOME

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in a wide-ranging context 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.

PO-1. Graduates should be able to do creative research and develop new technologies in the field of Microbilogy, which can contribute to the industry and to academia.

PO-2. Graduates should be able to practice Microbilogy in a responsible, professional and ethical manner and implement eco-friendly sustainable technologies for the benefit of industry as well as society.

PO-3. Graduates obtain position in successful career in industry, research institutions, academic, government organizations and entrepreneurship.

PO-4. Graduates to be professionally competent in Microbiology to solve the problems in environmental, food, biochemical and biomedical engineering.

PO-5. Graduate to be able to interact with their peers in industry and society as engineering professionals and leaders to set up technical ambience in the society.

PROGRAMMER 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:

PSO-1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.

PSO-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

PSO-3. Competent enough to use microbiology knowledge and skills to analyse problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc.

PSO-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.

SEMESTER I

PAPER 1 Code UMB 101: INTRODUCTION TO MICROBIAL WORLD

Course Outcomes

CO-1. Upon successful completion of the course, the students

CO-2. Will be acquainted with the historical account and development of microbiology as a scientific discipline.

CO-3. Will have gained knowledge on different systems of classification. They will also acquire an overview ofacellular and cellular microorganisms.

CO-4. Will have acquired in-depth knowledge of the diversity, distribution, cell structure, life cycles and economic importance of algae.

CO-5. Will have gathered detailed information on the diversity, distribution, structure, life cycles and

economicimportance of fungi.

PAPER 2 Code UMB 102: TECHNIQUES IN MICROBIOLOGY

Course outcomes

CO-1. 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
CO-2. Principles which underlie sterilization of culture media, glassware and plastic ware to be used for microbiological work.
CO-3. 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.
CO-4. 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.
CO-5. Several separation techniques which may be required to be handled later as microbiologists.

PAPER 3 Code UMB 103: CHEMISTRY

Course Outcomes:

CO-1. The students will learn about the principle, methodology, calculation and application involved in quantitative, chemical and spectrophotometric methods.
CO-2. 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.
CO-3. The students shall learn about the fundamentals of organic chemistry with references to structure and reactivity, reagents and reactions & reaction and mechanism.
CO-4. The students will learn about ionic, covalent bonding in molecules. compare/contrast the properties of molecular and ionic compounds.
CO-5. The students will learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances.

PAPER 5 Code UMBE 101: COMMUNICATIVE ENGLISH

Course outcomes

Students will

CO-1. Improved LSRW- listening, speaking, reading and writing skills and the related sub-skills.
CO-2. Recognize and use formal elements of organizational communications: Paper writing, reports, proposals, memorandums, letters etc.
CO-3. Enhanced vocabulary with right pronunciation and improved accuracy in grammar. • Effective oral presentations.

SEMESTER II

PAPER 1 Code UMB 201: BACTERIOLOGY

Course Outcomes

After successful completion of the course, the student

CO-1. 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.
CO-2. 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.
CO-3. Will gain insight into working and importance of compound microscope.
CO-4. Will understand nutritional requirements of different types of bacteria and formulation of media for bacterial growth.
CO-5. Will be able to briefly explain methods of asexual reproduction in bacteria.

PAPER 2 Code UMB 202: MEDICAL MICROBIOLOGY

Course Outcomes

Upon successful completion of the course, the student

CO-1. 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.
CO-2. 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.
CO-3. Will become acquainted with the spectrum of diseases caused by viral pathogens. Also, will understand thecourse of disease development and symptoms seen in diseases of different organ systems.
CO-4. Will understand the causation of fungal and protozoal diseases and methods of prevention and control.
CO-5. Will learn about the current approaches to diagnosis of diseases.

PAPER 3 Code UMB 203: CHEMISTRY

Course Outcomes

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

PAPER 4 Code UMBE201: BASICS OF COMPUTERS

Course outcomes

CO-1. The students shall learn about the introduction, basics, organization, types and preliminary knowledge ofoperating systems and system tools.
CO-2. Students will get the idea about data representation, networks terminologies, multimedia and its applications.
CO-3. Students will getgeneral awareness about the IT Act, system security and preliminary knowledge about theI-Tax, E banking and E reservations.

PAPER 5 Code UMBE 202: BIOANALYTICAL TECHNIQUES

Course Outcomes

Upon successful completion of the course, the student

CO-1. 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
CO-2. 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.
CO-3. 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.
CO-4. As well as be able to understand absorption spectra of biomolecules, and will be able to interpret UVvisible and fluorescence spectroscopy outputs.
CO-5. 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 withlimitations of each method.

SEMESTER III

PAPER 1 Code UMB 301 CELL BIOLOGY-I

Course Outcomes

Upon successful completion of the course, the student

CO-1. Will have gained knowledge about features of the cell wall, plasma membrane, cell transport mechanismsand cytoskeleton.
CO-2. Will be able to understand the structures and functions of the nucleus and different cell organelles. Thestructural organization and function roles of chromatin will be learnt.
CO-3. Will have understood the mechanisms of protein sorting, intracellular trafficking, protein export.
CO-4. Will have gathered understanding of how cells perceive and respond to various signals from within andoutside.
CO-5. Will have learnt the mechanisms of cell division and the significance of cell cycle and its regulation. Willbecome familiar with stem cell technology and its applications.

PAPER 2 Code UMB 302: PHYCOLOGY & MYCOLOGY

Course outcomes

By the completion of this course the students able to

CO-1. Describe useful and harmful activities of fungi and algae.
CO-2. Identify commonly available fungi and algae and their characteristics.
CO-3. Discuss how fungi and algae are used as biofertilizers in agriculture and as biopesticides.
CO-4. Grow mushroom in the laboratory.

PAPER 3 Code UMB 303: VIROLOGY

Course Outcomes

Upon successful completion of the course the student

CO-1. Will have acquired the knowledge in the following areas.
CO-2. Will be able to describe the nature, properties and structure of viruses and will also gain knowledge oftaxonomy of different groups of viruses.
CO-3. Will be familiar with diversity and multiplication of lytic and lysogenic bacteriophages.
CO-4. Will be able to describe different ways of viral transmission, and prominent and unusual genomic featuresof different viruses with their significance.
CO-5. Will understand about the replication strategies, maturation and release of important plant, animal and bacterial viruses.

PAPER 4 Code UMBE 301: MOLECULAR BIOLOGY-I

Course Outcomes

Upon successful completion of the course, the student

CO-1. 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.
CO-2. Will gain an in-depth knowledge of DNA replication mechanisms in prokaryotes and eukaryotes, enzymesand proteins involved in replication.
CO-3. 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.
CO-4. 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.
CO-5. Will get a clear understanding of translational mechanisms in both prokaryotes and eukaryotes along with the inhibitors of protein synthesis.

PAPER 5 Code UMBE 302: RECOMBINANT DNA TECHNOLOGY

Course Outcomes

Upon successful completion of the course, the student

CO-1. Will get an overview of developments and contributions of scientists in the field of genetic engineering.
CO-2. Will get familiarized with basic cloning tools such as enzymes used to manipulate DNA, and cloning vectors.
CO-3. Will have learnt various gene delivery methods and basic essential techniques of DNA, RNA and protein analysis.
CO-4. Will gather in-depth knowledge of DNA amplification and sequencing methods.
CO-5. Will become conversant with construction and screening of genomic and cDNA libraries.

SEMESTER IV

PAPER 1Code UMB 401: MICROBIAL PHYSIOLOGY AND METABOLISM

Course Outcomes

Upon successful completion of the course, the student

CO-1. Will have got acquainted with the diverse physiological groups of bacteria/archaea and microbial transportsystems.
CO-2. Will have an in-depth knowledge of patterns of bacterial growth, bacterial growth curve, calculation ofgeneration time and specific growth rate, and effect of the environment on growth.
CO-3. Will understand the variety of pathways used by bacteria for energy generation and conservation duringgrowth on glucose under aerobic and anaerobic conditions.
CO-4. Will become conversant with two important fermentation pathways in microbes.
CO-5. Will have an added knowledge on the groups and families of chemolithotrophs and phototrophs, based ontheir ability to extract energy from inorganic compounds and assimilate carbon from CO2.

PAPER 2 Code UMB-402: GENETICS AND GENOMICS-I

Course Outcomes

Upon successful completion of the course, the student will have

CO-1. Knowledge of Genetic material and genetic recombination.
CO-2. Understanding the stages of gene expression: phenomena of cell division.
CO-3. Improved understanding of mutation and mutagens.
CO-4. Applying the Mendelian principles and its extensions to solve genetic problems

PAPER 3 Code UMB 403: CELL BIOLOGY-I
Course Outcomes

Understanding of processes that control eukaryotic cell cycle, cell division and cell death.

CO-1. Conceptualized the mechanisms of signal transduction and cell-cell interaction.
CO-2. Knowledge of stem cell and their therapeutic uses and limitations.
CO-3. Linking the rapid advances in cell biology for a better understanding of diseases like Cancer and itscytologyPAPER 4Code UMBE 401: MOLECULAR BIOLOGY-II

Course outcomes

CO-1. Study of RNA polymerase and mechanisms in prokaryotic and eukaryotic cell.
CO-2. Study of RNA modification, split genes, RNA splicing, m-RNA transport
CO-3. Translation process in prokaryotic and eukaryotic cell.
CO-4. Transcription regulation in prokaryotes and eukaryotes and regulatory RNAs.

PAPER 5 Code UMBE 402: IMMUNOLOGY

Course Outcomes

CO-1. Upon successful completion of the course, the student
CO-2. Will be acquainted with the emergence of immunology and how the immune system protects us from infection through various lines of defence.
CO-3. Will have gained an in-depth knowledge of characteristics and functions of the cells of the immune systemand the organization of organs of the immune system.
CO-4. 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.
CO-5. 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.

SEMESTER-V

PAPER 1 Code UMB 501: FOOD AND DAIRY MICROBIOLOGY

Course Outcomes

On successful completion of the course, the student

CO-1. Will be aware of the possible sources of contamination of foods and the parameters affecting microbial growth in foods.
CO-2. Will gain insight into the microbial spoilage of some foods.
CO-3. 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 alsobe able to understand the health benefits of prebiotics, probiotics and symbiotic.
CO-4. 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.

PAPER 2 Code UMB 502: MICROBIAL ECOLOGY

Course Outcomes

After studying this course, the student

CO-1. Will know about the diverse microbial populations present in various natural habitats (different types).
CO-2. Would understand the interaction of microbes with both micro and macro-organisms (plants and animals).
CO-3. Would become aware of the importance of microbes in any ecosystem with reference to nutrient cycling/biogas-chemical cycling.
CO-4. Would become familiar with and gain knowledge about the various methods of waste treatment (solid andliquid) and management.
CO-5. Would become aware of the degradable properties of a microbial population present in a habitat/ecosystem.

PAPER 3 Code UMB 503: INDUSTRIAL MICROBIOLOGY

Course Outcomes

Upon successful completion of the course the student

CO-1. Will understand the development and importance of industrial microbiology and will be conversant withdifferent types of fermentation processes in liquid media as well as solid state substrates media.
CO-2. Will learn about the design, operation and uses of different types of fermenters of laboratory, pilot andindustrial scale.
CO-3. Will gain insight into the techniques of isolation, screening, preservation and maintenance of industriallyimportant microbial strains and different types of media used in fermentation processes.
CO-4. Will be acquainted with principles of techniques used for the extraction and purification of industrial products produced using microbial fermentation processes.
CO-5. Will have gained in-depth knowledge of the principles of microbial production and recovery of industrialproducts at large scale.

PAPER 4 Code UMBE 501: GENETICS AND GENOMICS II

Course Outcomes

Student will

CO-1. Conceptualize the mechanism of developmental biology and embryonic development of different modelorganism.
CO-2. Analyze and interpret biological and evolutionary problems in terms of genetics and genomics concepts.
CO-3. Knowledge of key processes involved in inheritance and expression of gene.

PAPER 5 Code UMBE 502: PLANT PATHOLOGY

Course Outcomes

Upon successful completion of the course, the student

CO-1. Student will know about concept of disease, causal agents of plant diseases, identification methods andmanagement of crop diseases.
CO-2. Student will know importance of sign and symptoms for detection of pathogens and disease, integratedmethods of disease management, use of biological and chemicals in disease management.
CO-3. Students will know various laboratory methods of detection of plant pathogens and evaluation ofbiological and chemical agents against plant pathogens.
CO-4. Student will know plant viruses, important viral diseases of crops, sign and symptoms and management ofviral diseases.
CO-5. Students will know biological method of plant growth, disease control and conventional and industrialproduction of bio control agents.

M.SC. BIOSCIENCE

PROGRAMMER OUTCOME

The aim of the undergraduate degree in Microbiology is to make students knowledgeable about the various basic concepts in a wide-ranging context 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.

PO-1. Critical Thinking: Identifying the assumptions that frame our actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO-2. Effective Communication: Read, Write, Speak and listen clearly in English and Hindi (Bilingual).

PO-3. Social Interaction: Provide a social exchange between two or more individuals.

PO-4. Effective Citizenship: Demonstrate social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO-5. Ethics: Recognize different value and moral systems and correlate them with present system.

PO-6. Environment & Sustainability: To understand the responsibility to conserve natural resources and protect global ecosystems to support health & wellbeing.

PO-7. Self-Directed & Life-long learning: It focuses on the process by which students take control of their own learning, in particular how they set their own learning goals, locate appropriate resources, decide on which learning methods to use and evaluate their progress.

PROGRAMMER 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:

PSO-1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.

PSO-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

PSO-3. Competent enough to use microbiology knowledge and skills to analyse problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc.

PSO-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.

SEMESTER I

PAPER 1 CODE BSC101: BIOLOGICAL DIVERSITY OF VIRUSES, BACTERIA AND FUNGI

Course Outcomes

CO-1. 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.

CO-2. 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.

CO-3. Empowers the student to acquire knowledge about the habitat, structure, reproduction, biochemical characterization and Classification of Bacteria, Cyanobacteria and Actinomycetes.

CO-4. Understanding of the structure, multiplication and classification of viruses, Scrapie Virosoids, Prions and Viroids; general account of Rickettsia, Chlamydia and Mycoplasma.

CO-5. Knowledge of habitat, structure, reproduction and classification of fungi.

PAPER 2 CODE BSC102: DEVELOPMENTAL BIOLOGY (ANIMAL)

Course Outcomes

CO-1. Enabling students to understand the process of development of male and female gonads including ultrastructural details of the reproductive tissues and cells.

CO-2. 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.

CO-3. The students are also made acquainted with initial process of embryogenesis; gastrulation and organogenesis taking some animal models.

CO-4. 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.

CO-5. The students learn various aspects of metamorphosis and organogenesis with respect to life cycle transformations in insects and amphibians.

PAPER 3 CODE BSC103: BASIC ECOLOGY

Course Outcomes

The student will able to get the huge knowledge of population ecology.

CO-1. Students will be able to study the concept, organization and study of the community with the concept ofniche and biodiversity.

CO-2. Students will be able to understand the vegetative organization in community. Students will get to

knowabout how changes take place during ecological succession.

CO-3. Student will have developed knowledge about structure and function of ecosystem. They also will understand about biogeochemical cycle in environment and its role.

CO-4. Demonstrate proficiency in the experimental techniques and methods to study the ecosystem.

PAPER 4CODE BSE101: BIOMOLECULES

Course Outcomes

CO-1. Enabling students to understand the importance of water in maintaining the various biochemical reactionssuch 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 theenzymes 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.

PAPER 5 CODE BSE102: BIOENERGETICS AND INTERMEDIARY METABOLISM

Course outcomes

CO-1. Learners will understand the concepts of bioenergetics, mitochondrial respiratory chain, cytochromescharacterization and Oxidative phosphorylation.

CO-2. Students will get huge knowledge of cell transport systems, influx and efflux mechanisms, symport, antiport, uniport.

CO-3. Students will learn about the carbohydrate metabolism; glycolysis, TCA cycle, energy generation, energyrich bonds, biosynthesis of sugars, HMP shunt and alternate pathways.

CO-4. Students will learn about lipid metabolisms; fatty acid synthesis and oxidation, triglycerol, steroids andterpenes.

CO-5. Students will understand about the amino acid and nucleic acid biosynthesis, degradation, regulation, ureacycle, inhibitors and inborn error metabolism.

SEMESTER-II

PAPER 1 CODE BSC201: TAXONOMY OF ANGIOSPERMS

Course Outcomes

CO-1. Understanding principles of biodiversity and its conservation. Gaining insight into the rules of nomenclature, adaptive features of ICBN and different classification systems.

CO-2. Learning and applying different techniques of identification, documentation of plants and role of computerin database identification. They will know how to prepare herbarium and use of keys to identify floras.

CO-3. Knowledge of modern taxonomy and its application in taxonomic evidences from anatomy, embryology palynology, cytology, secondary metabolites. Understanding numerical taxonomy OUT's coding.

CO-4. 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.

CO-5. 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.

PAPER 2 CODE BSC202: BIOSTATISTICS AND COMPUTER APPLICATIONS

Course Outcomes

CO-1. 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.
CO-2. Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.
CO-3. Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.
CO-4. Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.
CO-5. 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.

PAPER 3 CODE BSE201: BIOLOGY OF THE IMMUNE SYSTEM

Course Outcomes

Upon successful completion of the course, the student

CO-1. Will be able to understand the fundamental bases of immune system and immune response.
CO-2. Will be able to gather information about the structure and organization of various components of theimmune system.
CO-3. Will be able to understand the genetic organization of the genes meant for expression of immune cellreceptors and the bases of the generation of their diversity.
CO-4. Will be able to understand the operation and the mechanisms which underlie the immune response.
CO-5. Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases.

PAPER 4 CODE BSE202:RESOURCE UTILIZATION AND CONSERVATION

Course Outcomes

CO-1. Deep understanding of distribution, structure and function of various aquatic and terrestrial biomes.
CO-2. 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.
CO-3. 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.
CO-5. Gains insight knowledge about remote sensing of earth resources along with platforms, sensors and scanners, visual and digital interpretation of remotely sensed. PAPER 5 CODE BSE203:MICROBIAL METABOLISM

Course Outcomes

CO-1. The student will able to get the huge knowledge about microbial growth, measurement, growth curve,types of growth and effect of environmental factors.
CO-2. 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.
CO-3. Learners will gain the idea about respiratory metabolism EMP, ED, glyoxalate pathway, TCA

cycle,phosphorylation, Pasteur Effect and fermentation.

CO-4. Student will know about assimilation of nitrogen, synthesis of major amino-acids, polyamines;peptidoglycan-biopolymers as cell components.

CO-5. Students will understand the microbial development, sporulation and morphogenesis and organization ofmicrobes.

SEMESTER III

PAPER 1CODE BSC301: PLANT PHYSIOLOGY

Course Outcomes

CO-1. 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.

CO-2. Students will understand the process of Photosynthesis, Respiration and Nitrogen metabolism.

CO-3. Learners will gain the idea about Stress physiology – Responses of plants to biotic and abiotic stresses, biological clock and the photoperiodism.

CO-4. Student will know about the Plant Growth hormones (Auxins, Gibberellins. Cytokinins, Ethylene), theyunderstand the biosynthesis of phenolic acids, alkaloids.

CO-5. Demonstrate proficiency in the experimental techniques and methods to study the plant physiology.

PAPER 2 CODE BSC302: GENETICS& MOLECULAR BIOLOGY

Course Outcomes

CO-1. Understanding of DNA as the genetic material and its types. Knowledge of chromatin organization,euchromatin, heterochromatin, C value paradox and restriction mapping.

CO-2. Knowledge of Mutation, its kind and mechanism of DNA repair system.

CO-3. Conceptualize different aspects of genetics of microorganism with deep understanding of molecularmechanism of recombination, role of Rec ABC&D, linkage and crossing over.

CO-4. 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.

CO-5. 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 anddifferent models of gene expression in eukaryotes.

PAPER 3 CODE BSC303: ANIMAL PHYSIOLOGY

Course Outcomes

CO-1. The students learn the nutritional pattern in animals in relation to hormonal and enzymatic regulation of digestion with reference to homeostasis.

CO-2. Blood and lymph – their structure and function related to gas exchange, ion transport and clotting and defense is dealt in good detail.

CO-3. 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.

CO-4. The complete physiology of invertebrate and vertebrate excretion system is learnt by the pupil.

PAPER 4 CODE BSE301: ADVANCED MOLECULAR BIOLOGY

Course Outcomes

CO-1. To understand key principles of how cells work, including gene regulation, protein synthesis and signaltransduction.
CO-2. To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand thekey principles of Molecular Biology.
CO-3. To read, interpret and discuss major contributions to Molecular Biology research published in scientific research literature.
CO-4. To develop effective, creative and innovative solutions, both independently and cooperatively, to currentand future research problems in Molecular Biology.

PAPER 5 CODE BSE302: AGRICULTURAL MICROBIOLOGY

Course Outcomes

CO-1. 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.
CO-2. Critically discuss the need for agricultural microbiology and explain their limitations.
CO-3. Clarify application of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.
CO-4. Analyse various aspects of N2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.
CO-5. Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

PAPER 6 CODE BSE303: BIOPROCESS ENGINEERING AND TECHNOLOGY

Course Outcomes

Upon successful completion of the course, the student:

CO-1. Will have gained insight on industrially important microbes, recent developments in fermentation processes and various optimization strategies at fermenter level.
CO-2. Understands the concept of sterilization methods and principles of batch and continuous processes.
CO-3. Attains knowledge about designing of industrial strains and various media optimization strategies .
CO-4. Learns about the design, types of fermenters and various critical components of bioreactors
CO-5. Is able to describe control parameters, fluid rheology and process constraints in a large scale bioreactor

PAPER 7 CODE BSE304: BIOTECHNOLOGY

Course Outcomes

Upon successful completion of the course, the student:

CO-1. Will learn about various industrially relevant microbial products and their production process, role of biotechnology in environment management.
CO-2. 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.
CO-3. Learns about sterilization at reactor scale and different types of sterilization strategies
CO-4. 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 .

CO-5. Understands different types of regulatory approvals required for drug development and difference betweenbiologics, biosimilars and biobetters.

SEMESTER IV (CREDITS 18)

Course Outcomes

CO-1. Student is able to conceive a problem based on current published research.

CO-2. Student is able to carry out comprehensive survey of literature on the topic of research
CO-3. Student is able to make culture media for various microbes
CO-4. Student is able to isolate microorganism from different environmental/ food sources
CO-5. Student is able to identify the isolated microorganism using biochemical and molecular methods Studentis able to assess the microorganism's ability to produce various enzymes

M.SC. BIOTECHNOLOGY

PROGRAMME OUTCOMES:

The objective of the Master's Program in Biotechnology is to equip the students to gain conceptual and analyticalskills 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 andinterpretation 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 andtools. Students will be able to address application skills of biotechnological techniques and tools in fields of biomolecules including enzymes, environment, animals, microbes and plants.

PO-1. Critical Thinking: Identifying the assumptions that frame our actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO-2. Effective Communication: Read, Write, Speak and listen clearly in English and Hindi (Bilingual).

PO-3. Social Interaction: Provide a social exchange between two or more individuals.

PO-4. Effective Citizenship: Demonstrate social concern and equity centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO-5. Ethics: Recognize different value and moral systems and correlate them with present system.

PO-6. Environment & Sustainability: To understand the responsibility to conserve natural resources and protect global ecosystems to support health & wellbeing.

PO-7. Self-Directed & Life-long learning: It focuses on the process by which students take control of their own learning, in particular how they set their own learning goals, locate appropriate resources, decide on which learning methods to use and evaluate their progress.

PROGRAMMER SPECIFIC 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

PSO-1. Isolation of novel biological material, its assay and multiplication, and manipulation.

PSO-2. Application of modern emerging methodological and analytical tools and techniques in qualitative andquantitative assessment of biological materials and processes.

PSO-3. 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.

PSO-4. Efficient retrieval of information from national and international biological databases, analysis of retrieved information and contribution to new knowledge.

PSO-5. Integration of up- and down-stream processing of bioassay experiments and their analytical and application assessment.

SEMESTER I

PAPER 1 CORE CODE BTC101: CELL BIOLOGY

Course Outcomes

CO-1. Understanding of structure of prokaryotic and eukaryotic cell, and application of knowledge of microscopic techniques for cell study.
CO-2. Knowledge of functional integrity and structure of different cell organelles and transport of ions, nutrientsand macromolecules across membranes.
CO-3. Knowledge about signal transduction pathway with understanding of different type of receptors andsignaling molecules.
CO-4. Conceptualization of cell cycle, cell division and cell death. Deep understanding of events of mitosis, apoptosis, embryonic stem cells and therapeutic cloning.
CO-5. Knowledge about biology of cancer and its causes. Understanding of oncogenes, tumor suppressor gene,tumor viruses and molecular approach of cancer trea

PAPER 2 CORE CODE BTC102:ANIMAL CELL SCIENCE AND TECHNIQUES

Course Outcomes

CO-1. 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.
CO-2. 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.
CO-3. Knowledge about various techniques like Scaling up of animal cell culture, cell synchronization, cell cloning and micro-manipulation, cell transformation.
CO-4. Understanding the application of animal cell cultures, stem cell cultures, cell culture based vaccines, somatic cell genetics.
CO-5. Conceptualize the application of Organ and histotypic culture, measurement of cell death, apoptosis, three-dimensional culture and tissue engineering

PAPER 3 CODE BTC103: MICROBIAL PHYSIOLOGY AND GENETICS

Course Outcomes

CO-1. Gains insight about growth dynamics, mathematical expression, growth curves and yields, types of growth; effect of environmental factors storage and maintenance of cultures.
CO-2. Understanding of concepts of metabolic diversity, including photosynthetic, chemolithotrophicand

nitrogen fixation, nitrate and sulfate reduction, fermentation, decomposition, methanogenesis and acetogenesis, hydrocarbon transformation. Gains insight knowledge about structural and metabolic diversity of bacteria, viruses, viroids and prions. Prokaryotic cells structure.

CO-3. 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.

CO-4. 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.

PAPER 4 ELECTIVE CODE BTE101: BIOMOLECULES

Course Outcomes

CO-1. Enabling students to understand the importance of water in maintaining the various biochemical reactionssuch as buffering, phosphorylation, oxidation-reduction, etc.

CO-2. The students learn the principle of working of enzyme and the process of enzymology, i.e. how theenzymes 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

PAPER 5 ELECTIVE COURSECODE BTE102: BIOENERGETICS AND INTERMEDIARY METABOLISM

Course Outcomes

CO-1. Enabling students to understand finely detailed energy dynamics of a biomembrane, the components involved therein and various physiological attributes driven by aforementioned energy transformation.

CO-2. 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.

CO-3. The students also learn the anabolic and catabolic processes involving carbohydrates in marinating theenergy balance of the cell.

CO-4. Thebiosysnthesis of lipids that constitute the biomenbranes is understood at the level of enzymes and pathways.

CO-5. 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 purinesand pyrimidines is made acquainted to the learners.

SEMESTER II

PAPER 1 CODE BTC201: MOLECULAR BIOLOGY

Course Outcomes

CO-1. The students learn about different models and biochemical processes associated with nucleic acid replication in diverse model organisms.

CO-2. The learners get a deep acquaintance with the process of DNA recombination and repair in model organisms.

CO-3. 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.

CO-4. Students learn function of cancer-associated and cancer-preventing genes as well as techniques and applications related to ribozymes and antisense RNA.
CO-5. Sophisticated techniques related to genome mapping, DNA fingerprinting, genome cloning and recognition of desired genes are elaborated along their applications.

PAPER 2 CODE BTC202: MACROMOLECULES & BASIC ENZYMOLOGY

Course Outcomes

CO-1. The students learn the unitary model of functioning of the enzymes and the environmental factors affecting the efficiency of working of the enzyme
CO-2. 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.
CO-3. The students become well versed with the selected model enzymes with their regulatory pattern in overall control of anabolic and catabolic pathways. M.SC. BIOTECHNOLOGY 2020-2021 ONWARDS 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 Page 22 of 46
CO-4. 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.
CO-5. 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.

PAPER 3 CODE BTC203 BIOSTATISTICS AND COMPUTER APPLICATIONS

Course Outcomes

CO-1. 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.
CO-2. Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.
CO-3. Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.
CO-4. Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.
CO-5. 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 we

PAPER 4 ELECTIVE CODE BTE201: BIOLOGY OF THE IMMUNE SYSTEM

Course Outcomes

CO-1. Students will be able to understand the fundamental bases of immune system and immune response.
CO-2. Information about the structure and organization of various components of the immune system.
CO-3. Students learn the genetic organization of the genes meant for expression of immune cell receptors and thebases of the generation of their diversity.
CO-4. Will be able to understand the operation and the mechanisms which underlie the immune response. M.SC. BIOTECHNOLOGY 2020-2021 ONWARDS 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 Page 26 of 46
CO-5. 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 imm

SEMESTER III

PAPER 1 CODE BTC301: ENVIRONMENTAL BIOTECHNOLOGY

Course Outcomes

CO-1. 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.
CO-2. Empowers the students with the knowledge of Domestic waste water treatment, Classification of wastewater treatment (physical, chemical and biological)
CO-3. 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.
CO-4. 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.

PAPER 2 CODE BTC302: GENETIC ENGINEERING

Course Outcomes

CO-1. Students will understand the core concepts and fundamentals of genetic engineering.
CO-2. Develop their competency on different types of strain improvements.
CO-3. Analyses of the enzymes and vectors for genetic modification for required productivity.
CO-4. Examination of gene cloning and evaluate different methods of gene transfer like metagenomics M.SC. BIOTECHNOLOGY 2020-2021 ONWARDS 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 Page 33 of 46
CO-5. They are able to critically analyze the major concerns and applications of transgenic technology.

PAPER 3 CODE BTC303: PLANT BIOTECHNOLOGY

Course Outcomes:

CO-1. Understanding of different techniques of in vitro culture and media preparation. Concept of totipotency, morphogenesis, organogenesis and somatic embryogenesis.
CO-2. Knowledge of protoplast isolation, culture, fusion, somatic hybridization and cybridization.
CO-3. Concepts of transgenic plant production through Ri and Ti plasmids and direct methods.
CO-4. Concept of chloroplast transformation and its advantages, post harvest technology, and cryopreservation.
CO-5. Role of biotechnology in qualitative improvement in plants through herbicide resistance, insect resistance,disease resistance and N2 fixation. Knowledge of molecular markers: RFLP, PCR, QTL and MAS.

PAPER 4 CODE BTE301: ADVANCED MOLECULAR BIOLOGY

Course Outcomes

CO-1. To understand key principles of how cells work, including gene regulation, protein synthesis and signaltransduction.
CO-2. To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand thekey principles of Molecular Biology. M.SC. BIOTECHNOLOGY 2020-2021 ONWARDS 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 Page 37 of 46

CO-3. To read, interpret and discuss major contributions to Molecular Biology research published in scientificresearch literature.

CO-4. To develop effective, creative and innovative solutions, both independently and cooperatively, to currentand future research problems in Molecular Biology

PAPER 5 CODE BTE302: AGRICULTURAL MICROBIOLOGY

Course Outcomes

CO-1. 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.
CO-2. Critically discuss the need for agricultural microbiology and explain their limitations.
CO-3. Applications of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.
CO-4. Analyses of various aspects of N2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.
CO-5. Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

PAPER 6 CODE BTE303: BIOPROCESS ENGINEERING AND TECHNOLOGY

Course Outcomes

Upon successful completion of the course, the student:

CO-1. 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.
CO-2. Is able to describe control parameters, fluid rheology and process constraints in large scale bioreactors. Strategies of product recovery from a fermentation broth.
CO-3. 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.
CO-4. Analyze the importance of microbiological quality control programme's in food production.
CO-5. 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

PAPER 7 BTE304: BIOTECHNOLOGY

Course Outcomes

Upon successful completion of the course, the student:

CO-1. Will learn about industrially relevant microbial products and their production process, role of biotechnology in environment management.
CO-2. 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.
CO-3. Learns about sterilization at reactor scale and different types of sterilization strategies.

CO-4. 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 .

CO-5. Understands different types of regulatory approvals required for drug development and difference betweenbiologics, biosimilars and biobetters