COURSES OF STUDIES

FOR M.Sc. PROGRAM

Of Biotechnology

(Effective from Session 2022-23)

GANGADHAR MEHER UNIVERSITY, SAMBALPUR, ODISHA

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 SemII.
- Interdisciplinary Elective in SemIII.
- 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 IIIrespectively.
- 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	20	80	100	4	4
102	Microbiology	20	80	100	4	4
103	Biochemistry	20	80	100	4	4
104	Bioinstrumentation	20	80	100	4	4
105	Lab course		100	100	4	4
Total				**500**	**20**	**20**

Semester-2

Papers		**Marks**		**Total Marks**	**Duration (Hrs)**	**Credit Hours**
Paper No	**Title**	**Mid Term**	**End Term**			
201	Plant and Animal tissue culture	20	80	100	4	4
202	Genetics	20	80	100	4	4

203	Biostatistics	20	80	100	4	4
204	Cancer biology	20	80	100	4	4
205	Lab course		100	100	4	4
DSEPapers*						
206 A	Animal Physiology	20	80	100	4	4
206 B	Plant Physiology	20	80	100	4	4
206 C	Bioenergetics and Metabolism	20	80	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	20	80	100	4	4
302	Immunology and Immuno-techniques	20	80	100	4	4
303	Bioinformatics and Computational Biology	20	80	100	4	4
304	Environmental Biotechnology and Ecology	20	80	100	4	4
305	Lab Course		100	100	4	4
IDSEPapers**						
306 A	Medical Biotechnology	20	80	100	4	4
306 B	Developmental Biology (Plants and Animals)	20	80	100	4	4
306 C	Bioprocess technology	20	80	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	20	80	100	4	4
402	Agricultural Biotechnology	20	80	100	4	4
403	IPR, Biosafety and Bioethics	20	80	100	4	4
404	Genomics proteomics and metabolomics	20	80	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

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

Course Outcomes:

Students will be able to:

1. Comprehend the cellular architecture with fine details of various intracellular organelles.
2. Interpret molecular mechanisms involved at various stages of cell cycle and its regulation.
3. Correlate between signal molecules and their role in various cellular activities.
4. Analyse architecture of the genomes, genes, and the flow of genetic information through replication, transcription, translation.
5. Decipher regulation of gene expression, and its influence on various stages of development

Recommended Books:

Lewin B. Genes. Jones & Bartlett Publishers

Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science

Watson J.D, Baker T.A, Bell S.P, Gann A, Levine M and Losick R. Molecular Biology of the Gene. Benjamin-Cummins Publishing Co.

Freifelder D. Molecular Biology. Narosa Publishing House

102: MICROBIOLOGY

Course Objectives:

The objective of this course is to make students understand the existence of microbial world and diversity along with their origin and scope in present day life.

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), anoxygenic photosynthesis, oxygenic photosynthesis. Microbial nutrition, Chemoautotrophy, Chemoheterotrophy, Chemoorganotrophy, chemolithotrophy, syntrophy, nitrogen metabolism, nitrogen fixation

Unit 3-: Mechanisms in Bacteria

Normal microflora of skin, oral cavity, gastrointestinal tract, entry 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, insects, ticks. Food and water borne diseases, public health and water quality. 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 and physiology 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:

Prescott L, Harley J and Klein D. Microbiology. McGraw Hill Publishers.

Tortora G.J. Funke B.R. and Case C Microbiology:.L. An Introduction. Benjamin-Cummins Publishing Co.,

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 Vmax and Km). 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.

Course Outcomes:

Students will be able to:

1. explain the structure-function relationships of biomolecules.
2. characterize properties of enzymes and their kinetics, understand their role as biocatalysts involved in biochemical transformations.
3. correlate how different signals perceived by the organisms are converted into biochemical information which drives different functions of living systems.
4. Comprehend various metabolic pathways through which the biomolecules transform form one form

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.

Course Outcomes:

Students will be able to:

1. comprehend the principles of various bioanalytical techniques
2. learn centrifugation and electrophoretic techniques involved in isolation, purification and analysis of biomolecules.
3. learn spectrophotometric techniques for qualitative and quantitative analyses of biomolecules.
4. learn various microscopic i.e. imaging techniques to study structural and morphological features.
5. learn basic techniques used in various biotechnological applications.

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 SpectroscopyTechniques

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 aining 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

201: PLANT AND ANIMAL TISSUE CULTURE

Course Objectives:

The course will enable the students to acquire knowledge about various techniques like micropropagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

Unit 1: Plant Tissue Culture techniques

Conventional plant breeding, 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; single cell clones. somatic embryogenesis; transfer and establishment of whole plants in soil, Shoot tip culture: Rapid clonal propagation and production of virus free plant. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, 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, reporter gene with introns, use of scaffold attachment regions. 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, CFSC labeling, Mammalian cell transfection (transient), 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 PolII 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.

Course Outcomes:

Students will be able to:

1. Familiarize with organization of PTC Lab., aseptic manipulations and learn techniques of culturing tissues, single cells, protoplast and anther culture, hairy root culture and germplasm conservation
2. Undertake large scale in vitro propagation of plants and plan commercial production through micropropagation
3. Generate plants with desirable/novel traits through genetic manipulations using different methods of gene transfer and marker associated selections.
4. Recognize the importance of plant secondary metabolites, their production, and commercial application.
5. Acquire knowledge for isolation and growth of cells.
6. Develop proficiency in establishing and maintaining of cell lines
7. Apply the concept of stem cell technology in biomedical research

Recommended Books:

1. Plant tissue culture – theory and practice by Bhojwani S.S.
2. Plant cell culture – A practical approach by Dixion R.A.
3. Culture of Animal cells by R.I.Freshney. Wiley – Liss.
4. Animal Cell Culture – A Practical approach Ed. by John R.W.Masters (IRL Press).
5. Animal cell culture techniques, Ed. Martin Clynes, Springer.
6. Plant Cell, Tissue and Organ Culture, By Reinert, J. and YPS Bajaj (Springer – Verlag).
7. Plant tissue and cell culture, by Street, HE (Blackwell).
8. Stem cells in regenerative medicine by Audet (Springer).
9. Cell and tissue reaction engineering by Eibl (Springer).
10. Introduction to plant biotechnology.by HS Chawla: Oxford & IBH Publishing Co. Pvt. Ltd.,2000

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.

Course Outcomes:

Students will be able to:

1.Understand Theoretical knowledge of various topics of classical and modern genetics including: useful bacterial phenotypes, mutations, mutagenesis, transformation, conjugation and transduction.

2. Familiarization with concepts of Mendelian and non-Mendelian genetics, including: genetic diseases, human pedigrees, x-linked inheritance, Mitochondrial inheritance, genomic imprinting, behavioral traits etc.

3. Study of molecular genetics of Lambda phage, lytic/lysogenic cycles. Population genetics, migration etc.

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, Baye'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).

Course Outcomes

After completion of this course student would be able to

Use the biostatistics in public health.

Find the range for the given data and to compute the mean deviation for the ungrouped data.

Analyze the variance and standard deviation of discrete and continuous frequency distributions.

Distinguish between one- and two-way analysis of variance tests.

Grasp the concept of the Binomial, Poisson and Normal distribution and to calculate all the terms of ANOVA table.

Distinguish between coefficient r and rank correlation coefficient R

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

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

Course outcome:

The students will learn the facts about cancer, factors responsible for cancer, prevention and remedial measures

Recommended Books:

Wilson J.D. Text Book of Endocrinology. Saunders Publishers

Schatten H and Constantinescu G.M. Comparative Reproductive Biology. Blackwell Publishers, UK

Joy K.P, Krishna A, and Haldar C. Comparative Endocrinology and Reproduction. Narosa Publishers, Delhi

Nussey S and Whitehead. Endocinology-An Integrated Approach, Oxford: BIOS Scientific Publishers

Polonsky K. S, Larsen P. R and Kronenberg. Williams Textbook H.M of Endocrinology, Elsevier

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. Study of molecular markers

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, euromuscular 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)

Course Outcomes:

On completion of the course, students are able to:

1 Understand the Physiology of Digestion & Respiration.

2 Understand the Physiology of Circulation & nerve impulse and Reflex Action.

3. Understand the Physiology of muscle contraction & Excretion CO4 Understand the Physiology & Types of Endocrine glands.

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

Course Objectives:

This course aims to educate student about the mechanism and physiology life processes in plants. It focuses on the plant nutrient uptake and translocation, photosynthesis, respiration and nitrogen metabolism

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, Abscisic 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

1. understand the various physiological life processes in plants

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

3.They understand the role of various hormones, signaling compounds, thermodynamics and enzyme kinetics. During the course students will gain knowledge about various mechanisms such as channel or transport proteins involved in nutrient uptake in plants.

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 Salisburry& CW Ross: Plant Physiology

Hans-Walter Heldt: Plant biochemistry & Molecular Biology

206 C: Bioenergetics and Metabolism

Course Objectives:

Bioenergetics deals with how the living cells harness energy and channel it to biological work whereas intermediary metabolism means how the cells extract and utilize energy through numerous enzyme-catalyzed reactions. The students will learn both the interrelated aspects

Unit 1: Introduction Thermodynamics

First and second laws of thermodynamics. Gibbs free energy G, free energy change ΔG, endergonic & exergonic reactions, Standard state free energy changes-ΔG, ΔG0 and ΔG'0, Relationship between equilibrium constant and ΔG'o, Feasibility of reactions. ATP-Structure, properties and energy currency of the cell, Importance of Coupled reactions, other high energy

compounds.

Unit 2: Carbohydrate Metabolism

Carbohydrate metabolism: Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, gluconeogenesis, and glyoxylate pathway. Regulation of carbohydrate metabolism.

Unit 3: Electron transport and phosphorylation

Electron transport and oxidation phosphorylation: electron carriers, complexes I to IV, substrate level phosphorylation, mechanism of oxidative phosphorylation. Shuttle system for entry of electron. Biosynthesis and degradation of Lipids. Regulation of lipid metabolism

Unit 4: Nitrogen Assimilation

Nitrogen Assimilation: Overview of Nitrogen in biosphere and uptake by organism. Biosynthesis and degradation of amino acids. Regulation of amino acid metabolism. Biosynthesis and degradation of purine and pyrimidine nucleotides.

Course Outcomes:

Students will be able to

1. comprehend various biochemical changes that obey the basic thermodynamic principles.
2. correlate how the living organisms exchange energy and matter with the surroundings for their survival, and store free energy in the form of energy-rich compounds
3. recognize how the catabolic breakdown of the substances is associated with release of free energy; whereas, free energy is utilized during synthesis of biomolecules i.e., anabolic pathways
4. assess the crucial role of some hormones with regard to the integration of metabolic pathways.
5. apply the knowledge of metabolic pathways to biotechnological and biochemical research.

Recommended Books:

Nelson, Cox and Lehninger: Principles of Biochemistry

G Zubay: Biochemistry

Stryer: Biochemistry

Garrett and Grosham: Biochemistry

West, Tood, Mason and Bbruglen: Text book of biochemistry

White, Handler and Smith: Biochemistry

D.Voet and J C Voet: Biochemistry

Dixon and Webb: Enzymes

Price and Steven: Fundamentals of Enzymology

Plummer: Practicalbiochemistry

G Tripathi: Enzymebiotechnology

Walsh: Enzyme ReactionMechanism

Hammes: Enzyme catalysis andregulation

SEMESTER 3

301: GENETIC ENGINERING

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

Unit 1: Basics of Genetic engineering

Enzymes (Nucleases, Restriction endonucleases, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase). Vectors (Plasmids, Bacteriophages, Cosmids, Phagemids and Artificial Chromosomes). Nucleic acid sequencing (Maxum-Gilbert sequencing, Sanger's dideoxy sequencing). Nucleic acid amplification by PCR

Unit 2: Construction and screening of gene libraries

Construction of libraries (genomic and cDNA), library screening, preparation of nucleic acid probes by nick translation, random primer labeling and end labeling, hybridization techniques for identification of clones with gene of interest, screening by antibody-based methods

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

Physical methods (microinjection, electroporation, biolistic, liposomes), Chemical methods (PEG, DEAE, DMSO), Virus mediated transfection. Molecular markers in genome analysis (RFLP, RAPD, AFLP, SSR, SNP). Application of molecular markers in forensics, disease prognosis, genetic counseling, pedigree analysis

Unit 4: Characterization of cloned genes and mutagenesis

Expression of recombinant proteins, Native PAGE, SDS PAGE, Western blotting. Gene tagging and transposon tagging methods. Mutation and Mutagenesis: Point mutation, frameshift mutation, site directed mutagenesis, deletion mutagenesis

Recommended Books:

- Primrose S.B, Twymand 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.

Course outcome:
Student will understand the process of construction and screening of the genomic and cDNA libraries as well as expression of recombinant proteins

302: IMMUNOLOGY AND IMMUNOTECHNIQUES

Course Objectives:

The objective of this course is to provide students with detail understanding of different cells of the immune system and their role in immune protection and application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of infectious diseases, cancer, autoimmune disease, AIDS.

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, Lymphocytes trafficking, 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. Activation and regulation of B and T lymphocytes.

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 and MHC restriction. 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. Immunity to infectious agents (intracellular parasites, helminthes and Viruses), 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, immunofluorescence.

Course Outcomes:

Students will be able to

1. explain the role of immune cells and their mechanism in body defense mechanism.
2. apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. adopt immunological techniques for industrial uses.
4. demonstrate the association of immune system with cancer, autoimmunity, transplantation and infectious disease.
5. find out new vaccine target and develop strategy to design new vaccine.

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 FrancisGroup.

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

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

Course Objective:

To make students understand the essential features of the interdisciplinary field of science for better understanding biological data. To provide the student with a strong foundation for performing further research in bioinformatics. To find out the methods for analyzing the structure and function of DNA, RNA and proteins, and understand the basic concept of molecular modelling methods and their applications

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

Course Outcome:

The student should be able to understand basic research methods in bioinformatics.
The students will be able to demonstrate the most important bioinformatics databases, perform text- and sequence-based searches, and analyze the results in light of molecular biological knowledge.
The students will be able to experiment pair wise and multiple sequence alignment and will analyze the secondary and tertiary structures of protein sequences.
To let students to understand the use of Bioinformatics in drug design and development, finding new targets to treat disease; mechanism of drug designing

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. WILLEY-VCH press.

304: ENVIRONMENTAL BIOTECHNOLOGY AND ECOLOGY

Course Objectives:

To teach students the latest techniques and principles in environmental biotechnology. To provide hands on training on techniques and environmental biotechnology

Unit I: Introduction to Environmental Biotechnology

Ecosystems: biotic and abiotic components, Ecological pyramids, Food chains, Food webs, Habitat and niche, Energy flow in ecosystems, Types of ecosystems, Biological Magnification. Pollutants of atmosphere, water and solid wastes, Hazardous wastes. Microbial interactions in ecosystems. Introduction to Novel biocatalysts and biomaterials, Lignocellulosic residues, Biofuel and fossil fuels, Biomining and 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, colour codes, medical solid waste.

Unit III: Biodegradation and Bioconversion

Microorganisms in lignocellulose degradation, Cellulases and xylanases, Biodegradation of starch, glycogen, pullulan, dextrin and proteins. Xenobiotic compounds: chemical properties influencing biodegradability, mechanisms of degradation, microorganisms for degrading organic pollutants (petroleum products, methane/n-alkanes, alkenes, cycloaliphatic compounds). 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:

Environmental Science, S.C. Santra.
Environmental Biotechnology, Pradipta Kumar Mohapatra.
Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening
Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spence
Agricultural Biotechnology, S.S. Purohit.

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.

306A: MEDICAL BIOTECHNOLOGY

Students will develop an ability to use skills and modern technological tools necessary for medical biotechnological practices.

Unit-1: Oxidative stress: Role in physiological and pathological processes

Inflammation & pathogen defenses, Reproduction, ovulation, fertilization, implantation, parturition, Brain development: Differentiation into type I & II neurons, Chronic respiratory disorders-asthma, Cardiovascular disease atherosclerosis, Neurodegenerative disorders, stroke, Parkinson's, Alzheimer's, Diabetes, Cancer, Aging

Unit-2: Vaccinology

Historical perspective work of Edward Jenner on smallpox and cowpox, Louis Pasteur's contribution to vaccinology. Biology of vaccination-Basis of immunization, antigenicity and immunogenicity. Classical categories of vaccines-killed live; adjuvants and vehicles-mineral oil compounds, liposomes, saponins, and biodegradable micro particles. Modern categories of vaccines - multivalent vaccines, synthetic peptide vaccines, recombinant vaccines, DNA vaccines, combination vaccines. Commercial preparation of vaccines, cell culture-based vaccines,

regulatory aspects of vaccination for humans and veterinary use. Technical aspects of vaccination-routes of vaccination, schemes for vaccination - primary and boosters, storage of vaccines, risks of vaccination. Examples of vaccination-success of small pox vaccine, hepatitis B vaccine, rabies vaccine, challenges in vaccination against HIV, malarial parasites etc.

Course Outcomes:

By the end of this module, the student will be able to:

Study about reactive oxygen species and recognize its role in oxidative stress

Study the prospects for developing a vaccine against a named infectious disease, given information on its biology and epidemiology, and on the immune response in human hosts.

Suggested reading:

Recommended Books:

1. Introduction to Human Molecular Genetics – J.J Pasternak, John Wiley Publishers.

2. Human Molecular Genetics –Tom Strachen and A P Read, Bios Scxientific Publishers

3. Human Genetics Molecular Evolution, McConkey,

4. Recombinant DNA Technology, AEH Emery

5. Ganong's Review of Medical Physiology by Kimm E. Barrett, Susan M. Burman, Scott Biotano, Hedwen Brooks; Mcgraw Hill.

6. Human Physiology: The Mechanisms of Body Function by Arthur J. Vander, James Sherman & Dorothy S. Luciano; McGraw-Hill Higher Education.

7. Kuby Immunology by Kindt, T. J., Osborne, B. A. and Goldsby, R. A.; W. H. Freeman.

8.Fundamental Immunology by Paul, W. E.; Lippincott Williams and Wilkins.

9. Cellular and Molecular Immunology by Abbas, A. K., Lichtman, A. H. and Pillai, S.; Saunders.

306B: DEVELOPMENTAL BIOLOGY (PLANTS AND ANIMALS)

Course Objective:

To explain the students on the aspects of cell division, regulation of cell division, and differentiation of specialized cells to form complex multicellular organism

Unit 1: Seed development

Phases of development, Maturation; accumulation of desiccation related compounds, ABA regulation. Seed Dormancy: Physiological and molecular basis, Testa, Endosperm, Aleurone layers & Hormonal cross talk in dormancy. Alleviation of dormancy; Protein oxidation. Dormancy breaking chemicals and mechanism. Seed Germination: Pre-germination, Germination and post germination

Unit 2: Seed Ageing

Seed storage physiology: Orthodox & Recalcitrant; ROS metabolism, Mechanism of desiccation tolerance, dehydrins/LEA/peroxiredoxin, HSPs, Sugars. Longevity markers; β- mercaptopyruvate sulfur transferase (MST), L –iso aspartyl O-methyltransferase (PIMT). Seed Technology: Priming technology; biochemical and molecular aspects. Cryobanks, Cryopreservation of seed and embryo; Cryoprotective molecules, Vitrification, Encapsulation and Drying. Synthetic seeds

Unit 3: Cellular basis of differentiation:

Gametogenesis; fertilization, cleavage – types and mechanism, gastrulation, anterior/posterior, dorsal/ventral polarity development of drosophila, signalling cascades involved in the control of developmental program, cell specification with respect to amphibian, chick, phenomenon of the organizer with respect to amphibians: progressive determination, regional specificity of induction

Unit 4: Cellular development: Tetrapod limb development; axes formation, coordination of the three axes, regeneration: epimorphic, morphallactic and compensatory; plant meristem organization and differentiation in Arabidopsis, spatial and temporal regulations of gene expression during development and differentiation, programmed cell death, aging and senescence

Course outcome: The course paper provides basic understanding of the process and mechanism of development and differentiation of cells leading to formation of complex cell types

Recommended Books:

Alberts et al.: Molecular Biology of the Cell

SF Gilbert: Developmental Biology

Lewin Benjamin: Gene VIII

Dobzhansky et al.: Evolution, W. H. Freeman. New York

SW Fox and K Dose: Molecular Evolution and the Origin of Life, 1972, W.H. Freeman & Co Ltd.

306 C BIOPROCESS TECHNOLOGY

Course Objectives:

Plan a research career or to work in the biotechnology industry with strong foundation about bioreactor design and scale-up. Apply modeling and simulation of bioprocesses so as to reduce costs and to enhance the quality of products and systems.

Unit-1: Basics of Biochemical Engineering

Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics. Elemental balance equations; metabolic coupling – ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth.

Unit-2: Bioreactor design

Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.

Unit-3: Downstream Process and product recovery:

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic

techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.

Unit-4: Applications of microbial technology

Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery

Course Outcomes:

Recognizing the basic principles of bioprocess technology and different types of fermenters
Understanding the different processes involved in bioprocess technology
Developing and assessing the conditions for efficient and sustainable design of bioprocesses

Recommended Books:

Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.

Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.

Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York:

Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals.: McGraw-Hill.

El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.

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.

Course Outcomes:

The aim of the course is to provide participants with an introduction to research methods and report writing. Upon successful completion of the course you are expected to

1. Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. Have basic knowledge on qualitative research techniques
3. Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis
4. Have basic awareness of data analysis-and hypothesis testing procedures

402: AGRICULTURAL BIOTECHNOLOGY

Course Objective: The course is intended to provide the technology involve in crop improvements, molecular farming and production of transgenic crops.

Learning outcome:

• The students demonstrate familiarity with different method of crop improvement using biotechnological interventions

• Learn critical analysis and problem-solving skills to implement innovative plant biotechnology-based solutions

• Understanding of different bioprocesses involved in food production and different method of high value food product production.

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-galactorunase, 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).

Course outcome:

• The students will learn the process of filling the patent and protecting the intellectual property.

• Learn the biosafety regulations for handling and disposal of biohazards.

• Understand the various ethical issues pertaining to biotechnical research

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

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.

Course Outcomes:

Students will have a thorough understanding of various genomic technologies such as whole genome mapping & sequencing, genome annotation, global gene cloning and gene expression technologies, comparative genomics, Concept of haplotyping, introduction to pharmacogenomics, proteomics, etc. The students will know the vast amount of genome information in publicly available databases and how to access and best utilize for practical purposes.

Suggested readings:

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.

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