

**KHALLIKOTE UNITARY UNIVERSITY, BERHAMPUR****P.G. BIOTECHNOLOGY (Semester System- CBCS)****Total Marks =2500****Total Credits= 100****YEAR- 2025-26**

Sl No.	Semester/ Paper code	Title of the Paper	Total Marks TE+MT	No. of Credits
<b>FIRST SEMESTER: 24 CREDITS (600 MARKS)</b>				
1	101	Cell Biology	80+20	04
2	102	Biomolecules and Biochemistry	80+20	04
3	103	Biological techniques and Biostatistics	80+20	04
4	104	Microbiology	80+20	04
5	105P	Laboratory- 01 (Paper-102&103)	100	04
6	106P	Laboratory - 02 (Paper- 101&104)	100	04
7	107	Indian Knowledge System and Biotechnology	80+20	04
<b>SECOND SEMESTER : 24 CREDITS (600 MARKS)</b>				
8	201	Molecular Biology	80+20	04
9	202	Genetic Engineering	80+20	04
10	203	Plant Biotechnology	80+20	04
11	204	Animal Biotechnology	80+20	04
12	205P	Laboratory - 03 (Paper-201 & 202)	100	04
13	206P	Laboratory-04 (Paper- 203&204)	100	04
<b>THIRD SEMESTER : 24 CREDITS (600 MARKS)</b>				
14	301	Immunology	80+20	04
15	302	Bioprocess Engineering and Technology	80+20	04
16	303	Environmental Biotechnology	80+20	04
17	304	Information Technology and Bioinformatics	80+20	04
18	305P	Laboratory - 05 (Paper-301, 302 & 303)	100	04
19	306P	Laboratory - 06: (Paper-304)	100	04
<b>FOURTH SEMESTER : 24 CREDITS (600 MARKS)</b>				
20	401	Research Methodology	80+20	04
21	402	Bioresource Technology	80+20	04
22	403	Intellectual Property Rights, Biosafety and Bioethics	80+20	04
23	404	Project Dissertation and Presentation	100+10 0	08
24	405	Value Added Course (Journal club Presentation)	100	04

In Mid Semester Exam: 1 and 3 will be written exams for 40 marks and home assignment for 40 marks. In Mid Semester Exam 2: home assignment and viva for (40 + 40) marks and In End Semester Exam 4: home assignment and viva for (30+30) marks.

**P.G. (BIOTECHNOLOGY) FIRST SEMESTER**

**PAPER- 101: CELL BIOLOGY**

**Marks: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

**Unit -I. Cell and its Organelles- I**

Cell: Structural organization of the plant and animal cell: Cell wall: Structure and function: Biogenesis and Growth: Plasma membrane: Structure, latest models and functions: Chloroplast: Structure and PSI and PSII Genome organization: Mitochondria: Structure: Genome organization and formations.

**Unit -II. Cell and its Organelles-II**

Endoplasmic Reticulum and Golgi bodies: Structure and function. Lysosomes: Structure and function, Micro bodies (Peroxisomes, Glyoxysomes, Spherosomes): Structure and function, Ribosomes: Structure and function, Nucleus: Structure, Nuclear membranes, nuclear pores, nucleosome organization and P- bodies, role of microtubules and microfilaments, Cell Division: Stages and Molecular events.

**Unit -III. Cellular Functions**

Cell membrane transport: Location of ATPases, ion carriers, channels, pumps and receptors in the plasma membrane: Mechanism of transport of nutrients ions and macromolecules across the membrane, Cellular response: Mechanism of signal transduction: Cellular metabolism: Brief idea on different metabolite pathways in the cell and the mechanism of their regulation.

**Unit -IV. Cell cycle and Biology of Cancer**

Cell Cycle: Molecular events, models, systems and control mechanisms. Role of cyclins and cyclin- dependent-kinases. Apoptosis: Mechanism of programmed cell death; Biology of cancer: A generalized account of the biology of cancer, Structure, function and mechanism of

Prb and P53 tumor suppressor protein, Mutation and Mutagenesis, Ames test for Mutagenesis.

### **SUGGESTED BOOKS FOR READING:**

1. Alberts, B; Johnson, A; Lewis, J; Raff, M; Roberts, K; and Walter, P. (2008) Molecular Biology of the cell (6<sup>th</sup> Ed.), 2014
2. Lodish, H.F. (2016) Molecular Cell Biology (8<sup>th</sup> Ed.)
3. Watson, J.D (2008) Molecular Biology of the Gene (7<sup>th</sup> Ed.), 2013
4. Cooper, G.M & Hausman, R. E. (2013) The cell: A molecular Approach (9<sup>th</sup> Ed), 2023
5. Buchachnanan, B. B., Grisse, W. and Jones, R. L. J., (2000) Biochemistry and molecular biology of plants. American Society of plant physiologists, Rockville, USA
6. Lewine, B. (2004) Gene VIII, Person Prentice Hall, London.
7. Bolsover, S. R. *et al.* (2004) Cell Biology: A short course, John Wiley and Sons, New Jersey, USA

## **PAPER- 102: BIOMOLECULES AND BIOCHEMISTRY**

**Marks: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

### **Unit-I: Chemical Foundations of Biology**

Chemical Bonds: Covalent and weak bonds and their role in living systems. Principles of thermodynamics: Laws of thermodynamics: Enthalpy: Entropy: Concept of free energy: Standard change in free energy: Determination in standard change in free energy: Properties and factors affecting free energy: ATP: Versatility of ATP and its Biological importance. Redox potential: Redox potential and its role in understanding biological reactions, Water: Structure, properties and ionization: pH: Ionization of water: Derivation of expressions for pH and pOH: pH scale: pKa: Conjugate ionization of weak acids and bases.

### **Unit-II: Carbohydrates**

Classification of Carbohydrates: Monosaccharides: Aldoses and Ketoses: Stereoisomerism: Different formulae used to express the structures of monosaccharides: Cyanohydrin synthesis: Detailed structure of Glucose and structures of other monosaccharides: Important properties of monosaccharides: Biological importance, Oligosaccharides: Structure: Properties: Biological importance: Polysaccharides: Classification: Structure: Properties: Biological importance.

### **Unit – III: Amino acids, Proteins and Enzymes**

Amino acids: General Structure: Classification: Properties, Peptide bond- its nature and formation, Proteins: Details of Primary, Secondary, Tertiary, and Quaternary structure of proteins with examples, Ramachandran plot: Steric hindrances, limitations and Ramachandran angles, Fibrous and globular proteins, Enzyme action: Mechanism of Enzyme action with chymotrypsin as an example), Regulatory and active sites; Equations: Michaelis-Menten equation and its significance; Line weaver-Burk equation; Enzyme inhibition and kinetics: allosteric mechanism, Isozymes.

#### **Unit- IV: Lipids: Secondary metabolites: Nucleic acids**

Lipids: Fatty acids: structure and nomenclature: Glycerides: Formation, structure, distribution and biological role of mono, di and triglycerides: Lipoproteins: Structure and Biological importance: Glyceryl ethers, Terpenoids, Sterols: General idea: Role of lipids as Signals. Cofactors and Pigments: Secondary metabolites: General idea on pigments and isoprenoids: Nucleic acids: Sugar: Nitrogenous bases: Phosphate: Nucleosides: Nucleotides: DNA: Structure: Three dimensional forms: Function: RNA: Types: Structure and functions.

#### **SUGGESTED BOOKS FOR READING:**

1. Malacinski, G. M and Feidfelder, D (1998) Essentials of Molecular Biology, 3<sup>rd</sup> Ed. Jones and Bartel, London.
2. Lewine, B. (2004) Gene VIII, PersonPrentice Hall, London.
3. Pierce, B. A. (2006) Genetics: A Conceptual Approach. W. H. Freeman, New York.
4. Jeremy M. Berg, Lubert stryer (2023) Biochemistry 10<sup>th</sup> ed. Macmillan Learning.
5. Voet D and Voet J Biochemistry, International Edition (2021) 4<sup>th</sup> Ed John Wiley & Sons, Limited.
6. David L. Nelson (2021) Lehninger Principle of Biochemistry 8<sup>th</sup> ed. Macmillan Learning

### **PAPER-103: BIOLOGICAL TECHNIQUES & BIostatISTICS**

**Marks: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

#### **Unit- I: Physical and Analytical Techniques in Biology**

Physical techniques in protein, nucleic acid and polysaccharide structural analysis:  
Centrifugation: Principles of centrifugation, Normal, Ultra, Refrigerated, Differential, Density

gradient methods of centrifugation; Chromatography: Paper, Thin layer, Column, GLC, HPLC, ion-exchange, molecular sieve chromatography, Affinity chromatography; Electrophoresis: PAPER; Starch Gel; Cellulose Acetate; SDS-polyacrylamide; two-dimensional electrophoresis; Isoelectric focusing; Electrophoresis, Electroelution, Electroporation; Spectrophotometry: UV-VIS, IR, NMR, LASER, RAMAN and Mass spectroscopy; Beer-Lambert's Law, Colorimetry: Bomb colorimetry.

### **Unit-II: Sequencing, Denaturation, Hybridization and Ligand Interactions**

Sequencing: proteins and nucleic acids; Denaturation: Protein and nucleic acid; Nucleic acid hybridization – structural analysis and biological studies; Ligand interactions: protein-protein and protein-ligand interactions; examples from the cellular organization, Structural arrangements: Membranes, ribosomes, extracellular matrix, chromatin.

### **Unit- III: Biostatistics-I**

Populations and samples, Methods of sampling, Design of experiments, Classification and tabulation of data; histogram, frequency polygons; Measures of central tendencies – mean, median and mode; Measures of deviation, skewness, kurtosis, range, chi-square, standard deviation, Testing hypothesis: Type-I and Type-II errors and level of confidence.

### **Unit- IV: Biostatistics-II**

Probability: Random variables and their distribution; normal distribution, binomial distribution and Poisson distribution; Introduction to probability theory, binomial probability, conditional probability; tests of statistical significance: parametric and non-parametric tests, linear regression, correlation&causality, analysis of variance.

### **SUGGESTED BOOKS FOR READING:**

1. Lewine, B. (2004) Gene VIII, PersonPrentice Hall, London.
2. Pierce, B. A. (2006) Genetics: A Conceptual Approach. W. H. Freeman, New York. Cooper, T. G. (1977) The Tools of Biochemistry, John Wiley and Sons, Singapore.
3. Wilson, K. and Walker, J (2010) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, Delhi.
4. Gomez, K. A. and Gomez, A. A. ((1984) Statistical Procedures for Agricultural Research, 2<sup>nd</sup> Ed. John Weley and Sons, Singapore.

## **PAPER-104: MICROBIOLOGY**

**Marks: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

**Unit- I : Microbial culture and Genetic system:**

Methods in Microbial culture: Pure Culture techniques: Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media: Enrichment culture techniques for isolation of chemoautotrophs: Bacterial Cell wall: Gram stain, Flagella and motility. Bacterial genetic system: Transformation, conjugation, transduction and recombination. Bacterial genetic map reference to *E.Coli*. Viruses: Discovery and structure of viruses; Bacterial, Plant, Animal and Tumor viruses: DNA viruses: Positive strand, Negative strand and Double stranded RNA viruses, Viroids and Prions, Viral Genetics System, Plasmid, transposons. Genetic map of *E coli*

**Unit- II: Microbial taxonomy**

Microbial Evolution: Primitive organisms and their metabolic strategies and molecular coding: Classification of Microbes: An overall idea on microbial classification; Taxonomy of Bacteria: New approaches to bacteria taxonomy classification including ribotyping: Ribosomal RNA sequencing, Taxonomy of Virus: Principles of viral classification: Mycobacteria, Rickettsias, Mycoplasma, Methanogens, Hypothermophilic Archaea: Thermoplasma: Yeast Genetics.

**Unit- III: Microbial Growth and Metabolism**

Microbial Growth: Mathematical expression of growth; Growth curve; Measurement of growth and growth yields; Synchronous growth; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Microbial metabolism: An overview of microbial nutrition and metabolism: Bacterial photosynthesis; Chemolithotrophy; Hydrogen-iron- nitrite oxidising bacteria; Nitrogen and Sulphur reducing bacteria. Methanogenesis and acetogenesis: Fermentations-diversity: Role of anoxic decomposer, Nitrogen metabolism: Nitrogen fixation&Hydrocarbon transformation in microbes.

**Unit- IV: Microbial Pathology**

Host-Parasite Relationship: Normal micro flora of skin, oral cavity, gastrointestinal tract; Entry of pathogens into the host; Colonization and factors predisposing to infections, types of toxin (Exo, Endo, Entero) and their structure. Mode of actions: Virulence and Pathogenesis. Food and water borne diseases: Pathogenic fungal, Emerging and resurgent infectious diseases: Transmission of infectious diseases: Transmission of respiratory infections: Tuberculosis; STD including AIDS,

Hepatitis; Diseases transmitted by animals (rabies, plague): insects and ticks (rickettsias, Lyme, Disease, malaria). Chemotherapy/Antibiotics: Antimicrobial agents, Sulfa drugs, Antibiotics: Penicillins and Cephalosporins.

#### **SUGGESTED TEXT BOOKS FOR READING:**

1. Maloy, S. R., Cronan, J. E. Jr. and Freifelder, D. (2008) Microbial Genetics, 2<sup>nd</sup> Ed. Norosa, New Delhi.
2. Prescott, L. M., Harley, J. P. and Klen, D. A. (2022) Microbiology, 12<sup>th</sup> Ed. WCB Mc Graw Hill, New Delhi.
3. Alexopoulos, C. J., Mims, C. W. and Blackwel, M. (1996) Introductory Mycology, John Wiley and Sons, New York
4. Michael J. Pelczar (2023) Microbiology, 5<sup>th</sup> Ed, Tata McGraw Hill Education Pvt. Ltd., New York

#### **PAPER- 105P: Laboratory-01: Biomolecules and Biochemistry & Biological Techniques and Biostatistics**

**Marks: 100**

##### **Pattern of Question in Practical examination**

- 01. Major Experiment carries 40 marks (2× 20=40)**
  - 02. Minor Experiment carries 30 marks (2× 15=30)**
  - 03. Spotting/ Minor Experiment carries 10 marks (5× 2=10)**
  - 04. Question for Viva-voce carries 1 marks (10)**
  - 05. Question for Practical record carries 10 marks (10)**
1. Determination of absorption maxima of dyes.
  2. Verification of Beer-Lambert's Law
  3. Titration Curves of amino acids and organic acids.
  4. Quantitative Estimation of sugar and preparation of standard graph by using Anthrone method.
  5. Extraction&Estimation of quantity of sugar by using Nelson Somogyi method.
  6. Extraction and estimation of amino acid
  7. Extraction and estimation of soluble protein
  8. Extraction and estimation of RNA
  9. Extraction and estimation of DNA
  10. Enzymatic hydrolysis of polysaccharides
  11. Extraction assay of Catalase
  12. Extraction assay of Peroxidase
  13. Co-relation and regression analysis
  14. Measurement of Central tendency, and dispersion
  15. PH meter
  16. Spectro photometry
  17. Centrifugation

#### **SUGGESTED TEXT BOOKS FOR READING:**

1. Swati Agarwal and Suphiya Khan (2019) Advanced lab practices in Biochemistry and Molecular Biology.
2. David T Plummer (2006) An Introduction to practical Biochemistry (3<sup>rd</sup> Ed)

#### **PAPER-106P: Laboratory-02: Cell Biology and Microbiology**

**Marks: 100**

##### **Pattern of Question in Practical examination**

- Major Experiment carries 40 marks (2× 20=40)**



Traditional agriculture practices, Traditional Ayurveda and plants based medicines, sixty four art forms and occupational skills (64 Kalas) Metals and Metal working technology), town and Planning architecture in india. Vastu sastra. A Vaisesikan approach to physical reality, constituents of the physical reality.

### **Unit III: Indian knowledge system on Agriculture and Plant Biotechnology**

Indian agriculture system through ages; Indigenous knowledge Practices in crop production and management, in plant protection and weed management, in farm machine&tools, in soil and water management, in medicinal&aromatic plants for disease diagnosis, in animal husbandry, in stored grain pests' management; Indian knowledge system in Food Security.

### **Unit 4: Humanities&Social Sciences in IKS**

Health, Wellness&Psychology, Ayurveda sleep and food. Role of water in wellbeing, Yoga way of life (Astanga Yoga). Indian approach to Psychology, the Triguna system Body mind intellect. Consciousness complex. Governance, Public administration & Management reference to Ramayana, Artha sastra. Kautilyan state.

### **Suggested Books:**

1. Mahadevan et al. (2022) Introduction to Indian Knowledge system: Concepts and Applications, PHI learning Pvt. Ltd.
2. Trehan K (2013) Biotechnology. New Age international (p) Ltd.
3. Smith J E (2009) Biotechnology. Cambridge University Press
4. Goel D, Parashar S (2013). IPR, Biosafety and Bioethics. Pearson

### **P.G. (BIOTECHNOLOGY) SECOND SEMESTER**

#### **PAPER-201: MOLECULAR BIOLOGY**

**Marks: 100 (80 TE +20MT)**

#### **Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

#### **Unit-I: DNA Replication, Recombination and Repair:**

Mechanism of DNA replication: Enzymes and accessory proteins involved in DNA replication; Molecular mechanism of recombination; Holiday junction; Gene targeting; Gene disruption; Cre/Lox recombination; Rec A and other recombinases; DNA repair- various mechanisms of DNA repair.

#### **Unit-II: Transcription and Post-transcriptional Changes in RNA:**

Transcription process: RNA polymerase, General and specific transcription factors; Regulatory elements and mechanism of transcription regulation; 5' cap formation. Transcription termination 3' end processing and polyadenylation, Splicing: Brief description of mechanism of splicing, Inhibition of splicing, Export of mRNA: Editing nuclear export of mRNA; mRNA stability.

### **Unit- III: Translation and Protein Localization:**

Translation Process: Translation machinery; Mechanism of initiation, elongation and termination; Regulation of translation; Co-and post-translational modifications: Mechanism and modifications of proteins; protein import: import into nucleus, mitochondria, chloroplast and peroxisome; Receptor mediated endocytosis: Mechanism, Antisense Ribozyme Technology: Biochemistry of ribozyme; Hammer-head, hairpin and other ribozymes; Applications of antisense and ribozyme technologies.

### **Unit- IV: Molecular Mapping of Genome and Genome Sequencing:**

Mapping: General idea on Chromosomal mapping and physical mapping, map-based cloning; Choice of mapping population; Strategies for sequencing genome: Contigs, VNTRs, FISH Method, RFLP, RAPD and AFLP analysis, Molecular markers: Their linkage to disease resistance genes; RFLP and its application as marker, Genomic libraries: Methods of their preparation, YAC, BAC libraries.

### **SUGGESTED BOOKS FOR READING:**

1. Brown, T. A. (2017) Genomes. John Wiley and Sons (Asia), Singapore.
2. Brown, T. A. 8<sup>th</sup> Ed. (2020) Gene Cloning and DNA Analysis. Blackwell Science, London.
3. Glick, B. R. and Pasternak, J. J. (2003) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, Washington, D. C., USA.

## **PAPER- 202: GENETIC ENGINEERING**

**MARKS: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

**Unit-I: Molecular Tools:**

Enzymes: Restriction endonucleases, Ligases, Reverse transcriptase, Terminal transferase, poly A polymerase, DNA polymerase I&III, Thermophilic polymerases, T4 Polynucleotide kinase, Alkaline phosphatase, RNAases ( RNAase A/RNAase H), S1 Nuclease, Proteinase K, Lysozyme, Uracil DNA glycosylase; Oligonucleotides: Linkers, Adaptors and Primers their role in Genetic Engineering, Probes: DNA and RNA probes preparation, labeling and amplification; Vectors: Plasmids, Phages, Cosmids, Phagemids, BAC, PAC, MAC, YAC and Transposons; Expression: Shuttle and Binary vectors; Gene cartridges, Expression strategies for heterologous genes: Vector engineering and codon optimization, host engineering. Expression in bacteria and yeast.

### **Unit- II: Isolation, sequencing, synthesis and amplification of desired genes / DNA:**

DNA: Isolation, purification and yield analysis; Isolation of Genes: Isolation methods for genes coding for RNAs, specific/tissue specific proteins and unknown proteins; Gene sequencing: Automated sequencing, PCR/Microarray/ Mass spectrometry based sequencing; Gene synthesis: Methods of gene synthesis, Gene amplification; PCR technology: Principle and its application; Types: Basic, Inverse, Anchored, Asymmetric and RT ; Gene tagging: T-DNA and transposon tagging in identification and isolation of genes, DNA Transfection.

### **Unit- III: Cloning Strategies:**

Cloning genomic DNA: General principle of genomic DNA cloning including m-RNA enrichment; Genomic DNA libraries, Northern blotting, use of  $\lambda$  phage and high capacity vectors for cloning, PCR as an alternative for genomic DNA cloning, sub-genomic libraries; Alternative strategies of gene cloning: Cloning interacting genes- Two and three hybrid systems; Cloning differentially expressed genes, Nucleic acid microarray assay, Study of gene regulation : Primer Extension, SI mapping, Rnase protection assay.

### **Unit-IV: Trans-genes and gene products**

Site directed mutagenesis: Procedures of directed mutagenesis – Oligonucleotide directed mutagenesis with M13 Phage and Plasmid, PCR-amplified oligonucleotide directed mutagenesis, Random mutagenesis with degenerate oligonucleotide and nitrogenous base analogs, Display of Selected Mutants: Phage and Phagmid display of selected mutants, *in-vivo* mutagenesis: Procedure with an example. Gene product (Protein) engineering: Increasing enzyme activity, modifying enzyme specificity, Addition of disulfide linkages, Reduction of sulphydryl groups, Changing amino acids; Processing of recombinant proteins: Purification, refolding, characterization and stabilization, Targeted gene: Gene augmentation and Gene silencing.

### **SUGGESTED BOOKS FOR READING:**

1. Lewine, B. (2018) Gene XII, Person Prentice Hall, London.
2. Pierce, B. A. 7<sup>th</sup> (2019) Genetics: A Conceptual Approach. W. H. Freeman, New York.
3. Sandy B. Primrose, Richard Twyman 7<sup>th</sup> (2014) Principles of Gene Manipulation and Genomics

## **PAPER- 203: PLANT BIOTECHNOLOGY**

**Marks: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

### **Unit-I: Plant Tissue Culture - I:**

Introduction: Tissue culture laboratory: Culture room, Equipment and Glassware, Culture media (Composition and preparation); Techniques: Sterilization, Maintenance of aseptic conditions; Methods of incubation. Totipotency, cyto differentiation and organogenesis and their significance in plant tissue culture. Protoplast: Isolation and culture; protoplast fusion; Techniques and mechanism, hybrid types and their identification and isolation.

### **Unit-II: Plant Tissue Culture - II:**

Callus, Cell suspension and Single cell Culture : Principles, types, various protocols, factors involved, application; shoot and root regeneration; Somatic embryogenesis; Artificial seed; Organ culture: Principles, protocols and applications of anther, pollen, ovary, ovule, root culture; Characteristics and Importance of haploids and homozygous lines; Meristem culture: shoot tip culture and production of virus free plants; Embryo culture: Types, methods and embryo rescue, Cybrids: Somatic hybridization: somaclonal variations and its importance; Slow growth culture and cryopreservation, Applications of plant tissue culture

### **Unit-III: Plant Transformation Technology - I:**

General Principles of gene transfer: Vectors mediated gene transfer: Plasmid vectors: Agrobacterium-mediation : Basis of tumor formation: Hairy root: Features of Ti and Ri plasmids: Mechanism of Agrobacterium based gene transfer, Role of virulence genes Agro-infection: use of 35S and other promoters; Use of reporter genes and reporter genes with introns as genetic marker and use of scaffold attachment regions, Viral vectors: Multiple gene transfer, Methods of gene transfer: Physical delivery, Chemical mediated and direct uptake, Transgene: Confirmation of integrity, Inheritance and Stability, Transformation: Chloroplast and mitochondrial transformation: Problems of plant gene transfer.

### **Unit-IV: Plant Transformation Technology - II:**

Applications of plant transformation technology: (i) Herbicide resistance: Phospho-ionohticin, glyphosphate, (ii) Insect resistance: Bt genes, importance and role of Cry genes and Cry proteins: (iii) Viral resistance: coat protein mediated, nucleocapsid gene; (iv) disease resistance: chitinase, glucanase Antifungal proteins: thionine, and PR proteins, (v) Abiotic stress resistance: (vi) Plant secondary metabolites: Control mechanism and manipulation of phenylproanoid pathway, shikimate pathway; Antibodies; Edible vaccines; (vii)Molecular marker based Breeding: RFLP, AFLP, RAPD, SCAR, SPAPERP, QTL and Microsatellite based cloning and molecular marker assisted selection.

**SUGGESTEDTEXT BOOKS FOR READING:**

1. Brown, T. A. (2001) Gene Cloning and DNA Analysis. Blackwell Science, London.
2. Glick, B. R. and Pasternak, J. J. (2003) Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, Washington, D. C., USA.
3. H. S. Chawla (2003) Introduction to Plant Biotechnology 3<sup>rd</sup> ed Science Publishers USA
4. M. K. Razdan (2003) Introduction to Plant Tissue Culture 2<sup>nd</sup> ed, Science Publishers USA

**PAPER-204: ANIMAL BIOTECHNOLOGY**

**Marks: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

**Unit- I: Animal Cell Culture:**

Animal cell Culture: Equipment and materials for animal cell culture technology; Cell line cultures: Primary and established cell line cultures, Culture Medium: Introduction to balanced salt solutions and simple growth medium; Chemical, physical and metabolic functions of different constituents of culture medium; Additional Constituents: Role of carbon dioxide; Role of serum and supplements; Serum and protein defined media and their application.

**Unit-II: Culture Techniques and Related Phenomena:**

Basic Techniques of mammalian cell culture *in-vitro*: Disaggregation of tissue and primary culture: Maintenance of cell culture: Cell separation: Scaling-Up of animal cell culture. Cell synchronization; Cell cloning and micromanipulation; cell transformation; Somatic cell genetics; Organ and Histotypic culture; Measurement of cell death; Apoptosis.

**Unit- III: Applied Animal Cell Culture:**

Animal Cell Culture: General applications; Stem-cell culture: Stem cell and embryonic stem cell culture and their applications; Cell culture: Preparation of vaccines; Three-dimensional culture: Applications; Tissue engineering: applications.

#### **Unit-IV: Animal Reproductive Biotechnology:**

Structure of sperm and ovum; cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, embryo recovery and in vitro fertilization. Culture of embryos, cryopreservation of embryos, embryo transfer technology, transgenic manipulation of animal embryos, applications of transgenic animal technology.

#### **SUGGESTED TEXT BOOKS FOR READING:**

1. Gordon, I. (2005) Reproductive techniques in farm animals
2. Portner, R; (2007). Animal Cell Biotechnology: Methods and Protocols
3. Freshney, R. Ian. Culture of animal cells (8<sup>th</sup> edition), 2021

#### **PAPER-205P: Laboratory-03: Molecular Biology and Genetic Engineering**

**Marks: 100**

#### **Pattern of Question in Practical examination**

- 01. Major Experiment carries 40 marks (2× 20=40)**
- 02. Minor Experiment carries 30 marks (2× 15=30)**
- 03. Spotting/ Minor Experiment carries 10 marks (5× 2=10)**
- 04. Question for Viva-voce carries 1 marks (10)**
- 05. Question for Practical record carries 10 marks (10)**

1. Isolation of DNA from bacteria
2. Isolation of DNA from plants
3. Agarose Gel Electrophoresis of DNA
4. Cellulose acetate Electrophoresis
5. SDS PAGE
6. PCR Techniques

7. RFLP
8. Ligation of DNA
9. Southern Blotting
10. Western Blotting
11. Paper Chromatography
12. Thin Layer Chromatography
13. Column Chromatography
14. Ion-exchange Chromatography

**SUGGESTED TEXT BOOKS FOR READING:**

1. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual

**PAPER-206P: Laboratory-04: Plant Biotechnology and Animal Biotechnology**

**Marks: 100**

**Pattern of Question in Practical examination**

01. Major Experiment carries 40 marks (2× 20=40)
02. Minor Experiment carries 30 marks (2× 15=30)
03. Spotting/ Minor Experiment carries 10 marks (5× 2=10)
04. Question for Viva-voce carries 1 marks (10)
05. Question for Practical record carries 10 marks (10)

1. Maintenance of Lab
2. Media preparation
3. Sterilization of Explant and Inoculation
4. Callus Culture
5. Maintenance of culture
6. Culture of sterile plants and buds
7. Culture medium for animal cell culture
8. Adherent and floating cell culture
9. Isolation of lymphocytes
10. Culture of stem cell

**SUGGESTED TEXT BOOKS FOR READING:**

1. Butler M. & Dawson: Cell culture labfax

**P.G. (BIOTECHNOLOGY) THIRD SEMESTER**

**PAPER-301: IMMUNOLOGY**

**Marks: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

### **Unit- I: Introduction:**

Phylogeny of immune system: Innate and acquired immunity; Clonal nature of immune response; Organization and structure of lymphoid organs; Nature and Biology of antigens and super antigens; Antibody structure and function: Antigen-antibody interactions; Major histo-compatibility complex; BCR and TCR: Generation of diversity; Complement system.

### **Unit- II : Immune System:**

Hematopoiesis and differentiation: Lymphocyte trafficking; B and T-lymphocytes; Macrophages; Dendritic cells; Natural killer and lymphokine activated killer cells; Eosinophil, neutrophils and mast cells, Mechanism of T cell and NK cell mediated lysis” Antibody dependent cell mediated cytotoxicity, Macrophage mediated cytotoxicity.

### **Unit- III: Cell Mediated Cytotoxicity; Hypersensitivity; Autoimmunity**

Antigen processing and presentation: Generation of humoral and cell mediated immune responses; Activation of B- and T- lymphocytes; Cytokines and their role in immune regulation: T-cell regulation, MHC restriction; Immunological tolerance; General aspects and mechanism: Hypersensitivity and autoimmunity.

### **Unit- IV: Applied Immunology:**

Transplantation: immunity to infectious agents like intracellular parasites, helminthes and viruses; Tumor immunology; AIDS and other immune deficiencies: Hybridoma technology and monoclonal antibodies.

### **SUGGESTEDTEXT BOOKS FOR READING:**

1. Kinddt, T.J; Goldsby, R.A; Osborne, B.A and Kuby, J. 8<sup>th</sup> (2022): Kuby Immunology
2. Brostoff, J., Seaddin, J.K; Male, D, and Roitt, I.M; (2002): Clinical Immunology
3. Paul, W.E. 8<sup>th</sup> Ed (2022): Fundamental Immunology
4. Parhan,P, 6<sup>th</sup> Ed (2023): The Immune System

## **PAPER-302: BIOPROCESS ENGINEERING AND TECHNOLOGY**

**MARKS: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

### **Unit- I: Introduction**

Bioreactor: General Features; Isolation, preservation and maintenance of industrial microorganisms; Kinetics of microbial growth and death; Media and industrial fermentation; Air and media sterilization. Types of fermentation processes: Analysis of batch, fed-batch and continuous Bioreactors; Stability of microbial reactors; mixed microbial populations; Specialized Bioreactors: pulsed, fluidize, photo bioreactors etc.; Bioprocess parameters: Measurement and control and scale up.

### **Unit- II: Downstream Processing:**

Introduction: General idea on downstream processing, Processing procedure: Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, Chromatography: Role of Chromatography in downstream processing, Purification of the Product: Membrane process (Dialysis); Drying and crystallization.

### **Unit-III: Industrial Production of Chemicals:**

Whole cell immobilization: Methods of whole cell immobilization and its applications in industries, Industrial production of chemicals: Alcohol (ethanol), Acids (citric acid and gluconic acid) solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acids (Lysine, glutamic acid), Single cell protein (SCP): Production of single cell protein.

### **Unit- IV: Food Technology:**

Canning and packing: Elementary idea of canning and packing; Sterilization and pasteurization: Procedures employed for Sterilization and pasteurization of food products; Technology: Production of typical food/ food products (bread, Cheese, Idli), Food preservation: Techniques of food preservation.

### **SUGGESTED TEXT BOOKS FOR READING:**

1. Shuler, M.L; and Kargi, F. 3<sup>rd</sup> Ed (2017): Bioprocess Engineering: Basic Concepts
2. Stanbury, P.F and Whitaker, A, (2010): Principles of fermentation technology
3. Bailey, J.E, and Ollis, D.F (1986): Biochemical engineering fundamentals

### **PAPER-303: ENVIRONMENTAL BIOTECHNOLOGY**

**MARKS: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

#### **Unit- I : Environment:**

Introduction: Definition and basic concepts, Environmental components; Global environmental problems; Environmental priorities; Man, and environment: Interrelationship and manmade environment destruction, Environmental management: Methodology, problem solving approach and its limitations.

#### **Unit-II: Environmental Pollution: Air Pollution:**

Air Pollution: Methods of measurement; Sources of air pollution, Effects on men, vegetation and materials; Monitoring techniques, control through Biotechnology; Air pollution and Ozone depletion: Role of air pollution in ozone depletion and Biotechnological remedial measures, UV-B, Greenhouse effect and Acid rain: their impact and Biotechnological approaches for management.

#### **Unit- III: Environmental Pollution: Water Pollution:**

Water Pollution: Water as a scarce natural resource; Need for water management; Sources of water pollution; Waste water collection; Measurement of water pollution; Effluent: General idea on Industrial effluents and water pollution, Treatment: D.O.C. and C.O.D. methods and disposal of effluents, Degradation of: hydrocarbons, Oil pollutants, surfactants, pesticides; Bio pesticides: Role of Bio pesticides in integrated pest management.

#### **Unit- IV: Waste Treatment:**

Methods of waste water treatment: Aerobic process: Oxidation pond, activate sludge, trickling filter, towers rotating disc and drums; Anaerobic process: Anaerobic digestion, filters, up flow, anaerobic sludge, blanket reactors; Treatment schemes for waste waters: dairy, distillery, tannery, sugar, antibiotic industries; Methods of Solid wastes Treatment: Sources and management (composting, worm culture and methane production), Microbial degradation: Microbiology of degradation of xenobiotic in the environment, ecological considerations, decay and behavior of degradative plasmids.

#### **SUGGESTED TEXT BOOKS FOR READING:**

1. Eisendbud, M; (1997) Environmental Radioactivity, 4<sup>th</sup> edition
2. Enger, E.D; Smith B.E; (2013) Environmental Science- A study of inter-relationships
3. Mohapatra P K (2006) Textbook of Environmental Biotechnology International Publishing House, New Delhi.
4. A K De (2023), Environmental Chemistry, 11<sup>th</sup> Ed, New Age International Publisher.

## **PAPER-304: INFORMATION TECHNOLOGY AND BIOINFORMATICS**

**MARKS: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

### **Unit- I: Anatomy of a digital Computer:**

Working principle of different peripheral devices, low level and high-level languages, language translators, difference between compiler and translators, binary number system & conversion to decimal number system, Flow charting & writing of algorithm.

### **Unit- II: Structure of c program:**

Operators, Data types, if else statement, nested if, SWITCH, FOR, DO, WHILE statements, concept of arrays (1D 2D) library functions, user defined functions. Data structure memory representations, insertion and deletion operation on STACK&QUEUE simple query using SQL, DDL, DML&DCL.

### **Unit- III: Introduction to Bioinformatics:**

Genome project, life science discovery process, data source in life science, developing and biological data integration system challenges in biological information integration, Data base management system in bioinformatics: Data base management concept,&definition, data life cycle, steps of data life cycle.

### **Unit- IV: DBMS, Modeling and Simulation:**

Data mining: concept & methods, pattern matching, Pair wise sequence alignment, local vs. global alignment, multiple sequence alignment, Dot matrix analysis, substitution matrices. Modeling and Simulation: Fundamental concepts, continues simulation, discrete simulation, hybrid simulation, Monte Carlo methods, metropolis algorithm. Protein structure: Ab-initio method, heuristic method, template selection, alignment, model building & evaluation.

### **SUGGESTEDTEXT BOOKS FOR READING:**

1. Lesk, A.M 5<sup>th</sup> Ed (2019); Introduction to Bioinformatics
2. Pevsner, J. (2015); Bioinformatics and fundamental Genomics

**PAPER-305P: Laboratory-05: Immunology, Bioprocess Engineering and Environmental Biotechnology**

**Marks: 100**

**Pattern of Question in Practical examination**

- 01. Major Experiment carries 40 marks (2× 20=40)**
- 02. Minor Experiment carries 30 marks (2× 15=30)**
- 03. Spotting/ Minor Experiment carries 10 marks (5× 2=10)**
- 04. Question for Viva-voce carries 1 marks (10)**
- 05. Question for Practical record carries 10 marks (10)**

**A) Immunology**

- 1. Radial immunodiffusion
- 2. Ouchterlony Double diffusion method
- 3. Radial immunoassay
- 4. Immuno- electrophoresis
- 5. Rocket immunoelectrophoresis
- 6. Counter current electrophoresis
- 7. E LISA test.
- 8. Blood group Testing

**B) Bio-processing**

- 1. Instrumentation and operation of fermentor
- 2. Media preparation and inoculation

**C) Environmental Biotechnology**

- 1. Physical analysis of water
- 2. Chemical analysis of water (Salinity, Chlorinity, Hardness, N-content)
- 3. Determination of dissolved oxygen in polluted water
- 4. Determination of BOD of polluted water

**SUGGESTED TEXT BOOKS FOR READING:**

- 1. Practical Immunology. Franck C. Hay and Olwyn M. R. Westwood Wiley-Blackwell, 4<sup>th</sup> Edition.
- 2. A Handbook of Practical and Clinical Immunology, G. P. Talwar & S. K. Gupta. 2<sup>nd</sup> edition

## **PAPER-306P: Laboratory-06: Information Technology and Bioinformatics**

**Marks: 100**

### **Pattern of Question in Practical examination**

- 01. Major Experiment carries 40 marks (2× 20=40)**
- 02. Minor Experiment carries 30 marks (2× 15=30)**
- 03. Spotting/ Minor Experiment carries 10 marks (5× 2=10)**
- 04. Question for Viva-voce carries 1 marks (10)**
- 05. Question for Practical record carries 10 marks (10)**

### **INFORMATION TECHNOLOGY**

1. C-Programming on variables&Expression of assignments
2. Loops, if else. Case Statement, for, while, do-while
3. Break, continue go to statement
4. 1-D and 2-D array
5. Simple query using SQL, DDL, DML & DCL statement in SQL, data manipulation in SQL
6. Write a C program for calculating factorial of a number?
7. Write a C program to accept two number and swap it?
8. Write a C program to accept a number and check whether it is prime or not?
9. Write a C program to accept a number to find our multiplication table?
10. Write a C program to accept 10 number and store in an array and display in reverse order

### **BIOINFORMATICS**

1. Retrieval of Nucleotide sequence from data base
2. Retrieval Pair wise sequence alignment of nucleotide sequence using BLASTn algorithm
3. Retrieval Dot matrix analysis of two nucleotide sequence
4. Retrieval of protein sequence from data base
5. Pair wise sequence alignment of amino acid sequence using BLASTp algorithm
6. Retrieval Dot matrix analysis of two protein sequence
7. Multiple sequence alignment by Clustal W2 in EBI
8. Phylogenetic Analysis using Phylip Software
9. Selection of template, homology modeling using modeler

10. Create an employee table and store some records?
11. Create a student table and store some records?
12. Delete some record from employee table, who has left their job?
13. Insert some records in an employee table?
14. Display records whose salary more than 10,000?

### **SUGGESTED TEXT BOOKS FOR READING:**

1. Syed Ibrahim, K., Guru Subramanian, G., Zothansanga, Yadav, R.P., Senthil Kumar, N., Pandian, S.K., Borah, P., Mohan; Bioinformatics – A Student's Companion

## **P.G. (BIOTECHNOLOGY) FOURTH SEMESTER**

### **PAPER-401: RESEARCH METHODOLOGY**

**MARKS: 100 (80 TE +20MT)**

#### **Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

#### **Unit I: Introduction to Research methodology**

Research: Definition, Importance of research, Characteristics of research, Types of research (basic, applied, qualitative, quantitative, analytical, etc.); Features of translational research – Concept of laboratory to market (bench to public) – Industrial R&D.

Research process – Observation – Axiom – Theory – Experimentation; Selection and formulation of research problem, Research questions, Research design – Formulation of Hypothesis, Review of Literature, Framing Research objective.

#### **Unit II: Preparation for research**

Choosing a mentor, lab and research question; maintaining a lab notebook; Good lab practices; method of storing chemicals, solvents and glassware, procedures for maintenance of stock, handling of instruments; handling and storage of biological material, laboratory waste management and disposal; lab safety and management of personnel, facilities, buildings and equipment.

#### **Unit III: Process and skill of communication**

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in

conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences.

Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation&presentation; participating in group discussions; Internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

#### **Unit IV: Scientific communication**

Types of research report: Dissertation and Thesis, editorial, research paper, review article, short communication, conference presentation etc.; Scientific publication writing: elements of a scientific paper including abstract, introduction, materials&methods, results, discussion, references; drafting titles and framing abstracts;

Publishing scientific papers - Assessment of Quality of Journals, peer review process and problems, recent developments such as open access and non- blind review; plagiarism, software for plagiarism;ethical issues; scientific misconduct.

#### **SUGGESTEDTEXT BOOKS FOR READING:**

- 1) Leedy, P. D.,& Ormrod, J. E. (2015). *Practical research: Planning and design*. Pearson.
- 2) Pruzan, P. (2016). *Research methodology: the aims, practices and ethics of science*. Springer.
- 3) Booth, W. C., Booth, W. C., Colomb, G. G., Williams, J. M., Colomb, G. G., & Williams, J. M. (2003). *The craft of research*. University of Chicago press.
- 4) Thomas, C. G. (2021). *Research methodology and scientific writing*. Springer Nature.
- 5) Illingworth, S., & Allen, G. (2020). *Effective science communication*. IOP Publishing Limited.
- 6) Aines, R. D., & Aines, A. L. (2019). *Championing science*. University of California Press.
- 7) Resnik, D. B. (2005). *The ethics of science: An introduction*. Routledge.
- 8) C.R. Kothari: *Research Methodology- Methods and Techniques* (New Age International Publishers)

### **PAPER-402: BIORESOURCE TECHNOLOGY**

**MARKS: 100 (80 TE +20MT)**

**Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

**Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

#### **Unit I: Survey and Documentation of biodiversity and bioresources**

Biodiversity and bioresources: concept and scope; evolution of biodiversity, factors promoting biodiversity; levels of biodiversity - genetic, species and ecosystem diversity; measuring organismal diversity: species richness index, species evenness index, Shannon-Wiener Index and Simpson Index;measurement of biodiversity at spatial level: alpha, beta and gamma diversity.

Estimate of biodiversity loss; Means of biodiversity loss; Causes of biodiversity loss; Species threat status: IUCN threat categories and criteria; Red Data Book; Biodiversity hotspots; effect of climate change on biodiversity; Biopiracy: factors and reasons, steps to check biopiracy, applicability of modern technologies in checking biopiracy.

## **Unit II: Conservation of bioresources**

Why conserve bioresources; global measures for conserving bioresources: international conservation organizations (IUCN, WWF, UNEP, Biodiversity International, WCMC); multilateral treaties (Ramsar Convention, WHC, CITES, CBD). Biological Diversity Act, 2002 and Biological Diversity Rules, 2004, Wild Life (protection) Act, 1972 including amendments in 1991, Forest (conservation) Act, 1980, Bioresource Development Board, Indian Bioresource Information Network; National Biodiversity Authority, National Biodiversity Action Plan, 2008, State Biodiversity Boards; TRIPS Agreement, PVPFRA, Plant Breeder's rights, Farmer's rights, Tribunal rights, Traditional Resource rights, Variety registration.

## **Unit III: Conservation Strategies**

In situ conservation sites: Protected areas - Biosphere Reserves, National Parks, Wildlife Sanctuaries; Reserve Forests; Community conserved areas - Sacred groves and community forests; In situ conservation of aquatic ecosystems: lakes, wetlands, mangroves, coral reefs, and ponds. Ex situ conservation sites: Botanical Gardens and Arboreta, Field gene banks, Seed banks, Zoological parks, zoos and aquaria, In vitro conservation; cryopreservation and cryobanks; conservation in permafrost conditions. Gene banks: IBPGR, Indian gene banks for plant, animal, fish, microbial and insect genetic resources; NBPGR, National Genetic Resource Advisory Council.

## **Unit IV: Molecular Characterization of bioresources**

Biotechnology and its role in biodiversity conservation; Applications of molecular markers like RAPD, SSR, ISSR, SSAP and AFLP, Expressed Sequence Tags in molecular characterization of different bioresources. Proteins, isozymes and allozymes as markers, their significance in characterization; methods of isozyme and allozyme analysis. Softwares for molecular characterization and diversity analysis; Genetic and Genomic characterization of plant and animal resources for conservation and exploitation.

### **SUGGESTED TEXT BOOKS FOR READING:**

1. David, H. (2005). Handbook of biodiversity methods: survey, evaluation and monitoring. Cambridge University Press.
2. Krishnamurthy, K. V. (2003). *Textbook of biodiversity*. Science Publishers.
3. Singh, M. P., Singh, B., & Dey, S. (2004). *Conservation of biodiversity and natural resources*. Daya Books.
4. Dey, S. (2004). *Bioresources and Genepool Conservation*. Daya Books

## **PAPER-403: Intellectual Property Rights, Biosafety and Bioethics**

**MARKS: 100 (80 TE + 20MT)**

### **Pattern of Question in Term End examination**

**Duration: 3 hours**

**Group-A: 10 short questions each carries 02 marks (2× 10= 20)**

## **Group-B: 04 Long Questions in either or Format each carries 15 marks (4× 15=60)**

### **UNIT I Introduction to IPR**

Introduction to intellectual property; types of IP: patents, trademarks, copyright&related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art' : invention in context of "prior art" ; patent databases - country- wise patent searches (USPTO, EPO, India); analysis and report formation.

### **Unit II Patenting**

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure -publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists- university/organizational rules in India and abroad, collaborative research -backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

### **Unit III Biosafety**

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs&LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation– protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.

### **Unit IV Bioethics**

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

### **SUGGESTED TEXT BOOKS FOR READING:**

1. Sibi G (2021) Intellectual property Rights, Bioethics, Biosafety and Entrepreneurship in Biotechnology. Willey India Pvt. Ltd.
2. Jhamb S and Jain S (2022) Intellectual property Rights, Innovation and Entrepreneurship Development. Edwin Publications  
(Publications from WIPO should also be used)
3. D Goel & S Parashar (2013) IPR, Biosafety and Bioethics 1<sup>st</sup> Ed, Pearson.

### **PAPER-404: PROJECT**

**MARKS: 300**

**Dissertation Report – 200 Marks**

**Dissertation Presentation & Viva Voce- 100 Marks**

Student has to undertake a Research project in area of Biotechnology in a laboratory with in the state/outside the state as possible for a minimum period of three months and has to submit project thesis after completion with certificate from research guide. It should not involve mere collection of data from any source or training of a technique.

### **PAPER- 405: VALUE ADDED COURSE (JOURNAL CLUB PRESENTATION)**

**MARKS: 100**

Journal club presentation and presentation of published articles related to the topics of Biotechnology/project work will be taken into consideration. Presentation will on MS-ppt.