

COURSES OF STUDIES

FOR M.Sc. PROGRAM

Of Biotechnology

(Effective from Session 2025-26)



**GANGADHAR MEHER UNIVERSITY,
SAMBALPUR, ODISHA**

(2-Year Programme)

SCHOOL OF BIOTECHNOLOGY

Programme Structure

Post graduate programme comprising two years, will be divided into 4 (four) semesters each of six months duration.

Year	Semesters	
First Year	Semester I	Semester II
Second Year	Semester III	Semester IV

The detail of title of papers, credit hours, division of marks etc. of all the papers of all semesters is given below.

- There will be two elective groups namely:
- Discipline Specific Elective in Sem-II.
- Interdisciplinary Elective in Sem-III.
- A student has to select one of the DSE paper in Sem II and one of the papers in Sem III as offered by the department at the beginning of the semester II and semester III respectively.
- Each paper will be of 100 marks out of which 80 marks shall be allocated for semester examination and 20 marks for internal assessment (Mid Term Examination).
- There will be four lecture hours of teaching per week for each paper.
- Duration of examination of each paper shall be of three hours.

Pass Percentage:

- The minimum marks required to pass any paper shall be 40 percent in each paper and 40 percent in aggregate of a semester.
- No students will be allowed to avail more than three (3) chances to pass in any paper inclusive of first attempt.

Semester-1

Papers		Marks		Total Marks	Duration (Hrs)	Credit Hours
Paper No	Title	Mid Term	End Term			
101	Cell & Molecular Biology	30	70	100	4	4
102	Microbiology	30	70	100	4	4
103	Biochemistry	30	70	100	4	4
104	Bioinstrumentation	30	70	100	4	4
105	Lab course		100	100	4	4
Total				500	20	20

Papers		Marks		Total Marks	Duration (Hrs)	Credit Hours
Paper No	Title	Mid Term	End Term			
201	Plant and Animal tissue culture	30	70	100	4	4
202	Genetics	30	70	100	4	4

Semester-2

203	Biostatistics	30	70	100	4	4
204	Cancer biology	30	70	100	4	4
205	Lab course		100	100	4	4
DSEPapers*						
206 A	Animal Physiology	30	70	100	4	4
206 B	Plant Physiology	30	70	100	4	4
206 C	Nanobiotechnology	30	70	100	4	4
Total				600		24

*Discipline Specific Elective Paper. Any one paper can be opted by students of this Department.

Semester-3

Papers		Marks		Total Marks	Duration (Hrs)	Credit Hours
Paper No	Title	Mid Term	End Term			
301	Genetic Engineering	30	70	100	4	4
302	Immunology and Immuno-techniques	30	70	100	4	4
303	Bioinformatics and Computational Biology	30	70	100	4	4
304	Environmental Biotechnology and Ecology	30	70	100	4	4
305	Lab Course		100	100	4	4
Value added Course						
A	Biofertilizer Technology			100		3
B	Entrepreneurship in Biotechnology			100		3
IDSEPapers**						
306 A	Medical Biotechnology	30	70	100	4	4
306 B	Developmental Biology (Plants and Animals)	30	70	100	4	4
306 C	Bioprocess technology	30	70	100	4	4
Total				600		24

**Inter Discipline Specific Elective Paper. Any one paper can be opted by students of other Departments.

Semester-IV

Papers		Marks		Total Marks	Duration (Hrs)	Credit Hours
Paper No	Title	Mid Term	End Term			
401	Research Methodology	30	70	100	4	4
402	Agricultural Biotechnology	30	70	100	4	4
403	IPR, Biosafety and Bioethics	30	70	100	4	4
404	Genomics proteomics and metabolomics	30	70	100	4	4
405	Project work and Seminar Presentation			100	4	4
Total				500	20	20
20 Papers	Grand Total			2200		88

Detailed Syllabus

SEMESTER-1

101: CELL & MOLECULAR BIOLOGY

Course objective: To educate the students to understand the complex mechanism of cell and process of protein formation in a living system

Unit 1: Introduction to the Cell and Cell division

The Plasma membrane structure and Lipid bilayer, Membrane transport of Micro & Macromolecules by exocytosis and endocytosis, Cell division: Overview of the Cell cycle and its control. The complex global structure and functions of chromosomes, Lampbrush Chromosomes, Polytene chromosomes. Morphology and functional elements of eukaryotic chromosomes, Chromosomal DNA and its packaging and organization

Unit 2: Cell organelles and cell signaling

Structure and function of the Lysosome, Peroxisome, Mitochondria and Chloroplast, Ribosome, Golgi apparatus, Endoplasmic reticulum. Cell signalling: Identification of cell surface receptors, G Protein coupled receptors and their effectors, Second messengers

Unit-3: Prokaryotic and Eukaryotic replication and transcription

Prokaryotic and Eukaryotic replication, Prokaryotic transcription: a) Structure and function of RNA polymerases b) mechanism of transcription-initiation, elongation and termination – Rho-dependent and independent termination. Operon concept: inducible and repressible operons. Eukaryotic transcription: a) RNA polymerases b) Promoters and transcription factors

Unit-4: Gene splicing & translation

Gene splicing: a) Splicing– mechanism, b) Group I, II and nuclear introns, c) modification of mRNA -5' cap formation, 3' polyadenylation; RNA editing, Translation: a) Genetic code – Universality and degeneracy, Wobble hypothesis, b) charging of tRNA molecules and formation of aminoacyl tRNA; mechanism - initiation, elongation and termination, c) post-translational modifications of proteins

Recommended Books:

1. Lewin B. Genes. Jones & Bartlett Publishers

2. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science
3. Watson J.D, Baker T.A, Bell S.P, Gann A, Levine M and Losick R. Molecular Biology of the Gene. Benjamin-Cummings Publishing Co.
4. Freifelder D. Molecular Biology. Narosa Publishing House

FIRST SEMESTER

102: MICROBIOLOGY

100 Marks

CO-1: Remember and understand the basic concepts/Principles of Microbiology

CO-2: Analyse the Various Concepts to understand them through case studies

CO-3: Apply the knowledge in understanding practical problems

CO-4: Execute/Create the Project or field assignment as per the knowledge gained in the course

Unit 1 Microbial Classification and Bacteria

Beginning of Microbiology, milestones in the development of microbiology, spontaneous generation, Biogenesis and abiogenesis Contributions of Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory]. Application of microbiology. Methods in Microbiology: Sterilization, Culture Media, Pure culture technique, enrichment culture technique, Microbial staining methods, Maintenance and preservation of Microorganisms. Microbial evolution, systematics and taxonomy: Evolution of earth's earliest life forms, primitive organisms, their metabolic strategies and their molecular coding, New approaches to bacterial taxonomy, nomenclature, Bergey's manual, Ribotyping.

Unit 2:- Bacteriology

Bacteriology: The fundamental structure of bacteria, especially structures important for pathogenicity and virulence. Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response). Metabolic diversity among micro-organisms: Photosynthesis in micro-organisms (role of chlorophylls, carotenoids and phycobilins), Microbial nutrition, Chemoautotrophy, Chemoheterotrophy, Chemoorganotrophy, chemolithotrophy, syntrophy, nitrogen metabolism, nitrogen fixation

Unit 3:- Mechanisms in Bacteria

Normal microflora of pathogens into the host, Colonization and factors predisposing to infections.

Microbial diseases: Disease reservoirs, epidemiological technology, infectious disease transmission, respiratory infections caused by microbes, sexually transmitted diseases, diseases transmitted by animals and others. Microbial toxins: Exo-, Endo- and Entero-toxins, mode of action of toxins, virulence and pathogenesis.

Unit 4:- Applied Microbiology

Physiology and vaccine development: Use of proteomics and genomics for the development of vaccine of specific microorganisms, Environmental Microbiology: Microbial degradation of xenobiotics. Biomaterials. Isolation. Production. Characterization and its use, Industrial Microbiology: The application of fundamental principles of Microbiology to industrial Fermentations and processing. Antibiotics production etc.

Course Outcomes:

Students will be able to:

1. recognize and compare the structure and function of microbes.
2. check microbial contamination in environmental samples.
3. demonstrate aseptic microbiological techniques in the laboratory.
4. control microbial contamination and take safety measures.
5. apply norms of biosafety practices in various set ups.

Recommended Books:

1. Brock Biology of Microorganisms, Michael T Madigan, John M Martinko, Kelly S Bender, Pearson Education Limited (2014). ISBN-13: 978-9332586864.
2. Microbiology: An Introduction, Gerard J Tortora, Berdell R Funke, Christine L Case, 8th Edition, Pearson/Benjamin Cummings (2015). ISBN-13: 978-9332575417.
3. Prescott L, Harley J and Klein D. Microbiology. McGraw Hill Publishers.
4. Tortora G.J. Funke B.R. and Case C Microbiology:..L. An Introduction. Benjamin-Cummins Publishing Co.,
5. Pelzer, M. J. Chan, E.C.S. and Kreig, N. R. McGraw-Hill Publishing Co.

103: BIOCHEMISTRY

Course Objectives:

Objective of studying biochemistry is to know how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the nonliving things.

Unit – I: Introduction to metabolism

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Concept of energy rich compounds, Central role of ATP in metabolism, Common types of reactions involved in ATP metabolism, ATP Synthesis. Enzymes: Nomenclature, classification, Enzyme kinetics: Chemical kinetics, enzyme kinetics (Michaelis-Menten equation, Briggs-Halden Modification), determination of V_{max} and K_m). Mechanism of enzyme action: General principles of enzyme reactions catalysed by Chymotrypsin

Unit - II: Carbohydrates

Monosaccharides and derivatives of sugars, (glucose, fructose, sugar alcohol– mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin); Isomers of glucose, derivatives of glucose. Carbohydrate Metabolism Metabolic importance of glycolysis, TCA cycle, Amphibolic nature of TCA cycle, Energetics of Glucose oxidation, gluconeogenesis from TCA cycle intermediates and amino acids. Regulation of gluconeogenesis, Glycogenolysis, HMP shunt, Synthesis of Starch by C3 and C4 pathways of photosynthesis.

Unit - III: Nucleic acid and protein structure

Structure of purine and pyrimidine bases, nucleosides and nucleotides and their biological importance. Types of DNA: A, B, C, Z DNA, structure and biological significance, super helicity. Properties of DNA – hypochromic and hyperchromic effect, melting temperature, Denaturation and annealing. Amino acids - biological role. General structure of amino acids. Levels of organization of protein structure – primary structure – composition, Secondary structure – α helix (egg albumin), β - pleated sheath (keratin), triple helix (collagen), Tertiary structure –with reference to myoglobin. Ramachandran Plot, Quaternary structure with reference to haemoglobin, Basic concepts of protein folding, folding pathways, role of accessory proteins in protein folding, protein stability, globular proteins and maintenance of specific conformation.

Unit – IV: Lipids

Lipids: Definition and major classes of storage and structural lipids. Fatty acids structure and functions. Essential fatty acids. Triglycerides; structure and function, Saponification, Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: structure of sphingosine, ceramide. Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers. Degradation of odd and even carbon-fatty acids, Energetics of Beta Oxidation, Biosynthesis of saturated fatty acids.

Recommended Books:

Voet V and Voet J.G. Biochemistry. John Wiley Publishers.

Lehninger A.L. Principles of Biochemistry. W.H Freeman and Company.

Stryer L. Biochemistry. W.H. Freeman and Company.

104: BIOINSTRUMENTATION

Course Objectives:

The course is aimed to acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles.

Unit-1: Microscopy

Microscopy: Principle of operation and Instrumentation of Light microscopy (Bright field, Phase-contrast, Fluorescence), Confocal microscopy and Electron Microscopy (Scanning and transmission). The pH electrode, ion-selective and gas-sensing electrodes, Clark type oxygen electrode, Biosensors, Flow cytometry.

Unit 2: Spectroscopy

Spectroscopy–: Basic principles, Instrumentation and application of UV- visible absorption spectroscopy, Fluorescence spectrophotometry. Basic principle and application of Other types (IR, NMR, ESR and MASS) spectrophotometry. Elementary idea about X-ray crystallography, API- Electrospray and MALDI TOF.

Unit 3: Centrifugation and Chromatographic Techniques

Centrifugation techniques: Basic principles of sedimentation, Types of centrifuges, Types of

rotors, Methods in preparatory ultracentrifugation (differential and density gradient centrifugation). Chromatographic techniques: Principles of chromatography (Adsorption and Partition chromatography), Planar chromatography (Paper and Thin-layer chromatography), Column chromatography (Gas chromatography, Gel exclusion/permeation chromatography and FPLC, Ion-exchange chromatography, Affinity chromatography, HPLC).

Unit 4: Electrophoretic and Radioisotope Techniques

Electrophoretic techniques: General principles, support media, electrophoresis of proteins (SDS-PAGE, native gels, gradient gels, isoelectric focusing gels and two-dimensional gels), electrophoresis of nucleic acids (Agarose, pulse-field and sequencing gels). Radioisotope techniques: Nature of radioactivity, isotopes in biochemistry, measurement of radioactivity (carbon dating, Geiger-Muller counting and liquid scintillation counting), autoradiography.

Recommended Books:

- K Wilson and John: Walker Practical Biochemistry: Principles & Techniques
- RF Boyer: Biochemistry Laboratory: Modern Theory & Techniques
- S Carson, H Miller and D Scott: Molecular Biology Techniques: A Classroom Laboratory Manual
- TC Ford and J. M. Graham: An Introduction to Centrifugation
- R Baserga and D Malamud: Autoradiography: techniques and application
- T Chard: An Introduction to Radioimmunoassay and Related Techniques
- MD Bruch: NMR Spectroscopy Techniques
- BA Wallace and R William: Modern Techniques for Circular Dichroism and Synchrotron Radiation

105: LAB COURSE

1. Identification of biomolecules in different tissues by histochemical techniques Preparation of mitotic plate by carmine squashing method and phase identification.
2. Study of permanent slides of mitosis and meiosis
3. Isolation of genomic DNA from bacterial cells
4. Quantitation of DNA by Spectrophotometry
5. Study of the effect of chemical agents on chromosomes of plant cells.
6. Specific tests for sugars, amino acids and lipids Formal titration of amino acids
7. Achromic point determination using salivary amylase Effect of ions on salivary amylase activity

8. Enzyme assay and kinetics (ex. Amylase, Protease)
9. Glassware preparation and sterilization techniques- wet heat- dry heat- filter types- laminar flow chamber types- CDC- safety levels
10. Preparation of liquid & solid media, plating, pouring, inoculation and incubation for growth of microorganism.
11. Methods of obtaining pure culture of microorganisms (a) streak plate (b) Pour plate, and (c) spread plate methods
12. Microscopic examination of the microorganisms, identification and staining methods.
13. Micrometry and camera lucida drawings
14. Study of bacterial growth by turbidimetry/ spectrophotometry.
15. Biomass measurement for fungi
16. Isolation and enumeration of microorganisms from soil by serial dilution agar plating method.
17. Verification of Beers Law
18. Determination of absorption maxima of given chemicals.
19. Amino acid and carbohydrate separation by paper and TLC.
20. Separation of sub-cellular organelles by differential centrifugation.

SEMESTER-2

Unit 1: Plant Tissue Culture techniques

Introduction to cell and tissue culture, tissue as technique to produce novel plants and hybrids. Tissue culture media (composition and media), Initiation and maintenance of callus and suspension culture, somatic embryogenesis, Rapid clonal propagation and production of virus free plant. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; cybrids. Germplasm conservation: Cryopreservation and slow growth cultures. Chloroplast Transformation.

Unit 2: Plant transformation technology:

Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors. Use of 35S and other promoters, genetic markers, use of reporter genes and with introns, Methods of nuclear transformation, viral vectors and their applications, multiple gene transfers, vector-less or direct DNA transfer. Particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing.

Unit 3: Mammalian Cell Culture Techniques:

Preparation of culture media, Establishment of primary cell culture: mouse splenocyte culture, Handling mammalian cell lines: thawing, culture maintenance and cryopreservation, Cell counting using hemocytometer, Cell viability and proliferation assays: Trypan blue exclusion test, MTT assay, Propidium Iodide staining, Immuno fluorescence detection to check transfection efficiency (using fluorescence and confocal microscopes)

Unit 4: Regulatory mechanisms in Embryonic and adult stem cells:

Core regulatory circuitry, DNA methylation, histone modifications, histone modifiers, chromatin remodelers, RNA PolIII code, post transcriptional control of gene expression in ESC: role of miRNAs, RNA binding proteins. Spatial organization of genome during ESC development and differentiation. Stem cell therapies: Generation of induced pluripotent cells. Mechanism of direct stem differentiation.

202: GENETICS

Course Objectives:

Objective of studying Genetics is to analyze basic concepts of genetics and their applications in molecular biology

Unit 1:- Introduction and scope of Genetics

Chromosomal basis of inheritance during cell division, DNA as genetic material, Basic structure of DNA and RNA, DNA replication: Messelson and Stahl Experiment, Carins Experiment, Okazaki Experiment, Allele, multiple alleles, pseudo allele, complementation tests, Gene mapping methods: Linkage maps, tetrad analysis, mapping by using somatic cell hybrids, development of mapping population in plants.

Unit 2:- Mendelian and non-Mendelian inheritance

Basic Principles of Mendelian Inheritance: Segregation and Independent Assortment, Human pedigrees and inheritance, Gene Interaction: Sex determination and Sex-linked inheritance, Drosophila and other animals, Sex-determination in plants, Dominance, Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters

Unit 3:- Molecular and Cellular genetics-1

Linkage analysis and gene mapping in eukaryotes, Coupling and repulsion phases, Crossover and recombination. Yeast, Chlamydomonas/ Neurospora and higher plants, Basic Principles of Genetic Engineering, Fine Structure of gene and gene concept: Fine structure of rII gene–Benzer's experiments, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating. LOD score for linkage testing, karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit 4:- Molecular and Cellular genetics-2

Mutations, Spontaneous and induced mutations, Chromosomal mutation, structural and numerical alterations in chromosomes (deletion, duplication, inversion, translocation, ploidy and their genetic implications). Evolutionary history of bread wheat. Mechanism of chromosome mutations genetic and cytological features of deletions, Duplications, inversions and translocations, Somatic vs germinal mutation, Population genetics: gene pool, gene frequency, Hardy Weinberg genetic equilibrium; gene flow and genetic drift.

Recommended Books:

Griffiths A.J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C and Gelbart, W. M. An Introduction to Genetic Analysis, W. H. Freeman & Company.

Strickberger, M.W. Genetics, Macmillan Publishing Co.

Gardner, E.J., Simmons, M.J. and Snustad, D.P. Principles of Genetics, John Wiley & Sons.

203: BIOSTATISTICS

Course Objectives

To provide the basic concept of Biostatistics and interpret results of descriptive statistical methods effectively; communicate the results of statistical analyses accurately and effectively.

Unit I: Basic Statistics: Definition, functions

Introduction and definition of Biostatistics; Data collection, classification and Representation- Measures of Central Tendency, Mean, Median, Mode, Geometric and Harmonic Mean, Measures of Dispersion, Range, Inter-Quartile Range, Boxplot Mean Deviation Variance and Standard deviation, Coefficient of Variation and Standard error.

Unit II: Probability

Events and Probability, Conditional probability, Bayes's Theorem, Probability distribution,

Binomial Distribution, Poisson Distribution, Normal distribution and Application problems

Unit III: Correlation and regression

Introduction: Correlation: Types, Measures, Scatter plot, Regression and correlation analysis

Difference between Regression and Correlation

Unit IV: Hypothesis testing

Inference: Definition-parameter, Statistic sampling distributors, standard error, Type I and Type II errors, Hypothesis Testing (students T-test, Z-test, Chi-square test), Analysis of variance (ANOVA).

Text Books

1. N. Gurumani, An Introduction to Biostatistics, 2nd Revised Edition, MJP Publishers, Chennai, 2000.
2. B.K. Mahajan, Methods in Biostatistics for Medical Students and Research Workers, Jaypee Publishers, 6th Edition, 1997.
3. Sundar Rao, An Introduction to Biostatistics, Prentice- Hall of India, 3rd Edition, 2004.
4. P. Mariyappan, Biostatics: An Introduction, Pearson, Chennai, 2013.

204: CANCER BIOLOGY

Course objective:

To educate the students to understand the causes of cancer, process involved in cancer development and treatment

Unit 1: Cancer

Cancer: Cancer types, Characteristics of cancer cells; Cancer initiation, promotion and progression, termination. Factors responsible for carcinogenesis: Physical, chemical and biological. Tumor angiogenesis, Overview of invasion and the extracellular matrix and metastasis, Cell-cell interactions in cancer

Unit 2: Carcinogen Mechanism

Carcinogen Mechanisms: Introduction to oncogenes and mechanisms of oncogene activation: gene amplification and chromosomal translocations with dominant negative effects. Introduction to tumor suppressor genes. Mutations affecting the cell cycle, loss of checkpoint control and genetic instability. Replicative senescence, DNA damage and repair, Aberrant repair. Genetic predisposition to cancer

Unit 3: Stem cell technologies

Stem cell technologies: Immortal DNA strand hypothesis, Asymmetric cell division, Germline stem cells and germ line- derived pluripotent cells, Stem cell niche, epithelial stem cells, mesenchymal stem cells, neural stem cells, hematopoietic stem cells, cardiac stem cells, Cancer stem cells. Generation of chimeric animals: Pro-nuclear injection of blastocysts, transplantation of blastocysts into pseudo-pregnant mice and generation of chimeric animals. Reprogramming of the nuclei and gene editing technologies - TALEN, CRISPR Cas9

Unit 4: Tumour immunology

Tumor immunology: Principles of chemotherapy and chemoprevention, Vaccine development, immunotherapy and its limitations, disease prognosis and resistance to therapies

Recommended Books:

Text Book(s)

1. The Biology of Cancer – Robert Weinberg. Edition – 2nd ISBN:9780815342205 - 2013
2. Cancer Biology – V. Deepa Parvathi, Pearson India, ISBN: 9789356068056
3. Textbook of Cancer Biology – C. Vaman Rao & Jayaprakash Shetty, CBS Publishers, ISBN: 9789390620401
4. An Introduction to Cancer Biology: A Text Book – Nandan Bhattacharyya & Kalyani Khanra, ISBN: 9781517773991
5. Fundamentals of Cancer Biology – R.S. Verma, S. Chand Publishing, ISBN: 9788121924550

Reference Book

1. Cancer Sourcebook, Edited by Edited by Karen Bellenir, Omnigraphics, Inc., 2011, ISBN 978-0- 7808-1145-4
2. 2. Cancer cell signalling / edited by Amanda Harvey, John Wiley & Sons, Ltd, 2013, ISBN 978-1-119- 96757-6 (pbk.)
3. 3. The Tumor Microenvironment, Edited by Rebecca G. Bagley, 2010, ISBN 978-1-44196614-8 eISBN 978-1-4419-6615-5, DOI 10.1007/978-1-4419-6615-5, Springer New York Dordrecht Heidelberg London

205: LAB COURSE

1. Preparation of Plant tissue culture media.
2. To study the process of plantlet acclimatization.
3. To study organogenesis.
4. To study the process of anther culture development.
5. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
6. Chromosome mapping using test cross data.
7. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Construct and interpret graphical displays such as histograms, box plots, bar charts, and bivariate scatterplots
10. Collection of sample data and opening sample datasets
11. Calculating measures of central tendency and dispersion.
12. Practice conducting and interpreting T-test in the given data and interpreting confidence intervals
13. Hypothesis testing; Define null and research hypotheses. Practice conducting and interpreting ANOVA and interpreting confidence intervals
14. Conduct and interpret correlation and linear regression.
15. Isolation of chromosomal DNA from animal cells
16. Estimation of DNA by spectrophotometer
17. Separation of DNA using agarose gel electrophoresis
18. Preparation of silver nanoparticles using a plant extract
19. Biological synthesis of nanoparticles using microorganisms
20. UV-Visible spectroscopic analysis of synthesized nanoparticles

Discipline Specific Elective (DSE) 206 A: Animal Physiology

Course Objectives:

The objective of this course is to enable the students to gain knowledge of physiology of animals and to understand various aspects of physiological systems

Unit -1: Physiology-1

Physiology of digestion, Mechanism of respiration, Respiratory pigments, Oxygen equilibrium curve, Structure of heart and its working, Cardiac cycle and its regulation, Blood coagulation, Structure and function of nephron, Mechanism of urine formation, Osmoregulation.

Unit-2: Physiology-2

Nerve conduction and synaptic transmission of impulses, neuromuscular junction; Reflex action and its types–reflex arc; Mechanism of muscle contraction. Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor Unit, summation and tetanus.

Unit-3: Endocrinology

Functional Histology of endocrine glands -pineal, pituitary, thyroid, parathyroid, pancreas, adrenals; hormones secreted by them and their mechanism of action, Classification of hormones; Regulation of their secretion; Mode of hormone action; Signal transduction pathways utilized by steroidal and non-steroidal hormones; Hypothalamus (neuro endocrine gland) -principal nuclei involved in neuro endocrine control of anterior pituitary and endocrine system, Placental hormones.

Unit 4: Reproductive System

Histology of male and female reproductive systems, Puberty, Physiology of male and female reproduction; Methods of contraception (depicted through flowchart)

Recommended Books:

Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia Pvt. Ltd. /W.B. Saunders Company.

Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,

Victor P. Eroschenko. (2008). diFiores Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins.

206 B: Plant Physiology

Unit 1:- Introduction

Mineral nutrition and assimilations of inorganic nutrients. Plant mycorrhiza association, nitrogen metabolism, assimilation of cations, chloride dynamics, Essential and beneficial elements, macro and micronutrients, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents, Soil as a nutrient reservoir, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co- transport, symport, antiport.

Unit 2:- Plant Growth Regulators.

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Absciscic acid, Ethylene. Brassinosteroids and Jasmonic acid, Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization. Seed dormancy.

Unit 3:- ATP Synthesis

Mechanism of ATP synthesis, substrate level phosphorylation and oxidative phosphorylation), chemiosmotic mechanism, ATP synthetase, Boyers conformational change model, role of uncouplers.

Unit 4:- Stress Physiology

Defining plant stress, Acclimation and adaptation. Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction, stress related proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates, Stress sensing mechanisms in plants, Role of nitric oxide. Calcium modulation, Phospholipid signaling, Adaptation in plants; Changes in root: shoot ratio; Aerenchyma development; Osmotic adjustment; Compatible solute production. Calcium, phospholipids, cGMP

Course Outcomes:

Students will be able to

CO 1: understand the various physiological life processes in plants

CO 2: They will also gain about the various uptake and transport mechanisms in plants and are able to coordinate the various processes.

CO 3: They understand the role of various hormones, signaling compounds, thermodynamics and enzyme kinetics.

Recommended Books:

Fosket DF: Plant Growth & Development

Foyer CH: Photosynthesis

Bacon Ke: Photosynthesis: Photobiochemistry & Photobiophysics

Leopold AC & Kriedemann PE: Plant Growth & Development

Moore TC: Biochemistry & Physiology of Hormones

L Taiz & E Zeiger: Plant Physiology

BB Buchanan, W Gruissem & RL Jones: Biochemistry & Molecular Biology of Plants

MB Wilkins: Advanced Plant Physiology

JA Hopkins: Introduction to Plant Physiology

FB Salisbury & CW Ross: Plant Physiology

Hans-Walter Heldt: Plant biochemistry & Molecular Biology

206 C: Nanobiotechnology**Course Objectives****The course aims to:**

- Introduce students to the fundamental principles of nanoscience and nanotechnology.
- Explain the synthesis, characterization, and properties of nanomaterials.
- Introduce biological and environmentally friendly approaches for nanoparticle synthesis.
- Develop an understanding of nanomaterials in biotechnology, medicine, agriculture, and environmental applications.
- Familiarize students with the biosafety, toxicity, ethical, and environmental aspects of nanotechnology.

Course Outcomes:

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

CO1: Explain basic concepts, principles, and properties of nanomaterials.

CO2: Describe different physical, chemical, and biological methods of nanoparticle synthesis.

CO3: Explain major techniques used for nanoparticle characterization.

CO4: Discuss applications of nanobiotechnology in healthcare, agriculture, food, and environmental management.

CO5: Evaluate the potential risks, toxicity, biosafety, and ethical issues associated with nanomaterials.

Unit I: Fundamentals of Nanoscience and Nanotechnology

Introduction to nanoscience and nanotechnology, Historical development and milestones, Definition and scope of nanobiotechnology, Size-dependent properties of nanomaterials, Surface area-to-volume ratio, Classification of nanomaterials: Nanoparticles, nanotubes, nanofilms and nanocomposites. Types of nanoparticles: metallic, metal oxide, silica, carbon-based and polymeric nanoparticles. Role of nanotechnology in modern biotechnology.

Unit II: Synthesis of Nanomaterials

Top-down approaches, Mechanical milling, Lithography, Sputtering, Advantages and limitations. Bottom-up approaches, Sol-gel method, Chemical reduction, Co-precipitation, methods. Green and Biological Synthesis, Microbial synthesis of nanoparticles, Bacteria-mediated nanoparticle synthesis, Fungi-mediated nanoparticle synthesis, Algae and cyanobacteria-mediated synthesis, Plant-mediated nanoparticle synthesis. Role of enzymes, proteins and phytochemicals in nanoparticle formation. Advantages of biological synthesis over conventional methods.

Unit III: Characterization of Nanomaterials

Importance of nanoparticle characterization, UV-Visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Dynamic Light Scattering (DLS), Zeta potential analysis, Energy Dispersive X-ray Spectroscopy (EDX/EDS), Particle size, morphology and surface charge, Interpretation of basic characterization data.

Unit IV: Applications of Nanobiotechnology

Medical and Pharmaceutical Applications: Nanomedicine and nanopharmaceuticals, Biosensors, Antimicrobial nanoparticles. Agricultural Applications: Nanofertilizers, Nanopesticides and nanoherbicides. Plant growth and stress management, Nano-enabled delivery of nutrients and agrochemicals, Applications in sustainable agriculture, Nanoremediation, Removal of heavy metals and pollutants, Nanotechnology in genomics and molecular biology.

Recommended Textbooks/References

1. Pradeep, T. Nano: The Essentials—Understanding Nanoscience and Nanotechnology.
2. Cao, G. Nanostructures and Nanomaterials: Synthesis, Properties and Applications.
3. Poole, C.P. & Owens, F.J. Introduction to Nanotechnology.
4. Rai, M. & Ingle, A. Nanobiotechnology: Green Approaches to Nanoparticles.

SEMESTER 3

301: GENETIC ENGINEERING

Course Objective:

The objective of this course is to make students learn about basic techniques of molecular cloning and recombinant DNA technology

Course outcome:

CO1: Student will understand the process of construction and screening of the genomic and cDNA libraries

CO2: Student will understand the process of expression of recombinant proteins

Unit 1: Basics of Genetic engineering

Enzymes (Nucleases, Restriction endonucleases, Ligases, Alkaline phosphatase, Polynucleotide kinase, DNA polymerases, Terminal transferase, Reverse transcriptase). Linkers and Adapters, MCS, Vectors (Plasmids, Bacteriophages, Cosmids, Phagemids, Fosmids, Artificial Chromosomes: YAC, BAC, Shuttle vectors, Expression vectors: Yeast, Baculovirus, Mammals). Nucleic acid sequencing (Maxam-Gilbert, Sanger's dideoxy, High throughput). Nucleic acid amplification by PCR

Unit 2: Construction and screening of gene libraries

Construction of libraries (genomic and cDNA), methods for screening of clones (radiolabeled and non-radiolabeled based methods), preparation of nucleic acid probes by nick translation, random primer labeling and end labeling, Nucleic acid hybridization techniques for identification of clones with gene of interest (Southern, Northern, Dot and Slot blots), Antibody-based screening methods

Unit 3: Introduction of recombinant DNA into hosts & molecular markers

Physical methods (Electroporation, microinjection, microinjection, biolistic, liposomes, Silicon carbide-based delivery, Ultrasound based delivery, Direct DNA delivery), Chemical methods (PEG, DEAE, DMSO, EMS), Agrobacterium and Virus mediated transfection. Markers for screening of recombinant genes, Gene knock out strategies and RNA interference: Antisense RNA, siRNA, mi RNA. Expression of recombinant proteins using PAGE and Western blot.

Unit 4: Characterization of cloned genes and mutagenesis

Molecular markers in genome analysis (RFLP, RAPD, AFLP, SSR, SNP). Application of molecular markers in forensics, disease prognosis, genetic counseling, pedigree analysis, gene mapping. Mutation and Mutagenesis: Point mutation, frameshift mutation, site directed mutagenesis, deletion mutagenesis. Transposons and gene tagging, Genetic engineering regulations and safety guidelines

Recommended Books:

- Primrose S.B, Twyman R.M, and Old R.W. Principles of Gene Manipulation.

BlackwellScience.

- Sambrook J and Russell D. Molecular Cloning: A laboratory Manual. Cold Spring Harbor Laboratory Press.

302: IMMUNOLOGY AND IMMUNOTECHNIQUES

Unit-I: Introduction to Immunology

Basics of immunity, Phylogeny of Immune system, Innate and acquired Immunity, Clonal nature of Immune response. Cells of the Immune system: Haematopoiesis and differentiation, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural Killer cells, Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. Organization and Structure of Lymphoid Organs.

Unit-II: Antigen and Antibody

Nature and Biology of antigens and super antigens. Structure and function of antibody molecule, Antigen – Antibody interaction. Major histocompatibility complex proteins, Transplantation. Antigen processing and presentation, Generation of humoral and cell mediated immune response. Complement system. Interleukins. Cytokine and their role in immune regulation.

Unit-III: Mechanism of immune regulation

Cell-mediated cytotoxicity, Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity. Immunological tolerance, Hypersensitivity and Autoimmunity. Tumor Immunology. AIDS and other immunodeficiency diseases.

Unit-IV: Vaccine technology

Vaccine technology: Rationale of vaccine designing based on clinical requirements, Subunit vaccines, Attenuated vaccines, Vector vaccines, peptide vaccines and conjugate vaccines, cell-based vaccines. Catalytic antibodies. Immunotechnology – antigen-antibody interaction, affinity and avidity, agglutination, precipitin formation, immunodiffusion (SRID and DRID).

Immunoelectrophoretic – types and uses, radio immuno assay, ELISA, western blotting, ELISPOT assay.

Recommended Books:

Frank SA, Immunology University Press. and Evolution of Infectious Disease. Princeton

J.D Smyth, Introduction to Animal Parasitology. Cambridge University Press.

Ahmed N, DawsonN, Smith C and Wood Ed. Biology of Disease. Taylor and Francis Group.

Pommerville J.C.Alcamo's Fundamentals of Microbiology. Jones and Bartlett Publishers.

Salyers A. A and Whitt D.D. Microbiology-Diversity, Disease and Environment. Fitzgerald Sciences Publishers.

Goldsby RA, Kindt TK, Osborne BA and Kuby J. Immunology, 7th Edition, W.H. Freeman and Company.

Janeway CA, Travers P, Walport M, and Shlomchik M. Immunobiology, 8th Edition, Garland Publishing.

303: BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

Unit I: Biological databases

Introduction and history of bioinformatics Introduction to genomic research and data generation, Genome projects. Introductory bioinformatics Information Resources: NCBI, EBI, ExPasy Entrez & SRS System Primary Sequence & Structure Databases: Genbank, SwissProt/Uniprot, EMBL, PIR, PDB, KEGG etc.; Derived (Secondary) Databases of Sequences and structure: Prosite, Pfam, SCOP, CATH

Unit II: Biological sequence alignment

Sequence Similarity Basics: Similarity, Identity, Homology, Scoring, selectivity/Sensitivity, Gap cost, Linear and Affine Gap Penalty, Basic of scoring system and matrices (PAM, BLOSUM) Similarity Searching Tools: Pairwise Sequences Alignment: Dot matrix method, Global

(Needleman- Wunsch) and Local Alignment (Smith-Waterman) using Dynamic programming. BLAST and FASTA, Theory and Algorithms, variants of BLAST and FASTA

Unit II: Phylogenetic analysis and structure prediction

Concept of Multiple sequence alignment (MSA), Computational Methods and applications in Phylogenetic tree prediction: Substitution Models of evolution, Tree reconstruction methods (Distance based, character-based method, statistical), Bootstrapping. Protein secondary structure prediction methods.

Unit IV: Molecular modeling and drug design

Molecular modelling and drug design: Homology modelling, Concept of molecular mechanics and force fields, molecular dynamics simulation, Docking methods, Basic idea about Molecular descriptors and QSAR analysis, drug like Property of a molecule, target identification
Drug design Process

Text Books:

1. Mount DW, Bioinformatics: Sequence and Genome Analysis, Spring Harbor Press
2. Arthur Lesk, Introduction to Bioinformatics, Oxford University Press.
3. Baxevanis AS and Ouellette BF, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Wiley International Science.
4. Bryan Bergeron, Bioinformatics computing, Prentice Hall Inc
5. Bernhard Houbold, Thomas Wiehe, Introduction to computational biology: an evolutionary approach Blkhauser verlag press

Reference:

1. Tao Jiang, Ying Xu, Michael Q. Zhang, Current Topics in Computational Molecular Biology, MIT press.
2. Thomas Lengauer, Bioinformatics from genome to drug. WILEY-VCH press.

304: ENVIRONMENTAL BIOTECHNOLOGY AND ECOLOGY

100 marks

Unit I: Introduction to Environmental Biotechnology

Ecosystems: biotic and abiotic components, Ecological pyramids, Food chains, Food webs Energy flow in ecosystems, Types of ecosystems, Biological Magnification. water and solid wastes, Hazardous wastes. Microbial interactions in ecosystems. Lignocellulosic residues, Biofuel and, Biomining, bioleaching, Bioremediation, Biosensors in bioprocessing, ecosystem analysis and related software.

Unit II: Air, Water and Soil pollution

Point and non-point source pollution, Air pollution control: particulate emission, control devices, control of Sulphur dioxide pollution and vehicular pollution. Water pollution control: primary, secondary and tertiary treatment. Solid waste and soil pollution management: waste monitoring, treatment and management of non-hazardous solid waste, non-degradable solid waste, medical solid waste.

Unit III: Biodegradation and Bioconversion

Microorganisms in lignocellulose degradation, Biodegradation of starch, glycogen and proteins. Xenobiotic compounds: chemical properties influencing biodegradability, mechanisms of degradation, microorganisms for degrading organic pollutants. Microorganisms in metal absorption, factors affecting bioabsorption, Phytoremediation.

Unit IV: Biotechnological Applications in Environmental Management

Carbon sequestration, Bioremediation: microorganisms and techniques, Bioenergy, Bioethanol and Biodiesel, Biomethanation (Biogas from anaerobic treatment), Biofertilizers and biopesticides, Composting: process and decomposition stages, vermicomposting, Biopolymers and Bioplastics, Bioleaching, Nanomaterials.

Course Outcomes:

1. Theoretical knowledge of Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Pollution, Renewable resources; Sustainability; Microbiology of degradation and decay.
2. Study of role of biotechnological techniques in environment protection. Waste water collection; control and management; Waste water treatment; Sewage treatment through chemical, microbial

and biotech techniques

3. Concept building about applications of Remote sensing & Geographical Information System (GIS)

Recommended Books:

1. Environmental Biotechnology, A.K. Chatterjee, Prentice-Hall Of India Pvt Ltd (2011). ISBN-13: 9788120342989.
2. Environmental Biotechnology, Mh Fulekar, Oxford & Ibh Publishing Co Pvt Ltd (2006). ISBN-13: 9788120416918.
3. Environmental Biology by Varma and Agarwal (2012)
4. Environment Problems and Solution, DK Asthana, Meera Asthana, S Chand & Company Pvt Ltd (2010). ISBN-13: 9788121916547.
5. Environmental Biotechnology, Monika Jain, Narosa Publishing House (2014). ISBN-13: 9788184872705.

305: LAB COURSE:

1. Isolation of DNA and Agarose gel electrophoresis.
2. Isolation of protein and SDS-PAGE.
3. cDNA synthesis and cloning
4. Isolation of RNA and electrophoresis of RNA on denaturing gels.
5. Searching similar sequences using BLAST P and BLAST N
6. Multiple sequence alignment and finding conserved sequences.
7. Making Phylogenetic tree of given sequences by using Clustal Omega and MEGA.
8. Gene and promoter prediction for Prokaryotes and eukaryotes by using different tools.
9. Prediction of secondary structures of proteins by using on line tools.
10. Learning about molecule visualization software like Rasmol, Pymol etc.
11. Prediction of Tertiary structure of proteins and Validation of model protein structure: Energy minimization, Procheck, verify 3D, Prosa II, ERRAT etc.
12. Molecule drawing. Conversion of 2D structure to 3D structure.
13. Molecular docking and analysis of receptor with ligand.
14. Blood film preparation and identification of cells.
15. Lymphoid organs and their microscopic organization.

16. Immunization and collection of serum, Immunodiffusion.
17. Serological test: Hemagglutination test (HA), Hemagglutination Inhibition test (HI), ELISA etc.
18. Estimation of dissolved oxygen and salinity in water samples.
19. Estimation of Chemical Oxygen Demand (COD).
20. Estimation of Biochemical Oxygen Demand (BOD).
21. Determination of suspended solids in industrial effluents.

Value added course

(A) BIOFERTILIZER TECHNOLOGY

Credits: 03

Course objective:

Full marks: 100

Unit -1

[10 class]

General account about the microbes used as biofertilizer – *Rhizobium* – isolation, identification, mass multiplication, Actinorrhizal symbiosis. *Azospirillum*: isolation and mass multiplication – carrier-based inoculants, associative effect of different microorganisms. *Azotobacter*, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Unit -2

[10 class]

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation. Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit -3

[10 class]

Organic farming – Green manuring and organic fertilizers, biowastes, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocomposting making methods, types and method of vermicomposting – field application.

PRACTICAL: Practical will be based on the topic of this paper.

Reference books:

- 1.A Text Book of Microbiology-R.C.Dubey and Maheswari.
- 2.Handbook of Biopesticides and Biofertilizers-A.M. Deshmukh, R.M. Khobragade, P.P. Dixit.

(B) ENTREPRENEURSHIP IN BIOTECHNOLOGY**Course Objectives:****Full marks: 100**

CO1: To understand the processes of value addition to develop novel products, services and their possible commercialization.

CO2: create awareness about entrepreneurship among students. This course focuses on motivating students for entrepreneurship on creativity and innovation

Unit -1**[10 class]**

Integration of Science, technology and business. Basic principles and practices of management- Definition, concepts and application; Organization types, coordination, control and decision making in management. Entrepreneurship in the biotechnology context; Case studies of successful and unsuccessful bio-entrepreneurs industries Biotechnology: emerging industries with examples from Transgenics, Environmental biotechnology, New drug development, Contract Research Organization, marketing & consultancy

Unit -2**[10 class]**

Factors affecting biotech business: (finance, infrastructure, equipment, manpower, resources, project location, end product, quality issues, etc.) Core concept of Market: Identification and evaluation of market potential of various bioentrepreneur sectors. Role of Indian government in promoting biotechnology and its schemes, financial institutions in fostering bioentrepreneurship

Unit -3**[10 class]**

Personality and attitude, Organizational behavior, Leadership Principles of effective communication, (Body language, public speaking, presentations) business proposal writing. Communication aid and application of technology, Career Opportunities in the Life Sciences Industry Public policy, Regulatory and ethical challenges facing the entrepreneurial biotechnology firm.

PRACTICAL: Practical will be based on the topic of this paper.

Reference Books:

- Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies (2014); Craig Shimasaki, ed. Elsevier Inc.
- Innovation and Entrepreneurship in Biotechnology, An International Perspective Concepts, Theories and Cases (2006); Damian Hine and John Kapeleris Edward Elgar Publishing Limited
- Information for startups from Govt of India website, BIRAC website.

SEMESTER 4**SEMESTER 4****401: Research Methodology****Course Objectives:**

The course objective is to familiarize participants with basic of research and the research process. And to enable the participants in conducting research work and formulating research synopsis and report. Also, to familiarize the students to develop data analytics skills and meaningful interpretation to the data sets so as to solve the Research problem.

Unit-I Scope of Research and Ethics

Introduction and Scope, Research problem: Identification, Selection, Formulation of research objectives, Research design: Components, Types and Importance, Research ethics, Institutional ethics committee, Plagiarism-Pitfall

Unit-II Technical Writing

Types of technical documents; Full length research paper, Short/Brief communications, Letters to editor, Book chapter, Review, Conference report, Project proposal Components of a full length research paper; Title/Topic statement, Abstract/key words, Aims and objectives, Hypothesis

building, Rationale of the paper, Work plan, Materials and methodology, Results and discussion, Key issues and arguments, Acknowledgement, Conflict of interest statement, bibliography, Technical Resumes and Cover Letters Components of a research proposal; Project summary Key words, Origin of the proposal, Major objectives Methodology, Instrument facility available in the PI's department, Overview of status of Research and Development in the subject, Importance of the proposed project in the context of current status, Bibliography

Unit-III Scientometrics

How to cite and how to do referencing Literature search technique, using SCOPUS, Google Scholar, PUBMED, Web of science, Indian Citation Index, and RG Styles of referencing; APA, MLA, Oxford, Harvard, Chicago Annotated bibliography Tools for citing and referencing, Grammarly, Endnote etc

Unit-IV IPR and Cyber Law and literature searching.

Patents, Patent laws, process of patenting a research finding, Intellectual property (IP), Intellectual property right (IPR), Copyright, Trademarks, GI, Cyber laws, COPE. Search engine – Google and Yahoo; Pubmed, Scopus, Web of Science, Google Scholar, Indian Citation Index, Science Citation Index (SCI), h-index, i-10- index. Journal Impact Factor (JIF). Introduction to Plagiarism and Cyberlaws.

402: AGRICULTURAL BIOTECHNOLOGY

100 marks

Unit -I: Introduction to Agricultural Biotechnology

Introduction to agricultural biotechnology: conventional method of crop improvements vs. Biotechnological interventions, manipulation of resistance: fungal and bacterial disease, viral disease

Unit-II: Biotic and abiotic stresses

strategies for engineering insect resistance (bt genes, protease inhibitors, α -amylase inhibitors), strategies for engineering herbicide resistance, strategies for engineering stress resistance (drought

stress, salt stress, temperature stress).

Unit-III: Plant Disease resistance

Plant disease resistance: introduction, plant pathogen interaction, major type of plant pathogens, natural disease resistance pathways, biotechnological approaches to disease resistance (case studies), improvement of crop yield and quality: long shelf life of fruits and flowers, use of ACC synthase, poly-galacturonate, ACC oxidase; modification of fruit and flower color, seed storage protein quality, vitamin e fortification, Fe and mineral fortification, case studies of phytase production and golden rice.

Unit-IV: Advances in Agricultural Biotechnology

Genetic manipulation of crop yield by photosynthesis, nitrogen fixation, advances in agricultural biotechnology: molecular farming: plants as factories for pharmaceuticals and biomaterials, smart breeding: marker-assisted selection: non-invasive biotechnology alternative to genetic engineering of plant varieties, biofertilizers and biopesticides.

Suggested readings:

1. Plant Biotechnology Genetic Manipulation of Plants, Adrian Slater, Nigel W. Scott and Mark R. Fowler, Oxford University Press (2017). ISBN-13: 9780199560875.
2. Biotechnology: Expanding Horizons, BD Singh, Kalyani Publishers / Lyall Bk Depot (2016). ISBN-13: 9789327222982.
3. Introduction to Plant biotechnology, H.S Chawala, Oxford & Ibh Publishing Co. Pvt Ltd (2016). ISBN-13: 9788120417328.
4. Elements of Biotechnology, P K Gupta, Rastogi Publication (2015). ISBN-13: 9788171339372.
5. Modern Food Microbiology, James M. Jay, CBS Publishers & Distributors (2005). ISBN-13: 9788123904757.
6. Food Microbiology: Fundamentals and frontiers, M.P. Doyle, L.R. Beuchat, Thoma J. Montville, ASM press (2007). ISBN-13: 9781555814076.
7. Genetic transformation of plants, J.F. Jackson, H.F. Linskens, CBSPD (2009). ISBN-13: 9788184891065.

403: IPRS, BIOSAFETY AND BIOETHICS

Course Objective:

To educate the students on protection of intellectual property developed through the research and ethical issues related to biotechnological research.

Unit I: IPR and patents

Intellectual property rights and its types-patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; process patent vs product patent; IPs of relevance to biotechnology and few case studies; introduction to GATT, WTO, WIPO and TRIPS.

Unit II: Patent Database

Basic requirement of a patentable invention, prior art and state of art; patent databases; Indian Patent Act 1970 and recent amendments; patent database; procedure for filing a patent, international patenting-requirement, patent infringement- meaning, scope, litigation, remedies; case studies and examples-Rice, Neem etc.

Unit-III: Biosafety regulations

Introduction to biosafety regulations; primary containment for biohazards and biosafety levels; biosafety guidelines - government of india. Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC.

Unit-IV: Bioethics

Bioethics, public concerns on human genome research and transgenics- genetic testing and screening, ethics in clinical trials and GCP, ELSI & human genome project; ethics in human cloning (case study).

Suggested readings:

1. Biotechnology and Intellectual Property Rights, Kshitij Kumar Singh, Springer (2016), ISBN-13: 9788132229759.
2. Intellectual Property and Biotechnology: Biological Inventions, Rimmer Matthew, Edward Elgar, U.K. - Edward Elgar (2009). ISBN-13: 9781845429478.
3. Synthetic Biology and Intellectual Property Rights, Rajendra K. Bera, ISBN-13: 978-9535120407.
4. Intellectual Property Rights and the Life Science Industries: Past, Present and Future, Graham Dutfield, World Scientific Pub Co Inc (2009), ISBN-13: 9789812832276.
5. Bioethics and Biosafety, M. K. Sateesh, Ik International Pvt Ltd (2014), ISBN-13:

9788190675703.

6. Biosafety and Bioethics, Rajmohan Josi, Isha Books (2006). ISBN-13: 9788182053779.

7. IPR, Biosafety and Bioethics, Deepa Goel, Shomini Parshar, Pearson Education Limited (2013), ISBN-13: 9788131774700.

404: GENOMICS PROTEOMICS AND METABOLOMICS

Course objective:

The course is intended to provide thorough understanding modern technologies of the genomics pertaining to whole genome sequencing, genome mining, comparative genomics, global gene function technologies, protein structure & function technologies at the genome level, etc.

Unit I: Genome

Concept of genome organization and minimal cell genome; genome sequencing strategies, principles and methodology; genome sequencing projects- microbes, plants and animals; accessing and retrieving genome project information from web; recognition of coding and non-coding sequences and gene annotation.

Unit II: Comparative Genomics

Reverse genetics- strategies and applications, concept of TILLING, structural genomics, functional genomics and comparative genomics; high throughput screening in genome for drug discovery-identification of gene targets and drug development.

Unit III: Proteomics

Introduction to proteome, protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; isoelectrofocusing; peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and differential display proteomics, protein-protein interactions, yeast two hybrid and three hybrid system; protein microarray; structural proteomics; proteomics and drug delivery.

Unit-IV: Metabolomics

Introduction to metabolomics: metabolome, metabolomics, metabolite profiling, metabolome fingerprinting, role of biomarker in metabolomics, tools of metabolome studies: NMR, MS, GC,

LC, IR and its application, metabolome projects of plant and human, future prospective of metabolomics.

Recommended books:

1. Principle of gene manipulation and Genomics, S.B Primrose, R.M Twyman, 6thEd., Blackwell Science Ltd (2014). ISBN-13: 9788126548392
2. Discovering Genomics, proteomics & bioinformatics, Malcolm Campbell, Laurie J Heyer, Pearson Education Limited (2013). ISBN-13: 9788131715598.
3. From Genes to Genomes: Concepts and Applications of DNA Technology, Jeremy W. Dale, Malcolm von Schantz, Wiley, John & Sons (2007) ISBN-13: 9780470017340.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R Glick, Jack J Pasternak, Panima Book Distributors (2002). ISBN-13: 9788186535080.
5. Genetic Engineering, Smita Rastogi, Neelam Pathak, Oxford University Press (2009). ISBN-13: 9780195696578.

405: PROJECT WORK & SEMINAR PRESENTATION