M.Sc. BIOTECHNOLOGY CURRICULUM

FOR

SEMESTER CHOICE BASED CREDIT SYSTEM

UTKAL UNIVERSITY

Vani Vihar, Bhubaneswar,
Odisha

w.e.f Academic Session 2021-22

M.Sc. Course in Biotechnology
(Semester system)

M.Sc. BIOTECHNOLOGY

COURSE STRUCTURE

1ST SEMESTER:	**(500 Marks, 30 Credits)**
Paper-101 Biochemistry	(40 Lectures / 6 Credits)
Paper-102 Cell Biology and Genetics	(40 Lectures / 6 Credits)
Paper-103 Instrumentation & Analytical techniques	(40 Lectures / 6 Credits)
Paper-104 Biostatistics and Computational Biology	(40 Lectures / 6 Credits)
Paper-105 PRACTICAL-I	(60 Practical Classes / 5 Credits)
Seminar/Journal club/Assignment	(1 Credit)

2ND SEMESTER:	**(500 Marks, 30 Credits)**
Paper-201 Microbiology	(40 Lectures / 6 Credits)
Paper-202 Immunobiology and Immunotechnology	(40 Lectures / 6 Credits)
Paper-203 Molecular Biology	(40 Lectures / 6 Credits)
Paper-204 Animal Biotechnology	(40 Lectures / 6 Credits)
Paper-205 PRACTICAL-II	(60 Practical Classes / 5 Credits)
Seminar/Journal club/Summer training report	(1 Credit)

3RD SEMESTER:	**(500 Marks, 30 Credits)**
Paper-301 Genetic Engineering	(40 Lectures / 6 Credits)
Paper-302 Bioprocess Engineering and Industrial Biotechnology	(40 Lectures / 6 Credits)
Paper-303 **Core Elective courses**	
CE-1: Plant Biotechnology/CE-2: Microbial Technology/ CE-3: Proteomics	(40 Lectures / 6 Credits)
Paper-304 **Allied Elective courses**	(40 Lectures / 6 Credits)
AE-1 Animal Physiology and Developmental Biology	(for M.Sc. Biotechnology)
AE-2 Biotechniques	(for Allied subjects)
Paper-305 PRACTICAL-III	(60 Practical Classes / 5 Credits)
Seminar/Journal club	(1 Credit)

4TH SEMESTER:	**(500 Marks, 30 Credits)**
Paper-401 Evolution and Environmental Biotechnology	(40 Lectures / 6 Credits)
Paper-402: Free Elective (FE): Fundamentals of Life Science: Origin of Life, Living Systems and Living Processes	
Paper-403 Research aptitude, Scientific communication and Bio-entrepreneurship	(4 Credit)

Project Work: 404 (300 Marks, 20 Credits)

- Dissertation **[200]**
- Seminar presentation and Viva Voce **[50+50]**

Free Electives:

Fundamentals of life science: Origin of life, Living systems and living processes

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Total Marks: 2000
Total Credits: 120

1st SEMESTER

1st SEMESTER

Paper: 101 (Theory) **Full Marks: 100**

Subject: BIOCHEMISTRY

Course Objective:

- The course aims at:
  - ✓ Understanding of structure and function of major biomolecules.
  - ✓ Understanding central metabolic process and role of enzymes in modulating pathways.
  - ✓ The theoretical background of biochemical knowledge to interpret the results in biochemistry experiments.
  - ✓ Providing a basic understanding of the enzyme their properties and application in various industries.

UNIT-I

1. Chemical basis of life: Chemical composition and bonding, three dimensional structure (configuration and conformation, Isomerism and steriospecificity), Chemical Reactivity: Oxidation-reduction reactions, Nucleophilic substitution, internal rearrangements, Group transfer reactions, Condensation.
2. Water: Structure of water, water as a solvent, ionization of water, Weak Interactions in aqueous solution (Dipole movement, van der Waal's, ionic and hydrophobic interactions. Hydrogen bonding). Weak acids, bases, pH and buffers, Blood buffering system.
3. Bioenergetics: Laws of Thermodynamics, entropy, enthalpy and free energy, standard free energy, free energy change, chemical equilibrium. Phosphoryl group transfer and ATP.

UNIT-II

1. Amino acids: Classification and properties, Acid–base properties, Non-standard amino acids, amino acid derivatives in proteins, D-amino acids.
2. Peptides: Peptide bond, ionization behavior of peptides, biologically active peptides. Levels of protein structure. Determination of primary structure of protein. Three dimensional structures of proteins (Secondary, tertiary and quaternary structures, structural patterns: motifs and domains).
3. Protein denaturation and Protein folding
4. Biosynthesis of Amino acids, Amino acid catabolism (transamination, oxidative deamination and urea cycle), Protein degradation (proteosomal pathway) and Solid phase synthesis of peptides.

UNIT-III

1. General introduction & history of Enzymology, Importance of enzymes in understanding life process and Biotechnology, Nomenclature and classification of enzymes, Properties of enzymes, Assay of enzyme activity (Continuous and discontinuous assay; approaches to monitor enzyme activity), Various strategies for purification of enzymes.
2. Enzyme kinetics: Chemical kinetics, enzyme kinetics (Michaelis-Menten equation, Briggs-Halden Modification, determination of V_{max} and K_m). Eadie-Hostee plot, Lineweaver-Burk plot, Eisenthal-Cornis-Bowden direct plot. Kinetics of multisubstrate enzyme catalyzed reaction-Two substrate reaction (Single displacement and Double displacement (Ping-Pong reaction)
3. Mechanism of enzyme action: General principles of enzyme reactions catalysed by Chymotrypsin, RNase, Carbonic anhydrase, Restriction Endonucleases, NMP kinase.
4. Enzyme inhibition: types of inhibitors, determination of K_i
5. Regulation of enzyme action: Allosteric control, stimulation and inhibition by control proteins, covalent modification, proteolytic activation.

UNIT-IV

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- Electon transfer by chlorophyll, Molecular mechanism of Photosystem I & II, Transport across the thylakoid membrane, Light Harvesting complex, antennary complex.

UNIT-V

1. Lipids: Classification, storage lipids, structural lipids (glycerophospholipids and sphingolipids), signaling lipids, cofactors, terpenes, and pigments.
2. Biosynthesis and oxidation of fatty acids.
3. Nucleotides and Nucleic acids.
4. Biosynthesis and degradation of Nucleotides.
5. Coenzymes and vitamins.
6. Hormones.
7. Inborn errors in metabolism.

Books:

1. Lehninger Principle of Biochemistry by D.L. Nelson & M.M. Cox.
2. Biochemistry by D. Voet and J Voet.
3. Biochemistry by J.M. Berg, J.L. Tymoczko & Lubert Stryer.

Course Learning Outcomes:

The students will be able to

- ✓ Explain structure, function and metabolism of bio molecules
- ✓ Understand the concept of pH and biological buffer system
- ✓ Explain coordinate regulation of metabolic pathways
- ✓ Learn to Analyze and apply theoretical knowledge of biochemistry for designing of new biochemistry research project

Paper: 102 (Theory) **Full Marks: 100**

Subject: CELL BIOLOGY AND GENETICS

Course Objectives:

- The course aims at:

  - ✓ Illustration of the basics of genetics and inheritance and provide the students an understanding of the molecular basis of genetics and Mendel's fundamental work on genetics.
  - ✓ Explaining the concepts of Mendelian genetics and its exceptions
  - ✓ Making the student understand mutation, linkage and crossing over
  - ✓ Explaining the modes of inheritance viz. chromosomal & extra chromosomal
  - ✓ Explaining population genetics and application of Hardy-Weinberg principle

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UNIT- I

1. General organization of Prokaryotic and Eukaryotic cells.
2. Cell Wall and Cell Membranes: Cell wall of Eubacteria, lipopolysachharides, Peptidoglycans and related molecules. Prokaryotic cell inclusions: Endospores and gas vesicles, Eukaryotic cell wall and plasma membrane (composition and dynamics, membrane carobohydrates and their role in cell recognition).
3. Social context of cells: Cell junction, cell adhesion and extra-cellular matrix.
4. Cell motility: Cilia and flagella of prokaryotes and eukaryotes.
5. Cytoskeleton: Microtubules, intermediate filaments and microfilaments.

UNIT – II

1. Nucleus: Structure and function of nuclear envelope, nucleolus, Chromatin organization and its packaging, role of nuclear matrix in chromosome organization and function, matrix binding proteins.
2. Global structure of chromosome: Lampbrush chromosome, Polytene chromosome, Interphase chromatin, Euchromatin and Heterochromatin.
3. Cell cycle: Molecular models and events. Regulators and checkpoints in cell cycle (Cyclin and CDKs).
4. Molecular mechanisms of cell division, Mitosis (Behaviour of chromosomes, formation of mitotic spindle, Sister chromatid separation) Cytokinesis (Role of mitotic spindle in determining cytoplasmic cleavage site).
5. Cellular basis of differentiation and development: Benefits of sexual reproduction, Meiosis, Gametogenesis and fertilization.

UNIT-III

1. Mitochondria: Structure, function, mitochondrial DNA, origin and evolution of mitochondria

2. Chloroplast: Structure and function, chloroplast DNA and its significance, chloroplast biogenesis, origin and evolution
3. Intracellular compartments-I: Golgi apparatus and endoplasmic reticulum (structure & function).
4. Intracellular compartments-II: Lysosomes, peroxisomes (structure and function).

UNIT – IV

1. Transport across cell membrane: Major types of membrane transport, Active transport, Co-transport, Symports, Antiports, Ion channels, Osmosis.
2. Macromolecular trafficking into and out of nucleus
3. Protein sorting: Transport of proteins into mitochondria, chloroplast and lysosomes.
4. Vesicular traffic: Coated and un-coated vesicles, Transport of secretory materials,
5. Endocytosis.

UNIT- V

1. Mendel's laws of inheritance and chromosomal theory of heredity.
2. Gene linkage and crossing over, Chromosomal mapping, Tetrad analysis
3. Pedigree analysis. Lod score for linkage testing, Karyotypes, Genetic disorders, Polygenic Inheritance, Heritability and its measurements, QTL mapping.
4. The origin of genetic variability through mutation (Spontaneous and chemical mutation, Frame-shift mutation, point mutations and chromosomal abberations).
5. Human chromosomes, Genetic diseases and syndromes.

Books:

1. Molecular biology of the cell. By Alberts. *et al*.
2. Molecular cell biology. By Lodish *et al*
3. Cell, a molecular approach. By Cooper.
4. Cell Biology. By De Robertes and De Robertes.
5. Genetics by Sinnot, Don, Dobjanasky.
6. Genetics by Strickberger.
7. Genetics by Gardner.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the Structure and function of organelles in a cell. Cellular transport and protein trafficking, Cell signaling and cancer pathways, Techniques in cell biology and Concepts in human genetics and its applications.
- ✓ Understand the coordination of function of different cell organelles to develop a functional cellular structure
- ✓ Understand the process of cell division and growth, with a special focus upon microbial cells.
- ✓ Explain the organization and structure of cellular control System

- ✓ Learn the concepts of cycle cycle regulation and able to
- ✓ Analyze and apply its diverse roles in cancer cell research
- ✓ Understand the genetic basis of heredity, Mendelian and non- Mendelian modes of inheritance.
- ✓ Understand basics of cytogenetics, extra-chromosomal inheritance, linkage and cytoplasmic inheritance
- ✓ Explain the different types of sex determination system in different organisms
- ✓ Learn the concepts of gene and allele frequencies and able to analyze and apply the Hardy-Weinberg equilibrium for population genetics.

Paper: 103 (Theory) **Full Marks: 100**

Subject: INSTRUMENTATION & ANALYTICAL TECHNIQUES

Course Objective:

The course aims at:

- ✓ Providing an understanding of the fundamental concepts and underlying principles in the instruments used in biotechnology.
- ✓ Developing the analytical skill to enable them to interpret the data.

UNIT - I

1. Microscopy: Principle of operation and Instrumentation of Light microscopy (Bright field, Phase-contrast, Fluorescence), Confocal microscopy and Electron Microscopy (Scanning and transmission).
2. Microtomy and histological techniques.
3. Immuno-cytochemistry: Principles, techniques and application.

UNIT – II

1. Principles of electrochemical techniques: Electrochemical cells and reactions, potentiometry and voltametry.
2. The pH electrode, ion-selective and gas-sensing electrodes, Clark type oxygen electrode.
3. Biosensors.
4. Flow cytometry.

UNIT – III

1. Ultraviolet-visible absorption spectroscopy: Principle, Instrumentation and application.
2. Fluorescence spectrophotometry: Principle, Instrumentation and application.
3. Other types (IR, NMR, ESR and MASS) of spectrophotometry: Basic principle and application.
4. Elimentary idea about X-ray crystallography, API- Electrospray and MALDI TOF.

UNIT - IV

1. Centrifugation techniques: Basic principles of sedimentation, Types of centrifuges, Types of rotors, Methods in preparatory ultacentrifugation (differential and density gradient centrifugation, centrifugal elutriation).
2. 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 – V

1. 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).
2. Radioisotope techniques: Nature of radioactivity, isotopes in biochemistry, measurement of radioactivity (carbon dating, Geiger-Muller counting and liquid scintillation counting), autoradiography.

BOOKS:

1. Physical Biochemistry by David Freifelder.
2. Practical Biochemistry by Keith Wilson and John Walker.
3. Modern Experimental Biochemistry by Rodney Boyer.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the theory and practice of bio-analytical techniques
- ✓ Understanding the instrumentation used in Biotechnology
- ✓ Familiarity with working principals, tools and analytical techniques
- ✓ Analyze the limitations and creative use of techniques for solving of research problem

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Paper: 104(Theory) **Full Marks: 100**

Subject: BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

Course Objectives:

The course aims at:

- ✓ Introducing some fundamental ideas about Moments, Skewness and kurtosis by moments.
- ✓ providing understanding of the basic concepts of Probability and Probability Distribution
- ✓ understanding of Statistical Quality Control, Correlation and regression analysis,
- ✓ Testing Hypothesis and Analysis of variance.
- ✓ exploring the connection between basics as well the advance tools of the subject to demonstrate the link between theory and its real world applications
- ✓ Understanding the rapid use of bioinformatics.
- ✓ Learning the bioinformatics tools those are used in various field of Biotechnology.

UNIT - I

1. Statistics: Definition, functions and limitations.
2. Treatment of data: frequency distribution, Graph of Frequency Distribution
3. Descriptive Measures: Averages and Dispersions (Grouped and ungrouped).
4. Probability: Concepts, definition and elementary problems based on definition.

UNIT - II

1. Inference: Definition-parameter, Statistic sampling distributors, standard error,
2. Test of Hypothesis, type I and Type II errors.
3. Large sample tests**:** Z tests, small sample tests**:** t and F tests.
4. Chi-square test: Goodness of fit and Test of independence.

UNIT - III

1. Curve Fitting: First, Second degree and exponential curve.
2. Simple correlation and Regression.
3. Concept of multiple correction and Regression.
4. Analysis of variance: one way and two way classification.

UNIT – IV

1. Fundamentals of Computer: CPU, memory, I/O unit, storage, multimedia. Introduction to Operating Systems: DOS, Windows and Linux Operating Systems. Ideas about Computer Viruses. Use of online resources and the internet communication technology.
2. Idea on working with MS-Word, Excel and Power point.

3. Programming with C++ and PERL: Introduction, Control Flow: Statement and Block, if, if-else, Nested if-else statements, For, while, do-while loops, break, switch continue, Statements, go to statement. Functions and Arrays.
4. Computation of simple mathematical and statistical formulae using the Programming C++ and PERL.

UNIT - V

1. Introduction to Bioinformatics
2. Elementary idea about Database management system, e.g. Genebank, EMBL, Swiss-Prot, Sequence database like FASTA, BLAST algorithm and Bioinformatics tools.
3. Pairwise sequence alignment, Multiple sequence alignment, Gene prediction and Protein structure prediction.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the basics of Moments, Skewness and kurtosis by moments.
- ✓ Remember and understand the Probability and Probability Distribution.
- ✓ Understand the Statistical Quality Control, Correlation and regression analysis.
- ✓ Learn to understand, analyze, and apply The Testing of Hypothesis and Analysis of variance.
- ✓ Understand and remember about biological databases and its application in various sectors.
- ✓ Remember, understanding and creating sequence alignment by applying appropriate algorithms.
- ✓ Create phylogenetic trees by applying and evaluating suitable methods.
- ✓ Analyze, apply, and create protein structure and perform drug designing.

PRACTICAL

Paper: 105 (Not less than 6 hours) **Full Marks: 90**

1. Microscopy, Microtomy and Histological techniques.
2. Measurement of pH, Preparation of buffer, determination of pK value.
3. Determination of absorption maxima of given chemicals.
4. Validation of Beers and Lambert Law
5. Calibration curve of starch.
6. Estimation of Lipid and Cholesterol.
7. Estimation of Nucleic Acids.
8. Estimation of Proteins.
9. Estimation of Sugars.
10. Paper Chromatography of amino acids.
11. Gel exclusion chromatography.
12. TLC of lipids
13. SDS-PAGE
14. Enzyme assay (effect of substrate concentration, time and temperature)
15. Study of mitosis and meiosis
16. Computer and bioinformatics practical: Working with MS-Word, Power Point and Excel (Data entry and editing, use of inbuilt statistical function for computation and graph plotting), Implementation of programs. Introduction to NCBI databases

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Course Learning Outcomes:

The students will be able to:

- ✓ Understand the preparation of different concentration of solutions
- ✓ Understanding the preparation of biological buffers and identify its properties
- ✓ Explain the basic principle of spectrophotometer used to analyze the concentration of unknown solution
- ✓ Identify the unknown biomolecule by applying its properties

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Seminar/Journal club/Assignment **Full Marks: 10**

Course objective:

The course aim at

- ✓ Acquiring the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology.
- ✓ Encouraging the students to study advanced engineering developments
- ✓ Preparing and present technical reports.
- ✓ Encouraging the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

Contents

Each student has to deliver a lecture on a topic assigned to him/her linked to the subject for a minimum of thirty minutes duration and submit the write-up of the report for evaluation during the Seminar presentation.

Course Learning Outcomes:

The students will be able to:

- ✓ Survey the changes and updating of selected topic to know the current research of particular area
- ✓ Analyze and compile the data of selected topic and interpret the impact on the society and environment
- ✓ Compile the report of the study and present to the audience with following the ethics.
- ✓ Develop an understanding to review, and compile the data and also developed the presentation skills

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2nd SEMESTER

2nd SEMESTER

Paper: 201 (Theory) **Full Marks: 100**

Subject: MICROBIOLOGY

Course Objective:

The course aim at

- ✓ Understanding the prokaryotes with special concentration on the structure, metabolism and genetics of bacteria.
- ✓ Understanding of microbiology from the cellular to molecular levels of organization in Conjunction with bacterial physiology and metabolism.
- ✓ Understanding the scope and importance of microorganisms, in particular, bacteria, for human beings
- ✓ Understanding the central metabolic pathways operating in a bacterial cell for its growth and survival
- ✓ Learning the three genetic recombination techniques vital to bacterial heredity and variation

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UNIT –I

1. Beginning of Microbiology, milestones in the development of microbiology, spontaneous generation, Microbial Ecosystem, Microbial world, Branches of Microbiology, Application of microbiology**.**
2. Methods in Microbiology: Sterilization, Culture Media, Pure culture technique, enrichment culture technique, Microbial staining methods, Maintenance and preservation of Microorganisms, Culture collection centers.
3. Microbial growth: Growth curve, measurement of growth, growth yields, synchronous growth, continuous culture, growth as affected by environmental factors such as temperature, acidity, alkalinity, water availability and oxygen.
4. 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 – II

1. Elementary idea about Cynobacteria, Mycobacteria, Rickettsia, Chlamidias, Mycoplasma, Actinomycetes, Bacteria: Cell structure, genetic recombination in bacteria.
2. Metabolic diversity among micro-organisms: Photosynthesis in micro-organisms (role of chlorophylls, carotenoids and phycobilins), anoxygenic photosynthesis, oxygenic photosynthesis.

3. Microbial nutrition, Chemoautotrophy, Chemoheterotrophy, Chemoorganotrophy, chemolithotrophy, syntrophy, nitrogen metabolism, nitrogen fixation and biofertilizers, Industrial production of biofertilizers.

UNIT – III

1. Archea: Halophyles, Methanogens, Thermophyles
2. Eukarya: Algae, fungi, slime moulds and protozoa (overview).
3. Viruses: Discovery, classification and structure of viruses, Bacterial, plant, animal and tumor viruses, replication of DNA- and RNA- viruses, Examples of Herpes, pox, adenoviruses, retroviruses, viroids and prions.

UNIT- IV

1. Normal microflora of skin, oral cavity, gastrointestinal tract, entry of pathogens into the host, Colonization and factors predisposing to infections.
2. 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 born diseases, public health and water quality.
3. Microbial toxins: Exo-, Endo- and Entero-toxins, mode of action of toxins, virulence and pathogenesis.

UNIT - V

1. Chemotherapeutic agents: Growth factor analogues, Sulfa drugs, Quinolones
2. Antibiotics: Penicillins and Cephalosporins, broad-spectrum antibiotics, antibiotics from prokaryotes, antifungal antibiotics, mode of action of different antibiotics, resistance to antibiotics, Multiple Drug Registance.
3. Antiviral chemotherapeutic agents.

Books:

1. Brock Biology of Microorganisms, Maidgan,Martinko and Parker, Prentice Hall Inc., New York.
2. Microbiology, Prescott, Harley and Klein, William C Brown Press.
3. General Microbiology, S.B.Sullia and V. Santharam, Oxford & IBH, New Delhi.
4. Text book of Microbiology, R.C. Dubey and D.K.Maheswari, S.Cahnd and Company.
5. Modern concepts of Microbiology, H.D.Kumar and S.Kumar, Vikas Publications.
6. Microbiology: Fundamentals and applications, S.S.Purohit, Agro Botanical Publications, Jaipur.
7. Microbiology, Pelczar, Chan and Creig, Tata Mc Graw Hill Publ.

Course Learning Outcomes:

The students will be able to:

- ✓ Understand the differences between prokaryotic and eukaryotic cellular organization

- ✓ Understand the differentiate between Gram +ve and Gram –ve bacteria by performing the experiment
- ✓ Explain the physiology and metabolism of bacterial growth
- ✓ Learn the concepts of bacterial genetics and recombination and be able to Analyze and apply it for genetic engineering and diverse industrial applications

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Paper: 202(Theory) **Full Marks: 100**

Subject: IMMUNOBIOLOGY AND IMMUNOTECHNOLOGY

Course Objective:

The course aims at:

- ✓ Understanding the Role of antibody in biomedical applications
- ✓ Understanding the importance of immunology in disease processes, tissue transplantation and immune regulation are some of the areas of attributes of this course which can help the students to understand the biotechnology related to human kind.

UNIT- I

1. Introduction, Phylogeny of Immune system, Innate and acquired Immunity, Clonal nature of Immune response.
2. 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.
3. Organization and Structure of Lymphoid Organs
4. Activation and regulation of B and T lymphocytes.

UNIT-II

1. Nature and Biology of antigens and super antigens.
2. Structure and function of antibody molecule, Antigen – Antibody interaction,
3. Major histocompatibility complex and MHC restriction
4. Transplantation

UNIT-III

1. Antigen Processing and Presentation, Generation of humoral and cell mediated immune response.
2. BCR and TCR, generation of diversity
3. Complement system
4. Cytokine and their role in immune regulation

UNIT-IV

1. Cell-mediated cytotoxicity, Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity.
2. Immunological tolerance, Hypersensitivity and Autoimmunity.
3. Immunity to infectious agents (intracellular parasites, helminthes and Viruses), Tumor Immunology

4. AIDS and other immunodeficiency diseases.

UNIT-V

1. Vaccine technology: Rationale of vaccine designing based on clinical requirements, Subunit vaccines, Attenuated vaccines, Vector vaccines, peptide vaccines and conjugate vaccines, cell based vaccines.
2. Catalytic antibodies
3. Western blot and ELISPOT assay
4. Immunofluorescence

BOOKS

1. Kuby Immunology, 5th edition, By R. A. Goldsby et al.
2. Immunology By Roitt
3. Immunology by Khan
4. Fundamentals of immunology By William Paul.
5. Principles of Immunology by N.V. Shastri, Himalaya Publishing House.

Course Learning Outcomes

The students will be able to:

- ✓ Understand about immune system and its types.
- ✓ Understand Cellular and molecular basis of immune system.
- ✓ Understand Antigen antibody reaction and autoimmunity
- ✓ Understand Animal models in immunology
- ✓ Understand the structure of antibody and its Functions
- ✓ Create new technologies for the production of MABs and hybridoma technology in various applications.
- ✓ Analyze, apply, and create immunological techniques for better understanding of immune disorders.

Paper: 203 (Theory) **Full Marks: 100**

Subject: MOLECULAR BIOLOGY

Course Objectives:

The course aim at:

- ✓ Giving the student an overview of basic cell biology and its application. This course will focus on identifying key components that constitute living cells. The focus will be orientated around 'Cell Biology at work' with emphasize on key techniques currently used in the study of cells.
- ✓ Exposing the students to the chromosome structure & gene expression in both prokaryotes and eukaryotes. It also familiarizes students with extra chromosomal elements, antisense technology.

UNIT – I

1. Introduction to molecular biology.
2. Chemistry of nucleic acids, Structure and types of nucleic acids.
3. Prokaryotic and eukaryotic Genome organization, organelles genomes (mitochondrial and chloroplast genome).
4. DNA Replication: prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication.
5. Mutability and DNA repair.
6. Homologous and Site-specific Recombination, Transposition.

UNIT – II

1. Prokaryotic transcription: Principle and mechanism of gene regulation, The Operon concept, (lac-, trp-, ara-and his-operon). Transcript processing of tRNA and rRNA
2. Transcriptional control in lamda phage.
3. Eukaryotic transcription and regulation: RNA polymerases structure and assembly, Eukaryotic promoters and enhancers, General and specific transcription factors, transcriptional repressors, mechanism of transcription regulation, Transcriptional and post-transcriptional gene silencing.
4. Post transcriptional modifications (processing, capping and polyadenylation, splicing).

UNIT - III

1. The universal genetic code and genetic code in mitochondria.
2. Prokaryotic and eukaryotic translation: The translation machinery, mechanism of initiation, elongation and termination.
3. Regulation of translation, co- and post-translational modifications of proteins.

UNIT – IV

1. Signaling at the cell surface: Signaling molecules and cell-surface receptors, second messengers, G protein coupled receptor, activation of gene transcription by G protein coupled receptors.

2. Signaling pathways that control gene activity: TGFβ receptors and Smads, Cytokine Receptors and JAK-STAT pathway, Receptor Tyrosine kinases and Ras, MAP kinase pathways.
3. Phosphoinositides as signal transducers.
4. Pathways that involve signal-induced protein cleavage.
5. Down-modulation of receptor signaling.

UNIT – V

1. Gene regulation during development: General strategies of spatial and temporal gene expression, molecular mechanism of *Drosophilla* embryogenesis (Dorsal-Ventral patterning and segmentation).
2. Embryogenesis and early pattern formation in plants.
3. Cancer: Biology of cancer cell, viral and cellular oncogenes, tumor suppressor genes from humans: structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.

BOOKS

1. Molecular Biology by T.A. Brown
2. Genomes by T.A. Brown.
3. Genes and genome by M. Singer and P. Berg.
4. Gene – VIII by B. Lewin.
5. Molecular biology of the gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick.
6. Molecular Clonning: A laboratory manual by J. Sambrook and E.F. Fritsch.
7. Molecular biology LabFax, by T.A. Brown.

Course Learning Outcomes

The students will be able to understand:

- ✓ Various transposable DNA elements and their mechanism of transposition
- ✓ Various Molecular Biology processes like replication, transcription, translation
- ✓ Control and regulation of various processes
- ✓ How different genomes are packaged and organized
- ✓ Basic of structure of RNA and DNA
- ✓ The process of DNA replication and repair mechanisms.
- ✓ The process of transcription, translation and post-translation.
- ✓ Learn to understand, analyze, and apply the gene
- ✓ Regulation mechanism in various scientific fields, and creating new techniques.
- ✓ mechanisms for isolation of DNA from different Sources
- ✓ The basis of visualization of nucleic acid by electrophoresis.
- ✓ the importance of conserved domain for evolutionary identification

- ✓ Analyze the protein structure and sequences of its gene to modify its function according to the need

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Paper- 204 (Theory) **Full Marks: 100**

Subject: ANIMAL BIOTECHNOLOGY

Course Objectives

The course aim at

- ✓ Understanding about the basics of animal science
- ✓ Equipping students with culture techniques and scope of animal biotechnology
- ✓ Providing knowledge on genetic engineering in the improvement of animal for human welfare

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UNIT-I

1. Equipments and materials for animal cell culture: Design and layout of culture room, Basic equipments used in cell culture, Sterilization and aseptic techniques.
2. Culture media: General considerations in media design, Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture.
3. Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures.
4. Growth curve, Establishment of cell line, cell counting.

UNIT-II

1. Various methods of cell separation.
2. Cell cloning: Dilution cloning and suspension cloning, isolation of clones
3. Characterization of cultured cell: Morphology of cells, Species identification; identification of tissue of origin, identification of specific cell lines.
4. 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), Fermentation technology for the growth of animal cells and their products (Bioreactors, Hollow fibre reactors, Air-lift fermentors, chemostats and microcarriers).
5. Transformation of cells: Characteristics of transformed cells and the process of Immortalization (by suppression of senescence genes, induction by viral genes, by induction of telomerase and by chemical carcinogens).

UNIT-III

1. Organ culture.
2. In vitro fertilization, Embryo culture, embryo sexing of farm animals.
3. Three dimensional culture: Multicellular tumour spheroids (mono- & co-culture)
4. Tissue engineering: Design stages for tissue engineering, cell substrates and support materials, cell sources, orientation and protocol.

UNIT-IV

1. Cytotoxicity studies.

2. Necrosis and apoptosis (mechanism and assay)
3. Cryopreservation.

UNIT-V

1. Scope of animal cell culture.
2. Genetic engineering of animal cells: Transfection, microcell-mediated chromosome transfer, irradiation fusion gene transfer.
3. Hybridoma technology and production of monoclonal antibodies.
4. Stem cell culture and its application.

BOOKS

1. Culture of animal cells by R.I. Freshney.
2. Tissue Culture – Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson, Jr.
3. Cell Culture Lab Fax by Butler and Dawson.
4. Cell and Tissue culture: Laboratory procedures by Doyle and Griffiths.

Course Learning Outcomes

The students will be able to understand:

- ✓ Concept and different types in Animal Cell Culture.
- ✓ Various methods of cell separation
- ✓ Scope of animal cell culture.
- ✓ Use of molecular biology techniques genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical, agricultural and industrial applications.

PRACTICAL

Paper: 205 (Not less than 6 hours) **Full Marks: 90**

1. Growth curve, measurements of bacterial population and generation time by turbidometry and cell counting.
2. Preparation of liquid and solid media for growth of microorganisms.
3. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and slab cultures.
4. Isolation of pure cultures from soil/ water.
5. Microscopic examination of Bacteria, Cyanobacteria, Molds and study of organisms by Gram stain and staining of spores.
6. Assay of antibiotics and determination of antibiotic resistance.
7. Isolation of genomic DNA (Plant & Animal).
8. Southern Blotting.
9. Isolation of RNA/mRNA.
10. Northern Blotting.
11. Blood film preparation and identification of cells.
12. Lymphoid organs and their microscopic organization.
13. Immunization and collection of serum, Immunodiffusion.
14. Purification IgG from serums.
15. Western Blotting.
16. Serological test: Hemagglutination test (HA), Hemagglutination Inhibition test (HI), ELISA etc.
17. Primary culture of animal cell**:** Aseptic techniques, selection and isolation of organ, disaggregation (mechanical/enzymatic), seeding, Cell counting and cell viability, Primary culture.
18. Preparation of metaphase chromosome from cultured cells.
19. Isolation of bacteria on the basis of biochemical test: Oxidase test, Indole test, Methylene Red test, Urease test, Oxydation-Fermentation test, Catalase test, Coagulase test.

Course Learning Outcomes

The students will be able to

- ✓ Understand the different phase of cell division
- ✓ Understanding the preparation of different types of media used in microbial cultivation
- ✓ Explain the basic knowledge of isolation procedure of microbes form different natural sources
- ✓ Analyzing the number of bacteria in the original solution

- ✓ Conduct Immuno blotting
- ✓ Conduct Serological tests

Seminar/Journal club/Summer training report **Full Marks: 10**

Course Objectives:
The course aim at

- ✓ To acquire the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology.
- ✓ To encourage the students to study advanced engineering developments
- ✓ To prepare and present technical reports.
- ✓ To encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

Contents

Each student has to deliver a lecture on a topic assigned to him/her linked to the subject for a minimum of thirty minutes duration and submit the write-up of the report for evaluation during the Seminar presentation.

Course Learning Outcomes

The students will be able to understand:

- ✓ Surveying the changes and updating of selected topic to know the current research of particular area
- ✓ The methods of Analyzing and compile the data of selected topic and interpret the impact on the society and environment
- ✓ Compilation process of the report of the study and present to the audience with following the ethics.
- ✓ The Developing methods an understanding to review, and compile the data and also developed the presentation skills

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3rd SEMESTER

3rd SEMESTER

Paper: 301(Theory) **Full Marks: 100**

Subject: GENETIC ENGINEERING

Course Objective:

The course aims at:

- ✓ Gaining knowledge on gene manipulation using genetic engineering methods and its importance in plant, animal and environmental biotechnology.
- ✓ Understanding the principle behind different enzymes and vectors used in recombinant DNA technology.

UNIT-I

1. Scope of Genetic engineering, Milestones in genetic engineering
2. Molecular tools: Enzymes (Nucleases, Restriction endonucleases, Phosphomonoesterase, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase), Hosts (E. coli, yeast, animal cells and Plant cells) and Vectors (Plasmids, Bacteriophages, Cosmids, Phagemids and Artificial Chromosomes).
3. Means: Inserts (Genomic DNA, synthetic DNA, DNA from RNA or cDNA, PCR products, Nucleic acid purification, yield analysis, labeling nucleic acid probes (isotopic and non-isotopic labeling) Infection and transfection, Screening (Phenotypic, antibiotic and through hybridization).
4. Nucleic acid sequencing (Maxum-Gilbert sequencing, Sanger's dideoxy sequencing, pyrosequencing, automated DNA sequencing).
5. Nucleic acid amplification (PCR): General protocol, Primer designing, fidelity of thermostable DNA polymerases, Types of PCR (multiplex, nested, reverse transcriptase, real time, touch down, hot start and colony PCR), PCR in gene recombination (deletion, addition, overlap extension).

UNIT-II

1. Mapping of genome: Genetic and physical maps, physical mapping (restriction mapping, fluorescence in situ hybridization, sequence tagged site mapping), map based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, molecular markers in genome analysis (RFLP, RAPD, AFLP, SSLPs, STRs and SNPs).
2. Molecular markers linked to disease resistant genes, application of molecular markers in forensics, disease prognosis, genetic counseling, pedigree analysis, animal trafficking and poaching, germplasm maintenance, taxonomy and biodiversity**.**
3. Genome sequencing: Construction of libraries (genomic and cDNA), strategies for sequencing genomes, packaging, transections and recovery of clones, application of

sequence information for identification of defective genes. Expression cloning, Jumping or hopping libraries, Southwestern and Farwestern cloning.

UNIT-III

1. DNA transfection: Physical methods (microinjection, electroporation, biolistics, somatic cell fusion, Gene transfer by pronuclear microinjection), Chemical method (liposomes), Virus mediated transfection.
2. Expression Strategies for Heterologous genes: *Saccharomyces cerevisiae* expression systems (*S. cerevisiae* vectors, intracellular cellular production of heterologous proteins, secretion of heterologous proteins by *S. cerevisiae*), *Pichia pastoris* and other yeast expression systems, Baculovirus-insect cell expression systems, mammalian cell expression systems.

UNIT-IV

1. Mapping and quantifying transcripts: Northern blot, S_1 mapping, RNase protection assay and Primer extension, Run-off Transcription and G-less cassette transcription, Nuclear Run-on transcription and Reporter gene assays.
2. DNA-protein interactions: EMSA, DNase foot printing, Methyl interference assay, CHIP.
3. Protein-protein interaction cloning and yeast two hybrid system.
4. Phage display.

UNIT-V

1. Site-directed Mutagenesis and protein engineering.
2. Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
3. Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of gene through T-DNA transposon.
4. Gene therapy: Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation.
5. Knockout and transgenic technologies.
6. Gene silencing (ribozyme, antisense and RNAi technologies).

BOOKS

1. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch.
2. Genome by T.A. Brown.
3. DNA Science. A First Course in Recombinant Technology by Mickloss and Freyer
4. Molecular Biotechnology by S.B. Primrose
5. Molecular Biotechnology by Glick.
6. Molecular Biology by Weaver
7. Genes and Genomes by Singer and Berg

Course Learning Outcomes

The students will be able to understand:

- ✓ Various natural and laboratory based modifications of DNA.
- ✓ How molecular damage is repaired.
- ✓ Tools creating DNA constructs.
- ✓ Various protein expression strategies.
- ✓ about the use of enzymes in genetic engineering
- ✓ and Explain gene cloning, transformation and transfection and techniques used in genetic engineering
- ✓ And Explain genomic and cDNA library construction for cloning and scopes and applications of genetic engineering
- ✓ And Apply theoretical knowledge of genetic engineering for development of new recombinant DNA molecules

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Paper: 302(Theory) **Full Marks: 100**

Subject: BIOPROCESS ENGINEERING AND INDUSTRIAL BIOTECHNOLOGY

Course Objectives:

The course aims at:

- ✓ Familiarizing students with basic idea of microbial kinetics, upstream processing, bioreactor design and operation, and downstream processing.
- ✓ Learning about fermentation processes, kinetics of microbial growth and all the steps involved upstream and downstream processing for any production process.
- ✓ Understanding the industrial applications of bioprocess engineering.

UNIT – I

1. Industrial application of enzymes: Enzymes used in detergents, uses of proteases in food, leather and wool industries.
2. Application of enzymes in food processing: Production of glucose syrup from starch using starch hydrolyzing enzymes, production of syrup containing maltose, enzymes in sucrose industry, glucose from cellulose, lactase in dairy industry, glucose oxidase and catalase in food industry, Cheese making by protease.
3. Medical applications of enzymes: Use of enzymes in medical diagnostics and clinical treatment.

UNIT –II

1. Problems with the use of enzymes in solution and objectives of immobilization
2. Methods of enzyme immobilization: Adsorption, entrapment, Direct covalent linking, cross-linking.
3. Kinetics of immobilized enzymes, effect of solute partition & diffusion on the kinetics of immobilized enzymes.
4. Enzyme electro-catalysis (Biosensors): General approach to immobilization of enzymes into electrodes.
5. Measurement of enzyme activity, Regeneration of cofactors.
6. Abzymes and its application.

UNIT III

1. Introduction to bioprocess engineering
2. Bioreactors: batch, fed batch and continuous bioreactors, Uses of immobilized enzymes, bioreactors using immobilized enzymes.
3. Specialized bioreactors: pulsed, fluidized and photo-bioreactors.
4. Media for industrial fermentation, air and media sterilization.

5. Sources of microbes for industrial use, kinetics of microbial growth and death, measurement and control of bioprocess parameters.
6. Downstream processing, removal microbial cells from bioreactors, foam preparation, filtration, drying and crystallization.

UNIT – IV

1. Industrial production of chemicals: alcohols (ethanol), Acids (citric acid and gluconic acid), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acid (lysine and glutamic acid).
2. Whole cell immobilization and their industrial application.
3. Microbes in mineral beneficiation, and oil recovery.
4. Large scale production methods of biofertilizers (Cyanobacteria, *Rhizobium, Azotobacter, Azospirilum, Azolla*, PSB, Mycorrhiza) and protocols for their use.

UNIT – V

1. Food technology: Elementary idea of canning and packing.
2. Sterilization and pasteurization of food products.
3. Food preservation, Single cell proteins (*Spirulina*, Yeast).
4. Micro-algal technology (*Dunaliella, Haematococcous*).

BOOKS

1. Enzymes in industry: Production and application by W. Gerhartz, VCH Publishers, New York.
2. Principles of enzymology for technological applications, Butterworth Heinemann Ltd.
3. Enzyme technology by M.F. Chaplin and C. Bucke. Cambridge University Press.
4. Concepts in Biotechnology by D. Balsubramanian *et al*., Universities Press.
5. Biochemical Engineering by Aiba, Humphery and Mills.
6. Biochemical Engineering Fundamentals by Baily and Oilis.
7. Principle of Fermentation Technology by Stanbury and Whitaker.
8. Process Engineering in Biotechnology by Jackson.
9. Microalgal biotechnology by Borowitzka.

Course Learning Outcomes

The students will be able to understand:

- ✓ Design of Fermenter/ bioreactors
- ✓ Mass transfer, KLa concept and significance in bioprocess.
- ✓ Designing of media Sterilization and monitoring of process variables
- ✓ Strain Improvement and importance.
- ✓ Downstream processing methods
- ✓ Biological and kinetic concepts underlyingbioprocesses engineering
- ✓ Explain procedures for the design and control of bioreactors the basic upstream processing principles
- ✓ Apply the bioprocess engineering in different industries for the benefit of mankind

Paper: 303 Core Elective (Theory) Full Marks: 100

Subject: PLANT BIOTECHNOLOGY

Course Objectives:

The course aim at

- ✓ Making students understand about the basics of plant science
- ✓ Equipping students with culture techniques and scope of plant biotechnology
- ✓ Providing knowledge on genetic engineering in the improvement of plants for human welfare

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UNIT-I

1. Conventional plant breeding, Introduction to cell and tissue culture, tissue as technique to produce novel plants and hybrids.
2. Tissue culture media (composition and media), Initiation and maintenance of callus and suspension culture; single cell clones.
3. Morphogenesis and Organogenesis in plants; Organization of shoot and root apical meristem, shoot and root development, Leaf development and Phyllotaxy, Transition to flowering, Floral meristem and Floral development in *Arabidopsis* and *Antirrhinum*.

UNIT-II

1. Shoot tip culture: Rapid clonal propagation and production of virus- free plants, Anther, pollen and ovary culture for production of haploid plants and homozygous lines, Embryo culture and embryo rescue.
2. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
3. Cryopreservation, slow growth and DNA banking for germplasm conservation.

UNIT-III

1. 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.
2. Use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold attachment regions.
3. Methods of nuclear transformation, viral vectors and their applications, multiple gene transfers, vector-less or direct DNA transfer,
4. Particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing.

UNIT-IV

1. Application of plant transformation for productivity and performance: Herbicide resistance, atrazine, Insect resistance, Bt-genes, non-Bt like protease inhibitors, disease resistance.
2. Virus resistance, chitinase, 1-3 beta glucanase, antifungal proteins, thionins, PR proteins, nematode resistance.
3. Abiotic stress, use of ACC synthease, ACC oxidase, male sterile lines, carbohydrate composition and storage, ADP glucose pyrophosphatase.

UNIT-V

1. Chloroplast transformation: advantages, vectors, success with tobacco and potato.
2. Metabolic Engineering and industrial products: Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway.
3. Alkaloids, biodegradable plastics, edible vaccines, oleosin partioning technology.

BOOKS

1. Plant Biotechnology by J. Hammod, P. McGarvey, V. Yusibov.
2. Plant cell and Tissue Culture for the production of Food Ingradients by Fu, Singh and Curtis.
3. Biotechnology in crop improvement. H.S.Chawla.
4. Biotechnology and Genomics, P.K.Gupta, Rastogi publications.
5. Handbook of plant tissue culture, ICAR, publications & information division, New Delhi.
6. Biotechnology, B.D. Singh & R.P. Singh, Kalyani publishers.

Course Learning Outcomes

The students will be able to understand:

- ✓ The Methods for developing transgenic plants
- ✓ Transgenic methods to improve algal, fungal and plant productivity
- ✓ Importance of secondary metabolites and production in plants
- ✓ Molecular approaches used for plant breeding and trait selection
- ✓ Concept of molecular farming and the derived products

Paper-304-Allied Elective (AE-1) **Full Marks: 100**

Subject: ANIMAL PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY
ALLIED ELECTIVE COURSE (ZOO-304)
ANIMAL PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY

Course Objectives

The course aims at:

- Making students understand about the basics of animal physiology
- Providing knowledge Developmental biology of Human and other vertebrates.

UNIT 1: ANIMAL PHYSIOLOGY (I)

Blood groups, Blood cells, haematopoiesis, Cardiac Cycle, Principles of ECG, Blood Pressure; Neural and chemical regulation of cardiac cycle.
Hormonal control of reproduction.

UNIT 2: ANIMAL PHYSIOLOGY (II)

Mechanism of breathing, transport and exchange of gases, Neural and chemical regulation of respiration. Structural organization of kidney, Urine formation, Regulation of water & electrolyte and acid –base balance.

UNIT 3: ANIMAL PHYSIOLOGY (III)

Nervous system & sense organs, Neurons, Action potential, Central Nervous System & Peripheral Nervous system, Vision, Hearing and tactile response.

UNIT 4: DEVELOPMENTAL BIOLOGY (I)

Pioneering experiments in Developmental biology (Contributions of Spemann and Mangold; Holtfreter; Briggs and King; Patric Steptoe and Robert Edwards) Gametogenesis, fertilization, gastrulation, Extra embryonic membranes, cell commitment and differentiation.

UNIT 5: DEVELOPMENTAL BIOLOGY (II)

Axis formation in Drosophila, morphogen gradient, eyes lens induction, limb development, regeneration, metamorphosis

BOOKS:

1. Guyton and Hall Textbook of Medical Physiology (Guyton Physiology) by John E. Hall

Course Learning Outcomes

The students will be able to understand:

- ✓ The key events related to early embryogenesis including fertilization, cleavage, and compaction. Implantation, gastrulating and formation of body plan.
- ✓ The basis of organogenesis.
- ✓ Relate defects in prenatal development to congenital anomalies.

Paper-304- Allied Elective (AE-2) **Full Marks: 100**

Subject: BIOTECHNIQUES

Course Objective:

The course aim at:

- Providing an understanding of fundamental concepts and underlying principles in the instruments used in biotechnology. In addition, the course is expected to develop the analytical skill to enable them to interpret the data. The course will also help students in understanding microbilogical methods, cell culture techniques, immunotechniques

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UNIT-I (Microbial Techniques)

1. Methods in microbiology: Criteria for microbial classification and approaches to taxonomy, sterilization, culture media, pure culture technique, microbial staining methods, maintenance and preservation of microorganisms.
2. Microbial growth: Growth curve, measurement of growth, growth yields, synchronous growth, continuous culture, environmental factors affecting growth.
3. Microbes for industrial use: Primary and Secondary metabolites, Fermentation and Fermented products, Biofertilizers, Microbes in mineral beneficaion and bioremediation, Microbial toxin-BET, Test for sterility, Microbial limit test.
4. Commonly used vectors for gene-cloning, DNA manipulating enzymes, construction of genomic and cDNA libraries.

UNIT-II (Cell Culture Techniques)

1. Equipments, materials and Culture media for animal cell culture: Design and layout of culture room, Basic equipments used in cell culture, Sterilization and aseptic techniques; Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture.
2. Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures; Establishment of cell line; Characterization of cultured cell
3. Tissue culture media (composition and media), Initiation and maintenance of callus and suspension culture; single cell clones.
4. Shoot tip culture: Rapid clonal propagation and production of virus- free plants, Anther, pollen and ovary culture for production of haploid plants and homozygous lines, Embryo culture and embryo rescue.

UNIT-III (Purification and Bio-separation techniques)

1. Isolation and purification of Bimolecules like, protein, DNA and RNA.
2. Separation of Biomolecules (protein/nucleic acids) by electrophoresis, SDS-PAGE and 2D Gel Electrophoresis.

3. Principles and applications of electrophoresis.
4. Principles and applications of chromatography, types and application of chromatography (Gel exclusion, Gas, Liquid and HPLC)

UNIT-IV (Spectroscopy)

1. Principles and Applications of Spectrophotometer, Ultraviolet-visible absorption Spectroscopy: Principle, Instrumentation and Application.
2. Fluorescence spectrophotometry: Principle, Instrumentation and Application.
3. Other types (IR, NMR, ESR and MASS) of Spectrophotometry: Basic principle and application.

UNIT-V (Immuno-technology)

1. Antigen- antibody interaction and their applications in Immuno-diagnostics.
2. Detection of antigen/protein by Western Blotting.
3. ELISA and CHIP
4. FACS and its applications.

BOOKS:

1. Microbiology, Prescott, Harley and Klein, William C Brown Press.
2. Culture of animal cells by R.I. Freshney.
3. Tissue Culture – Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson, Jr.
4. Plant cell and Tissue Culture for the production of Food Ingradients by Fu, Singh and Curtis.
5. Practical Biochemistry by Keith Wilson and John Walker.
6. Modern Experimental Biochemistry by Rodney Boyer.
7. Kuby Immunology, 5th edition, By R. A. Goldsby et al.
8. Immunology By Roitt

Course Learning Outcomes

The students will be able to:

- ✓ Understanding the instrumentation used in Biotechnology
- ✓ Understand the theory and practice in Microbilogy, cell culture, immunology
- ✓ Understand the theory and practice of bio-analytical techniques
- ✓ Familiarity with working principals, tools and techniques of analytical techniques
- ✓ Analyze the limitations and creative use of techniques for solving of research problem

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PRACTICAL

Paper: 305 (Practical) **Full Marks: 100**

1. Sterilization techniques.
2. Bacterial culture and storage techniques.
   (i) Isolation of individual colonies.
   (ii) Plate sterilization techniques.
   (iii)Storage of bacterial culture.
3. Growth pattern of bacterial cells.
4. Isolation and purification of plasmid.
5. Restriction digestion and mapping of plasmid.
6. Preparation of competent cells.
7. Bacterial transformation.
8. Restriction digestion of λ – DNA.
9. Demonstration of apoptosis.
10. PCR/ RFLP/ RAPD.
11. Preparation of plant tissue culture medium.
12. Organ culture, Callus propagation.
13. Immobilization of enzyme and whole cell.
14. Isolation and characterization of microbes from contaminated food.
15. Batch culture of microbes in a Fermentor.
16. Production of alcohol using a suitable substrate.

Course Learning Outcomes

The students will be able to

- ✓ Understand and conduct different Sterilization techniques, microbial methods, Organ Culture methods, Bioprocess developments.

4th SEMESTER

4th SEMESTER

Allied Elective (AE)-401 **Full Marks-100**

Subject: EVOLUTION AND ENVIRONMENTAL BIOTECHNOLOGY

Course Objective:

The course aims at:

- ✓ Understanding various phenomenon of evolution biology and Environmental science
- ✓ Understanding intellectual property rights, patenting, ethical issues and Biosafety in context to biotechnology. The specific objectives of the course are:
- ✓ Teaching students about intellectual property rights (IPRs) and their different kinds
- ✓ Making students understand the process of patent filing
- ✓ Making students aware about the patenting of materials of biological origin
- ✓ Imparting knowledge of ethical practices appropriate to biotechnology research

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UNIT-I

1. Origin of basic biological molecules: Abiotic synthesis of organic monomers and polymers, Concepts of Oparin and Haldane, Experiments of Miller, The first cell; Origin and Evolution of Prokaryotes and Eukaryotes
2. Concepts of Neutral Evoluion, Molecular divergence and Molecular clocks, Molecular tools in Phylogeny; Classification and Identification.
3. Protein and Nucleotide sequence analysis, Origin of new Genes and proteins, Gene duplication and Divergence.

UNIT-II

1. Environment: Basic concepts and issues, Environmetal modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozonwe depletion, Ingfluence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons.
2. Acid rain, Arid and semi-arid plant bioecdhnology, Green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions.

UNIT-III

1. Wastewater Treatment, Oxidation pond, Anaerobic process of treatment, Solid waste management(Composting, Vermicultre and Biogas production), Biopesticides, Biofuels.
2. Bioremediation, Degradation of Xenobiotoc compoubnds, Bioprospecting of Marine Organisms, Sea weeds as food, Phycocolloids and source of Pharmaceuticals compounds.

UNIT-IV

1. Concept of Habitat and Niche; Niche width and Overlap, Resource partitioning, Character displacement, Characteristics of a population, Population growth curves, Population regulation, Life history strategies (R and K selection), Concept of Metapopulation, Interdemic extinctions, Age structured populations.
2. Species interaction: Types of interactions, Inter-specific competition, Herbivory, Carnivory, Pollination, Symbiosis, Community ecology, Nature of communities, Community structure and attributes, Levels of species diversity and measurement.
3. Ecological succession; Types, Mechanism, Changes involved in succession, Ecosystem Ecology; Ecosystem structure, Ecosystem function, Energy flow and Mineral cycling(C, N, P) Structure and function of terrestrial (Forest, Grassland) and aquatic (Fresh water, Marine, Eustrine) ecosystem, Biogeography; Major terrestrial Biomes, Biogeographical zones of India.

UNIT-V

1. Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of GMOs).
2. Agreements and Treaties (GATT & TRIPS agreement, Madrid agreement, Hague Agreement, WIPO treaties, Budapest treaty, PCT, Indian Patent Act 1970 & recent amendments.
3. Basics of patents (Types of patent application and Specifications), concept of Prior Art and patent filing procedures.

Course Learning Outcomes

The students will be able to understand:

- ✓ Global and regional threats to the environment
- ✓ Role of Biotechnology in analysis and treatment of pollutants
- ✓ Concept of EMP, EIA and environmental laws.
- ✓ Concept of GIS and RS

FREE ELECTIVE (F.E-402)

FUNDAMENTALS OF LIFE SCIENCE: ORIGIN OF LIFE, LIVING SYSTEMS, AND LIVING PROCESSES

Course Objective:
The course aims at:

- ✓ Understanding of fundamental concepts of life sciences through detail study on the origin of life, living systems, and living processes

Unit -I

1. What is life?
2. What is the unit of life?
3. Cellular basis of life and chemical composition of cells
4. How cells obey physical and chemical laws?
5. How cells diversify to perform various activities in our body?

Unit -II

1. What do you understand by terms gene, genome and genetics?
2. Genetics Vs Epigenetics
3. How I inherited my qualities from my parents?
4. Where my characters are located and how they are expressed?
5. How do I develop from a single cell to multi-cellular organism?

Unit -III

1. How plants trap solar energy and make food for animals?
2. How body digests and gets energy from food?
3. How transport occurs in body?
4. How body functions are regulated?
5. How life continues and why I age?

Unit -IV

1. How life is evolved on our planet?
2. Biodiversity and diverse forms of life
3. How human being is evolved?
4. How human activities affect our environment?
5. What is global warming, Acid rain, Green house effect?

Unit -V

1. Another world of living organisms: microbes.
2. Are all microbes harmful to us?
3. How I fight against microbes and defend my body?
4. Common health ailments like Diabetes, Cancer, AIDS, Cardiac dysfunction
5. Adolescents: health risks and solutions

Course Learning Outcomes

The students will be able to:

- ✓ Understanding various domains of life forms and their origin.
- ✓ Understand the theory and practices in Genetics
- ✓ Understand the theory and practice of Exobiology
- ✓ Understand various forms of ecosystem, plant physiology, planet science and micobes

Paper-403 **Full Marks: 100**

Subject: Research aptitude, Scientific communication and Bio-entrepreneurship

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Course Objectives

The course aims at:

- ✓ Familiarizing students to read scientific literatures and create framework for experiments.
- ✓ Giving an overall idea about research ethics in the practical field.
- ✓ Understanding of analysing the data and improve communication skills.
- ✓ Providing knowledge on how to build interrelationship between research and business.

Course Structure

1. Good Laboratory practices (GLP), Ethical principles and Plagiarism
2. Data analysis and plotting software: Sigma plot, Graphpad Prism, FinchTV, ImageJ, BioRender, Illustrator.
3. Journal Club: Critical analysis and presentation of a recent peer-reviewed scientific article with high impact factor.
4. Scientific writing: Writing a comprehensive review and presentation.
5. Introduction and scope in Bio-entrepreneurship: Biotechnology business models; Types of biotechnology based industries, Strategies and mode of operations; Entrepreneurship development programs supported by public and private agencies (MSME, DBT, BIRAC, Make in India).

Course Learning Outcomes

The students will be able to:

- ✓ Understand scientific approaches in cultivating research; develop methodologies and its ethical implication.
- ✓ Read, write, understand, critically analyse scientific literatures and imply them in designing hypothesis and experiments.
- ✓ Understand the importance of business in research development, rationale for IPR and patents.

NB*- Each student has to submit a review on a relevant and contemporary topic under the course (to be allotted by the Department), which will be evaluated followed by a presentation by the student.

4th SEMESTER

Paper: 404(Project work) **Full Marks: 300**

Course Objectives

The course aims at:

- ✓ Acquiring the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology.
- ✓ Encouraging the students to study advanced engineering developments
- ✓ Preparing and present technical reports.
- ✓ Encouraging the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

Contents

Each student has to carry out a project work during his/her tenure in 4th Semester and submits a dissertation towards partial fulfillment of M.Sc. degree in Biotechnology. The student has to defend his/her project work in a seminar which will be evaluated by a minimum of two external experts appointed by the University.

Course Learning Outcomes

The students will be able to:

- ✓ Understand the basic knowledge of research ethics and biosafety Level
- ✓ Create research plans/ideas with the help of relevant literature and execute and achieved it in limited time frame
- ✓ Analyzing the research data and find significance by correlating it with the present problems/challenges
- ✓ Apply the knowledge and capability required for independent work as a Master of Science in Biotechnology
- ✓ Survey the changes and updating of selected topic to know the current research of particular area
- ✓ Analyze and compile the data of selected topic and interpret the impact on the society and environment
- ✓ Compile the report of the study and present to the audience with following the ethics.
- ✓ Develop an understanding to review, and compile the data and also developed the presentation skills

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