COURSES OF STUDY

M.Sc. (Biotechnology)

SEMESTER SYSTEM
(Effective for the session 2021-2023)

RAVENSHAW UNIVERSITY
CUTTACK

M. Sc. COURSE IN BIOTECHNOLOGY

Department of Botany, Ravenshaw University, Cuttack.

(SEMESTER SYSTEM)

Eligibility

Any student who has passed B.Sc. (Hons.) in Botany, Zoology, Life Science, Microbiology and Biotechnology are eligible to apply.

Admission

The candidates are to take admission after qualifying in an entrance test conducted by the university. The admission will be strictly as per the merit list in each category.

Course and Regulation

1. The course is of two years duration with four semesters for theory, laboratory practical work and a dissertation paper. The courses will be credit based with 20 credits in each semester.

2. Each semester shall have 4 theory papers of 4 credit each and one practical paper of 8 credit points. The candidate shall have to appear the mid semester and end semester examination (both theory and practical) at the end of each semester.

3. Each theory paper carries 50 marks of which 10 marks mid semester and 40 marks end semester evaluation. The duration of mid semester and end semester examination will be of one hour and 3 hours, respectively.

4. Each Practical paper carries 100 marks (20 marks mid semester and 80 marks in end semester) and will have examination of six hours duration. Each student will have to pursue a dissertation work in the fourth semester and defend the work in the fourth semester examination.

5. The Semester system of examination will have evaluation by examiners as suggested by the Board of Studies.

6. For passing a semester examination a candidate must secure a minimum of B grade in

practical and B- grade in aggregate of the theory papers in each semester. If the grade secured in a theory paper is F then the said mark will not be included in the aggregate.

7. If a candidate passes all the four semester examination he/she will be declared to have passed the M.Sc. examination in Biotechnology.

8. Attendance in each semester shall be strictly adhered to University Rules.

9. A candidate may repeat only once in one or more papers of any semester examination within a period of one year of the said semester examination. However, if the candidate does not clear the1st & 2nd semesters, his/her result will not be published even after successfully completing the 3rd and 4th semester. In case a candidate is unsuccessful in 3rd and 4th semester, he shall appear in the immediate next examination of the next batch for the same semester. A candidate failing on any semester examination will be allowed to appear once only in the examination for that semester conducted for the next batch of students and also be allowed to continue to the next semester. A candidate not appearing two consecutive semester examinations will be considered to have discontinued his/her study and will not be allowed to appear the remaining semesters.

10. Merit list will be prepared as per university rules, from among the students those who have cleared all semester examinations in 1st chance in one time without repeat of any paper.

11. The candidates who have failed in one semester may be allowed to appear the same in the immediate next chance, following the due provision of the Ravenshaw University. However, he will be not given another chance to appear.

SUMMARY OF THE COURSES OFFERED IN DIFFERENT SEMESTER

Paper No	Course title	Maximum Marks
	1st Semester	
Paper 1.1.1	CELL BIOLOGY AND BIOMOLECULES	50
Paper 1.1.2	ENZYMOLOGY AND MACROMOLECULES	50
Paper 1.1.3	IMMUNOLOGY	50
Paper 1.1.4	INSTRUMENTATION AND COMPUTATIONAL BIOLOGY	50
Paper 1.1.5	PRACTICALS	100
	2nd Semester	
Paper 1.2.1	GENETICS	50
Paper 1.2.2	MOLECULAR GENETICS	50
Paper 1.2.3	MICROBIAL PHYSIOLOGY	50
Paper 1.2.4	MOLECULAR BIOLOGY	50
Paper 1.2.5	PRACTICALS	100
	3rd Semester	
Paper 2.3.1	GENETIC ENGINEERING	50
Paper 2.3.2	PLANT BIOTECHNOLOGY	50
Paper 2.3.3	ANIMAL BIOTECHNOLOGY	50
Paper 2.3.4	ENVIRNOMENTAL BIOTECHNOLOGY & BIOPROCESS TECHNOLOGY	50
Paper 2.3.5	PRACTICALS	100
	4th Semester	
Paper 2.4.1	STUDENT SEMINAR	50
Paper 2.4.2	REVIEW	50
Paper 2.4.3	PROJECT	100
Paper 2.4.4	PROJECT PRESENTATION	100

Value Added and Add On Course (Optional), Total Course duration- 30 hours

Semester	Course	Course Title	Marks
Value Added Course (Optional)			
Any Semester	VA- 01	Chlorophyll Fluorescence Analysis	50
Any Semester	VA-02	Hydroponics For Soilless Organic Cultivation Of Plants	50
Any Semester	VA-03	Hairy Root Culture As A Source Of Secondary Metabolites	50
Add On Course (Optional)			
Any Semester	AO-01	Computational Bioinformatics	50
Any Semester	AO-02	Plant Tissue Culture	50
Any Semester	AO-03	Basics Of Microbiology	50

SEMESTER I

Paper 1.1.1- CELL AND DEVELOPMENTAL BIOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. Understand the basic components of prokaryotic and eukaryotic cells; DNA as the genetic material; basic mechanism of DNA replication
2. Understand how energy is used and generated in cells
3. Understand how cells undergo mitosis & meiosis
4. To impart knowledge on the importance of pH and buffer on cell survival and function; To learn chemical bonds in biomolecules and their role in molecular stability as well as flexibility.
5. To learn the basic principles of thermodynamics and the energy balance of cellular processes.
6. To learn the structure, function and properties of various biomolecules.

Outcomes:

On completion of the course the students shall

1. understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
2. know how these cellular components are used to generate and utilize energy in cells
3. have knowledge on cellular components underlying mitotic and meiotic cell division.
4. apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes.
5. Have knowledge on molecular interactions and energy balance of cellular reactions.
6. Have knowledge to understand the structural specificities of various biomolecules.

UNIT I Cell Structure and Function

1. Cell : Cell Theory, Structure of Prokaryotic & Eukaryotic cells, Structural organization of cell wall and plasma membrane
2. Structure and function of organelle: Mitochondria, Chloroplast, Nucleus, Endoplasmic reticulum, Golgi-apparatus, Lysosome, Peroxisome
3. Structure and function of cilia and flagella
4. Cytoskeleton and cell movement

UNIT II Cell Regulation

1. Transport of nutrients, ions and macromolecules across membranes
2. Cellular energy transactions: Role of mitochondria and chloroplast
3. Cell cycle: Molecular events and model systems
4. Signaling system: Cellular responses to environmental signals in plants & animals, mechanism of signal transduction
5. Cellular basis of differentiation and development: Germ cell determination in Drosophila and mammals, Gametogenesis and fertilization Early development in Drosophila: Genes that pattern the Drosophila body plan, Development in Arabidopsis

UNIT III: Biomolecules I

1. Chemical foundations of Biology: pH, acids, bases pK, buffers
2. Atomic bonds and Molecular interactions: Weak bonds (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction), Covalent bonds
3. Classes of organic compounds and functional groups, Atomic & molecular dimensions, space filling and ball & stick model
4. Bioenergetics – Basic principles, Laws of thermodynamics, Equilibria and concept of free energy, Standard free energy, free energy change, Coupled processes

UNIT IV: Biomolecules II

1. Polysaccharides: Types, Structural features, Monosaccharides - classification and reactions Aminoacids : Classification, chemical reactions and physical properties
2. Proteins : Classification, properties, structure of proteins, separation and purification of proteins
3. Lipids: Classification, structure & functions
4. Nucleic acids: Basic properties of nucleotides and their functions, Types, structure & chemistry of nucleic acids

PAPER 1.1.2-ENZYMOLOGY AND MACROMOLECULES
50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. To gain knowledge about Nomenclature, Classification, Extraction and properties of enzymes and their immobilisation method.
2. To develop concept about how proteins get inhibited and their mechanism of action.
3. To describe about photosynthesis pathway and the pigments and mechanism involved in this.
4. Explore the types and physical and chemical properties of macromolecules found in an organism
5. Conceptualisation about protein and nucleic acid sequencing.

Outcomes:

On completion of the course the students shall

1. be able to get idea about the enzyme extraction process and assay
2. understand the kinetics and their mode of action and inhibition.
3. have an idea about photosynthetic pathway and carbohydrate metabolism.
4. Have knowledge about all the structure, function and every aspects of bio-macromolecules can be studied.
5. The students will have idea about the methods by which a protein/ nucleic acid get sequenced

UNIT I: Enzymology

1. Enzymes: Properties, Nomenclature, Classification, Extraction, Assay & Purification.
2. Immobilised Enzymes: Physical & chemical methods.
3. Enzyme kinetics: Chemical kinetics, Enzyme kinetics (Michaelis-Menten equation, Briggs Haldane modifications), Determination of V_{max} and K_m.
4. Enzyme inhibition: Types of inhibitors, Determination of K_I .
5. Mechanism of enzyme action: General principle of mechanism, Mechanism of enzyme reaction catalysed by Lysozyme, RNAse, Chymotrypsin.
6. Regulation of enzyme action: Allosteric control, Stimulation and inhibition by control proteins, Covalent modification, Proteolytic activation

UNIT II: Carbohydrate Metabolism

1. Carbohydrates: Classification, configuration and conformation of monosaccharides, sugar derivatives, important disaccharides. Structural and storage polysaccharides, glucosaminoglycans, proteoglycans, glycoproteins and glycolipids.
2. Carbohydrate metabolism: Glycolysis, TCA cycle, glyoxalate cycle, pentose-phosphate pathway.
3. Gluconeogenesis, glycogen metabolism, biosynthesis of starch and sucrose, regulation of carbohydrate metabolism

4. Oxidative phosphorylation, electron transport and ATP synthesis
5. Photosynthesis: General concept and historical background, photosynthetic pigments and light harvesting complexes, mechanisms of electron and proton transport. ATP synthesis Carbon assimilation- the Calvin cycle, photorespiration and its significance. C4 cycle, the CAM pathway, biosyhthesis of starch and sucrose.

UNIT III: Macromolecules I

1. Glyco and lipoproteins: Structure and function, Protein denaturation
2. Protein-protein and protein-ligand interactions: Physical and chemical methods for study Protein folding: Biophysical & cellular aspects
3. Nucleic acid hybridization: Structural analysis & biological studies

UNIT IV: Macromolecules II

1. Organization of macromolecular complexes: Chromatin organization and packaging
2. Sequencing of protein: End group analysis (N-terminus and C-terminus identification), Cleavage of the disulfide bonds, separation, purification and characterization of the polypeptide chains, sequence determination, sequencing by Mass Spectrometry
3. Sequencing of nucleic acids: Sanger's technique & Maxam Gilbert's technique
4. Confirmational properties of polynucleotides and polypeptides at secondary and tertiary structural features & their analysis

PAPER 1.1.3-IMMUNOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. Knowledge of the structure and function of the major organ systems, including the molecular, biochemical and cellular mechanisms for maintaining homeostasis.
2. Conceptualize how the innate and adaptive immune responses coordinate to fight invading pathogens.
3. Determine what immunomodulatory strategies can be used to enhance immune responses or to suppress unwanted immune responses such as might be required in hypersensitivity reactions, transplantations or autoimmune diseases.
4. Critically review the sample literature to determine the strengths and weaknesses of the data published in immunology and its novelty.
5. To learn the process of development of vaccines.

Outcomes:

On completion of the course the students will be able to

1. identify the cellular and molecular basis of immune responsiveness.
2. describe immunological response and how it is triggered and regulated.
3. demonstrate a capacity for problem-solving about immune responsiveness.
4. transfer knowledge of immunology into clinical decision-making through case studies presented in class.
5. understand the process of development and application of vaccines.

UNIT I: Immunology-I

1. Introduction, Phylogeny of immune system, Innate and Acquired immunity, Clonal nature of immune response
2. Cells of the immune system: Hematopoiesis and differentiation, Lymphocyte trafficking, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural killer cells, Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells
3. Organization and structure of lymphoid organs

UNIT II: Immunology-II

1. Nature and biology of antigens and super antigens, Structure and function of Antibody molecules, Antigen-antibody interactions, Major histocompatibility complex and MHC restriction
2. Antigen processing and presentation, Generation of humoral and cell mediated immune responses, BCR & TCR, Cytokines and their role in immune regulation

UNIT III: Immunology-III

1. Complement system: Complement system as a part of innate & adaptive immune system, complement activation by classical, alternative and lectin pathway, complement mediated lysis and other effects of complement activation

2. Hypersensitivity & Immuno regulation: IgE-mediated type 1 hypersensitivity, IgE binding receptor in the target cell, mechanism and molecular events in the mast cell degranulation by IgE, Pharmacologically active mediators of type 1 reactions. Mechanisms behind type 2, 3 & 4 hypersensitive reactions

UNIT IV: Immunology-IV

1. Activation and regulation of B- and T-lymphocytes, Cell mediated cytotoxicity, Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, macro-phage mediated cytotoxicity
2. Autoimmunity, Transplantation, Tolerance, Tumor immunology
3. AIDS and other Immunodeficiency diseases
4. Hybridoma technology and Monoclonal antibodies

PAPER 1.1.4- INSTRUMENTATION AND COMPUTATIONAL BIOLOGY
50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. To study the basic principles of operation and application of various types of microscopes in biological studies and analysis of biological samples.
2. To understand the principles of spectrophotometry, spectrofluorimetry and high end spectroscopic techniques
3. To learn various chromatographic techniques and understand their applications in biology.
4. To understand the theories, procedures and applications of different types of electrophoresis. Use of electrophoretic techniques in separation of biomelecules.
5. To learn the basics of computers and understand the methods of data analysis using computers.
6. To know the fundamentals of bioinformatics and their application in biotechnology

Outcomes:

After the completion of the course the students shall be able to

1. Understand the basics and ability to use different types of microscopes.
2. Understand the principles and functions of a typical spectrophometer and spectrofluorimeter as well as to have an idea on NMR and Mass spectroscopy.
3. Have knowledge on the principles of chromatography and skill to prepare some chromatograms for separating biomolecules.
4. Have knowledge on various electrophoretic techniques and their application and skills to prepare gel slabs.
5. Learn the use of computers and ability to link computer application in biology.
6. Have knowledge and skills on the use of the digital data available in the virtual space. and ability to identify their application for biology.

UNIT I: Instrumentation I

1. Microscopy: Principle of light transmission, Phase contrast microscope, Fluorescence microscope, Transmission and Scanning electron microscope
2. Principle and use of analytical instruments: pH metry, Spectrophotometry, Fluorescence spectroscopy, NMR spectroscopy, Mass spectroscopy

UNIT II: Instrumentation - II

1. Chromatography: Paper chromatography, TLC, Gel permeation, Ion exchange, GLC, Affinity chromatography, HPLC and FPLC
2. Electrophoresis: Theory and application of Polyacrylamide and Agarose gel electrophoresis, Capillary electrophoresis, 2D Electrophoresis, Gradient electrophoresis, Pulsed field gel electrophoresis

UNIT III: Computer application

1. Introduction of digital computers: Organization, Low level and high level languages, Binary number system
2. Introduction to Corel Draw
3. Flow charts & programming techniques: Introduction to programming in C
4. Introduction to data structure and data base concepts
5. Introduction to internet and its applications
6. Introduction to MS-OFFICE: Software covering word processing, spread sheet and presentation software
7. Bioinformatics and Biotechnology

UNIT IV: Biostatistics

1. Brief description, Tabulation of data and its graphical representation
2. Measures of central tendency and dispersion: Mean, Median, Mode, Range, Standard deviation, Variance
3. Hypothesis testing: Level of significance, Tests of significance, (F & t-test), Chisquare test. Simple linear regression and correlation
4. Computer Oriented statistical techniques: Frequency table of single discrete variable, Computition of means, variance and standard deviation, t-test, Correlation and regression

PAPER 1.1.5: PRACTICALS

100 Marks (6 hours) (80 marks end term and 20 marks mid term evaluation)

Objectives:

1. To Prepare the slides of cells and tissues
2. To learn the theoretical principles and practical application of spectrophotometer.
3. To learn the qualitative and quantitative determination of sugars, amino acid, proteins, lipids and nucleic acids.
4. To perform the chromatographic separation of biomelecules.
5. To perform the Enzymes purification and Kinetic analysis.
6. To carry out the Electrophoresis of DNA
7. To learn the statistical methods for data analysis using computers.

Outcomes:

On completion of the course the students shall

1. Be able to prepare different division stages of Mitosis and Meiosis
2. Know the use of a spectrophotometer and colorimeter.
3. Be able to identify and quantify sugars, amino acid, proteins, lipids and nucleic acids.
4. Be perform the TLC and other chromatographic separations.
5. Be able to perform the Enzymes purification and Kinetic analysis
6. Have knowledge the method of Electrophoresis of proteins and nucleic acids from cells and tissues.
7. Have the knowledge for application of sample comparison and group comparison tests for analysis of data.

PRACTICALS:

1. Cell Structure analysis
2. Cell division - Mitosis/Meiosis
3. Microtomy
4. Sub cellular fractionation and marker enzymes
5. Titration of amino acid
6. Validation of Beer-Lambert's law
7. Determination of absorption spectra and maxima of a supplied dye
8. Colorimetric determination of pK
9. Qualitative determination of sugars, amino acid & lipids.
10. Isolation & estimation of cholesterol
11. Isolation & estimation of DNA.
12. Isolation & estimation of RNA.
13. Isolation & estimation of protein
14. Estimation of oil's iodine number
15. Paper chromatography of amino acids
16. TLC
17. Gas chromatography to isolate mixture of alcohols

18. Electrophoresis of proteins
19. Enzymes: purification and Kinetic analysis
20. Electrophoresis of DNA
21. Determination of Tm of nucleic acids
22. Testing the difference between two samples by t-test
23. Testing the difference between expected value and observed value by Chi-square test.
24. Testing the interaction of factors by F-test
25. Practicals for computer applications
26. Model building using space filling/ball and stick models.

SEMESTER II

PAPER 1.2.1- GENETICS

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. To understand the basic Mendelian principles of genetics and the concept of gene.
2. To study various types of Gene interactions and its effect on morphology.
3. To understand the importance of Linkage and Crossing over for assortment of genes.
4. To learn the causes and effects of polyploidy.
5. To study the Chromosomes, Sex chromosome and Sex linked inheritance of Man and Drosophilla
6. To understand the Extra - chromosomal inheritance

Outcomes:

On completion of the course students hall have

1. An up to date knowledge about Mendelian principles of genetics and on the structure and concept of gene.
2. Proper understanding about gene interaction and the Multiple allelic systems.
3. An understanding of linked genes and their inheritance pattern.
4. Knowledge to explain the Autopolyploidy, Allopolyploidy, Segmental allopolyploidy, and Autoallopolyploidy
5. An understanding on the importance of sex chromosomes.
6. Ability to describe how the organellar genes inherit and regulate the expression of characters.

UNIT I: Mendelian genetics I

1. Mendelian principles, the concept of gene; Dominance; Multiple allelic systems, Gene

interactions

2. Linkage and Crossing over, Crossing over mechanism

UNIT II: Mendelian genetics II

1. Change in chromosome number: methods

2. Polyploidy: Autopolyploidy, Allopolyploidy, Segmental allopolyploidy, Autoallopolyploidy; Analysis of autopolyploids (Triploids); Aneuploids

3. Structural alterations in chromosome: Deletion, Duplication, Inversion, Translocation

Analysis of translocation heterozygotes

UNIT III: Mendelian genetics III

1. Chromosomes of Man and Drosophilla

2. Sex chromosome and sex determination in Drosophila and Human

3. Sex linked inheritance in Drosophila_and man

4. Regulation of sex expression in animals

5. Extra - chromosomal inheritance

UNIT IV: Quantitative genetics

1. Quantitative inheritance

2. Population genetics; Hardy-Weinberg law

3. Change in gene frequency

4. Inbreeding depression and heterosis

PAPER 1.2.2: MOLECULAR GENETICS
50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives

1. To understand the structure of DNA and its mechanism of replication and repair.
2. To have an idea about mutation, and process of mutagenesis.
3. To understand the structure and mechanism of action of RNA polymerase and reverse transcriptase.
4. To have knowledge about gene regulation in prokaryotes and eukaryotes.
5. To understand the process of transformation, transduction and conjugation in bacteria.

Outcomes

On completion of the course the students shall

1. Have knowledge on the structural diversity of DNA and the process of replication and repair.
2. Have a clear understanding on different types of mutations and their importance.
3. Have knowledge on RNA polymerase and reverse transcriptase.
4. Understand the operon concept in *E. coli* and the role of chromatin in gene regulation.
5. Knowledge regarding bacterial genetic system, transposons, DNA and RNA phages

UNIT-I Gene as unit of mutation and recombination

1. Identification of DNA as the genetic material

2. Mutagenesis: Mutagenic agents, Mechanism of mutagenesis; mutagenesis by nitrous acid, hydroxylamine, alkylating agents, intercalators and UV.

3. Gene mutation, Mechanism of gene mutation, elucidation of nonsense, missense and frame shift mutations. Gene as the unit of expression, colinearity of gene and polypeptide.

4. Recombination- models and mechanisms, Homologous recombination, FLP/FRT and Cre/Lox recombination; Rec A and other recombinases.

UNIT-II DNA replication and repair

1. DNA Replication: DNA replication models; DNA polymerase- mode of action; Mechanism of DNA replication; Enzymes and accessory proteins involved in DNA replication;

2. RNA polymerases and reverse transcriptase: structure and mechanism of action

3. Enzymes involved in DNA modification, methylases, demethylases, Dnases, DNA gyrase, Topoisomerase

4. DNA repair

UNIT-III Microbial genetics

1. Genes, mutation and mutagenesis: UV and chemical mutagens; Types of mutation ; Ames test for mutagenesis; Methods of genetic analysis.

2. Bacterial genetic system: Transformation, Conjugation, Transduction, Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli.

3. Viruses and their genetic system: DNA Bacteriophage and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic system of Yeast and Neurospora

UNIT-IV Regulation of gene expression in prokaryotes and eukaryotes

1. Control of gene expression: Operon concept - E. coli lactose, arabinose and tryptophan operon

2. Positive and negative control, attenuation control, control sequences: promoter, operator, terminator and attenuator. Cis and trans acting factors

3. Role of chromatin in eukaryotic gene regulation: DNA methylation, chromatin remodeling, homeotic genes and epigenetic regulation of gene expression during development

PAPER 1.2.3 MICROBIAL PHYSIOLOGY
50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives

1. To learn the amazing diversity of the microorganisms and their importance.
2. To study the experimental techniques for the isolation, purification and culture of microbes.
3. To study the microbial growth pattern and metabolic diversity of microorganisms.
4. To study on the characteristics, and diversity of viruses and associated diseases.
5. To learn the host parasite relationship and the types of the antimicrobial agents and their mode of action.

Outcomes

On completion of the course the students shall

1. Properly know the diversity of microbial world and their application potential.
2. Learn the techniques for isolation, preservation and maintenance of important industrial microorganisms alongside their taxonomic informations.
3. Able to know the microbial growth kinetics batch culture, fed-batch culture and continuous culturing systems as well as their nutritional requirements.
4. Be able to know the viral life cycle and the methods for viral disease control.
5. Have knowledge about antimicrobial agents for control of microbes.

UNIT I: Introduction to microbiology

1. The beginning of microbiology: Discovery of the microbial world; Role of microorganisms Microbial evolution, systematic and taxonomy: Evolution of earth and earliest life forms (their metabolic strategies and molecular coding); New approaches to bacterial taxonomy: ribotyping, ribosomal RNA sequencing

2. Methods in Microbiology: Pure culture techniques; Theory and practice of sterilization; Construction of culture media; Enrichment of culture techniques for isolation of nutritionally different microorganisms.

UNIT II: Microbial growth and metabolism

1. Microbial growth: Mathematical expression of growth; Growth curve; Measurement of growth and growth yields; Synchronous culture; Continuous culture; Growth as affected by environmental factors.

2. Metabolic diversity among microorganisms: Photosynthesis in microorganisms;

Chemolithlo trophy; Methenogenesis and acetogenesis; Fermentation; Nitrogen fixatation; Hydrocarbon transformation.

UNIT III: Microbial diversity and microbial diseases

1. Prokaryotic diversity: Diversity amongst bacteria; Archea as earlieast life forms and their diversity; Eukarya; Diversity amongst viruses (Animal and Tumor viruses, DNA viruses, Positive strand-,Negative strand-, and Double stranded RNA viruses, Adenoviruses, Retroviruses); Viriods and Prions.

2. Microbial diseases: Disease reservoirs; Epidemiological terminologies, Respiratory infecections; Sexually transmitted diseases; Diseases transmitted by animals and insects; Food and water borne diseases.

UNIT IV: Pathogenesis & chemotherapy

1. Host parasite relationship: Normal microf1ora of skin, oral cavity, gastro intestinal tract; Entry of pathogen to host; Colonization; Factors predisposing to infections; Types of toxins (Exo-, Endo- and Entero-) and their structure; Mode of activities: Virulence and pathogenesis.

2. Chemotherapy/Antibiotics: Antimicrobial agents; Sulphadrugs; Antibiotics: Pencillins and Cephalosporines; Broad spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

PAPER 1.2.4: MOLECULAR BIOLOGY
50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. To study about transcription and transcriptional gene silencing.
2. To learn the mechanism of translation and protein localization.
3. To learn the mechanism and regulation of oncogenesis.
4. To study the antisense RNA and ribozyme technology
5. To understand the genomic sequencing and genomic DNA libraries.
6. To study the molecular mapping of genome.

Outcomes:

On completion of the course the students shall

1. Have clear understanding on the principle and mechanism of transcription and its regulation by gene silencing.
2. Be able to understand the transcriptional and post transcriptional protein modification and their localization in cell and cellular organelle.
3. Be able to describe the role of Oncogenesis and the regulatory pathways.
4. Be able to describe the role of antisense RNA and ribozyme technology in gene silencing.
5. Be able to describe how genomic sequencing can be made by using genomic DNA libraries.
6. Have clear understanding gene mapping and how physical maps can be done.

UNIT I: Transcription and translation

1. Transcription: Prokaryotic transcription; Eukaryotic transcription; RNA polymerase; Transcription factors; Regulating elements and mechanism of transcription regulation; Transcriptional and post transcriptional gene silencing.

2. Modification in RNA: 5' cap formation; Transcription termination; 3' -end processing and polyadenylation; Splicing, Editing, Nuclear export of m-RNA; m-RNA stability.

3. Translation: Prokaryotic and eukaryotic translation; The translation machinery; Mechanism of initiation, elongation and termination; Regulation of translation; Co-and Post-translational modification of proteins.

UNIT II: Protein localization and oncogenesis

1. Protein localization: Synthesis of secretory and membrane proteins; Import into nucleus, mitochondria, chloroplast and peroxisome; Receptor mediated endocytosis.

2. Oncogenesis, Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.

UNIT III: Antisense RNA and ribozyme technology

1. Antisense Technology: Molecular mechanism of antisence molecules; Disruption of RNA structure and capping

2. Ribozymes: Biochemistry of ribozyme: hammer-head, hairpin ribozymes; Strategies for designing ribozymes; Applications of antisence and ribozyme technology.

UNIT IV: Genomic sequencing and molecular mapping of genome

1. Genome sequencing: Genomic sizes; Organelle genomes; Genomic libraries; YAC, BAC libraries; Strategies for sequencing genomes; Packaging, transfection and recovery of clones

2. Molecular mapping of genomes: Genetic and physical maps; Southern and fluorescence in situ hybridization for genome analysis; Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis; Application of RFLP in forensic, disease prognosis, genetic counselling.

PAPER 1.2.5: PRACTICALS
100 Marks (6 hours) (80 marks end term and 20 marks mid term evaluation)

Objectives:

1. To learn the methods of isolation, culture and measurement of growth of microbes.
2. To assay the antibiotics and demonstrate the antibiotic resistance.
3. To learn the biochemical characterization of microbes.
4. To learn the methods of isolation of plasmids and nucleic acids.
5. To learn the blotting methods

Outcomes:

On completion of the course the students shall

1. Have knowledge the method for culture of microbes and their growth measurement procedure.
2. Able to assay the antibiotics by microbes and demonstrate the antibiotic resistance.
3. Be able to make biochemical characterization of microbes using qualitative methods.
4. Gain knowledge about isolation of plant, animal and genomic DNA and RNA.
5. Have knowledge to perform Southern blotting

PRACTICALS

1. Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods; slants and stab cultures; storage of microorganisms
3. Isolation of pure cultures from soil and water
4. Measurement of growth; Preparation of growth curve; Measurement of bacterial population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon and nitrogen sources on growth.
5. Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain and Staining for spores.
6. Study of mutation by Ames test.
7. Assay of antibiotics and demonstration of antibiotic resistance.
8. Analysis of water for potability and determination of MPN
9. Bacterial transformation
10. Biochemical characterization of selected microbes.
11. Transduction
12. One step growth curve of coliphage
13. Isolation of plasmids.
14. CO_2 fixation by photosynthetic microbes.
15. Isolation of genomic DNA
16. Southern blotting
17. Isolation of RNA
18. Blood film preparation and identification of cells
19. Lymphoid organs and their microscopic organization
20. Western blotting
21. ELISA
22. Immunodiagnosis (Demonstration using commercial kits)

SEMESTER III

PAPER 2.3.1: GENETIC ENGINEERING
50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. To study the scope and basic procedures of genetic engineering
2. To learn about different Cloning vectors.
3. To understand the cDNA synthesis and cDNA Library construction
4. To understand about the Nucleic acid microarray
5. To study about In vitro synthesis and processing of recombinant proteins.

Outcomes:

On completion of the course the students shall

1. Understand principle and mechanism of action of Enzymes used in RDT, Restriction enzymes and PCR technology
2. Know about the use of Plasmids, Phagemids, Cosmids and Artificial chromosome as cloning vectors.
3. Have a clear understanding synthesis and cloning of cDNA and cDNA Library construction and sequencing.
4. Have knowledge about the Nucleic acid microarray and Protein engineering and mutagenesis.
5. Be able to describe the about In vitro transcription and translation and the procedure for expression and regulation of transgenes.

UNIT I: Tools and Techniques of Genetic Engineering

1. Introduction to genetic engineering, History, Milestones, Scope, Genetic Engineering

Guidelines

2. Enzymes used in RDT, Restriction enzymes, DNA modifying enzymes.

3. Basic principles of nucleic acid isolation and purification, Nucleic acid amplification (PCR): General protocol, fidelity of thermostable DNA polymerases, Types and applications of PCR

4. Restriction mapping of DNA fragments and map construction.

UNIT II: cDNA, Gene Cloning & Protein Engineering

1. Concept of Gene Cloning, Cloning vectors; features and types, Plasmids, Phagemids, Cosmids and Artificial chromosome.

2. cDNA synthesis and cloning: m-RNA enrichment; Reverse transcription; DNA primers, linkers, adopters and their chemical synthesis; cDNA Library construction and sequencing.

3. Alternative strategies of gene cloning: Cloning interacting genes Two- and Three- hybrid systems; Cloning differentially expressed genes

4. Nucleic acid microarray.

5. Strategies for Protein engineering; Random and Site directed mutagenesis.

UNIT III: Gene regulation and expression

1. DNA transfection, Northern blot, Primer extension, Sl mapping, RNase protection assay, Reporter assays.

2. Expression strategies for heterologous genes: Vector engineering and codon optimization;

3. Host engineering; In vitro transcription and translation; Expression in bacteria, yeast, insects and insect cell, mammalian cells and plants.

4. Processing of recombinant proteins: Purification and refolding; Characterization of recombinant proteins; Stabilization of proteins.

UNIT IV: Transposon tagging and Gene therapy

1. Role of gene tagging in gene analysis, T-DNA and transposon tagging; Identification and

isolation of genes through T-DNA or transposon.

2. Transgenic and gene knock out technologies: Targeted gene replacement; Chromosome engineering.

3. Gene therapy: Vector engineering; Strategies of gene delivery; Gene replacement/ augmentation, correction, editing, regulation and silencing.

PAPER 2.3.2: PLANT BIOTECHNOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. To study methods of cultivation of different plant tissues
2. To learn about Direct and indirect gene transfer techniques in plants
3. To study about metabolic engineering and in vitro production of secondary metabolites.
4. To learn different molecular mapping methods.
5. To understand the Intellectual property rights (IPR) and Plant Genetic Resources (PGR)utilization and management.

Outcomes:

On completion of the course the students shall

1. Have knowledge the about culture and differentiation of different plant tissues and production of somatic embryos.
2. Be able to describe the Agrobacterium mediated gene transfer in plants and the methods of direct genetransfer.
3. Gain knowledge regarding about metabolic engineering and manipulation of different biosynthetic pathway for production of secondary metabolites
4. Learn the application of markers techniques and marker assisted selection.
5. Have a clear understanding on IPR and patenting for conservation and equitable use of Plant Genetic Resources (PGR)

UNIT I: Techniques of Plant Tissue Culture

1. Conventional plant breeding, Introduction to Plant Tissue culture, Tissue culture media (composition and preparation); Initiation and maintenance of callus and suspension culture; Single cell clones.

2. Somatic embryogenesis; Embryo culture and embryo rescue; Protoplast isolation, fusion and culture; Selection of hybrid cells and regeneration of hybrid plants; Cybrids; Anther, pollen and ovary culture for production of haploid plants and homozygous lines

3. Cryopreservation.

UNIT II: Plant Transformation

1. Agrobacterium mediated gene transfer; Agrobacterium based vectors, viral vectors and their application.

2. Direct gene transfer techniques; chemical methods, electroporation, microinjection, particle bombardment. Use of 35S and other promoters, reporter genes and selectable markers in plant transformation technology. Excision of markers.

3. Transformation of chloroplast genome in higher plants: Advantages, vectors, success with tobacco and potato.

UNIT III: Metabolic engineering

1. Metabolic engineering and industrial products: Plant secondary metabolites; Control mechanisms and maipulation of shikimate pathway, phenyl alanine pathway, alkoloids, industrial enzymes, biodegradable plastics, therapeutic proteins, antibiotics, edible vaccines

2. Production of secondary metabolites by plant suspension cultures; Hairy root cultures as a source of secondary metabolites.

UNIT IV: Molecular Markers in Plant Breeding and IPR

1. Molecular maps of plant genomes: RFLP Genetic maps in plants, Linkage of major genes and QTLs to RFLPs, Uses of RFLPs maps, RAPDs and SSRs. Map based cloning, Marker assisted selection.

2. IPR and Plant Genetic Resources (PGR), Patenting of biological material: implication of patenting of higher plants, patenting transgenic organisms and isolated genes, patenting of genes and DNA sequences, Plant breeders right (PBRs) and Farmers Rights

PAPER 2.3.3: ANIMAL BIOTECHNOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objectives:

1. To learn the basic requirements for setting a animal tissue culture system
2. To learn the culture and growth estimation of animal tissue.
3. To study the processes for upscaling of culture of tissues.
4. To learn about the limitations and applications of animal tissue culture

Outcomes:

On completion of the course the students shall

1. Learn to prepare the cells and media for culture and learn the prepation process for axenic culture.
2. Know about the primary culture and the maintenance of culture cell lines.
3. Have knowledge about the reactors and their operation.
4. Know the importance of stem cells and organotype cell culture.

Unit-I Tools and techniques of Animal biotechnology

1. Equipments and materials for animal cell culture: Design and layout of culture room, Basic equipments used in cell culture, Sterilization and aseptic techniques, Substrates

2. Culture media: Introduction to the balanced salt solution and simple growth medium; Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium; Role of carbon dioxide, serum and supplements; Serum and protein free defined media and their application.

Unit-II Cell culture and growth

1. Primary culture and its maintenance: Various techniques of tissue disaggregation, Primary culture, Monolayer and suspension cultures

2. Biology and characterization of the cultured cells, Growth curve, Subculture, Establishment of cell line and their maintenance, cell quantitation and staining.

Unit III Culture augmentation techniques

1. Scaling up of cultured cells: Anchorage dependent cell culture: Substrate for cell growth (conventional methods and new trends), Suspension culture: Modes (Batch, Fed-batch, continuous and perfusion culture modes),

2. Fermentation technology for the growth of animal cells and their products (Bioreactors, Hollow fibre reactors, Air-lift fermentors, chemostats and microcarriers).

3. Cell cloning and micromanipulation

Unit IV Cell transformation, cell death and applications of animal cell culture

1. Cell transformation
2. Measurement of cell viability and cytotoxicity, Measurement of programmed cell death
3. Application of animal cell culture: Stem cell cultures: Embryonic stem cells and their applications; Organ, organotypic and histotypic cultures.
4. Cell culture based vaccines.

PAPER 2.3.4: ENVIRNOMENTAL BIOTECHNOLOGY & BIOPROCESS TECHNOLOGY

50 Marks (3 hours) (40 marks end semester and 10 marks mid semester examination)

Objective:

1. To study the approaches for management of air, water and soil pollution.
2. To learn the sustainable approaches for efficient treatment of pollutants and organic wastes
3. To the importance of biofertilizers and microbial fuel cell.
4. To learn and diversity, construction and operation of bioreactors.
5. To study the bioprocessing techniques using bioreactors.
6. Learn the production and processing techniques used in the industries for production of microbial metabolites.

Outcome:

On completion of the course the students shall

1. Learn different biotechnological approaches for treatment of pollutants in air, water and soil.
2. Have in depth knowledge on the microbial application for degradation of xenobiotics and production of valuable products from wastes.
3. Know the approaches for production, storage and application of biofertilizers and also microbial fuel cells for energy generation.
4. Know the design, operation and regulation of industrial bioreactors for fermentation of solid and liquid media.
5. Understand the procedure for fermentation and the regulatory principles.
6. Have ability to understand the production of industrial products like acids, metabolites and antibiotics using microbes.

UNIT I: Environmental pollution

1. Air pollution and its control: Sources of air pollution, Ozone depletion; UV -B; Green house effect and acid rain: their impact and biotechnological approaches for management.

2. Water pollution and its control: Sources of water pollution; Waste water treatment-physical, chemical and biological treatment processes. Effluent treatment: D.O.C. and C.O.D., treatment and disposal of effluents.

3. Soil pollution and its control

UNIT II: Environment management for sustainability

1. Degradation of Xenobiotics: Ecological considerations, Decay behavior & degradative plasmids; Degradation of Hydrocarbons, Oil, Pesticides; Bioremediation of contaminated soils and waste land; Biopesticides in integrated pest management.

2. Solid wastes: Composting, Vermiculture and methane production;

3. Bioenergy and Fuel, microbial fuel cell

4. Biofertilizers, Bioleaching and biomining

UNIT III: Bioprocess Engineering

1. Bioprocess engineering: General principles, Bioreactor design; Media for Industrial Fermentation; Media sterilization; Isolation, Preservation and Maintenance of Industrial microbes; Measurement and control of bioprocess parameters

2. Types of fermentation processes: Analysis of Batch, Fed-batch and Continuous bioreactions; Stability of microbial reactors; Analysis of mixed microbial populations; Specialized bioreactors (pulsed, fluidized, photobioreactors)

UNIT IV: Down stream processing and Industrial applications

1. Downstream processing; Removal of microbial cells and solid matter; Foam separation; Precipitation; Filtration; Centrifugation; Cell disruption; Liquid-liquid extraction; Chromatography; Drying and crystallization

2. Industrial applications: Whole cell immobilization and their industrial applications; Industrial production of chemicals: Alcohol (ethanol); Acids (citric acid, acetic acid); Solvents (glycerol, acetone, butanol); Antibiotics (penicillin, streptomycin, tetracycline); Amino acids (lysine, glutamic acid); Single cell protein. Food technology: Elementary idea of canning and packing, Sterilization and pasteurization.

PAPER 2.3.5: PRACTICALS

100 Marks (6 hours) (80 marks end term and 20 marks mid-term evaluation)

Objectives:

1. To learn the electrophoretic separation and quantification of nucleic acids.
2. To learn the techniques of tissue culture.
3. To learn the methods for isolation and culture of protoplasts.
4. To learn the techniques of cell counting and cell viability test.
5. To learn the physicochemical and biological estimation of water quality.

Outcomes:

On completion of the course the students shall

1. Have practical Knowledge of Agarose gel electrophoresis and restriction mapping of DNA.
2. Have practical Knowledge tissue and media preparation, Callus propagation, organogenesis and acclimatization of in vitro regenerated plants.
3. Gain knowledge regarding the Protoplast isolation and culture.
4. Have knowledge of handling of bacterial cells and their viability testing.
5. Be able to determine the dissolved oxygen (DO), BOD, COD and microbial load of sewage and surface water.

PRACTICALS

1. Bacterial culture and antibiotic selection media

2. Isolation of plasmid DNA.

3. Quantification of nucleic acids.

4. Agarose gel electrophoresis and restriction mapping of DNA.

5. Construction of restriction map of plasmid DNA.

6. Preparation of media.

7. Surface sterilization.

8. Organ culture.

9. Callus propagation, organogenesis, transfer of plants to soil.

10. Protoplast isolation and culture.

11. Anther culture, production of Haploids.

12. Cytological examination of regenerated plants.

13. Agrobacterium culture, selection of transformants.

14. Preparation of tissue culture medium and membrane filtration

15. Preparation of single cell suspension from spleen and thymus.

16. Cell counting and cell viability.
17. Trypsinization of monolayer and sub-culturing.
18. Detection of coliforms for determination of the purity of potable water.
19. Determination of total dissolved solids of water.
20. Determination of dissolved oxygen concentration of water sample.
21. Determination of biological oxygen demand (BOD) of a sewage sample.
22. Determination of chemical oxygen demand (COD) of sewage sample.
23. Test for the degradation of a aromatic hydrocarbons by bacteria.
24. Survey of degradative plasmids in microbes growing in polluted environment.
25. Estimation of nitrate in drinking water.
26. Use of alginate for cell immobilization

FOURTH SEMESTER

PAPER 2.4.1: STUDENT SEMINAR

50 marks; end-term evaluation

Objective:

1. Awareness of how to use values in improving student's professionalism.
2. Learning about personal and communication styles for team building
3. Learning from research paper, review article and scientific journals about current research going on in various field of biology.
4. To promote respect for diversity issues and concepts.

Outcome:

On completion of the course the students shall

1. Learn basics and principals of value management.
2. Have improved communication skill and team spirit.
3. Learn how to search and compile information and make a presentation before others.
4. Students will learn to build and support great and valuable talent.

PAPER 2.4.2: REVIEW

50 marks

Objectives:

1. To teach students how to write review paper in biological science.
2. To get ready to face the challenge on how to write research paper.
3. To learn scientific writing skill and how to search research paper for a particular topic.
4. To learn the procedure for compilation and citation of references in the text and in the reference section.

Outcomes:

On completion of the course the students shall

1. Learn how to search research article for a particular topic.
2. Develop potential to write a scientific and research paper.
3. Have better presentation skill and analytical ability.
4. Know the method of reference citation and reference indexing.

PAPER 2.4.3: PROJECT

100 marks

Objectives:

1. To have experience on how to work in research labs.
2. To learn hands on training on how use various scientific instruments.
3. To learn the methods for pursuing research as a career.

Outcomes:

On completion of the course the students shall

1. Have exposure to research.
2. Be able to handle various scientific equipment for response measurement and be able to interprete research data
3. Develop interest for research related career.

PAPER 2.4.4: PROJECT PRESENTATION

100 marks

Objectives:

1. To learn how to present research work after completion of the project.
2. To train on presentation kills.
3. To eliminate the stage fear in student.
4. To increase confidence level of student in public speaking skills and how to express and defend his research work.

Outcomes:

On completion of the course shall

1. Learn to prepare a presentation of the important findings of their research.
2. Gain skill to present the research outcomes and relate them to the objectives.
3. Have confidence to speak in open forum.
4. Have an improved presentation skill.

VALUE ADDED COURSES (OPTIONAL)

PAPER- VA-01: CHLOROPHYLL FLUORESCENCE ANALYSIS

Course duration- 30 hours, 50 Marks (Course-wise evaluation) (Exam Time: 3 hours)

Objectives:

1. To learn the scope and application of natural and artificial fluorescence and their biological importance.
2. To understand the basis of emission and excitation spectra.
3. To understand chlorophyll a fluorescence kinetics with short, medium and long exposure to light.
4. To have knowledge on JIP fluorescence and ability to analyse the fluorescence spectra.
5. To learn the principles and measurement of the electron transport.

Outcomes:

On completion of the course the students shall

1. Understand the characteristics of natural pigments and synthetic dyes with regard to their absorption and fluorescence properties.
2. Have knowledge on the light absorption and emission.
3. Develop skills to measure fluorescence using spectrofluorometer and ability to interpret the emission spectra.
4. Have knowledge on the energy transfer in the photosystems and JIP-fluorescence rise.
5. Skill to use PEA and MPEA and to analyse the fluorescence spectra and skill to quantify the bioenergetic parameters and interpret the data.

UNIT - I

Fluorescence spectrophotometry: Definition, scope and measuring principles. Spectrofluorimeter- design and function. Chlorophyll and phycobiliprotein fluorescence. Fluorescence ratios as biological tools; room temperature and low temperature fluorescence kinetics; Fluorescence dyes; Absorption and emission spectra; bioapplications.

UNIT - II

Chlorophyll *a* fluorescence: Definition, excitation and emission spectra. Concept of excitation energy transfer; FRET; Energy transfer in LHC; Electronic vibration states; Jablonsky principles; Kautsky effect; Fast and delayed fluorescence, OJIP fluorescence rise- Principles and applications; Native and differential fluorescence spectra.

UNIT- III

Plant efficiency analysis, Principle and application of PEA and MPEA: PSI - absorption changes, water-PS-NADP+ electron transport, Bioenergetic parameters - Performance indicating and stress indicating parameters: End reaction performances; Efficiency analysis, Dissipation function, Performance analysis of OEC; PS I , PS II and whole chain electron transport measurement.

PAPER- VA-02: HYDROPONIC CULTURE FOR SOILLESS ORGANIC CULTIVATION OF PLANTS

Course duration- 30 hours, 50 Marks (Course-wise evaluation) (Exam Time: 3 hours)

Objectives:

1. To study about Introduction Soilless Organic Cultivation, types, importance of Cultivation of plants under Hydroponic condition.
2. To learn about the Physical parameters affecting growth of Hydroponically Cultivated plants.
3. To study about various Nutrition medium for Hydroponic Cultivated plants.
4. To know about Precaution and troubleshoot of Cultivation of plants under Hydroponic condition.
5. To understand about disease and pest management and management of waste Nutrient Solution
6. To learn about the future prospective of Hydroponic Cultivation of Commercial plants.

Outcomes:

On completion of the course the students shall

1. Have knowledge about the types, methods and importance of Hydroponic Cultivation of plants. Have clear understanding how the physical parameters affect the growth of Hydroponically Cultivated plants.
2. Have ability to understand the Processing and modification of RNA.
3. Gain knowledge about different Nutrition medium for Hydroponic Cultivated plants.
4. Be able to describe the precaution and how to troubleshoot of Cultivation of plants under Hydroponic condition.
5. Be able to describe the Disease and pest management of hydroponic plants
6. Have knowledge about future prospective of Hydroponic Cultivation of Commercial plants.

UNIT - I

Introduction of Soilless Organic Cultivation, Types of Soilless Cultivation, Importance of aquaculture or Hydroponic Cultivation of plants, Current status of Hydroponic Cultivation in Indian Scenario, Bic principle of Hydroponic Culture, Different types of Hydroponic Cultivation Techniques: Raft Systems, Top Feed/Drip System, NFT (Nutrient Film Technique), Vertical growing.

Unit - II

Physical parameters affecting growth: Temperature, Light, Humidity. Nutrition medium for Hydroponic Cultivation of plants. Growing Substrates, Chemical Management of Nutrient Availability in the Hydroponic Solution, Nutrient Chemical Forms and Uptake Processes, Nutrient- nutrient Interactions, Use of Nanoparticles, Plant Growth-Promoting Rhizobacteria in Hydroponic Solutions, Realtime Monitoring of Hydroponic Solutions via Sensors: TDS. pH, DO etc.

Unit - III

Precaution and Troubleshoot of Hydroponic Cultivation: Contaminant control, Algal growth control, Microorganism control, Oxygen control, Flow of nutrient control. Deficiency management of macro and micro nutrient. Disease and pest management. Management of waste Nutrient Solution. Future prospective of Hydroponic Cultivation of commercial plants.

PAPER-VA-03: HAIRY ROOT CULTURE AS A SOURCE OF SECONDARY METABOLITES

Course duration- 30 hours, 50 Marks (Course-wise evaluation) (Exam Time: 3 hours)

Objectives:

1. To study the adventitious root induction and proliferation
2. To know the different method for hairy root initiation and applications
3. To compare the different types of secondary metabolites using different techniques.

Outcomes:

1. This course will provide a platform to prevent the overexploitation of plants having root importance in the natural habitat.
2. Secondary metabolites can be useful for Pharma companies/ Drug industries.
3. Students will aware about the instruments used for secondary metabolite estimation.

Unit-I

Plant Derived Chemicals: Primary metabolites and secondary metabolites, origin, types, structure and function; Morphological and chemical differentiation; secondary metabolites as a source of defence to biotic and abiotic stresses. Industrial applications

Unit-II

Methods for Secondary Metabolite Production: Plant cell, tissue & organ culture; Shoot culture, Root culture Callus culture, Cell suspension culture, Somaclonal variations etc. Hairy root culture using *Agrobacterium rhizogenes* (Protocol for Ri plasmid incorporation, integration and expression). Biochemical (opine analysis) and molecular characterization (PCR with *rol* gene primers).

Methods to enhance the production of secondary metabolites: Metabolic engineering, Precursor feeding, Biotransformation and Mass multiplication using bioreactor.

Unit-III

Different Methods for Extraction of Secondary Metabolites: Multi-elemental analysis by EDXRF and EPIXE techniques, qualitative phytochemical and antimicrobial analysis, quantification by TLC, HPLC, HPTLC and identification by NMR. Institutes involved in this work (IMMT, IOP & NISER Bhubaneswar, CIMAP / CDRI, Lucknow etc.)

ADD ON COURSES (OPTIONAL)

PAPER- AO-01: COMPUTATIONAL BIOINFORMATICS

Course duration- 30 hours, 50 Marks (Course-wise evaluation) (Exam Time: 3 hours)

Objectives:

1. To educates students regarding the interdisciplinary application of biological sciences and information sciences.
2. To study on the algorithms and computational systems in biological sciences and solve biological problems.
3. To have an idea on programming language to biology background students will be helpful in picking career in the exciting world of bioinformatics

Outcome:

On completion of the course the students shall

1. An understanding of the integration of biological and information science for deciphering complex biomelecules.
2. Be able to use computer software for comparison and data interpretation.
3. have additional understanding on the algorithms and programming concepts to students to gain knowledge in the interdisciplinary field of bioinformatics.

UNIT-I

Definition of Identity Substitution Matrix, Amino Acid substitution matrix - concepts of PAM and BLOSUM Matrix. Pairwise Alignment, Concept of Global vs Local Alignment - The Dot plot, The Needleman-Wunsch and The Smith-Waterman Alignment. BLAST - Types and Use, Multiple Sequence Alignment and its application.

UNIT-II

Definition of Phylogeny and Phylogenetics, Concept of molecular clocks, Types of Trees and Tree construction. Terms and Terminology in phylogenetics, Cladograms and Dendrograms, Classes and Types of Tree generation methods, Use of MEGA Packages in Phylogenetics.

UNIT-III

Definition of Programming and Algorithms. Different types of machine languages, Python language and its application in computation bioinformatics, Fundamentals of Python - Variable names, Data Types, Operators and Strings. Fundamentals of visualization tools in structural biology. Use of Pymol tool.

PAPER-AO 02: PLANT TISSUE CULTURE

Course duration- 30 hours, 50 Marks (Course-wise evaluation) (Exam Time: 3 hours)

Objectives:

1. To know the about the plant tissue culture techniques and its practical applications.
2. To understand the requirement for setting up a tissue culture laboratory.
3. To know the commercial aspects of plant tissue culture.

Outcomes:

On completion of the course the students shall

1. Ability to understand the basic of plant tissue culture methods and application for crop improvement.
2. Gain knowledge to develop a startup facilities using tissue culture techniques.
3. Be able to understand the economics of the process and know its potential.

UNIT-I

Introduction to plant tissue culture: Laboratory organization and requirement, Sterilization (Heat, wet, chemical and filter), Culture media and its composition, Role of macro- and micronutrients, vitamins, amino acids, carbon sources and gelling agents in tissue culture, Plant growth regulators and their uses in plant tissue culture, Preparation of culture media.

UNIT-II

Micropropagation: Micropropagation vs Macropropagation, Stages of micropropagation, selection of plants and explants, proliferation of shoot, rooting of shoots, acclimatization; Maintenance: Culture and Environmental factors; Tissue culture of elite/ ornamental/ medicinal plants. National Certification System for Tissue Culture Raised Plants (NCS-TCP). Commercial aspects of plant tissue culture.

UNIT-III

Practical/ Demonstration: Plant tissue culture laboratory equipment, Sterilization of plasticwares, glassware and other accessories, Preparation of stock solution and culture media, Readiness of Laminar airflow cabinet for aseptic culture work, Plant propagation techniques: Collection and sterilization of explants, Inoculation of explants and sub-culture techniques, *in vitro* and *ex vitro* rooting, Plant acclimatization.

PAPER-AO 03: BASICS OF MICROBIOLOGY

Course duration- 30 hours, 50 Marks (Course-wise evaluation) (Exam Time: 3 hours)

Objectives

1. To introduce the students to the early inventions and discoveries, which helped in establishment of Microbiology as a separate discipline.
2. To introduce the students to the classification of amazing diversity, growth and application of microorganisms.
3. To introduce the students to the general features of Archaea and Eubacteria.
4. To introduce the students to the algal, fungal and bacteria toxin and their pathogenicity.

Outcomes

On completion of the course the students shall

1. The content would provide the necessary information on microbial world and their importance to the mankind.
2. Students would learn the morphology and habitats of different types of microbes and their interaction for co-existence.
3. The students shall know the characteristics of Archaea and Eubacteria and their importance to the ecosystems.
4. The students shall have an ides on the diversity of microbial toxins and their impact on human health.

UNIT-I Introduction to Microbiology

Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming; Role of microorganisms in fermentation; Germ theory of disease; Development of various microbiological techniques and golden era of microbiology; Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman; Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

UNIT-II Microbes and Our surroundings

Environmental microbiology: Definitions of environment and examples of important microbes in soil, water and sediments covering the planet and their role in biogeochemical cycling. Microbial flora of water: Water pollution, role of microbes in sewage and domestic waste water treatment systems. Microorganisms as indicators of water quality. Microbes in agriculture and remediation of contaminated soils: Biological fixation; Mycorrhizae; Bioremediation of contaminated soils.

UNIT-III Microbial Interactions

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non-symbiotic interactions Microbe-animal interaction: Example of common human diseases and their causative agents.

Suggested Reading Books:

1. Brock Biology of Microorganism, M T Madigan, JM Martinko and J parker, Prentice Hall.
2. Microbiology, M J Jr Pelzar, ECS Chan and N R kreig, Tata Mc Graw Hill.

SUGGESTED READING

1st SEMESTER

1. Reproduction in Eukaryotic cells, DM Prescott, Academic press
2. Developmental Biology, SF Gilber., Sinauer Associates Inc.
3. Cells in Development and Inheritance, EB Wison, Macmilan.
4. General Biochemistry, Linus pauling, W.H.Freeman and Company
5. Biochemistry, D. Voet and JG Voet, 1. Wiley and Sons.
6. Physical Biochemistry, D Frefilder, W.HFreeman and Company.
7. Understanding Chemistry, CNR Roo, University Press.
8. Kuby Immunology, 4th edition RA. Goldsby, T.J.Kindt, B.A.Osborne. Freemann Company.
9. Fundamentals of Immunology, Wiliam paul.
10. Immunology, Roitt and others, Mosby-Boston, Chicago, London, Toaronto.
11. Introduction to protein structure, C. Brenden and J Tooze, Garland publishing
12. Biophysical Chemistry, cantor, W H freeman.

2nd SEMESTER

1. The science of genetics, AG Atherly, JR Girton and IF MC Donald, saunders College Publishing USA, Fort Worth, USA
2. Genetics principles and analysis (4th Edition) . DL Hart and EW Jones, Jones and Bartett Publishers, Massacheusetts, USA
3. Genetics, PJ Russe (5th Edition), The Benjamin Curunings Publishing Company inc, USA
4. General Microbiology, RY. Stainer, JH Ingrahamm, ML Wheelis and PR Painter, the Mac Milan Press Ltd.
5. Brock Biology of Microorganism, M T Madigan, JM Martinko and J parker, Prentice Hall.
6. Microbiology, M J Jr Pelzar, ECS Chan and N R kreig, Tata Mc Graw Hill.
7. Molecular Biology of cell, Alberts. B, et. AI, Garland Science, Taylor and Francis group.
8. Molecular cell biology, Lodish et al. W.H. Freman and Company
9. Molecular Cloning- a laboratory manual, J. Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbour Press.
10. Gene VIll. Benjamin Lewin, Oxford University Press.
11. Genomes. T A Brown. John Wiley and Sons.
12. Physical Biochemistry, D Frefilder, W.H.Freeman and Company.

3rd SEMESTER

1. Culture of animal cells, 3rd edition, RIan. Freshney, John Wiley and Sons.
2. Cell Growth and Division: A practical approach. Ed. R Basega, TRL Press.
3. Animal.cell culture techniques. Ed. Martin Clynes, Springer Verlag
4. DNA cloning: A practical approach, DM Clover and BD hames, IRL Press
5. Molecular biotechnology (2nd Edition). S B Primrose, Blackwell Scientific Publishers
6. Plant Biotechnology. J.Hammond, R Mc Garvey and V. Yusibov (Eds). Springer Verlag.
7. Biotechnology in Crop hnprovement. HS.Chawia. International Book Distributing Company

8. Environmental ChemistIy, A.K.Dey, Wiley Eastern Ltd.
9. Wastewater Engeneering- Treatment, Disposal and Reuse, Metcalf and Eddyt, Tata Mc Graw Hill, New Delhi.
10. Biochemical Rreactors, B Atkinson, Pion Ltd.
11. Bioprocess Technology: Fundamentals and applications, KTH, Stockholm.
12. Bioreaction Engineering Principles. J.Jacson and J Villadsen, Penum Press.
13. Biochemical Engineering, J M Lee, prentice Hall Inc.
14. Bioprocess Engineering- Kinetics, Mass Transport, Reactor and Gene expression, W F Vieth, John Wiley and Sons, Inc.