

**MANGALORE UNIVERSITY
DEPARTMENT OF BIOSCIENCES**

**SCHEME and SYLLABUS for TWO YEAR (FOUR SEMESTERS)
M.Sc. in BIOSCIENCES POSTGRADUATE DEGREE PROGRAM**

**AS PER GUIDELINES FOR IMPLEMENTATION OF COMMON COURSES IN PG
PROGRAMMES**

Preamble:

This syllabus is revised keeping in mind the recent advancements in the field of Biological Sciences, the knowledge- and skill-based profile expected from a Master's in Biosciences along with fulfilling the requirement for the students' career prospects and was duly approved by the BoS in 2026. It is in accordance with UGC NHEQF levels and as per the approved Graduate Attributes and Learning Outcomes.

The present M.Sc. in Biosciences Programme has a total of 89 credits with 54 (60%) credits from the Hard Core courses, 20 (24%) credits from Soft Core courses and 06 (7%) credits from Open Electives.

Programme Outcomes (PO)

PO1. Enhancement of state-of-the-art knowledge: Upgrade knowledge to develop general competencies and analytical skills on an advanced level required for teaching, research, industry, entrepreneurship and public administration in biological sciences.

PO2. Skill-based use of tools and techniques: Independently operate various tools and acquire skills for applying appropriate methods to assess samples and carry out innovative studies on basic or applied aspects of biology.

PO3. Social Responsibility: Apply the knowledge of life sciences to contextually address specific issues in society with special reference to health and the environment for well-being and sustainable development.

PO4. Effective Communication: Effectively communicate diverse aspects of biology through oral presentations, written proposals, dissertations, reports, data analysis, interpretation and documentation.

Programme Specific Outcomes (PSO)

PSO1. Gain basic to advanced level knowledge in various branches of life sciences thus enabling students to build the confidence to pursue careers in academics, and industries and become entrepreneurs in India and abroad.

PSO2. Empower with skill-based expertise and technical know-how in the field of biological sciences.

PSO3. Develop good communication skills with a sound technical background in biological sciences, thus providing a strong foundation for both academic and industrial placements as well as setting up entrepreneurial ventures.

PSO4. Evolve in-depth scientific knowledge in various branches of biology.

PSO5. Explore, analyze and interpret lab- and field-based data using state-of-the-art techniques and tools in planning and executing innovative projects in life sciences.

M.Sc. BIOSCIENCES – SCHEME
AS PER GUIDELINES FOR IMPLEMENTATION OF COMMON COURSES IN PG
PROGRAMMES

I SEMESTER

Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARDCORE COURSES–THEORY							
BSH 417	Biomolecules	4	3	70	30	100	4
BSH 418	Cell Biology	4	3	70	30	100	4
BSH 419	Biochemical Techniques	4	3	70	30	100	4
SOFT CORE COURSES –THEORY (Any ONE to be opted)							
BSS 420	Developmental Biology	3	3	70	30	100	3
BSS 421	Plant & Animal Systematics						
BSS 422	Molecular Biology						
PRACTICAL COURSES							
BSP 423	Biomolecules Lab	4	3	35	15	50	2
BSP 424	Cell Biology Lab	4	3	35	15	50	2
BSP 410	Biochemical Techniques Lab	4	3	35	15	50	2
BSP 425	Developmental Biology Lab	4	3	35	15	50	2
BSP 426	Plant & Animal Systematics Lab						
BSP 427	Molecular Biology Lab						
Total						600	23

II SEMESTER

Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES–THEORY							
BSH 467	Microbiology	4	3	70	30	100	4
BSH 468	Genetics	4	3	70	30	100	4
BSH 469	Enzymology	4	3	70	30	100	4
SOFT CORE COURSES –THEORY(Any ONE to be opted)							
BSS 453	Applied Microbiology	3	3	70	30	100	3
BSS 455	Metabolism and Bioenergetics						
BSS 464	Marine Biology						
PRACTICAL COURSES							
BSP 470	Microbiology Lab	4	3	35	15	50	2
BSP 471	Genetics Lab	4	3	35	15	50	2
BSP 472	Enzymology Lab	4	3	35	15	50	2
BSP 458	Applied Microbiology Lab	4	3	35	15	50	2
BSP 460	Metabolism and Bioenergetics Lab						
BSP 466	Marine Biology Lab						
OPEN ELECTIVE COURSES (Any ONE to be opted)							
BSE 461	Biodiversity and Conservation	3	3	70	30	100	3
BSE 462/A	Eco-friendly Practices						
Total						700	23+3

III SEMESTER

Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES– THEORY							
BSH 501	Animal Physiology	4	3	70	30	100	4
BSH 514	Plant Physiology and Pathology	4	3	70	30	100	4
SOFT CORE COURSES –THEORY (Any TWO to be opted)							
BSS 504	Immunology	3	3	70	30	100	3
BSS 515	Ecology and Biodiversity	3	3	70	30	100	3
BSS 516	Research Methodology and Biostatistics						
PRACTICAL COURSES							
BSP 506	Animal Physiology Lab	4	3	35	15	50	2
BSP 517	Plant Physiology and Pathology Lab	4	3	35	15	50	2
BSP 509	Immunology Lab	4	3	35	15	50	2
BSP 518	Ecology and Biodiversity Lab	4	3	35	15	50	2
BSP 519	Research Methodology and Biostatistics Lab						
OPEN ELECTIVE COURSES (Any ONE to be opted)							
BSE 511	Pollution and Bioremediation	3	3	70	30	100	3
BSE 512	Stem Cell Biology and Regenerative Medicine						
BSE 513	Behavioural Biology						
Total						700	22+3

IV SEMESTER

Code	Title	Teaching Hrs/week	Exam Hrs	Marks Exams	Marks IA	Total Marks	Credits
HARD CORE COURSES–THEORY							
BSH 562	Biotechnology and Bioinformatics	4	3	70	30	100	4
SOFT CORE COURSES –THEORY (Any ONE to be opted)							
BSS 554	Nutritional Biology	3	3	70	30	100	3
BSS 563	Environmental Toxicology						
PRACTICAL COURSES							
BSP 564	Biotechnology and Bioinformatics Lab	4	3	35	15	50	2
BSP 558	Nutritional Biology Lab	4	3	35	15	50	2
BSP 565	Environmental Toxicology Lab						
MOOC*							2
PROJECT WORK							
BSP 559	Project Work (Report/Dissertation & Presentation/Viva-voce)	4 (Guidance)	-	70	30	100	4
Total						500	17
Grand Total							83+6+2*

*The MOOCS-SWAYAM/NPTEL course shall be taken by students in online mode offered by SWAYAM/NPTEL course coordinator. The courses can be taken anytime during their Masters' programme and the courses completion certificate shall be obtained before the completion of fourth semester term days.

NOTE:

The present M.Sc. in Biosciences Programme under CBCS Scheme has a total of 89 credits with 54 (60%) credits from the Hard Core courses, 20 (24%) credits from Soft Core courses and 06 (7%) credits from Open Electives.

BASIS FOR INTERNAL ASSESSMENT: Internal Assessment marks in theory papers shall be awarded on the basis of theory tests (70 Marks), Objective tests (15 Marks), Seminars, and Assignments (15 Marks). The marks obtained shall be reduced to 30. Practical Internal Assessment marks shall be based on practical tests, viva and records. 25 marks for Practical Test and 05 marks for Viva and 05 marks for Class Records. The marks obtained shall be reduced to 15. 30 marks for Project Work (Report/Dissertation and Presentation/Viva).

THEORY QUESTION PAPER PATTERN: Question Papers in all four semesters consist of three sections (The model question paper is enclosed). Part -A: Write short notes on any five out of seven: (8x2=16 Marks). Part-B: Answer any five questions out of seven (5x6=30 Marks). Part - C: Answer any three questions out of five: (3x8=24 Marks). Questions are to be framed from all the units of the syllabus by giving equal weightage.

PRACTICAL QUESTION PAPER PATTERN: 30 marks for practical exam proper (Major experiment-10marks, Minor experiments-5x2=10marks, Identity and Comment-2x2.5=5 marks), 05 marks for Viva and 05 marks for Class Record.

PROJECT WORK to be conducted either in the Department or any other Institution or in an Industry under the supervision of a teaching faculty. Evaluation is based on Project Report/Dissertation and Presentation/Viva which carry 70 marks.

M.Sc. BIOSCIENCES SYLLABUS
I SEMESTER
BSH 417 BIOMOLECULES

Course Outcomes:

Upon successful completion of the course, students will be able to:

- CO1. Have in-depth knowledge of biochemistry and appreciate the knowledge of biochemistry in the day-to-day life
- CO 2. Demonstrate an understanding of basic biochemical principles with reference to the structure and functions of proteins, carbohydrates and lipids, and their metabolic pathways.
- CO3. Understand the mechanisms of transport and excretion of cholesterol and sterols
- CO 4. Know the clinical relevance of studying biomolecules and metabolic disorders.

UNIT I

13 hrs.

Carbohydrates: Structure and classification of carbohydrates, monosaccharides, disaccharides and polysaccharides. Monosaccharides and Disaccharides- Pentoses, hexoses, deoxy sugars, amino sugars, muramic acid, neuraminic acid. Linkages in sucrose, lactose and maltose, trehalose and glycosides. Polysaccharides- Homopolysaccharides and heteropolysaccharides; starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, bacterial cell wall polysaccharides. Glycoproteins, Proteoglycans- characteristics and functions in biological system.

UNIT II

13 hrs.

Amino acids -Nomenclature classification of amino acids, Zwitter ionic structure, reaction of amino acids, stereochemistry of amino acid D and L, R and S. Physical and chemical properties including pKa values. Non-standard, non-protein and biologically active amino acids. Essential/non-essential amino acids, Unusual amino acids. Naturally occurring peptides. Peptide synthesis-Merrifield solid phase peptide synthesis. **Primary structure:** Elucidation of primary structure of proteins – Determination of amino acid composition, end group analysis, cleavage by enzymes and chemicals, separation of fragments. Manual and modern methods of sequencing and reconstructing the protein sequence. Assignment of disulfide bonds.

UNIT III

13 hrs.

Secondary structure: Peptide bond - structure and conformation, Ramachandran plot. Secondary structure: α helix and other types of helices, β pleated sheets, irregular, turns, loops and triple helical structures. Helix stabilizing and destabilizing amino acids. Motifs (super secondary structure – triose phosphate isomerase, concanavalin-A and Rossmann fold) and domain structure (glyceraldehyde-3-phosphate dehydrogenase). **Protein folding:** Tertiary structure of myoglobin. Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation, Anfinsen's experiment. **Quaternary structure and symmetry:** Structure and function of myoglobin and hemoglobin. **Protein folding pathways:** Protein dynamics – kinetics of protein folding and disulfide bond formation.

UNIT IV

13 hrs.

Lipids: Classification of lipids. Occurrence and Properties of Fatty Acids, Phospholipids, Glycolipids, sphingolipids, gangliolipids, Ceramide, Sphingosine, essential, non-essential fatty acids, omega 3 and omega 6 fatty acids, micelles, vesicles, liposome, mixed micelles, trans fatty acids, Prostaglandins, Thromboxanes, leukotrienes.

Nucleic Acids: Nucleoside, nucleotides of nucleic acids. shorthand notation for nucleic acids. Physiochemical properties of nucleic acids- Melting of DNA, T_m , factors affecting T_m , Cot curve, classification of DNA based on cot curve. Chargaff's rule. Watson and Crick model. A, Z DNA other models of DNA structure, forces stabilizing the structure of DNA. Denaturation- hypochromic and hyperchromic effect. Renaturation kinetics-effect of salts and complexity. Types of RNAs-mRNA, rRNA, tRNA, snRNA, miRNA, siRNA and parasitic RNAs (viroid and satellite RNA). Primary, secondary and tertiary structure of tRNA.

References:

- Nelson, D.L., Cox, M.M. (2014). Lehninger Principles of Biochemistry, W.H. Freeman, New York.
- Berg J.M., Tymoczko J.L., Stryer, L. (2010) Biochemistry, 6thEd., W.H. Freeman, New York.
- Zubay, G. (1998) Biochemistry, 4th Ed., WBC/McGraw Hill.
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- Murray, R.K., Granner, D.K. Mayer, P.A., Rodwell, V.W. (2009) Harper's Biochemistry 28th Ed., Appleton & Lange.
- White, A., Handler, P., Smith, E.L. (2004) Principles of Biochemistry, 6th Ed., Tata McGraw Hill, New Delhi.
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- Wilson K., Walker J. (Eds.) Principles and Techniques of Biochemistry & Molecular biology, 6th Ed, Cambridge University Press.
- Buchanan B.B., Gruissem, W., Jones, R.L. (2005) Biochemistry and Molecular Biology of Plants, Courier Companies Inc
- Skooge, A., Holler F.J., Nieman T. A. (2006) Principles of Instrumental Analysis, 6th Ed., Brooks/Cole
- Voet, D., Voet, J.G., Pratt, C.W. (2006) Fundamentals of Biochemistry-Life at the Molecular Level, 2ndEd., Wiley.
- Lippard, S.J., Berg J.M. (1997) Principles of Bioinorganic Chemistry, Panama Publishing. Jackson M. B. (2006) Molecular & Cellular Biophysics, Cambridge University Press.
- Van Holde, K.E., Johnson, W.C., Ho, P.S. (1998) Principles of Physical Biochemistry, Prentice Hall
- Harvey, R.A., Ferrier D.R., Champe P.C. (2007) Biochemistry, 4thEd., Lippincott Williams and Wilkins
- Satyanarayana U., Chakrapani U. (2008) Biochemistry, 3rd Ed., Elsevier Publishers
- Appling, D.R., Anthony-Cahill, S.J. and Mathews, C.K. (2016). Biochemistry: Concepts and Connections. Pearson Education.
- Puri, D. (2018).Textbook of Medical Biochemistry, Elsevier Health Sciences.
- Hames D, Hooper N (2005) Biochemistry (BIOS Instant Notes), Taylor & Francis

BSH 418 CELL BIOLOGY

Course Outcomes:

Upon successful completion of the course, students will be able to:

- CO1. Comprehend the general structure and molecular organization of chromosomes.
- CO2. Gain theoretical knowledge of how to use basic tools and techniques such as microscopy
- CO3. Explain the physiochemical properties of biological membranes with structural and functional insights.
- CO4. Understand how cells communicate with one another and the role of various messenger molecules in signal transduction.

UNIT I

13 hrs

Membrane structure: Different models of membrane structure - Lipid bilayer, membrane proteins, membrane carbohydrate, transport across biomembranes, Mechanisms of endocytosis and exocytosis, Ion channels, Electrical properties of membranes; Nerve impulse transmission. Chemical composition of cell walls, cross linkage, porosity, tensile strength, turgor modifications in special types of cells, plasmodesmata, fluid transport between cells. Integrating cells into tissues: Cell adhesion, Cell junctions; Extracellular matrix, extracellular matrix receptors and signaling.

UNIT II

13 hrs

Subcellular Organization: Ultrastructural organization and functions of Golgi complex, endoplasmic reticulum, mitochondria, chloroplast, peroxisomes, lysosomes, ribosomes, nucleus and nucleolus. Structure, organization and types of eukaryotic chromosomes, Heterochromatin, euchromatin, telomeres, types of chromosomes, polytene chromosomes and lampbrush chromosomes. Banding techniques; karyotyping, FISH. Chromosome dynamics during cell division: Mitosis, meiosis, microtubules, centrosome, centromere, kinetochore, metaphase and anaphase movements, motor proteins, cytokinesis. Cell cycle and its regulation: checkpoints, CDKs. Apoptosis – apoptotic pathways. Autophagy.

UNIT III

13 hrs

Cell signaling: Various types of cell signaling-endocrine, paracrine, juxtacrine and autocrine. Signaling molecules – hormones, growth factors (EGF, NGF and Insulin), neurotransmitters, gases, lipids, peptides. Structure of transmembrane receptors and mechanism of signal transduction: G-protein coupled receptors, Ion channel receptors, tyrosine kinase linked receptors & receptors with intrinsic enzyme activity. Second messengers – Ca^{2+} , IP_3 , cAMP, cGMP. MAPK/ERK signalling pathways. Nitric oxide signalling; generation and action. Receptor downregulation, sensitization and upregulation. Mechanism of action of steroid hormones: intracellular receptors (cytosolic and nuclear receptors). Insect hormones: structure, function and applications of molting hormone, juvenile hormone, pheromones. Plant hormones.

UNIT IV

13 hrs

Molecular biology of cancer: Differences between benign and malignant tumors. Hallmarks of cancer. Epidemiology of cancer. Morphological and ultrastructural properties of cancer cells. Abnormal cell growth: mechanism of transformation of cells. Types of growth-

hyperplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms. Stages and grades of cancer - initiation, promotion and progression Genetic basis of cancer, physical and chemical carcinogenic agents; Viral and cellular oncogenes, tumor suppressor genes, Telomerases and their role in cancer. Free radicals, antioxidants in cancer.

References:

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- Becker, W.M, Kleinsmith, L.J. Hardin J. (2012) Becker's World of the cell, 8th Ed, Dorling Kindersley (India) Pvt Ltd
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- Cooper, G.M. (2009) The cell-A molecular approach. 5thed. Sunderland (MA), Sinauer Associates, Inc.
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- Gilbert, S.F. (2006) Developmental Biology. 6thEd., Sunderland (MA), Sinauer Associates Inc.
- Karp, G. John Harris, D(ed) (2010).Cell and Molecular Biology – Concepts and experiments. 6th Ed., Wiley & sons, New York.
- Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology. 2ndEd. Harper Collins College Publishers
- Krebs, J.E., Goldstein E.S., Lewin T. (2011)Genes X, 5th ed. Jones & Bartlett Publisher
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. (2007) Molecular cell biology, 6thEd., W.H. Freeman and company, New York.
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- Swanson, C.P., Webster, P.L. (1989). The Cell. 5thEd., Prentice Hall of India Pvt. Ltd., New Delhi.
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- Voet, D., Pratt, C.W., Voet J.G. (2008) Fundamentals of biochemistry: Life at the molecular level, 3rd Ed. John Wiley & Sons
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick R. (2004) Molecular biology of the gene, 5th Ed., Cold Spring Harbor Laboratory Press
- Wilson K. Walker J. (Eds.) Principles and Techniques of Biochemistry & Molecular biology, 6th Ed., Cambridge University Press.

BSH 419 BIOCHEMICAL TECHNIQUES

Course Outcomes:

Upon successful completion of the course, students will be able to:

- CO1. Know the principle and applications of basic biochemical techniques.
- CO 2. Understand the role of biological solutions and calculations
- CO 3. Understand principle, instrumentation, applications and types of chromatography
- CO 4. Know the principle, instrumentation, applications and types of centrifugation
- CO 5. Understand the principle, instrumentation, applications and types of electrophoretic techniques

UNIT I

13 hrs.

Separation techniques: Physical and chemical methods of cell disruption techniques, Precipitation of proteins (salt, acid, organic solvent, isoelectric precipitation, immunoprecipitation), Principle and applications of Lyophilization, Dialysis and Ultra-filtration. **Centrifugation:** Basic Principles of centrifugation – Relative centrifugal force (RCF). Svedberg coefficient, sedimentation velocity and equilibrium. Classification of rotors. Types of centrifuges-Preparative centrifugation- Differential and density gradient centrifugation, Sub-cellular fractionation, Analytical ultracentrifugation-design and applications.

UNIT II

13 hrs.

Chromatographic techniques: Introduction, principle, procedure and applications of Adsorption chromatography (hydroxyapatite and Hydrophobic interaction), Partition (normal phase and reverse phase), Paper chromatography and Thin-layer Chromatography (TLC). Ion exchange (Cation and anion exchange), Gel filtration, Affinity chromatography (immune affinity and IMAC), Gas liquid chromatography (GLC), High performance liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC).

UNIT III

13 hrs.

Electrophoretic techniques for biomolecule separation: Theory of electrophoresis, factors affecting electrophoresis. Principle and applications of Native PAGE, SDS-PAGE, Agarose gel electrophoresis, zymogram, gradient gels, 2-D gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, DNA sequencing gels, capillary electrophoresis. Visualizing separated components - staining for proteins nucleic acids, fluorescence, PAS staining.

Spectroscopic techniques: Basic principles and electromagnetic spectrum. Beer-Lambert's Law and its applications and limitations, Molar extinction coefficient. Principle & applications of spectrophotometers in biochemical and biomedical sciences- Colorimeter, Fluorimetry, Turbidimetry, UV-Vis Absorption spectroscopy, atomic absorption spectroscopy, Fluorescence Spectroscopy, CD/ORD spectroscopy, Mass spectrometry, Infrared and Raman Spectroscopy, Nuclear Magnetic Resonance, Electron Spin Resonance, X-ray crystallography. Fiber pattern of DNA. Cytophotometry and flow cytometry.

UNIT IV

13 hrs.

Isotopes in Biochemistry: Definition and types of radiation. Units of radioactivity, Specific activity, and half-life of radioisotopes. Interaction of radioactivity with matter, Basic

principles and applications of Geiger-Muller counter, scintillation counters, Autoradiography, Application of commonly used isotopes (Tritium, Carbon-14, Phosphorous-32, Sulfur-35, Iodine-131) in biological sciences. Advantages and restriction of radiotracer experiments and safety aspects.

References:

- Patabhi, V. & Gautham, N. (2003). Biophysics, Narosa Publ House,
- Khopkar, S.M. (2008). Basic Concepts of Analytical Chemistry, 3rdEd., New Age Publications.
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- Krishna A.P. (2014) Textbook of Medical Physiology, 2ndEd, Suman Publications.
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- Jackson, M.B. (2006). Molecular and cellular biophysics. Cambridge University Press.

SOFT CORE COURSES

BSS 420 DEVELOPMENTAL BIOLOGY

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Understand the components of cell cycle control, mechanisms of cell division, apoptosis and senescence.
- CO 2. Gain in-depth knowledge in the field of developmental biology
- CO 3 Understand how gametes are produced, both in plants and animals.
- CO 4. Comprehend the process of cell differentiation at the molecular level.
- CO 5. Understand how the early developmental events occur in vertebrates.
- CO 6. Know how the genes play a role in axis specification and embryogenesis.

UNIT I**10 hrs**

Components in cell cycle control-Cyclins, CDKs in yeast and mammalian cells. Check-points in the cell cycle. Mechanics of Cell Division- Different stages of mitosis. Cohesins and Condensins in chromosome segregation, Microtubules in spindle assembly, Structure of kinetochore, centrosome and its functions, Sister Chromatid separation. Cytokinesis role of actin & myosin in the generation of the contractile ring. Meiosis – Significance. Chiasma formation - Synaptonemal complex. Recombination during meiosis - recombination nodules.

UNIT II**10 hrs**

Chief events in animal development; History of thoughts and conceptual developments; experimental embryology; the concepts of differential gene activity. Gametogenesis in animals: Spermatogenesis; Oogenesis; Molecular events during fertilization. Gametogenesis in a few plant systems; early development in a typical plant.

UNIT III**10 hrs**

Cell differentiation: Definition and concept, Mechanism of gene action during cell differentiation; Factors influencing cellular differentiation. Creating multicellularity. Cleavage types; gastrulation; Fate maps; Concepts of determination; Morphogenetic cell movements-cell adhesion and contact inhibition. Competence and induction, totipotency; Nuclear transfer experiments. Morphogenetic determinants in egg cytoplasm; Germ cell determinants and germ cell migration; Early vertebrate development-cell movements, Gastrulation, germ layers–ectoderm, endoderm and mesoderm. Neurulation and organogenesis

UNIT IV**10 hrs**

Developmental patterns in metazoans; Body axes - establishment of body axes in mammals; Genetics of axis specification in *Drosophila*; Homeobox concept - homeotic genes. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*. Seed formation and germination.

References:

- Davidson, E.H. (1976). Gene activity in Early Development. Academic Press. New York.
- Browder, L.W., Erickson, C.A., Jeffery, W.R. (1991). Developmental Biology, 3rdEd. Saunders, Philadelphia.
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- Sussman M. (2011) Animal growth and development. Prentice Hall
- Buttery P.J., Lindsay, D.B., Haynes, N.B. (1986) Control and Manipulation of animal growth. Elsevier, London

BSS 421 PLANT AND ANIMAL SYSTEMATICS

Upon successful completion of the course, students will be able to:

- CO1: Understand and appreciate how important biosystematics is to know the concept of basic principles of evolutionary relationships and taxonomy.
- CO2: Know how to categorize classification and construct the phylogenetic tree and its analysis.
- CO 3: Classify animals according to their characteristic features
- CO4: Know the principles and rules of ICBN and ICZN and gain confidence in plant and animal classification.

Unit I

10 hrs

Biosystematics: an introduction; Origin and evolution of angiosperms; co- evolution of angiosperms and animals; Basic principles of identification, nomenclature, classification of angiosperms; Evidence from palynology, Cytology, Phytochemistry, Embryology, Morphology, Anatomy, and molecular data - rRNA genes, Cytochrome B, Cytochrome C, Cytochrome C oxidase and other conserved sequences; Numerical approaches.

Unit II

10 hrs

Field inventory: Functions and importance of Herbarium; Virtual herbarium; Botanical gardens of India; Documentation: Flora, E-flora; Monographs, Journals; Keys: Single access and Multi- access. Botanical nomenclature: Principles and rules of ICBN; Ranks and names; the principle of priority, binomial system; type method, authorization, valid-publication, rejection of names; Typification. Families of Angiosperms: Descriptive studies of Magnoliaceae, Rosaceae, Rubiaceae, Liliaceae, Poaceae and Orchidaceae.

Unit III

10 hrs

Classification and Phylogenetic Analysis: Components of classification; Procedure of classification (phenetic and cladistic), presentation of classification - Linnaean/Taxonomic hierarchy, ways of constructing a phylogenetic tree. Phylogenetic analysis - Purpose, terminology, methods of phylogenetic analysis (Phenetic method, dendrogram method, pairwise distance; Cladistics method, parsimony, maximum likelihood); phylogenetic lineages.

Unit-IV

10 hrs

Zoological Nomenclature: International code of zoological nomenclature (ICZN); International rules of nomenclature – Historical and contemporary situation; Operative principles and important rules of nomenclature; Latin words and abbreviations and Linnaean Signs; DNA bar- coding, the taxonomic bottleneck, digitization of taxonomic data.

References:

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BSS 422 MOLECULAR BIOLOGY

Course Outcomes:

After undergoing the course, students will be able to:

CO1. Comprehend gene transcription and its regulation in prokaryotes and eukaryotes.

CO2. Understand protein synthesis and post-translational modifications

CO3. Understand the role of non-coding RNAs and mi RNAs.

UNIT I

10hrs

Discovery, models and mechanism of Prokaryotic and eukaryotic DNA. Organization of Prokaryotic and eukaryotic genes - Chromatin organization, nucleosome model, gene families, tandemly repeating genes, pseudogenes. Prokaryotic and eukaryotic DNA replication and repair, DNA ligases, topoisomerases, gyrases. Chromatin modelling and epigenetics – methylases, acetylases and deacetylases.

UNIT II

10hrs

Central dogma of molecular biology. Mechanism of DNA transcription in prokaryotes and eukaryotes, promoter initiation and transcription; fine structure of eukaryotic gene, exons, introns, repetitive DNA, Promoters enhancers, silencers, regulatory sequences, Regulatory sequences and transacting factors: DNA-binding Proteins, RNA polymerase types. Post-

UNIT III

10hrs

Transcriptional modification: mRNA processing (capping, polyadenylation, splicing, introns and exons). RNA types- Non-coding RNAs, micro RNAs, siRNA, shRNA, snoRNAs. Regulation of gene expression in bacteria (Operon Model: Lac operon, catabolite repression. Negative and positive control, Trp operon attenuation, anti-termination) and eukaryotes -;

UNIT IV

10hrs

Translation in prokaryotes and eukaryotes, role of ribosomes and different types of RNA in translation, clover leaf model of tRNA, mechanism of initiation, elongation and termination, ribonucleoproteins, post translational modifications- Protein folding, role of chaperons. O and N glycosylation, Fatty acylation, attachment of glycosyl anchor, phosphorylation, other modifications, protein sorting, inhibitors of protein synthesis.

References:

- Cooper, G.M. (2009) The cell-A molecular approach. 5thed. Sunderland (MA), Sinauer Associates, Inc.
- Friefelder, D.(1987). Molecular Biology, 2ndEd. Jones and Bartlett Pub. Inc., Boston.
- Gilbert, S.F. (2006) Developmental Biology. 6thEd., Sunderland (MA), Sinauer Associates Inc.
- Karp, G. John Harris, D(ed) (2010).Cell and Molecular Biology – Concepts and experiments. 6th Ed., Wiley & sons, New York.
- Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology. 2ndEd.

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- Krebs, J.E., Goldstein E.S., Lewin T. (2011) Genes X, 5th ed. Jones & Bartlett Publisher
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. (2007) Molecular cell biology, 6th Ed., W.H. Freeman and company, New York.
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- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick R. (2004) Molecular biology of the gene, 5th Ed., Cold Spring Harbor Laboratory Press
- Wilson K. Walker J. (Eds.) Principles and Techniques of Biochemistry & Molecular biology, 6th Ed., Cambridge University Press.

PRACTICAL COURSES

BSP 423 BIOMOLECULES LAB

Course Outcomes:

After undergoing the course, students will be able to:

- CO1. Develop skills required for biochemical qualitative and quantitative work
- CO2. Learn methods to proteins, carbohydrates, lipids and NPN substances.
- CO3. Operate instruments used in biochemistry labs
- CO4. Conduct biochemical tests to diagnose some metabolic diseases.

1. Handling of pipette and understanding accuracy and precision of pipette
2. Qualitative analysis of carbohydrates: monosaccharides, disaccharides and polysaccharides
3. Qualitative tests for the proteins,
4. Qualitative tests for lipids and NPN substances.
5. Preparation of buffers and their pH determination
6. Preparation of normal, molar and percent solutions
7. Understand serial dilutions
8. Estimation of amino acids and nitrogen analysis by Micro-Kjeldahl method
9. Enzyme activity: Effect of temperature, pH, Km determination
10. Spectrophotometric estimation of metabolites: serum protein, sugar, creatinine, urea, uric acid
11. Colorimetric analysis of vitamins, ascorbic acid, etc.,
12. Estimation of plant phenolics
13. Tests to measure glycosuria, proteinuria, etc

BSP 424 CELL BIOLOGY LAB

Course Outcomes:

After undergoing the course, students will be able to:

- CO1. Learn methods to study cell division and cell cycle
- CO2. Develop skills in histological staining techniques to isolate the sub-cellular organelles.
- CO3. Perform agarose gel electrophoresis and realize its applications in biological research.
- CO4. Isolate plasmid DNA, genomic DNA and total RNA from bacteria and other sources and determine their purity
- CO5. Execute restriction digestion and mapping of DNA.
- CO6. Design primers and run the PCR reaction.
- CO7. Become skilled in gel documentation instrument (Gel doc) and image development.

1. Micrometry and camera lucida drawings
2. Cell (RBC) counting using haemocytometer
3. Study of plasmolysis in cells of *Rheo* leaves.
4. Determination of mitotic index in onion root tips
5. Preparation of tissues for histology, Sectioning & Staining-Differential staining of tissue sections
6. Histochemistry- localization of a) Carbohydrates b) Proteins c) Nucleic acids
7. Hematoxylin staining and study on histology of liver, intestine, stomach, ovary, etc.,
8. Study of mitotic stages in onion root tip
9. Study of meiosis in Onion inflorescence/grasshopper testis
10. Study of chromosomal aberration in *Allium cepa* after chemical induction
11. Trypan blue exclusion test of cell viability
12. Isolation of Sub cellular organelles
13. Measurement of Na-K ATPase in membrane fractions
14. Determination of osmotic fragility of erythrocyte membranes
15. Observation of microscopic slides to study the properties of cancer cells
16. Agarose gel electrophoresis
17. Isolation of plasmid DNA from bacteria and its identification by electrophoresis
18. Isolation of genomic DNA from various sources and its identification
19. Restriction digestion and mapping of DNA
20. Isolation of total RNA from various sources and gel electrophoresis
21. Design of primers and PCR
22. Determination of DNA/RNA purity by UV-Visible spectrophotometry
23. Demonstration of gel documentation and imaging

BSP 410 BIOCHEMICAL TECHNIQUES LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- CO 1. Separate the mixtures by planar and column chromatographic techniques.
 - CO 2. Undertake quality analyses required in food industry by identifying additives, vitamins, preservatives, proteins, sugars and amino acids.
 - CO 3. Use UV-Vis spectrophotometry for estimation.
 - CO 4. Operate flame photometry.
 - CO 5. Perform electrophoretic techniques for separation and determination of molecular weight.
 - CO 6. Perform immune-diffusion techniques and ELISA for detecting presence and quantity of antigens.
 - CO 7. Use centrifugation for separation of molecules.
-
1. Ascending, descending and circular paper chromatography for separation of amino acids/carbohydrates
 2. TLC of amino acids (1D and 2D)/carbohydrates
 3. UV-Visible Spectrophotometry-verification of Beer Lambert's law
 4. Flame photometry and its application in the estimation of serum, calcium, potassium and lithium and sodium.
 5. HPLC (Demonstration)
 6. Gel electrophoresis-native and SDS-PAGE and estimation of molecular weight of Proteins
 7. ELISA for quantification of an antigen.
 8. Immuno diffusion

9. Centrifuge use and application of centrifugations techniques for separation
10. Separation by filtration technology

BSP 425 DEVELOPMENTAL BIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Develop practical skills using model organisms in developmental biology
- CO2. Gain the skills to isolate and mount the imaginal discs, sex comb, genital plate.
- CO3. Carry out practicals on developmental mutants in *Drosophila* and *Arabidopsis*.
- CO4. Carry out staining techniques for gametes and embryo.

1. Study of model organisms used in developmental Biology.
2. Isolation and mounting of imaginal discs.
3. Structure of sperms and eggs.
4. Isolation and mounting of sex comb and genital plate in *Drosophila*.
5. Study of developmental mutants in *Drosophila* and *Arabidopsis*.
6. Spiral cleavage and general development in snail.
7. Study of hemimetabolous and holometabolous development in insects.
8. Lifecycle and metamorphosis in frogs.
9. Structure of *Drosophila* and chick egg.
10. Study of chick embryo by vital staining technique.
11. Developmental stages in frog.
12. Developmental stages in chick.
13. Study of spermatogenesis in rat.
14. Plant cell totipotency (growing a carrot from adult cells)
15. Seed germination

BSP 426 PLANT AND ANIMAL SYSTEMATICS LAB

Course Outcomes:

After undergoing the course, students will be able to:

- CO1. Classify angiosperm from domain to species level using the keys
 - CO2. Gain the skill of herbarium preparation.
 - CO3. Classify representative animals
 - CO4. How to preserve animal species
 - CO5. Gain knowledge of molecular taxonomy with reference to DNA bar-coding.
1. Study of vegetative and floral characters of selected families of Dicotyledonous and of Monocotyledons
 2. Plant classification from domain to species level
 3. Demonstration of virtual herbarium
 4. Field visit, plant collection, and herbarium preparation
 5. Mounting of a properly dried and pressed specimen of any wild plant with herbarium labelling
 6. Interaction and co-evolution of flowering plants and animals
 7. Study the evolution of a few plants
 8. Animals Preserving Techniques
 9. Cladistics
 10. Systematics and Phenetics
 11. 16S ribosomal RNA in phylogenetics
 12. Phylogenetic comparative methods–use of evolutionary trees in other studies-comparative biology, adaptation or evolutionary mechanisms.

BSP 427 MOLECULAR BIOLOGY LAB

Course Outcomes:

After undergoing the course, students will be able to:

- CO1. Isolate plasmid DNA, genomic DNA and total RNA from bacteria and other sources and determine their purity
- CO2. Execute restriction digestion and mapping of DNA.
- CO3. Design primers and run the PCR reaction.
- CO4. Become skilled in gel documentation instrument (Gel doc) and image development.

- 1. Agarose gel electrophoresis
- 2. Isolation of plasmid DNA from bacteria and its identification by electrophoresis
- 3. Isolation of genomic DNA from various sources and its identification
- 4. Restriction digestion and mapping of DNA
- 5. Isolation of total RNA from various sources and gel electrophoresis
- 6. Design of primers and PCR
- 7. Determination of DNA/RNA purity by UV-Visible spectrophotometry
- 8. Demonstration of gel documentation and imaging

SEMESTER II

HARD CORE COURSES

BSH 467 MICROBIOLOGY

Course Outcomes:

Upon successful completion of the course, students will be able to:

- CO1. Understand basic concepts, historical perspectives and contributions in Microbiology.
- CO2. Understand the evolution of prokaryotic and eukaryotic metabolism
- CO3. Learn about microbial nutrition and the culture of microbes in the laboratory.
- CO4. Discern various factors affecting the growth and death of microorganisms.
- CO5. Explain the microbial metabolic pathways with their applications.

UNIT I

13 hrs

Introduction to microbiology: Contributions of early microbiologists, Koch Postulates. Branches and scope of microbiology. Origin and evolution of microorganisms, the discovery of anaerobic life, trends in the evolution of archaeobacteria, eubacteria and eukaryotes. Evolution of prokaryotic and eukaryotic metabolism. Modern methods of tracing and analysis of evolution. Microbial diversity, habitats, lifecycles, structure and classification of bacteria, cyanobacteria, actinomycetes, fungi and viruses; numerical and molecular taxonomy. General account of symbiosis, mutualism, antagonism, parasitism and commensalism in microorganisms.

UNIT II

13 hrs

Microscopy: Principle and applications of Light, Phase contrast, differential interference contrast, fluorescence, Confocal and Electron Microscopy. Stains and staining- Principles of staining, simple staining, negative staining, differential staining, Gram and acid fast staining, flagella staining, capsule and endospore staining.

Bacteria: Morphological types; cell wall – cell walls of Gram negative, Gram positive, cell membrane, capsule type's composition and function. Structure and function of flagella, pili, gas vesicles, Intracytoplasmic inclusions. Endospore and exospores. Bacterial chromosomes and bacterial plasmids. Diseases associated with bacterial infections – cholera, botulism, typhoid.

UNIT III

13 hrs

Fungi: General characters, Distribution and Nutrition in fungi, Ultra structure of fungal cell, Reproduction in fungi - vegetative, asexual and sexual. Fungal systematics - Chytridiomycota, Hypochytridiomycota, Oomycota, Zygomycota, Basidiomycota, Ascomycota, Deuteromycota, Fungal fruiting bodies, Types of spores. **Viruses:** Discovery, nomenclature, classification and properties of viruses, Morphology and ultra structure - capsid and their arrangement, envelope - types and their composition, viral genome - types and structure, Sub viral agents - viroids, prions, virusoids and satellite viruses. Corona virus. Diseases associated with viral infections – Covid, Hepatis, HIV. Risk levels and Biosafety laboratories. Biological warfare and Bioterrorism.

UNIT IV

13 hrs

Microbial nutrition and cultivation: Nutritional categories of microorganisms, the role of microbial nutrients. Selective media, selective isolation and methods of preservation of microbes. Microbial growth, population, growth kinetics and growth curves, generation time, batch and continuous cultures (e.g. chemostat, turbidostat), measurement of growth, microbiological assays (e.g. antibiotics, amino acids and vitamins). Factors affecting growth of microorganisms: temperature, pH, water activity, O-R potential, salinity, hydrostatic pressure, disinfectants, antiseptics and chemotherapeutic agents. Methods of sterilization: disinfection, antiseptic, tyndallisation, pasteurization: Physical- dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter, Chemical-phenol and phenolic compounds, (halogen aliphatic alcohol, formaldehyde, ethylene oxide, heavy metals) anionic and cationic detergents. Culture collection centres (ATCC, IMTECH, NCCS-MCC etc.).

References:

- Brock, T.B. and Madigan (2003). Brock Biology of microorganisms. 10th Ed. Prentice Hall.
- Pelczar, J. and Chan, E.C.S. (1988). Elements of microbiology. Mac Graw Hill New York.
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- Stanier R.Y. (1990). The microbial world. Prentice Hall New Delhi, 5thed.
- Prescott, Harley & Klein (2002). Microbiology, 5th, 6th, 7th Eds., McGraw Hill Pub.
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- Pommerville, J.C. (2010) Alcamo's Fundamentals of Microbiology. 9thedition. Jones and Bartlett.
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- Faruque, S.M. (Ed.) (2012) Foodborne and Waterborne Bacterial Pathogens: Epidemiology, Evolution and Molecular Biology Caister Academic Press
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- Pollack, R.A., & Findlay, L. (2009). Laboratory exercises in microbiology. John Wiley & Sons, Inc.
- Anderson, D.G., Salm, S., & Allen, D.P. (2016). Nester's Microbiology: A Human Perspective p. 896. McGraw-Hill.
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BSH 468 GENETICS

Course Outcomes:

Upon successful completion of the course, students will be able to:

- CO1. Gain in-depth knowledge in Genetics
- CO2. Understand principles governing inheritance and variations
- CO3. Comprehend recombination in bacteria and development of rDNA technology.
- CO4. Understand the phenomenon of mutation and learn skills to detect mutations

UNIT I

13 hrs

Mendelian inheritance: Principles, Modifications of Mendelian monohybrid and dihybrid ratios-Incomplete dominance, Codominance, Lethal genes and Multiple alleles. Applications of Mendel's principles- the punnet square method, forked-line method, probability method; Formulating and testing genetic hypothesis-the chi-square-test, linkage and crossing over. **Cytological basis of inheritance:** Linkage and crossing over; Genetic mapping of chromosomes. Sex determination, Dosage compensation in mammals and *Drosophila*. Sex-linked inheritance (*Drosophila* and Human). Sex-related traits, genetic disorders.

UNIT II

13 hrs

Genetics of Bacteria: Transformation, transduction, Conjugation. Plasmids. Extra chromosomal inheritance with examples; Genomic organization in prokaryotes and eukaryotes; Laws of DNA constancy and C-value paradox. **Mutations:** Classification, types of mutations with examples - deletion, duplication, translocation, inversion, transversion, transition, spontaneous and induced mutations, molecular mechanisms of mutations. Biochemical basis for mutations; Detection of mutations –mutagenicity testing-Ames test, tests in *Drosophila* (ClB, SMART) and mouse (DLT, MNT, Mitotic and meiotic, specific locus test)

UNIT III

13 hrs

Genetic recombination at Molecular level: Reciprocal recombination, site-specific recombination, models of recombination (Holliday model), Role of Rec A in Recombination. Transposable genetic elements: Bacterial transposons, Is elements, Composite transposons, Tn3 elements, Eukaryotic transposons- Ac and Ds elements in maize; P elements and Hybrid dysgenesis, Retrotransposons. Alu sequences.

Human genetics: Human chromosomes, Sex chromosomal and autosomal diseases - – Sickle cell anemia, Down's syndrome, Turners's syndrome, Cri-du-chat syndrome, Klinefelter's syndrome, Cystic fibrosis. Pedigree analysis and genetic counseling, gene therapy. Pedigree analysis and genetic counseling, gene therapy.

UNIT IV

13 hrs

Population and evolutionary genetics: Genetic variation, SNPs, gene pool, allele frequencies, Hardy-Weinberg equilibrium, inbreeding, outbreeding and changes in allelic frequency. Natural selection, Genetic drift, gene flow, Speciation: allopatric and sympatric; Convergent evolution; Sexual selection; Co-evolution, proteins and DNA sequence polymorphism, Molecular basis of evolution in human.

References:

- Gardner, E.J., Simmons M.J. & Snustad, D.P. (1991). Principles of Genetics. 8thEd. John Wiley and Sons, Inc., New York.
- Hartl, D.L., Freifelder D. and Snyder, L.A. (1988). Basic Genetics. Jones and Bartlett Publishers, Boston.
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BSH 469 ENZYMOLOGY

UNIT I

13 hrs.

Introduction to enzymes: Nomenclature and IUB classification of enzymes. Nature of enzymes, localization, isolation, precautionary techniques for purification, characterization of enzymes. Criteria of purity for enzymes. Active site structure. Methods of determining active site structure-isolation of ES complex, affinity labeling, chemical modification studies. Units of enzyme activity, specificity and specific activity of enzymes. Assay methods-coupled enzyme assays, continuous, end point and kinetic assay.

UNIT II

13 hrs.

Enzyme Kinetics: Rate of reaction, order and molecularity. Michaelis Menton equation, initial velocity approach, steady state approach. V_{max} , K_m and their significance. Linear transformation of Michaelis- Menton equation- Lineweaver Burk plot, Eddie Hofstee, Haynes- Wolf and Cornish-Bowden plot. Turnover number. Inhibition-Competitive, non-competitive, un-competitive and product inhibition. Irreversible inhibition- suicide inhibition. Determination of K_i . Bi-substrate Reaction- Cleland's notation with examples or ordered, Ping-Pong, and random. General rate equation. Primary and secondary plots.

UNIT III

13 hrs.

Nature of Enzyme Catalysis-Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic catalysis, intermolecular catalysis, entropy effects. Effect of temperature and pH on enzyme catalyzed reaction. Mechanisms of Action of Specific Enzymes- Chymotrypsin, zymogen activation, acid-base catalysis, charge relay network. Lysozyme, Alcohol dehydrogenase, Ribonuclease, Carboxypeptidase A, RNA as enzyme.

UNIT IV

13 hrs.

Coenzymic action of NAD^+ , FAD, TPP, PLP, biotin, CoA, Folic acid, Lipoic acid. Multimolecular Forms- LDH, multifunctional enzyme (DNA polymerase), multi enzyme complex (PDC), Metabolic Cooperativity- Binding of ligands to macromolecules-scatchard plot, cooperativity, positive and negative cooperativity. Oxygen binding to hemoglobin. Hill equation, homotropic and heterotrophic effectors, aspartyl transcarbamylase as an allosteric enzyme. Immobilization of enzymes and their applications. Applications of enzymes in medicine and industries, Unconventional forms of enzymes- synzymes, abzymes, DNazymes, allozymes, nanozymes.

References

- Enzyme Biochemistry, Biotechnology and Clinical Chemistry. Palmer T., Harwood Pub., 2001
- Enzyme Technology. Chaplin M.F. & Bucke C., Cambridge Univ. Press, 1990
- Fundamentals of Enzymology. Price, N.C. & Stevens, L., Oxford Pub., 1999
- Immobilized Enzymes and Cells. A. Rosevear et al., IOP Pub., 1987
- Industrial Enzymes and their Applications. Uhlig H. John Wiley and sons, 1998
- Thermostability of Enzymes. Gupta M.N., Narosa Pub., 1993

SOFT CORE COURSES BSS 453 APPLIED MICROBIOLOGY

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Understand the applications of Microbiology in biomedical and industrial fields.
- CO2. Comprehend the beneficial and harmful interactions of microbes with other organisms.
- CO3. Use fermentation for production of ethanol, lactic acid and other industrial products.
- CO4. Gain theoretical knowledge of food microbiology, prevention of air-and food-borne diseases and food poisoning.
- CO5. Gain the basics of soil microbiology and its allied applications in agriculture.
- CO6. Know the importance of aquatic microbiology and learn water purification and assessment of drinking water quality.

UNIT I

10 hrs

Microbial Ecology: Microbial symbiosis, mutualism, plant-microbe interactions (e.g. mycorrhizas), animal-microbe interactions (human, ruminants and non-ruminants). Microbes in extreme environments - hydrothermal vents and coral reefs. Microorganisms as bio-indicators. Microbial bioremediation - role in environmental management, advantages and disadvantages. Transgenic microbes and their applications. Ecological implications of

genetically modified microorganisms.

UNIT II

10 hrs

Fermentation: Ethanol, lactic acid, mixed acids, 2-3 butanediol, clostridial and propionic acid fermentation with emphasis on their ecological niches, merits and demerits. Food Microbiology: Classification of foods and oriental foods; Basic principles of food spoilage and methods of food preservation; Milk and milk products, milk microflora and their estimation, milk-borne diseases and prevention; Food poisoning, food-borne diseases and prevention.

UNIT III

10 hrs

Air Microbiology: Microflora of air and methods of their estimation, monitoring air allergens, air-borne diseases and prevention. Soil Microbiology: Soil microflora and methods of their estimation, role of soil micro organisms, bioconversion and decomposition. Biological nitrogen fixation (symbiotic and non-symbiotic), microbial phosphorus solubilization and their importance in soil fertility and agriculture.

UNIT IV

10 hrs

Biopesticides (fungi, bacteria and viruses). Biofertilizers, plant-growth promoting microorganisms, biocontrol agents and bioprotectants. Aquatic Microbiology: Microbes in water and waste water and methods of their estimation (e.g. MPN), drinking water microbial standards and water purification; Water-borne diseases and prevention.

References:

- Brock T.B. and Madigan M.T. (1991) Biology of microorganisms, Prentice Hall.
- Pelczar J. and Chan E.C.S. (1981) Element of Microbiology, McGraw Hill, New York
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- Dubey, R.C. (1993) Textbook of Biotechnology, S Chand Publ.
- Maier, R.M., Pepper, I.L. and Gerba, C.P. (2008) Environmental Microbiology, Academic Press
- Jjemba, P.K. (2004) Environmental Microbiology-Principles and Applications, Science Publ., USA

BSS 455 METABOLISM AND BIOENERGETICS

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Understand the mechanisms and regulation of anabolic and catabolic processes
- CO2. Know various disorders associated with metabolic pathways.
- CO3. Understand the physiological importance and metabolism of vitamins.
- CO4. Comprehend the concept of bioenergetics and thermodynamic principles in biology.

UNIT I

10hrs

Overview of metabolism, Metabolism of carbohydrates, pathways and regulation, gluconeogenesis, glycogenolysis, anaerobic glycolysis, citric acid cycle, hexose monophosphate shunt. Metabolism of lipids, Biosynthesis of fatty acids, Oxidation of fat and fatty acids, beta, alpha and omega oxidation, ketogenesis and ketolysis, metabolisms of acylglycerols and sphingolipids, cholesterol synthesis, transport and excretion, lipoprotein metabolism

UNIT II

10hrs

Protein and amino acid metabolism, nitrogen balance, transamination and deamination, catabolism of aromatic and sulphur containing amino acids, urea cycle and disorders, Metabolisms of purines and pyrimidines, metabolism and functions of fat soluble A, D, E and K and water soluble B complex (B1, B2, B3, B5, B6, B7, B9 and B12) & C vitamins

UNIT III

10hrs

Microbial metabolism: Energy sources and classification; metabolism in autotrophs, heterotrophs; hexose and pentose phosphate pathways; synthesis of peptidoglycan, intermediary metabolism and secondary metabolites. Aerobic and anaerobic respiration, fermentation, electron transport system and substrate phosphorylation.

UNIT IV

10hrs

Bioenergetics, Thermodynamic principles in biology, Concept of free energy. Energy rich bonds, Coupled reactions, Electron transport chain, oxidative phosphorylation, group transfer, Biological energy transducers, inhibitors of electron transport chain, uncouplers

References:

1. Voet, D., Voet, G.(1994).Biochemistry.2ndEd., John Wiley and Sons
2. Stryer, L.(2004).Biochemistry. 4th Edition
3. Harper,(2003).Biochemistry. Lange publications.26thed.
4. Lehninger, A.L., Nelson, D.L., Cox M.M.(2001). Principles of Biochemistry. CBS Publications
5. Devlin, T.M.(2005)Text-book of Biochemistry with clinical correlations 2ndEd.

BSS 464 MARINE BIOLOGY

After completion of the course, students will be able to:

- CO1. Gain knowledge on the important physical, chemical, and biological features of marine environment , and recognize the importance of past and present marine research, especially in India.
- CO2. Identify and classify various marine habitats and organisms, and analyze ecological adaptations and environmental factors influencing biodiversity and conservation strategies in coastal and deep-sea ecosystems.

- CO3. Assess marine productivity and plankton dynamics, and explain the ecological and economic importance of marine plant communities such as hydrophytes, halophytes, and seaweeds.
- CO4. Evaluate and apply knowledge of marine pollution, conservation policies, mariculture techniques, and biotechnological applications for sustainable use of marine resources and pollution control.

UNIT I

10 hrs

Introduction to the Marine Environment: Physico-chemical characteristics of seawater (temperature, salinity, dissolved oxygen, nutrients, pH); Tides, waves, ocean currents, upwelling, monsoon cycles; Marine Habitats and Communities: Coastal ecosystems: Estuaries, coastal wetlands (marshes, mangroves, swamps), tidal flats; Marine habitats: Coral reefs, seagrass beds, open ocean, deep sea; Extreme environments: Polar seas, hydrothermal vents, mud banks, oxygen minimum zones.

UNIT II

10 hrs

Ecological Parameters and Adaptations: Environmental factors of marine habitats; Adaptations of marine organisms: Pelagic, benthic, intertidal, and deep-sea forms; Coral reef ecology, bleaching and conservation strategies. Marine Productivity and Ecology: Biological productivity - Definition, influencing factors; Concepts: Liebig's Law of Minimum, Shelford's Law of Tolerance; Planktonology: Classification, distribution, sampling, blooms, red tides, shellfish poisoning; Hydrophytes and halophytes: Types, adaptations, ecological and economic roles; Seaweeds: Classification, distribution, commercial uses.

UNIT III

10 hrs

Marine Pollution and Management: Sources and types of marine pollution (chemical, plastic, thermal, oil spills); Eutrophication, harmful algal blooms, red tides; Global frameworks and policies on marine pollution. Biodiversity and Conservation: Marine resources: Fishes, molluscs, crustaceans, marine wildlife; Conservation and management: Marine biosphere reserves, marine parks; Endangered marine species and CITES convention; Global initiatives: Regional Seas Programme (UN), Antarctic Treaty, SDG 14 (Life Below Water).

UNIT IV

10 hrs

Mariculture and aquaculture: Techniques for shrimp, oyster, shellfish, and seaweed farming; Indian fishing industry: Capture, preservation, and processing; Economic importance and nutritional value of marine fish; Bioactive compounds and drug metabolites from marine flora and fauna; Introduction to marine biotechnology and its applications

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PRACTICAL COURSES

BSP 470 MICROBIOLOGY LAB

Course Outcomes:

After undergoing the course, students will be able to:

- CO1. Understand basic techniques and instrumentation in microbiology.
- CO2. Apply the techniques of sterilization of media and glassware.
- CO3. Isolate, identify and culture microorganisms
- CO4. Perform microbial motility tests.
- CO5. Execute the filter sterilization and microbial isolation.

1. Introduction to basic techniques and instrumentation in microbiology
2. Microscopic observations of microorganisms and micrometry
3. Staining techniques: Properties of stains, microbial smear preparation, simple and differential staining for morphological studies, Gram's staining, endospore staining, intracellular lipids, acid-fast staining, flagella, viability tests and relief (negative) staining;
4. Microbial motility tests.
5. Microbial culture media, microbial growth
6. Sterilization of media and glassware, filter sterilization
7. Stock culture, subculture, maintenance of culture.
8. Techniques of microbial isolation.

BSP 471 GENETICS LAB

Course Outcomes:

After undergoing the course, students will be able to:

- CO1 Understand the importance of *D. melanogaster* as an excellent model in Genetics.
- CO2 Maintain and conduct experiments using *D. melanogaster*.
- CO3 Conduct crossing experiments to learn Mendelian and non-Mendelian Genetics
- CO4 Solve genetic problems such as legal issues like paternity and maternity disputes.

1. Salient features and method of maintenance of *Drosophila melanogaster* culture.
2. Techniques for handling and examining the flies.
3. Preparation of salivary gland chromosomes of *D. melanogaster* and identification of different arms.
4. Preparation of salivary gland chromosomes in *D. nasuta*
5. Identification of blood types in humans.
6. Experiments to demonstrate patterns of inheritance of a few characters (Crossing).
7. Study of (i) mating behaviour in *Drosophila* (ii) somatic mitosis in *Drosophila*.
8. Biochemical separation of eye pigments in *Drosophila*
9. Genetic problems.

BSP 472 ENZYMOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to :

- CO 1. Acquire hands-on training in enzymology practicals
- CO 2. Understand enzyme kinetics using suitable examples
- CO 3. Learn to apply enzymes
- CO 4. Learn advantages of immobilization of enzymes

1. Extraction, isolation and purification of soluble
2. Extraction, isolation and purification of membrane bound enzymes
3. Enzyme assays
4. Mechanism of action of lysozyme
5. Mechanism of action of chymotrypsin
6. Mechanism of action of polymerases
7. Immobilization of enzymes and their applications

BSP 458 APPLIED MICROBIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to :

- CO 1. Carry out quantitative and qualitative assessments of microflora of soil, water and air.
- CO 2. Selectively isolate and identify microbes using morphological and biochemical tools.
- CO 3. Understand the symbiotic association of microorganisms through experiments.
- CO 4. Assess microbial quality of drinking water and milk.
- CO 5. Perform microbiological assays for antibiotics and amino acids.

1. Quantitative and qualitative assessment of microflora of soil, water and air by direct and indirect methods.
2. Selective isolation of microbes (bacteria, actinomycetes, yeasts and fungi)
3. Studies on symbiotic association of microorganisms (rhizobia, cyanobacteria and arbuscular mycorrhizae)
4. Simple and special morphological and biochemical tests for identification of bacteria,

fungi

5. Assessment of microbial quality of drinking water and milk
6. Microbiological assays (antibiotics and amino acids)

BSP 460 METABOLISM AND BIOENERGETICS LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Perform spectrophotometric estimation of various metabolites.
 - CO2. Diagnose some of the metabolic diseases through biochemical tests.
 - CO3. Quantify vitamins and phenolics in plant samples.
 - CO4. Calculate free energy change, redox potential, and mitochondrial respiration.
-
1. Spectrophotometric estimation of metabolites: serum protein, sugar, creatinine, urea, uric acid
 2. Colorimetric analysis of vitamins, ascorbic acid etc.,
 3. Estimation of plant phenolics
 4. Tests to measure glycosuria, proteinuria etc
 5. Calculations in Bioenergetics: standard free energy change, redox potential, mitochondrial respiration etc

BSP 466 MARINE BIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to :

- CO1. Perform qualitative analyses of water samples for various parameters.
 - CO2. Identify freshwater, marine and benthic organisms
 - CO3. Estimate the productivity of aquatic ecosystems.
 - CO4. Understand the food and feeding habits in fish.
-
1. Water quality parameters
 2. Water quality analysis Salinity and DO testing
 3. Freshwater, marine and benthic organisms.
 4. Plankton sampling - Preparation of temporary and permanent slides of plankton.
 5. Estimation of productivity.
 6. Hydrophytes, halophytes and seaweeds.
 7. Food and feeding habits in fish.
 8. Sewage organisms.
 9. Marine biodiversity survey
 10. Seaweed collection
 11. Pollution mapping
 12. Instrumentation in aquatic biology and field visits: Coastal ecosystems, estuaries, marine laboratories

OPEN ELECTIVE COURSES

BSE 461 BIODIVERSITY AND CONSERVATION

Course Outcomes:

After successful completion of the course, students will be able to:

- CO 1. Understand the relevance of biodiversity and conservation.
- CO 2. Describe the levels of biodiversity organizations.
- CO3. Understand Indian ecological/geographical diversity, including Himalayan region,

Desert, Western Ghats, Coastal region and Hotspots of biodiversity.
CO4. Understand microbial diversity and its importance.

UNIT I

12hrs

Basic concepts and definitions, scope, biosphere, habitats, food chain, food web. Levels of biodiversity organizations – Genetic diversity, Species diversity and Ecosystem diversity. Indian ecological/geographical diversity: Himalayan Region, Deserts, Semiarid region, Gangetic plains, Western Ghats, Coastal region; Hotspots of biodiversity.

Microbial diversity: Bacteria, Cyanobacteria, Fungi and Lichens, Algae, Protozoa and viruses, habitat. Mushrooms – edible and nonedible. Plant and animal association with microbes. Beneficial and harmful microbes, Culture, Cultivation of bacteria. Microbial products.

UNIT II

12hrs

Plant diversity: Lower and higher group of plants, plant ecosystem and its classification. Major ecosystem types, tropical forests, temperate forests. Arid and Semiarid ecosystems, boreal forests, Arctic and Alpine systems, grasslands, wetland ecosystem. Marine ecosystems, Epiphytes, parasites and orchids. Values and uses of plant diversity. Animal diversity: Lower and higher group of animals, their ecological niches. Zoogeographical regions of the world and India. Animals in temperate, tropical and boreal forests, cave and mountains, Coastal ecosystems, mangrove and estuaries, coral reefs.

UNIT III

12hrs

Biodiversity Conservation: Causes and prevention of Plant and Animal biodiversity loss; IUCN Red List Categories and Criteria. Conservation strategies – *Ex-situ* and *In-situ* conservation, Protected ecosystems – Biosphere reserves, National parks, Sanctuaries, Botanical gardens, Sacred groves; Wildlife conservation and wildlife conservation act; Centers of diversity study.

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BSE 462/A ECO-FRIENDLY PRACTICES

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Understand how mankind is responsible for polluting the environment and disturbing biodiversity and their larger impact on human society.
- CO2. Get sensitized on how and what activities can be adopted in day-to-day life that helps

the conservation of nature and natural resources.

- CO3. Gain the wisdom of some of the international days observed for the conservation of nature.
- CO4. Appreciate some of the great environment conservation activists of India and get inspired.

UNIT I

12hrs

Basic concepts and Definitions: Environment; ecosystem; Ecological footprint; Carbon footprint; Environmental pollution - air, water, and soil. Human-caused ecological problems - Global warming; climate change, species extinctions, plastic pollution; habitat destruction; biodiversity loss; ozone layer depletion; Human-wildlife conflict; natural calamities (flood, coastal flooding, cold wave, drought, heatwave, cyclone, ice storm, landslide, lightning, riverine strong wind, tornado, wildfire).

UNIT II

12hrs

Role of individuals in the conservation of nature: The 4Rs: Reduce, Reuse, Recycle and Recover; Waste segregation; Trash to Treasures with some examples; The concept of the free cycle; Plastic pollution - single-use plastics; Energy star appliances; public transport; health benefits of walking and cycling; Home gardening; plantation drive; afforestation; home energy audit; recycling of kitchen wastes; organic farming; composting - vermicompost; pot compost; biogas production; renewable energy - solar panels; solar lights; solar heater; integrated pest management; rainwater harvesting; Wasteland management through biodiesel plantation; Eco-friendly gifts and mementos; Community participation in nature conservation;

UNIT III

12hrs

International Days for Nature conservation: World Environment Day; World Wetlands Day; World Wildlife Day; Global Recycling Day; International Day of Forests; World Water Day; Earth Day; International Day for the Conservation of the Mangrove Ecosystems; International Day for Natural Disaster Reduction; World Soil Day. Great inspiring personalities of India for nature conservation: Sunderlal Bahuguna; Salim Ali; Rajendra Singh; Medha Patkar; M. S. Swaminathan; Vandana Shiva; Saalumara Thimmakka; Panduranga Hegde.

References:

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**III SEMESTER
HARD CORE COURSES
BSH 501 ANIMAL PHYSIOLOGY**

52 hrs

After successful completion of the course, students will be able to :

- CO1. Gain in-depth understanding of gastrointestinal system, associated disorders, digestive processes and mechanism of absorption of nutrients.
- CO2. Comprehend ultrastructure and functioning of nerves and muscles.
- CO3. Understand the importance of various endocrine glands, associated disorders, hormones and their mode of action
- CO4. Understand osmoregulation and excretion mechanisms and modes across organisms.
- CO5. Comprehend the concept of thermoregulation and adaptive features.
- CO6. Develop in-depth understanding of sensory receptors

UNIT I

13 hrs

Gastrointestinal System: Digestive processes and mechanisms of absorption of dietary carbohydrates, proteins and lipids; coordination of digestive and absorptive activities; gastrointestinal disorders. Nervous system: Neuron and glia structure and nerve impulse conduction synapses, synaptic transmission and neurotransmitters; reflex mechanisms; functions of the sensory and motor areas of the CNS (human); neurodegenerative disorders: Alzheimer's, Parkinson's, Epilepsy; autonomic nervous system.

UNIT II

13 hrs

Endocrine system: Hypothalamus. Endocrine glands -pituitary, thyroid, parathyroid, adrenals, pancreas, ovary, testis, pineal, placenta hormones -release, transport, mechanism of action and biological action; Circadian rhythms; Neurohormones of the hypothalamus; endocrine disorders. Muscular system: Contraction of skeletal muscle; molecular basis of muscle contraction; energetics of muscular contraction; neuromuscular transmission and excitation contraction coupling; muscle atrophy and dystrophy.

UNIT III

13 hrs

Osmoregulation and excretion: Biological significance of water; Osmoregulation in aquatic and terrestrial vertebrates; regulatory mechanisms; Major functions of excretory system; Organs of excretion- Basic processes responsible for the formation of the excreted fluid; Functional types- Generalized excretory organs and Specialized excretory organs; Classification of excretory organs and their distribution in the animal Kingdom; General patterns of nitrogen and non-protein nitrogen excretion; physiology of urine formation in mammals; renal diseases.

UNIT IV

13 hrs

Thermoregulation: Thermoregulation-a phenomenon of homeostasis; Thermoregulatory adaptations-Physiological, Physical and Behavioral adaptations; Thermoregulation in aquatic and terrestrial invertebrates; Thermoregulation in Vertebrates-Fishes, Amphibians, Reptiles, Birds and Mammals. Receptor system: Sensory receptors-classification and properties; Receptor Mechanisms: Chemoreceptors- gustatory receptors and olfactory receptors, Mechanoreceptors- Touch or pressure receptors, Pain receptors, Receptors concerned with equilibrium, gravity, acceleration and vibration, Phonoreceptors; Electromagnetic receptors- Photoreceptors Thermoreceptors; Special Senses-Neurophysiology of Vision, Hearing and Chemical senses.

References:

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BSH 514 PLANT PHYSIOLOGY AND PATHOLOGY**52 hrs****Course Outcomes:**

After successful completion of the course, students will be able to:

- CO 1. Understand the role of various nutrients in plant growth
- CO 2. Comprehend the various concepts of water relation in plants and physiological processes.
- CO 3. Gain in-depth knowledge on photosynthesis and regulatory mechanisms.
- CO 4. Understand role of various growth regulators in plant growth
- CO 5. Gain knowledge on different methods and tools of plant breeding
- CO 6. Understand plant pathology

UNIT I**13 hrs**

Soil Fertility and Plant Nutrition - Importance of soil testing, soil sampling methods, interpretation of soil test reports. Classification of plant nutrients and their essential functions, deficiency symptoms of nutrients and their remedies. Inorganic Fertilizers – classification, chemical composition, timing and methods of application, soil amendment substances. Sand culture, Soil culture, Hydroponics, Aeroponics. Nitrogen, phosphorus and sulphur metabolism in plants.

UNIT II**13 hrs**

Water relations in plants: water requirements, Physical forces involved in water absorption, Osmotic system, Water potential, Site and path of water absorption; Ascent of Sap, mechanism of translocation of water and solutes; Factors affecting water absorption;

Transpiration- Types of transpiration, structure and functions of stomata, mechanism of stomatal movement, Factors affecting transpiration, Guttation, anti-transpirants. Photosynthesis: Chloroplast and photosynthetic pigments; Concept of photosynthetic unit; Oxygenic and anoxygenic photosynthesis; Concept of pigment system; Stages of photosynthesis- cyclic and non-cyclic photophosphorylation; Hill reaction, Photorespiration; carbon dioxide fixation in C₃ and C₄ plants, CAM plants; Factors affecting photosynthesis.

UNIT III

13 hrs

Plant Growth and Growth Regulators- Plant growth, Growth curve, measurement of growth, Phytohormones: Biosynthesis, Mechanism of action and application of auxins, gibberellins, cytokinins, ethylene, abscisic acid; Vernalin, Florigen, Morphactins; Phytochromes. Plant breeding: Objectives– high yield, improved quality, disease and pest resistance, early maturity, photosensitivity, varieties for new seasons, resistant varieties. Breeding in self-pollinated crops. Methods of breeding- Selection, Backcross method, Hybridization-objectives, types, procedure. Mutagenesis.

UNIT IV

13 hrs

Plant pathology- Plant pathology in relation to important diseases of crop plants. Important plant diseases: Plant diseases caused by viruses, mycoplasma, bacteria, fungi, protozoa, nematodes, parasitic angiosperms - symptoms, etiology, life cycle, transmission etc. Molecular biology of stress response in plants.

Seed borne diseases and transmission: Pollination, fertilization, embryogenesis, morphology and physiology in relation to seed infection. Seed-borne pathogens and their importance - viruses, bacteria, fungi and nematodes; seed infection and contamination. Diagnosis of crop diseases, assessing their intensity and losses. Factors responsible for disease development and status of plant diseases in changed scenario of cropping system in Karnataka. Post-harvest problems in storage and their management.

References:

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SOFT CORE COURSES

BSS 504 IMMUNOLOGY

40 hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Gain an in-depth knowledge of immunology.
- CO2. Understand the structure and functions of various immune cells and organs
- CO3. Comprehend antigen and antibody structure and the mounting of immune responses.
- CO4. Understand autoimmunity, hypersensitivity and immunodeficiencies
- CO5. Understand the principles and application of various immunological techniques.

UNIT I

10 hrs

Immunology: History and scope of immunology; Immunity, classification of immunity; Host defence: cellular, tissue and humoral immunity; Acquired immunity; Primary and secondary lymphoid organs; Immune response of T and B cells; Cytokines – structure and functions. Immune defence: invasion, antigens, toxins.

UNIT II

10 hrs

Antibodies: Production, structure, classification and functions; hypervariable region, Isotypic, allotypic and idiotypic variations. Antigenicity and immunogenicity, haptens. Complement. Major Histocompatibility Complex (MHC), HLA polymorphism. Tissue haplotypes and disorders, Tissue and organ grafting, graft rejection, Immune suppression.

UNIT III

10 hrs

Autoimmune diseases: Thyrotoxicosis, Systemic Lupus Erythematosus, Antinuclear antibodies. Hypersensitivity - reactions. Tumor immunology– tumor antigens, immunosurveillance, immunological escape. Immune deficiency diseases– AIDS; Immunological tolerance, Immunization and Vaccines: Types and production.

UNIT IV

10 hrs

Immunological techniques: Antigen-antibody reactions. Precipitation and agglutination, immunodiagnosis, ELISA, RIA, immunoblotting and immunofluorescence and chemiluminescence; Fluorescent activated cell sorter (FACS); Hybridoma technology, production and application of monoclonal antibodies. Edible vaccines – Benefits, limitations, production, examples.

References:

- Abul K. Abba, Andrew H. Lichtman, Jordan S. Pober (1997) Cellular and molecular immunology - Saunders Co.
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- Barrett JT, (2018) Microbiology and Immunology Concepts. Lippincott-Raven, USA

BSS 515 ECOLOGY AND BIODIVERSITY

40h

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Understand biodiversity, hotspots, conservation and management
- CO2. Develop knowledge of forest and landscape ecology and watershed management.
- CO3. Understand fisheries and aquaculture methods for commercial production of seafood
- CO4. Learn about the impacts of aquatic pollution.
- CO5. Develop in-depth knowledge in population ecology, prey-predatory dynamics, life-history strategies, energy budgets and reproductive strategies.

UNIT I

10 hrs

Biodiversity: types, significance, distribution and measurements-Species richness: Simpson index, Shannon Wiener index, Evenness. Megadiversity countries, hot spots, biodiversity of Western Ghats and Eastern Himalayas. Wildlife management: Present status of threatened wildlife of Western Ghats; Conservation, Administrative and Judicial measures.

UNIT II

10 hrs

Forest and landscape ecology: types of forests and their distribution with reference to Western Ghats; Vegetation mapping; Plant-animal interactions; Integrated pest management. Landscape Ecology – watersheds management.

UNIT III

10 hrs

Behavioral Ecology: Introduction, evolution and natural selection, fitness and adaptation, proximate and ultimate causes of behavior, fixed action patterns, imprinting, associate and non-associate learning. Intelligence: its components and attributes, case studies of intelligence behavior in coots, crows and chimpanzees. Foraging ecology, search and handling time, optimization, generalization and specialization, territoriality, group foraging, selfish herd concept, interspecific mutualisms.

UNIT III

10 hrs

Population ecology: Demography-life tables; population structure-recruitment patterns, settlement and migration; population growth-growth patterns, age and growth, allometry, growth parameters; biotic parameters-predation, prey-predatory dynamics, competition, mutualism and population regulation; life history strategies-life history traits, longevity and survival rates, energy budgets, and reproductive strategies, *k*-selection and *r*-selection.

References:

- Burn, A.J., Coaker, T.H. and Jepson, P.C. (1987). Integrated pest management. Academic Press, London. 474 pp.
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- Lieth, H. (1989). Tropical rainforest ecosystems. Elsevier, Amsterdam. 713pp.
- MacArthur, R.H. and Nilson, E.O., (1967). The theory of Island biogeography. Princeton University Press, Princeton.
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- Pianka, E.R., (1983). Evolutionary ecology. Harper and Row, New York. 416pp.
- Pielou, E.C., Mathematical ecology. Wiley, New York, 385pp.
- Pook, R.W., (1974). An introduction to qualitative ecology. McGraw Hill, Tokyo. 532pp.
- Roughgarden, J.J., 1987 Science of ecology. MacMillan, New York. 710pp.
- Sivaraju, V.V., and Balachandran, I. (1994). Ayurvedic drugs and their plant sources. 27. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 570pp.
- Southwood, T.R.E. (1978). Ecological methods, Chapman and Hall, London. 524 pp.
- Techniques to maintain biological diversities, 1988. SIRC, London.
- Tiwari, S.K., (1985). Readings in Indian Zoogeography. Today and Tomorrow's Printers and Publishers, New Delhi. 604pp.
- Zaika, V.E., (1970). Specific productivity of aquatic invertebrates. Wiley, New York, 154 pp.

BSS 516 RESEARCH METHODOLOGY AND BIOSTATISTICS

40 hrs

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Gain the knowledge on the fundamental principles and types of research, and formulate research problems and hypotheses effectively.
- CO2. Critically review scientific literature, design appropriate research methodologies, and apply suitable sampling techniques.
- CO3. Demonstrate the ability to collect, analyze, and interpret qualitative and quantitative data using appropriate tools and ethical research practices.
- CO4. Apply biostatistical methods and software tools to perform data analysis, hypothesis testing, and present research findings effectively.

UNIT I

10 hrs

Introduction to Research: Definition, scope, and objectives of research. Types of research: Basic vs. applied, Qualitative vs. quantitative, Exploratory, Descriptive, Analytical. Research process and steps. Research Problem and Hypothesis: Identifying and defining a research problem; Criteria for a good research problem; Hypothesis formulation: Null and alternative hypotheses, Types of hypotheses. Experimental Design Basics: Concepts of variables (independent, dependent, control). Literature Review and Research Design: Literature Review; Purpose and importance of a literature review; Sources of literature; Referencing styles: APA, MLA, etc. Research Design: Meaning, components, and importance of research design; Types: Experimental, Correlational, Longitudinal, Cross-sectional, Case study. Model organisms in biological research: *E.coli*, *C. elegans*, *Danio rerio*, *D. melanogaster*, *Mus musculus*.

UNIT II**10 hrs**

Data Collection, Ethics, and Presentation: Data Collection Method data; Primary vs. Secondary data. Tools: Questionnaires, Interviews, Observations, Surveys, Focus groups. Ethics in Research: Ethical principles and guidelines; Informed consent, confidentiality, ICMR-Human Ethical guidelines; Guidelines for use of animals - Committee for Control and supervision of Experiments on Animals (CCSEA); Institutional Biosafety Committee;; Plagiarism; Role of Institutional Review Boards (IRBs); Reporting and Presentation: Structure of a research report/thesis; Abstract writing, referencing, and bibliography; Presentation techniques: Oral and Poster presentation.

UNIT III**10 hrs**

Biological data-frequency distribution, graphical and diagrammatic representations; Measures of Central tendency - Mean, Median and Mode; Measure of Dispersion - Range, Variance, Standard deviation, Coefficient of variation, Standard error, Diversity Index. Populations versus sample-sampling techniques, Confidence limits. Sampling Design: Probability vs. Non-probability sampling. Sampling methods: Random, Stratified, Systematic, Cluster. Sampling errors and bias. Random experiment-probability. Binomial, Poisson and Normal distributions and their applications in genetics.

UNIT IV**10 hrs**

Simple linear Regression and Correlation analysis. Multiple regression. Principles of experimental design, Analysis of variance: One- way analysis of variance (ANOVA) and Two-way analysis of variance. Tests of significance-Normal, χ^2 , (Chi-square), 't' and F tests; Testing for goodness of fit, Statistical packages.

References:

- Kothari, C. R., & Garg, G. (2019). Research methodology: Methods and techniques (4th ed.). New Age International Publishers.
- Kumar, R. (2023). Research methodology: A step-by-step guide for beginners (6th ed.). SAGE Publications.
- Krishnaswamy, K. N., Sivakumar, A. I., & Mathirajan, M. (2009). Management research methodology: Integration of principles, methods and techniques. Pearson Education.
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- Rosner, B. (2015). Fundamentals of biostatistics. Nelson Education.
- Le, C.T., & Eberly, L.E. (2016). Introductory biostatistics. John Wiley & Sons.
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PRACTICAL COURSES

BSP 506 ANIMAL PHYSIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Perform experiments to estimate enzyme activity and understand factors affecting enzyme activity
 - CO2. Perform experiments on hormonal control of reproductive biology.
 - CO3. Perform experiments in muscle physiology and osmoregulation.
 - CO4. Conduct qualitative tests for excretory products and demonstrate active transport
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- 1. Gastrointestinal function–Factors affecting enzyme activities in digestion of food stuffs.
 - 2. Quantitative estimation of Enzyme (amylase)activity.
 - 3. Neuroendocrinology–Effect of hormones on blood glucose in rats.
 - 4. Study of estrous cycle in mice
 - 5. Study of sperm count, sperm morphology and sperm motility
 - 6. Muscle Physiology-Histochemical detection of SDH activity in red and white muscle fibres.
 - 7. Osmoregulation-Estimation of Fluid balance in an animal.
 - 8. Osmotic relationships in animals at the level of cell as well as entire organism.
 - 9. Excretion-Qualitative tests for excretory products. Demonstration of active transport.

BSP 517 PLANT PHYSIOLOGY AND PATHOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Realize the importance of each nutrient in plant growth through experimentation and observation.
 - CO2. Observe mineral deficiency symptoms in plants.
 - CO3. Know how to perform the tests for understanding water relations.
 - CO4. Understand photosynthesis by conducting some allied experiments.
 - CO5. Understand the role of growth hormones in plants.
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- 1. Plant nutrition- Observation of mineral deficiency symptoms in plants.
 - 2. Water relations-Experiments to demonstrate the diffusion pressure deficit in plant cell.
 - 3. Determination of stomatal index, stomatal frequency and measurement of stomatal aperture.
 - 4. Determination of water potential
 - 5. Photosynthesis- Separation and estimation of chloroplast pigments. Demonstration of Kranz anatomy
 - 6. Growth hormones and their regulation-
 - 7. Experiments to demonstrate the effect of hormones on shoot apex.
 - 8. Plant pathology Pathogens in crop plants

BSP 509 IMMUNOLOGY LAB

Course Outcomes:

After successful completion on the course, students will be able to:

- CO1. Develop skills in immunology lab experiments.
- CO2. Isolate lymphocytes and identify different blood cells
- CO3. Understand hemolymph cells in insects
- CO4. Perform immunoassays using various immunodiffusion methods
- CO5. Detect and quantify antigens and allergens using established methods

1. Study of immune system in rats
2. Blood film preparation and study of immune cells
3. Isolation of lymphocytes
4. Study of insect hemocytes
5. Ouchterlony double diffusion assay
6. Radial Immunodiffusion technique
7. Immunological diagnosis of pregnancy and infection
8. DOT-ELISA technique
9. Rocket immune electrophoresis method
10. Detection of allergens: Pollen Count by sticky slide method

BSP 518 ECOLOGY AND BIODIVERSITY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Enhance the theoretical knowledge of applied ecology with lab experiments and field visits.
- CO2. Understand plant-animal interactions and prey-predator relationship.
- CO3. Unravel medicinal properties of plants and significance of conservation
- CO4. Develop skills of remote sensing.
- CO5. Identify freshwater and marine fishery resources.
- CO6. Estimate growth parameters and determine the probability of death.

1. Biodiversity
2. Terrestrial biodiversity
3. Aquatic biodiversity
4. Plant-animal interactions
5. Endangered medicinal plants.
6. Landscapes analysis through remote sensing data.
7. Freshwater fishery resources
8. Marine fishery resources
9. Estimation of growth parameters
10. Life-tables
11. Prey-predator relationships

BSP 519 RESEARCH METHODOLOGY AND BIOSTATISTICS LAB

Course Outcomes:

After successful completion of the course, students will be able to

- CO 1. Perform suitable statistical tests for evaluation of data
- CO 2. Make suitable graphical representations of data
- CO 3. Perform statistical tests - t test, F-test, ANOVA
- CO 4. Develop the skill to use search engines, internet tools and databases

1. Measurement of Central tendencies, mean, median, mode
2. Measures of dispersion range SD, CV & SE
3. Scatter plot
4. Simple Correlation & Regression, Multiple Correlations
5. Construction of frequency table
6. Theoretical distribution, Binomial poisson & normal
7. Statistical inference, normal, t test, chi-square & F test
8. Analysis of Variance

OPEN ELECTIVE COURSES
BSE 511 POLLUTION AND BIOREMEDIATION

36 hrs

Course Outcomes

After successful completion of the course, students will be able to:

- CO1. Understand causes and effects of environmental pollution and bioremediation.
- CO2. Know about air, water and land pollutants and their impact.
- CO3. Realize the impacts of water pollution on aquatic biota and human health.
- CO4. Know the causes of acid rain, photochemical smog, global warming, ozone depletion and haze.
- CO5. Understand the concept of bioremediation and how to use microorganisms, plants and enzymes to detoxify contaminants.
- CO6. Know about biological treatment of liquid wastes and solid wastes.

UNIT I

12hrs

Environmental pollution: Types of pollution – Air, water, land, sound and radioactive pollution. Water pollutants: Major sources- Domestic, municipal, industrial and agriculture; types and standards; Impact of water pollution on aquatic biota and human health.

UNIT II

12hrs

Atmospheric Pollutants: Major sources, types and standards; Primary pollutants - Carbon monoxide, sulphur oxides, nitrogen oxides, particulate matter, hydrocarbons, asbestos and CFCs; Secondary pollutants; Impact of air pollutants on climate-Acid rain, photochemical smog, global warming, ozone depletion and haze.

UNIT III

12hrs

Remediation: Types of remediation - Physical, chemical and biological; Bioremediation - *in-situ* and *ex-situ* bioremediation; Phytoremediation; Microbial remediation; Biological treatment of liquid wastes and solid wastes.

References:

- Diwakar Rao, P.L. (1990). Pollution control Handbook, Utility Publications Ltd., Secunderabad, India.
- Eaton, A.D., Clesceri L.S. & Greenberg, A.E. (1995). Standard Methods for the Examination of Water and Wastewater, APHA, Washington.
- Moriarty, F.(1975). Pollutants and animals; A factual perspective. George Allan & Unwin Ltd., London.
- Schmitz, R.J. (1996). Introduction to water pollution biology. Asian Books Pvt. Ltd., New Delhi.
- Trivedi, P.R. and Sudarshan, K. (1995). Global Environmental issues, Commonwealth Publications, New Delhi.
- Vernberg *et al.* (1981). Biological monitoring of marine pollutants, Academic Press, New York.
- George, A. (2000). The Ecology of seashores, CRC Press.
- Agrawal, K.C. (2002). Environmental Pollution: Causes, Effects and Controls.
- Binoda C. Sabata (1995). River Pollution in India.
- Khetan S.K. (2000). Microbial Pest Control.
- James, G.A. (1999). Ethical Perspective on Environmental issues in India

BSE 512 STEM CELL BIOLOGY AND REGENERATIVE MEDICINE

36 hrs

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Gain in-depth knowledge in the field of stem cell biology and regenerative medicine
- CO2. Understand the different types of stem cell and their applications.
- CO3. Learn about state-of-the-art technologies, applications and ethics in research of stem cell biology.
- CO4. Understand the legal and ethical aspects of stem cell research and applications.
- CO5. Know the principles and applications of tissue engineering and nanotechnology.

UNIT I

12hrs

Basics of stem cell biology, origin, development, types and properties of stem cells, embryonic stem cells and induced pluripotent stem cells (iPSCs), foetal (amniotic, umbilical cord blood and stem cells from other embryonic tissues), adult stem cells- Hematopoietic stem cells, mesenchymal stem/stromal cells, neural stem cells, hepatic stem cells and skeletal muscle stem cells, cancer stem cells, state-of-the-art technologies, applications and ethics in research of stem cell biology and differentiation

UNIT II

12hrs

Introduction and principles of regenerative medicine, cell-based therapies, pluripotency and regenerative medicine, Cell-cell interactions in tissue regeneration, Isolation and culture of stem cells, Viral and non-viral vectors in stem cell research, Genome editing and use of genetically engineered stem cells. Applications of stem cell-based therapies in bone, blood, cardiovascular regeneration, musculo-skeletal repair, hepatocyte and neuronal transplantation, legal and ethical aspects of stem cell research and applications

UNIT III

12hrs

Nanotechnology: Definition, nanomaterials and their applications; Regenerative medicine, biomaterials and scaffolds in regenerative medicine, principles and applications of tissue engineering, modes of cell and tissue delivery, *in-situ* tissue engineering and bioartificial organs, GMP and regenerative medicine

References:

- Appasani K., Appasani, R.K. (2013) Stem cells and regenerative medicine, Humana Press, 2013
- Lanza R., Atala, A. (2014) Essentials of stem cell biology, 3rd Ed., Academic Press

BSE 513 BEHAVIOURAL BIOLOGY

After successful completion of the course, students will be able to

- CO1. Understand the evolution of social behaviour and types of social behaviours
- CO2. Discern various types of social behaviours across organisms
- CO3. Understand communication and the adaptive significance of these behaviours
- CO4. Appreciate how epigenetics moulds behaviour

UNIT 1

12hrs

Sociobiology: Definition, introduction, history, scope, and significance. Basics of ecology and society; The evolution of animal societies. Instinctive, or intuitive behavior; Evolutionarily stable strategy hypothesis. Social behaviors: Aggregation, reproductive behaviour, territoriality, pack hunting, dominance interactions, parental care, and cooperative interactions within families.

UNIT II**12hrs**

Eusociality in insects: Hive society of social insects (ants, bees, and wasps); Eusociality in crustaceans (shrimps); mammals (mole rats); Cooperative breeding in birds, parental care. Social interactions in microbes-cooperation, conflict, and population. Spatial structure. Plant-pollinator networks.

UNIT III**12hrs**

Communication for social interactions: plumage, morphological characters, vocalizations, pheromones, vibrations; The adaptive significance of social organization; altruism; cooperation; courtship and reproductive behavior; the genetics, development, and epigenetics of social behavior.

References:

- Aronson, E., & Aronson, J. (2018). The social animal. Worth Publishers, Macmillan Learning.
- Brooks, D. (2012). The social animal: The hidden sources of love, character, and achievement. Random House Incorporated.
- Buss, D.M. (Ed.). (2005). The handbook of evolutionary psychology John Wiley & Sons.
- Martin, P., Bateson, P. P. G., & Bateson, P. (1993). Measuring behaviour: an introductory guide. Cambridge University Press.
- Peterson, G.R. (2005). Sociobiology: The new synthesis. 25th Anniversary edition.
- Wilson, E. (2000). Sociobiology: the new synthesis, 25th anniversary edition

**IV SEMESTER
HARD CORE COURSE
BSH 562 BIOTECHNOLOGY AND BIOINFORMATICS**

52 hrs

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Understand how organisms and biological processes are used in biotechnology.
- CO2. Gain in-depth knowledge of useful microorganisms, bioreactors and fermentation technologies.
- CO3. Know how to produce bioplastics, biofertilizers, biopesticides, biodiesel and hybrid plants.
- CO4. Learn about the applications of plant tissue culture and production of various hybrid plants.
- CO5. Gain the basic idea about IPR, patenting and entrepreneurship.
- CO6. Become familiar with animal cell culture, production of transgenic animals and assisted reproductive techniques
- CO7. Understand rDNA technology, principles and applications of PCR, RT-PCR, DNA fingerprinting and genome editing technologies.

UNIT I

13 hrs

Microbial Biotechnology: Production of-silage, probiotics, single cell proteins, hormones and growth factors. Microbial polysaccharides, bioplastics, cell immobilization and its applications. Plant Biotechnology: Plant tissue culture laboratory and aseptic techniques, culture media, callus induction, organogenesis, somatic embryogenesis, micropropagation, production of secondary metabolites, selective markers, somaclonal variation, synthetic seeds and cryopreservation. Haploid production: pollen, anther and ovule cultures. Cell suspension culture, protoplast culture, protoplast fusion and hybridoma technology. Transgenic plants, production of disease-, salinity-, pest-, herbicide-, drought-resistant and high yielding varieties of plants. Production of improved varieties using Ti plasmids. Biodiesel: advantages, production process - transesterification; biodiesel plants (*Jatropha curcas*; *Pongamia pinnata*).

UNIT II

13 hrs

Animal Biotechnology: Animal cell culture techniques, culture media, Natural and synthetic cell culture media composition, primary and secondary cell cultures, cell lines and cell strains and growth factors. Stem cells, gene expression in cell culture, organ culture, histotypic culture, cytotoxicity and cell viability assays, Hybridoma technology, production and application of monoclonal antibodies, Assisted Reproductive Techniques: In-vitro fertilization, embryo transfer, super ovulation and cloning, Transgenic animals and their uses. Animals as bioreactors. Biotechnological applications in sericulture, sylviculture, wildlife conservation and management.

UNIT III

13 hrs

Molecular Biotechnology: Gene manipulation, restriction enzymes, DNA insertion through vectors, clone selection and expression of cloned genes. Expression systems and their applications: *E.coli*, Streptomyces, yeast, baculovirus and animal cells as cloning hosts. Analysis of DNA-DNA sequences, mutagenesis and gene expression, DNA extraction methods and amplification using PCR and RTPCR techniques; DNA fingerprinting. Overview of next generation sequencing and digital PCR highlights. Genome editing technologies: engineered nucleases (Meganucleases; Zinc finger nucleases); TALEN;

CRISPR-Cas9; gene silencing. Intellectual Property Rights (IPRs) / Patent – basic knowledge. Entrepreneurship in biological sciences.

UNIT IV

13 hrs

Introduction to Bioinformatics: Biological database types and their functioning, primary sequence and structure databases. DNA and protein sequence Analysis, FASTA, BLAST and GCG Wisconsin/Emboss packages, Microarray techniques, Gene Expression analysis, Protein Folding, Lattice models, Comparative modeling, threading, folds and function, Distributed Computing approach, genome@home, folding@home, protein structure based targeted drug design – small molecular interactions and docking, Systems biology: Genomics, proteomics, metabolomics and personalized medicine.

References:

- Moo-Young, M. (2011) Comprehensive Biotechnology, Vol.1,2,3&4, Pergamon Press
- Cruger, W. & Cruger, A. (1990) A textbook of Industrial Biotechnology
- Glazer, A.G. (1994) Microbial Biotechnology, WH Freeman and Co.
- Peppler, H.J. (1979) Microbial Technology, Vol.1 & 2, Academic Press
- Bajaj, Y.P.S. (2007) Biotechnology in Agriculture and Forestry, Springer Verlag Publ.
- Russell, G.E. (1988) Biotechnology of Higher Plants, Intercept Publ.
- Reinert J., Yeoman, M.M. (1982) Plant Cell and Tissue Culture. A Lab manual. Narosa Publ.
- Mantell, S.H. and Smith H. (1983) Plant Biotechnology. Cambridge Univ. Press.
- Houdebine, L.-M. (2003) Animal Transgenesis and Cloning by John Wiley & Sons.
- Butler, M. (2004) Animal Cell Culture and Technology, BIOS Scientific Publishers.
- Davis, J.M. (2002) Basic Cell Culture: A Practical Approach (Practical Approach Series), Oxford university press, Oxford

SOFT CORE COURSES **BSS 554 NUTRITIONAL BIOLOGY**

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Understand the basics of nutrition science and its practical applications in day-to-day life.
- CO2. Describe the nutritional requirement and challenges of different age groups through life cycle.
- CO3. Explain the role of proper nutrition during pregnancy and lactation.
- CO4. Describe the physiological changes which take place through lifecycle
- CO5. Understand the types of food safety hazards and its mitigation measures.

UNIT I

13 hrs

Introduction to nutrition science: Composition of food (carbohydrates, proteins, fats, vitamins, minerals, fiber and water), balanced diet, food groups (The 11 food groups), RDA, factors affecting RDA, determination of RDA of different nutrients, reference man and woman, practical application of RDA, current diet and nutrition scenario, common nutrition problems (Starvation, Protein Energy Malnutrition, Nutritional anaemia).

UNIT II

13 hrs

Life span nutrition: Nutritional requirements for adults (reference man and woman), infants, pre-school children, school children, adolescent children. Geriatric nutrition. Nutrition for expectant and Lactating women: Preconceptual nutrition, physiological changes during

pregnancy, nutritional requirements for pregnant women, physiology of lactation, nutritional requirements of a nursing mother.

UNIT III

14 hrs

Food safety hazards: Biological hazards (bacteria, molds, parasites), chemical hazards (Food additives, pesticides/agricultural product residues, veterinary drug residues) physical hazards (natural and unnatural), allergic hazards (Milk, egg, nuts, wheat, shellfish), food adulteration hazards (types and mitigation measures).

References:

- Srilakshmi B.(2021) Nutrition Science, 7thedition, New Age International Publishers.
- Shrilakshmi B.(2019) Dietetics, 8thedition, New Age International Publishers,
- Sharma A.(2017) Principles of therapeutic nutrition and dietetics, CBS Publishers and distributors Pvt. Ltd.
- Lawley R, Curtis L, and Davis J. (2012) Food Safety Hazard Guidebook, RSC publishing, 2nd edition,
- Shubhangini A.J. (2017) Nutrition and dietetics, McGraw Hill Education, 4thedition.
- Longval T., Ananthan R., Bhaskarachary K. and Venkaiah K. (2017) Indian Food Composition Tables. ICMR- National Institute of Nutrition, Telangana, India.
- A Report of the Expert Group. Nutrient Requirements for Indians. (2020) ICMR-National Institute of Nutrition, Telangana, India

BSS 563 ENVIRONMENTAL TOXICOLOGY

40 hrs

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Understand the principles and scope of environmental toxicology, explain the definition, historical context, and significance of environmental toxicology, including major pollution incidents and various environmental pollutants.
- CO2. Demonstrate the understanding of ADME processes, dose-response relationships, and mechanisms of toxicity at cellular and molecular levels, including endocrine disruption and genotoxicity.
- CO3. Evaluate environmental and human health risks. Students will be able to assess toxicant fate, environmental persistence, and perform ecological and human health risk assessments using appropriate testing methods and regulatory guidelines.
- CO4. Propose suitable bioremediation, pollution control, and waste management methods, and evaluate emerging concerns such as nanotoxicology and the impacts of climate change on toxicity.

UNIT I

10 hrs

Introduction to Environmental Toxicology: Definition, scope, and significance; Historical development and major incidents (e.g., Minamata, Bhopal, Endosulfan, Arsenic tragedies). Types of Environmental Pollutants: Heavy metals (e.g., lead, mercury, arsenic, cadmium); Pesticides and herbicides; Industrial chemicals (e.g., PCBs, dioxins); Emerging contaminants (e.g., PFAS, microplastics). Radiation toxicology.

UNIT II

10 hrs

Toxicokinetics and Toxicodynamics: Absorption, distribution, metabolism, and excretion (ADME); Dose-response relationship; Bioaccumulation and biomagnification. Mechanisms of Toxicity: Cellular and molecular basis (oxidative stress, enzyme inhibition); Endocrine

disruption; Genotoxicity and mutagenesis. Remediation and Control: Bioremediation and phytoremediation; Pollution control technologies; Waste management and treatment strategies. Nanotoxicology; Climate change and toxicity; Occupational toxicology.

UNIT III

10 hrs

Environmental and Biological Monitoring: Ecotoxicology; Impact on aquatic and terrestrial ecosystems; Bioindicators and sentinel species; Ecological risk assessment. Testing Methods: In vitro vs. in vivo testing; OECD guidelines for testing; Acute, sub-chronic, and chronic toxicity.

UNIT IV

10 hrs

Environmental Fate of Toxicants: Transport, transformation, and degradation in air, water, and soil. Environmental persistence and half-life. Human Health Risk Assessment: Hazard identification, dose-response, exposure assessment, risk characterization; Toxicological Standards and Guidelines. Regulatory agencies (e.g., EPA, WHO, REACH; US-FDA); Threshold limit values, NOAEL, LOAEL

References

- Connell, D. W. et al. (1999). Introduction to ecotoxicology. Wiley-Blackwell. Environmental Toxicology
- Newman, M. C. (2014). Fundamentals of ecotoxicology: The science of pollution (4th ed.). CRC Press.
- Hodgson, E. (2010). A textbook of modern toxicology (4th ed.). Wiley.
- Klaassen, C. D. (Ed.). (2013). Casarett & Doull's essentials of toxicology (3rd ed.). McGraw-Hill Education.
- Walker, C. H., et al. (2012). Principles of ecotoxicology (4th ed.). CRC Press.
- Duffus, J. H., et al. (2007). Introduction to toxicology and chemistry of pollutants. Blackwell Publishing.
- Manahan, S. E. (2011). Environmental chemistry (9th ed.). CRC Press.
- Gallo, M. A. et al. (Eds.). (2008). Casarett and Doull's toxicology: The basic science of poisons (7th ed.). McGraw-Hill Education.
- Rand, G. M. (Ed.). (1995). Fundamentals of aquatic toxicology: Effects, environmental fate, and risk assessment (2nd ed.). CRC Press.
- Sharma, R. K. (2016). Environmental toxicology. Alpha Science International.

PRACTICAL COURSES

BSP 564 BIOTECHNOLOGY AND BIOINFORMATICS LAB

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Develop laboratory skills in biotechnology
- CO2. Use solid surface fermentation technique for production of antibiotics.
- CO3. Carry out PCR and do the analysis
- CO4. Do vermicomposting and mushroom cultivation.
- CO5. Perform plant tissue culture techniques and check the nutritional and anti-nutritional qualities of edible seeds.
- CO6. Develop the skill to use Search engines, internet tools and databases.
- CO7. Gain practical knowledge of restriction mapping and microarray techniques.

1. Plant tissue culture
2. Evaluation of nutritional and antinutritional qualities of edible seeds.

3. Evaluation of soil qualities (e.g. texture, bulk density and water holding capacity)
4. Evaluation of soil components (e.g. nitrogen, phosphorus, organic carbon)
5. Production and analysis of vermicompost
6. Pattern of decomposition of organic matter (e.g. leaf and woody litter)
7. Solid state fermentation
8. Biogas production
9. Functional properties of food (e.g. water absorption capacity, gelation, foaming and emulsion)
10. DNA extraction methods and PCR /RT PCR confirmation
11. Analysis of RT PCR data in terms of copy number or quantification.
12. Analysis of DNA and protein sequences
13. Biological databases
14. BLAST, FASTA
15. Restriction mapping
16. Microarray techniques
17. Web lab viewer and Ras mols
18. Educational tour - Visits to industries / Research Laboratories and report submission.

BSP 558 NUTRITIONAL BIOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Understand and prepare meal plans using food exchange lists for different age groups and physiological conditions
 - CO2. Create awareness about low-cost nutritional rich food for children.
 - CO3. Describe different adulteration tests for foods.
 - CO4. Understand the food spoilage microorganisms.
1. Adulteration tests (3 samples- cereal/sugar products, milk/milk products, spices and condiments)
 2. Planning balanced diet for reference man and woman using ICMR RDA
 3. Planning and preparing two different low-cost weaning foods
 4. Planning a diet for PEM and Nutritional anaemia
 5. Planning a diet for: Adolescent child, Pregnant woman, Lactating woman, Elderly
 6. Estimation of total microbial count of yeast and molds from spoiled food samples

BSP 565 ENVIRONMENTAL TOXICOLOGY LAB

Course Outcomes:

After successful completion of the course, students will be able to:

- CO1. Learn and practice safety measures to be taken in laboratories.
 - CO2. Determine acute and chronic toxicities through bioassays.
 - CO3. Estimate oil and grease from water and differentiate between clean and polluted water samples
 - CO4. Perform tests for detection of metals and other toxic pollutants and food adulterants.
 - CO5. Assess effect of metals on plant growth
1. Good Laboratory Practices
 2. Safety notices in environmental toxicological studies.
 3. Bioassay experiments using different test systems.
 4. Behavioural study of the fish under exposure to toxicants.
 5. Experiments on solid waste

6. Estimation of oil and grease in water sample.
7. Demonstration of catalase activity in polluted waters.
8. Spot test for detection of metals, residual chlorine, nitrite poisoning, fluoride toxicity, food adulterants and pesticide residues.
9. Effect of CdCl_2 on germination of Bengal gram.
10. Effect of toxicants in meristematic tissue (Onion root tips).
11. GC analysis of pesticide residues in food samples.

BSP 559 PROJECT WORK

Course Outcomes:

After successful completion of the course, students will be able to

- CO1. Carry out a research-based study-select a problem, frame the objectives, conduct literature review, tabulate, represent and interpret the results.
- CO2. Do field work for collection of samples, questionnaire-based surveys.
- CO3. Apply research methodologies, techniques and tools to conduct lab-/field-based research
- CO4. Understand different types of standard methods of citation and references.
- CO5. Write the dissertation, present and interpret the research data scientifically.
- CO6. Build up the capacity to carry out a research project independently.
- CO7. Get skilled to be appointed/absorbed based on the theme of the project work.

Model Question Paper
First Semester M.Sc. BIOSCIENCES Degree Theory Examination

Time: 3 Hours

Max. Marks:70

PART-A

1. Write short notes on any EIGHT of the following: (8x2=16)

- a)
- b)
- c)
- d)
- e)
- f)
- g)
- h)
- i)
- j)

PART-B

Answer any FIVE questions from the following: (5x6=30)

- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

PART-C

Answer any THREE questions from the following: (3x8=24)

- 9.
- 10.
- 11.
- 12.