M.Sc BIOTECHNOLOGY
CHOICE BASED CREDIT SYSTEM (CBCS)
DEPARTMENT OF GENETICS & BIOTECHNOLOGY, OSMANIA UNIVERSITY
COURSE STRUCTURE FOR INSTRUCTION & EXAMINATION
(Proposed Scheme for Academic year 2022-23)

SEMESTER - I							
S. No	**Syllabus Ref. No**	**Subjects**	**Credits**	**Teaching Hours/ Week**	**Marks**		
					Internal Assessment	**Semester Exam**	**Total**
THEORY							
1.	BT101T	Cell Biology & Genetics	3	4	30	70	100
2.	BT102T	Biological Chemistry	3	4	30	70	100
3.	BT103T	Microbiology	3	4	30	70	100
4.	BT104T	Statistics, Laboratory Management & Safety, Entrepreneurship	3	4	30	70	100
PRACTICALS							
1.	BT151P	Cell Biology & Genetics	2	4	-	50	50
2.	BT152P	Biological Chemistry	2	4	-	50	50
3.	BT153P	Microbiology	2	4	-	50	50
4.	BT154P	Biostatistics	2	4	-	50	50
		Total	**20**	**32**			**600**

SEMESTER - II							
S. No	**Syllabus Ref. No**	**Subjects**	**Credits**	**Teaching Hours/ Week**	**Marks**		
					Internal Assessment	**Semester Exam**	**Total**
THEORY							
1.	BT201T	Molecular Biology – The Genome	3	4	30	70	100
2.	BT202T	Molecular Biology – Genes to Proteins	3	4	30	70	100
3.	BT203T	Immunology	3	4	30	70	100
4.	BT204T	Microbial Technology	3	4	30	70	100
PRACTICALS							
1.	BT251P	Molecular Biology – The Genome	2	4	-	50	50
2.	BT252P	Molecular Biology – Genes to Proteins	2	4	-	50	50
3.	BT253P	Immunology	2	4	-	50	50
4.	BT254P	Microbial Technology	2	4	-	50	50
		Total	**20**	**32**			**600**

Note: T= Theory; P=Practicals

SEMESTER - I
THEORY PAPER - I
BT 101 T - CELL BIOLOGY AND GENETICS

1. **Course Objectives (C. Obj.):**
   a. To understand basic aspects of intracellular organization of a eukaryotic cell
   b. To comprehend the Mendelian Genetic principles in humans, plants and animals and Obtain basic knowledge of hierarchical structure and organization of chromosomes, insight into chromosomal anomalies and learn the science behind gene mapping in eukaryotes
   c. To comprehend the biochemical and molecular processes of cell division and cell death

2. **Course Outcomes (C.O.):**
   a. Comprehend the cellular architecture and processes
   b. Ability to apply Mendelian inheritance principles to humans, plants & animals and Understand the importance of fidelity of chromosome organization and to localize genes by techniques
   c. Knowledge regarding the basic mechanisms underlying cell division and cell death

COURSE PLAN

UNIT I: CELL STRUCTURE AND FUNCTION

1. Membrane System and Transport
   A. Membrane Structure and Transport:- Structure of plasma membrane - membrane lipids, membrane proteins; Transport across cell membranes - passive diffusion, facilitated diffusion, ion channels, active transport, carriers.
   B. Endomembrane System and Transport:- Rough ER - targeting and secretion of proteins; Smooth ER - lipid synthesis and export; Golgi complex - organization and functions, vesicular transport (endocytosis and exocytosis); Lysosomes – structure and functions, autophagy.
   C. Nuclear Envelope and transport between Nucleus and Cytoplasm:– Structure of nuclear envelope; Nuclear pore complex; Selective transport of proteins to and from the nucleus; Regulation of protein import; Transport of RNAs.

2. Organization, Genetic Systems and Function of Organelles involved in Cell Energetics and Metabolism
   A. Mitochondria:– Organization and function; Protein import and mitochondrial assembly; Oxidative phosphorylation - electron transport chain, chemiosmotic coupling; Transport of metabolites; Mitochondrial genome.
   B. Chloroplast:– structure and function; Import and sorting of chloroplast proteins; Photosynthesis - electron flow through PSII and PSI, cyclic electron flow, ATP synthesis.
   C. Peroxisomes:- Structure, functions, assembly, import of proteins.

3. Structure and Organization of Cytoskeleton and Cell Movements
   A. Actin Filaments:– Structure, assembly and organization; Role in cell - association with plasma membrane, cell movements (muscle and non-muscle contraction), protrusions of cell surface.
   B. Intermediate filaments:- proteins, assembly, organization, types and functions
   C. Microtubules:–Structure, organization and assembly; Role of microtubule and motors in movements - organelle transport, intracellular organization, separation of mitotic chromosome, cilia and flagella

4. Internal Organization in Nucleus
   A. Chromosomes and higher order chromatin structure:-– Euchromatin and heterochromatin: Organization of chromosomes in nucleus - nucleosomes, chromatin fiber, looped chromatin domains: Centromeres, telomeres.
   B. Nucleolus –Organization of nucleolus; ribosome assembly.
   C. Functional Domains within the Nucleus:- Sub-compartments – replication origins, nuclear bodies; chromosomal territories.

5. Cell cycle and Cell processes
   A. Eukaryotic cell cycle:– Phases; Regulation, checkpoints; Cyclins and Cyclin dependent kinases.
   B. Mitosis and meiosis:-Stages of mitosis- cdk1/cyclinB, progression to metaphase, spindle assembly checkpoint, progression to anaphase, cytokinesis: Process of meiosis-regulation of oocyte meiosis, fertilization.
   C. Cell signaling mechanisms in Cell death: Necrosis, Apoptosis - intrinsic & extrinsic pathways and termination of signal pathway.

UNIT II: MENDELIAN AND NON-MENDELIAN INHERITANCE

1. Mendelian Inheritance
   A. Mendel's Laws:-Mendel's experiments and reasons for success: Monohybrid cross -Law of segregation, Law of dominance, reciprocal cross, test cross, back cross; Dihybrid cross-Law of Independent Assortment, test cross, back cross.
   B. Chromosome Theory of inheritance:-Boveri and Sutton's Chromosomal theory of inheritance- support of Mendel's law, Morgan's experiment, non-disjunction
   C. Mendelian Genetics in Humans:–Pedigree symbols – pedigree analysis – autosomal, sex-linked pattern of inheritance.

2. Extensions to Mendelian Inheritance
   A. Allelic Interactions - Incomplete dominance, co-dominance, over-dominance; Lethal factor; Multiple alleles- eye colour in drosophila, ABO blood group in man, coat colour in rabbit, self-incompatibility in plants; Pleiotropism.

B. Non allelic Interactions - Supplementary gene interaction, complimentary gene interaction, inhibitory gene interaction, duplicate gene interaction, polymeric gene interaction, masking gene interaction.
C. Complex Loci - R locus in maize, Rh blood group system.

3. Sex-linked inheritance and sex determination
   A. Sex-Linked Inheritance in Drosophila - X-linked white eyes in Drosophila
   B. Sex-linked Inheritance in Man - X-linked inheritance - colour blindness, haemophilia; Y-linked traits; XY-linked inheritance; sex-influenced traits; sex-limited traits; dosage compensation.
   C. Sex Determination - Chromosomal sex- determining systems; Genic-sex determining systems; Environmental sex determination; Sex determination in Drosophila and man.

4. Genes and Environment
   A. Penetrance and Expressivity - mechanisms explaining incomplete penetrance and differences in expressivity.
   B. Polygenic Inheritance – Quantitative inheritance, examples - kernel colour in wheat, length of corolla in tobacco, skin colour, height, eye colour; Characteristics and analysis of polygenic traits
   C. Norm of Reaction – Gene-environment interaction - eye size in Drosophila, reaction to elevation in Achillea, developmental noise.

5. Extranuclear Inheritance
   A. Maternal inheritance:- shell coiling in snails, eye pigmentation in flour moth.
   B. Cytoplasmic inheritance:- chloroplast inheritance -variegated four o clock plant; mitochondrial inheritance - petite in Yeast, poky strain in *Neurospora*, mitochondrial inheritance in humans; male sterility in plants, iojap in maize; Endosymbionts - sigma virus, spirochaetes, kappa particles, milk factors.
   C. Uniparental Inheritance - streptomycin sensitivity in *Chlamydomonas*.

UNIT III: LINKAGE, GENE MAPPING AND CYTOGENETICS

1. Discovery of Linkage
   A. Early evidence for linkage and genetic recombination:-Chromosome theory of inheritance, Morgan's experimental crosses of white eye and miniature wings, Bateson and Punnett experiment on linkage.
   B. Cytological proof of crossing over:– Stern's experiment in Drosophila, Creighton and McClintock evidence of crossing over in Maize; Theories of crossing over, types of crossing over, factors affecting crossing over.
   C. Constructing Genetic Maps - detecting linkage through test cross – linkage groups.

2. Gene mapping
   A. Gene mapping with Two-point test crosses:– types of linkage, recombination frequency, significance of linkage, limitations of two-point test cross.
   B. Genetic mapping with Three-point test crosses:- distance and gene order, interference, coefficient of coincidence.
   C. Constructing genetic linkage maps in humans:- grandfather method, autosomal linkage.

3. Tetrad Analysis and Mitotic Crossing Over
   A. Tetrad analysis in *Neurospora* – first and second division segregation, gene order, analysis of ordered tetrads.
   B. Tetrad analysis in Yeast – analysis of unordered tetrads.
   C. Mitotic crossing over –*Aspergillus nidulans,* twin spots in Drosophila.

4. Chromosomes
   A. Chromosomes:- Morphology and Classification: Morphology - chromatid, centromere, telomere, secondary constriction, satellite, chromomere; Variation in morphology-isochromosomes, bridge-breakage-fusion bridge cycles, ring chromosomes, Robertsonian translocation; Classification – telocentric, acrocentric, submetacentric, metacentric.
   B. Specialized Chromosomes:– polytene chromosomes, lamp brush chromosomes
   C. Karyotype Analysis:- types of karyotype - classical, spectral; steps involved in karyotype analysis; chromosome staining and banding - formation of karyogram/ideogram.

5. Chromosome aberration
   A. Variation in Chromosome number:- Euploidy - monopoid, diploid, tripoid, tetraploid (autotetraploid, allotetraploid), polyploid.
   B. Variation in Chromosome number:- Aneuploidy- monosomy, trisomy, tetrasomy, double trisomy, nullisomy.
   C. Variation in Chromosome structure:- translocations, inversions, deletions, duplications.

PRACTICALS
BT 151 P - CELL BIOLOGY AND GENETICS

UNIT I:

1. Preparation of Blood Smear and Differential Staining of Blood cells.
2. Isolation of Chloroplasts.
3. Chromatin Extraction and Electrophoresis
4. Study of Mitosis Stages.
5. Study of Meiosis Stages.
6. Identification of Blood Groups
7. Solving Problems on Monohybrid and Dihybrid ratios, Multiple alleles, Epistasis.
8. Pedigree Analysis and Inheritance Patterns in Man.

UNIT II:

1. Growth of Neurospora, analysis of cross and ascospore observations.
2. Solving Problems on Gene Mapping– Three-point Test Crosses,
3. Solving Problems on Tetrad Analysis
4. Study of Polyploidy in Onion Root Tips
5. Karyotyping of Normal &Abnormal Chromosome Sets in Humans
6. Preparation of Polytene Chromosomes
7. Preparation of *Hordeum vulgare* Karyotype

REFERENCE BOOKS

1. An introduction to Genetic Analysis by Anthony, J.F. J.A. Miller, D.T. Suzuki, R.C. Richard Lewontin, W.M-Gilbert, W.H. Freeman publication.
2. Principles of Genetics by E.J.Gardner and D.P. Snusted. John Wiley & Sons, New York.
3. The Science of Genetics, by A.G. Atherly J.R. Girton, J.F. Mcdonald, Saundern College publication
4. Principles of Genetics by R.H. Tamarin, International edtnMcGrawhill
5. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill
6. Cell & Molecular Biology. E.D.D De Robertis & E.M.F De Robertis, Waverly publication.
7. Molecular Biology of the cell. Alberts, B; Bray, D, Lews, J., Raff, M., Roberts, K and Watson, J.D. Garland publishers, Oxford
8. Molecular Cell Biology Lodish, H., Baltimore, D; Fesk, A., Zipursky S.L., Matsudaride, P. and Darnel American Scientific Books. W.H. Freeman, NewYork
9. Cell and molecular biology by Gerald Karp, Wiley
10. The cell: a molecular approach by Goeffrey Cooper and Robert Hausmann

SEMESTER - I
THEORY PAPER - II
BT 102 T- BIOLOGICAL CHEMISTRY

1. **Course Objectives (C. Obj.):**
   a. To learn the basics of chemistry related to biomolecules
   b. To understand the carbohydrate metabolism
   c. To comprehend metabolism of lipids, nucleic acids and amino acids & to learn cellular signaling processes

2. **Course Outcomes (C.O):**
   a. Understanding the basics about bio-molecules, bio-energetics and enzymology
   b. Comprehending the carbohydrate metabolism and networks
   c. Critically understanding biosynthesis of lipids nucleic acids and amino acids and how cells communicate and carryout physiological processes

COURSE PLAN

UNIT I: BIOLOGICAL MACROMOLECULES, PROTEINS AND ENZYMES

1. Carbohydrates
   A. Aldoses & Ketoses, Classification of monosaccharides
   B. Disaccharides, Oligosaccharides and Polysaccharides
   C. Glycoconjugates – Proteoglycans, Glycoproteins, Glycolipids
2. Amino acids & Proteins
   A. Structure, Classification, & Properties of Amino acids
   B. Primary, secondary & tertiary structure of Proteins, Ramchandran's plot
   C. Techniques for studying protein structure: X-ray crystallography, NMR spectroscopy
3. Lipids, Vitamins & Pigments
   A. Classification of lipids, Storage lipids – Fatty acids and Triacylglycerols
   B. Structural Lipids – Phospholipids, Glycolipids, Sphingolipids, Sterols
   C. Vitamins – Vitamin A, D, E & K; Pigments
4. Components of enzymes and classification of enzymes
   A. Structure and components of enzymes
   B. Classification of enzymes
   C. Properties of enzymes
5. Michaelis-Menten equation and its applications
   A. Derivation of Michaelis-Menten equation
   B. Lineweaver-Burke plots
   C. Enzyme kinetics for different types of inhibitors

UNIT II: CARBOHYDRATE METABOLISM

1. Glucose Metabolism

A. Glycolysis and its regulation
B. Gluconeogenesis and its regulation, Cori cycle
C. Pentose phosphate pathway, Entner-Doudoroff pathway

2. Tricarboxylic acid Cycle
   A. Reactions of Tricarboxylic acid Cycle
   B. Regulation of Tricarboxylic acid Cycle
   C. Glyoxylate pathway and its regulation
3. Oxidative Phosphorylation
   A. Components of electron transport chain
   B. Q – cycle, Coenzyme Q significance
   C. Mechanism of ATP Synthase activity
4. Glycogen metabolism
   A. Glycogenesis - process and function
   B. Glycogenolysis - process and function
   C. Regulation of Glycogenesis and Glycogenolysis
5. Photosynthesis
   A. Components and functions of Light reactions (PSII & PSI)
   B. C3 or Calvin cycle and its significance; Photorespiration
   C. C4 pathway and CAM pathway & their advantages

UNIT III: FATTY ACID, AMINO ACID AND NUCLEOTIDE METABOLISM AND SIGNAL TRANSDUCTION

1. Fatty acid metabolism
   A. Beta oxidation, Fatty acid biosynthesis
   B. Oxidation of unsaturated fatty acids
   C. Cholesterol metabolism
2. Amino acid metabolism
   A. Protein degradation and catabolism of amino acids
   B. Urea cycle and its significance
   C. Biosynthesis of Amino acids
3. Nucleotide metabolism
   A. Purine biosynthesis
   B. Pyrimidine biosynthesis
   C. Degradation pathways of nucleotides
4. Components and reactions of signal transduction
   A. Types of signal transduction: autocrine, paracrine and endocrine signaling
   B. Components of signaling pathways: Adapters and Secondary messengers
   C. Biochemical reactions in cellular signaling: Phosphorylation,Ubiqutination and Acetylation
5. Signaling Pathways

A. G-protein coupled receptor pathway-Structure of G proteins,GTPases)
B. Signaling pathways of receptor tyrosine kinases
C. Wnt (Canonical and non-canonical pathways) and Notch signaling pathways

PRACTICALS

BT 152 P - BIOLOGICAL CHEMISTRY

UNIT I:

1. Preparation of buffers and measurement of pH
2. Qualitative tests for sugars
3. Qualitative tests for amino acids
4. Qualitative tests for lipids
5. Paper chromatography
6. Column chromatography
7. Estimation of amylase activity

UNIT II:

1. Isolation and estimation of protein
2. Analysis of protein using SDS-PAGE.
3. Detection of protein phosphorylation.
4. Estimation of cholesterol.
5. Estimation of LDH levels
6. Starch gel electrophoresis
7. Estimation of chlorophyll content in plant sample.
8. Measurement of respiratory quotient

REFERENCE BOOKS

1. Lehninger's principles of Biochemistry (David L. Nelson and Michael M. Cox)
2. Biochemistry (Jeremy M. Berg, John L. Tymoczko, LubertStryer)
3. Biochemistry:-By: Rex Montgomery.
4. Harper’s Biochemistry. By: Robert K. Murray.
5. Enzymes. By: Trevor Palmer.
6. Enzyme structure and mechanism By: AlanFersht
7. Principles of Biochemistry. By: Donald J. Voet, Judith G.Voet, Charlotte W.Pratt
8. Analytical Biochemistry By Cooper
9. Principles and techniques of Biochemistry and Molecular Biology Edited by Keith Wilson and John Walker
10. Experimental Biochemistry: A Student Companion by Sashidhar Beedu
11. Practical Biochemistry By Plummer
12. Molecular biology of the cell. New York: Garland Science [Alberts, B., Johnson, A., Lewis,J., Raff, M., Roberts, K., & Walter, P. (2002)].

SEMESTER - I
THEORY PAPER - III
BT 103 T - MICROBIOLOGY

1. Course Objectives (C.Obj):

a. To learn about the general characteristics of microorganisms, microscopy,sterilization and containment

b. To learn about general characteristics of bacteria; bacterial isolation, growth,culturing and preservation

c. To learn about viruses and their general characteristics

2. Course Outcomes (C.O):

a. Understanding the basics of microbiology and microbial classification

b. Critical understanding of identification, isolation and culture of different bacteria and know how to preserve them

c. Knowledge of general characters, isolation, detection and culturing of viruses

COURSE PLAN

UNIT I: GENERAL CHARACTERISTICS OF MICROORGANISMS

l. General Microbiology

A. Historical perspective, Scope & relevance of Microbiology

B. Microscopy and its applications - Principles and working of Bright field, Fluorescent, Phase Contrast and Electron microscopes

C. Classification of microorganisms; Diversity of microorganisms – Bacteria, Mycobacteria & Mycoplasma, Archaea, Fungi, Algae, Protozoa, Virus

2. Control of microorganisms

A. Disinfection, Antisepsis and Sterilization and their applications

B. Methods of sterilization - dry heat, moist heat, radiation methods, filtration methods, chemical methods

C. Sterilization at industrial level – Steam sterilization, Flash sterilization, Low temperature sterilization, Gas sterilization

3. Containment and antimicrobial agents

A. Concept of Containment facility – Primary and Secondary containment; Biosafety Levels

B. Types of antimicrobial agents – Sulfonamides, Antibiotics (Penicillin, Cephalosporin etc.)

C. Development of microbial resistance to various antimicrobial agents; types of mechanisms

4. Preservation of microbial cultures

A. Principles of preservation of microbial cultures

B. Methods of preservation of microbial cultures- repeated subculturing, preservation at low temperature, Sterile soil preservation, mineral oil preservation, deep freezing, Liquid nitrogen preservation, freeze-drying (lyophilization)

C. Importance of preservation of microbial cultures in industry

5. General characters of Algae, Fungi, Protozoa
   A. General characteristics of Algae (Cyanophyta, Chlorophyta, Phaeophyta, Rhodophyta) ; Economic importance of Algae (agriculture, industry, medicine)
   B. General characteristics of Fung (Phycomycetes, Basidiomycetes, Ascomycetes, Deuteromycetes); Economic importance of Fungi; Pathogenic Fungi (Humans)
   C. General characteristics of Protozoa; Entamoeba and Plasmodium as human pathogens

UNIT II: BACTERIA AND THEIR CHARACTERISTICS

1. General characters & Identification of Bacteria
   A. General characters of Bacteria
   B. Identification of bacteria – conventional methods - simple staining, differential staining, structural staining, Special staining methods
   C. Molecular approaches for bacterial identification – PCR & Genome sequence based
2. Isolation of bacteria
   A. General methods for isolation of bacteria - Serial dilution technique
   B. Plating methods – Pour plate method, Spread plate & Streak plate techniques
   C. Membrane filter technique
3. Cultivation and Growth of bacteria
   A. Bacterial growth - typical growth curve - batch and continuous cultures, synchronous cultures
   B. Measurement of bacterial growth- measurement of cell number and cell mass
   C. Factors influencing bacterial growth- temperature, pH, water activity, Oxygen concentration, salt concentration, pressure and radiation
4. Pure cultures of bacteria
   A. Concept of pure culture, methods of pure culture
   B. Enrichment culturing techniques, Single cell isolation
   C. Pure culture development
5. Microbial diseases & diagnosis
   A. Diseases caused by bacteria in humans - *Staphylococcus*, *Streptococcus*, *Mycobacterium tuberculosis*
   B. Infectious disease and their transmission - Air, Water, Vector-Borne, Food-Borne, Zoo-Borne
   C. Different diagnostic tests for different microorganisms - WIDAL, CAMP, CLO, ALA, Salt Broth test, Acetate Utilization Test, Bile Solubility Test

UNIT III: VIRUSES AND THEIR CHARACTERISTICS

l. General characters & Classification
   A. History of Virology
   B. General characteristics, classification and nomenclature of viruses
   C. Importance of Viruses in Biotechnology

2. Bacteriophages
   A. Structure & Replication of Bacteriophage (T2)
   B. Characteristics & importance of M13 phage
   C. Lambda phage - Lytic and Lysogenic cycles
3. Isolation, purification & detection of viruses
   A. Isolation and Purification of viruses by Filtration
   B. Isolation and Purification of viruses by Precipitation and Centrifugation
   C. Detection of viruses: physical, biological, immunological and serological methods
4. Cultivation of viruses
   A. Purpose of cultivation of viruses
   B. Methods of cultivation of viruses
   C. Cell culture method - animal cell inoculation & chick embryo
5. Structure & characteristics of important viruses
   A. Structure and characteristics of plant viruses - TMV, CaMV, RTBV
   B. Structure and characteristics of Hepatitis virus, Polio virus, HIV
   C. Structure and characteristics of Corona and Influenza viruses

PRACTICALS
BT 153 P - MICROBIOLOGY

UNIT I:

1. General instructions of microbiology laboratory; Microscopic observation
2. Preparation of microbiological media – minimal media, basic media
3. Preparation of enriched media, enrichment media, differential media
4. Preparation of fungal culture media – potato dextrose agar
5. Sterilization of media – autoclave, filtration
6. Staining techniques for bacteria – Simple staining
7. Staining techniques for bacteria – Gram's staining
8. Staining techniques for fungi – Lactophenol Cotton blue staining

UNIT II:

1. Isolation & identification of pure culture of bacteria
2. Preservation & maintenance of pure cultures of microbes – slant & stab cultures
3. Culturing of microbes – tube culture, flask culture, shake flask culture
4. Study of bacterial growth curve
5. Bacterial antibiotic sensitivity analysis
6. Isolation and culture of fungi/algae
7. Inoculation of virus in chick embryo

REFERENCE BOOKS

1. Microbiology by M.J. Pelzar, E.S.N. Cfan and N.R. Kreig, McGraw Hill Publ.
2. Introductory Microbiology by J. Heritage, E.G.V. Erans, R.A. Killington, Cambridge
3. University Press.
4. General Microbiology by H.G.Schlegel Cambridge University Press.
5. General Microbiology by Stanier, R.Y, J.L. Ingrahm, M.L. Wheel is & P.R. Painter.
6. Microbiology– Concepts and Application. John Wiley and Sons, New York

SEMESTER - I
THEORY PAPER - IV
BT 104 T- STATISTICS, LABORATORY MANAGEMENT & SAFETY, ENTREPRENEURSHIP

1. **Course Objectives (C.Obj.):**
   a. To understand the significance of sampling & data alignment & to understand the concept of applying appropriate test statistics
   b. To learn about Laboratory Management & Safety
   c. To know the importance of Entrepreneurship

2. **Course Outcomes (C.O):**
   a. Learn to estimate appropriate descriptive measures for a data in a given study and Design & help in derive inferences based on the statistical comparisons
   b. Comprehension about Good laboratory practice Laboratory Management & Safety
   c. Acquire Knowledge and Concepts of Entrepreneurship

COURSE PLAN
UNIT I: BIOSTATISTICS

1. Introduction to Biostatistics
   A. Population and Sample, Random sample, methods of sampling, sampling bias, sample size
   B. Types of Study designs
   C. Data and Types of variables, Levels/scales of variables
2. Descriptive analysis of data
   A. Data alignment and representation,
   B. Measures of central tendency (mean, median, mode)
   C. Measures of dispersion (Range, standard deviation, mean deviation, variance, Coefficient of variation), Skewness and Kurtosis
3. Probability
   A. Concept of probability, Types of events, Laws of probability(Addition and multiplication laws)
   B. Bayes theorem and its applications
   C. Probability distributions: Features and applications ofBinomial, Poisson and Normal Distribution
4. Tests of Hypothesis
   A. Null and alternate hypothesis, test of significance, p-value, Type I and Type II errors, confidence intervals and confidence levels
   B. Test statistics: Z test (for proportions and means), t-test (students t-test, paired t test)

C. Analysis of categorical data: Chi-square test (test for goodness of fit, homogeneity test, linkage, test of independence); non-parametric tests

5. Multivariate analysis
   A. Analysis of variance - One way and Two-way Anova (F- test)
   B. Correlation analysis (Simple and multiple correlation, methods of correlation, Coefficient of correlation (r), Pearson's correlation, Spearman's Correlation)
   C. Regression analysis (simple and multiple regressions, linear and curvi-linear regression, logistic regression)

UNIT II: LABORATORY MANAGEMENT & SAFETY

1. Administration of Laboratories
   A. Administration of Laboratories, Laboratory design, Security measures
   B. Laboratory bio security concepts
   C. LaboratoryInformation management system (LIMS)
2. Laboratory safety
   A. Laboratory safety- good laboratory practices (GLP), Lab safety rules
   B. Biosafety levels – BSL1, BSL2, BSL3, BSL4
   C. Laboratory Safety policies – Policy statement, Policy intention, Policy implementation
3. Quality control and Quality assurance
   A. Basic principles of quality control (QC)
   B. Basic principles of quality assurance (QA)
   C. Importance of Quality control and Quality assurance in industry
4. Handling of hazardous material
   A. Handling of hazardous chemical compounds – corrosive solvents, toxics, explosives, flammable liquids, irritants, carcinogens, toxic gases
   B. Handling of radioactive materials – radioactive hazard, protective wear, safety measures
   C. Handling of biological hazardous materials – bacterial & fungal strains
5. Storage & disposal of hazardous material
   A. Storage of hazardous materials
   B. Disposal of biological hazardous materials
   C. Disposal of radioactive materials

UNIT III: ENTREPRENEURSHIP

1. Concept of Entrepreneurship
   A. Concept, definition of Entrepreneur, Characteristics of Entrepreneur
   B. Concept, definition, functions of Entrepreneurship, Process of Entrepreneurship
   C. Entrepreneurship training and education
2. Types of Startups
   A. Concept of Startups, Factors affecting Startups
   B. Advantages of Startups

C. Types of Startups, Successful Startups

3. Types of Entrepreneurship
   A. Types of Entrepreneurship
   B. Entrepreneurship resources and financing
   C. Process of Entrepreneural development
4. Product planning and development
   A. Product planning and development - Project management,Search for business idea
   B. Concept of Projects, Project identification, Formulation, Design and network analysis
   C. Project report and project appraisal
5. Bio-entrepreneurship & Plagiarism
   A. Importance of Bio-entrepreneurship
   B. Promoting Bio-entrepreneurship
   C. Plagiarism ; Plagiarism checking tools

PRACTICALS

BT 154 P - BIOSTATISTICS

UNIT I: DESCRIPTIVE STATISTICS

1. Preparation of cross tabs, Construction of bar graphs, histogram, frequency polygon, pie diagram, box plot, scatter plot and data interpretation
2. Estimation of Mean, Median, Mode, Standard deviation, Variance, coefficient of variation and standard error for grouped and ungrouped data
3. Problems on probability
4. Problems on Binomial and Poisson distributions
5. Problems on Normal distribution
6. Calculation of correlation coefficient
7. Problems on linear Regression, calculation of slope from linear regression graph, Analysis of Logistic regression
8. Estimation of Sample size

UNIT II: INFERENTIAL STATISTICS

1. Fisher Z transformation
2. Hypothesis testing: Z test for means, Z test for proportions
3. Hypothesis testing using t-test: Paired t-test, Unpaired t-test
4. Hypothesis testing using Chi-square test: Goodness of fit, test of independence, 2 X 2 contingency, m X n contingency
5. Hypothesis testing using F test: Problems on one-way ANOVA
6. Hypothesis testing using F test: Problems on two-way ANOVA
7. Data analysis using MS Excel

REFERENCE BOOKS

1. Quantitative Genetics By Falconer
2. Biostatistics By Vishweswara Rao
3. Biostatistics By Khan and Khanum
4. Fundamentals of Biostatistics By P.H. Rao and Janardhan
5. Population Genetics By V. Venugopal and Pratibha Nallari
6. Biostatistical Methods in Agriculture Biology and Medicine By Khan and Khanum
7. Guides to entrepreneurship in biotechnology by P. Ponnumurugan, J Robinson and B. Kalpana
8. Guidelines for entrepreneurship development program for biotechnology graduates by P. Ponnumurugan and Nithya. B
9. CRC handbook of laboratory safety by A. Keith Furr

SEMESTER - II
THEORY PAPER - I
BT 201 T - MOLECULAR BIOLOGY - THE GENOME

1. **Course Objectives (C.Obj):**
   a. To give insights into genome organization of prokaryotes and eukaryotes
   b. To impart knowledge on the process of genome replication in prokaryotes and eukaryotes
   c. To enable basic understanding of DNA damage and repair pathways and introduce to genome rearrangements and recombination mechanisms

2. **Course Outcomes (C.O):**
   a. Knowledge on organization of prokaryotic and eukaryotic genomes
   b. Understanding of DNA replication in prokaryotes and eukaryotes
   c. Comprehension of DNA damage and repair pathways involved and knowledge of mechanisms of DNA recombination and genome rearrangements and their role in genome evolution

COURSE PLAN

UNIT I: GENOME ORGANIZATION

1. Genetic Material & Structure
   A. DNA as Genetic Material - Historical Account
   B. RNA as Genetic Material
   C. Structure of DNA (Watson and Crick model); Forms of DNA – A, B & Z, Supercoiled DNA
2. Genome Organization & Genome Complexity
   A. Packaging of Viral genome (RNA & DNA viruses), Prokaryotic genome organization – Nucleoid; features, size
   B. Eukaryotic genome organization – Nucleosome, 30 nm fibre, Solenoid loops, Chromosome (Centromere & Telomere); Euchromatin & Heterochromatin
   C. Genome Complexity – Genome Size, Chromosome Number, Gene Size, Gene Density, C-value Paradox
3. Non repetitive & Repetitive DNA, Transposons
   A. Melting of DNA & Reassociation Kinetics; Unique sequences
   B. Repetitive DNA – Interspersed & Tandem repeats; Minisatellies & Microsatellites
   C. Transposons – types and mechanisms of transposition; Retrotransposons – Class I & II, Retrogenes, Role of Transposons in genome evolution.
4. Gene Families, Gene duplication & amplification
   A. Gene families; Tandem array Gene families; Clustered Gene families – Globin Gene & Histone Gene Clusters
   B. Gene Duplication; Pseudogenes – processed & nonprocessed

C. Gene Amplification – Mechanism & Significance of Gene Amplification

5. Extrachromosomal & Organellar Genomes
   A. Organization of plasmid DNA – bacteria, Yeast
   B. Organization of Mitochondrial genome - features, size and contents of genome
   C. Organization of Chloroplast genome - features, size and contents of genome

UNIT II: GENOME REPLICATION

1. DNA replication
   A. Modes of DNA replication – Semiconservative mode (Meselson & Stahl Experiment)
   B. Replication Origin & Replication fork; Okazaki fragments, Fidelity of replication
   C. Enzymes and proteins involved in DNA replication
2. Replication of Prokaryotic Genome
   A. Process of bacterial DNA replication – initiation, extension and termination
   B. Structure and assembly of DNA polymerases – DNA Pol I, Pol II & Pol III
   C. Regulation of bacterial DNA replication
3. Replication of Eukaryotic Genome
   A. Replication process of eukaryotic DNA – initiation, extension and termination; Structure and assembly of DNA polymerases
   B. Maintenance of telomeric ends – replication of telomeric DNA, Telomerase
   C. Regulation of eukaryotic DNA replication
4. Extrachromosomal & Organellar genomes
   A. Replication of plasmid DNA – Θ model, rolling circle model
   B. Replication of mitochondrial genome - D loop model
   C. Replication of chloroplast genome – double D loop model
5. Errors & Inhibitors of DNA Replication
   A. Replication associated errors - Tautomeric shifts, Wobble
   B. Replication associated Strand slippage
   C. Inhibitors of DNA replication – Nucleoside analogues, DNA Topoisomerase inhibitors

Unit III: DNA DAMAGE, REPAIR & RECOMBINATION

1. Mutations
   A. Spontaneous mutations and Induced mutations
   B. Physical and Chemical mutagens
   C. Types of mutations – base substitution (transition, transversion), deletions and insertions
2. DNA Damage
   A. Oxidative damage, Depurination, Depyrimidination
   B. O^6 – methylguanines, Cytosine deamination
   C. Single and Double strand breaks

3. DNA Repair mechanisms
   A. Photoreactivation, Base excision repair, Nucleotide excision repair, Mismatch repair, SOS repair
   B. Proof reading, Direct reversal of damaged DNA, Post replication repair
   C. Cellular Responses to DNA damage, DNA repair defects & disorders
4. Recombination
   A. Homologous recombination – Holliday junctions, rec BCD pathways
   B. Site-specific recombination; Non-Homologous end joining recombination
   C. Mechanism and regulation of meiotic recombination
5. Genome rearrangements & Genome instability
   A. Genome rearrangements – duplication, deletion, insertion, inversion & translocation
   B. Mechanism of gene duplication and amplification; Whole genome duplication
   C. Causes and types of Genome instability; Effects of Genome instability

PRACTICALS
BT 251 P - MOLECULAR BIOLOGY - THE GENOME

UNIT I:

1. Isolation of genomic DNA from bacteria
2. Isolation of genomic DNA from fungi/algae
3. Isolation of genomic DNA from human blood
4. Isolation of genomic DNA from plants
5. Isolation of genomic DNA from animal tissue
6. Qualitative analysis of genomic DNA using agarose gel electrophoresis
7. Determination of quantity of genomic DNA using UV/Visible spectrophotometer

UNIT II:

1. Determination of melting temperature of DNA
2. Reassociation kinetics and estimation of Cot values
3. Estimation of GC content in the given DNA sample
4. Demonstration of RAPD technique
5. Demonstration of DNA Fingerprinting technique
6. Induction of mutations by chemical agents
7. Induction of mutagenesis using UV radiation
8. Determination of DNA damage by Comet assay

REFERENCE BOOKS

1. Molecular Biology of the Cell, Bruce Alberts, Alexander Johnson, Julian Lewis,Martin Raff,Keith Roberts and Peter Walter.
2. Molecular Biology of the Gene by J.D. Watson, N.H. Hopkins, J.W, Robertis, A.
3. Steitz& A.M. Weiner, Benjamin Cummings Publ. California
4. Molecular Cell Biology Lodish, H., Baltimore, D; Fesk, A, Zipursky S.L., Matsudaride, P. and Darnel American Scientific Books. W.H. Freeman, NewYork
5. Genes VII. Benjamin Lewis, OxfordUniv. Press, Oxford
6. Molecular Biology by D, FreifelderNarosa Publishing house New York, Delhi
7. Advance Molecular Biology Twyman, R.M., Bios Scientific publishers Oxford
8. Molecular Biology by T.A. Brown
9. Essentials of Molecular Biology. D. Freifelder, Panima publishing co-operation
10. Genes & Genomes – A changing perspective by Singer &Berr, Universal Science Books, California.
11. DNA Damage Repair, Repair Mechanisms and Aging by Allison E. Thomas Nova Science Publisher's, 2010.
12. Chromosomal Translocations and Genome Rearrangements in Cancer by Janet D. Rowley, Michelle M. Le Beau, Terence H. Rabbitts Springer International Publishing, 2015.

SEMESTER - II
THEORY PAPER – II
BT 202 T– MOLECULAR BIOLOGY– GENES TO PROTEINS

1. **Course Objectives (C.Obj):**
   a. To impart conceptual understanding of prokaryotic and eukaryotic genes and their organization and to give insights into transcription and RNA processing
   b. To highlight the important mechanisms and components, their role in translation
   c. To create an understanding about gene regulation and Epigenetics

2. **Course Outcomes (C.O):**
   a. Comprehension of gene organization and gene expression in prokaryotes & eukaryotes
   b. Acquire knowledge about translation and provide understanding of the core principles of genetic code and protein synthesis
   c. Understanding concepts of the gene regulation and Epigenetics

COURSE PLAN

UNIT I: GENES, RNA SYNTHESIS & PROCESSING

1. Prokaryotic & Eukaryotic genes
   A. Structure of Prokaryotic gene - promoter, operator, coding region (structural genes) & terminal region; collinearity & polycistronic mRNA; Operons – Lac & Trp Operons
   B. Fine structure of Eukaryotic gene - core & proximal promoters, enhancers, exons, introns, UTRs, monocistronic mRNA
   C. Functional RNA genes (rRNA, tRNA); Regulatory small RNA coding genes (miRNA, lncRNA)
2. RNA Synthesis in Prokaryotes
   A. Bacterial RNA Polymerase – Structure (Core & Holoenzyme)
   B. Transcription process - initiation, elongation and termination
   C. Significance of sigma and rho factors in transcription
3. RNA Synthesis in Eukaryotes
   A. Transcription factors, activators & repressors, specific factors (Zinc fingers, Leucine zippers, helix loop helix and homeodomain)
   B. Eukaryotic RNA Polymerases – Type I, II, III; Structure
   C. Transcription process - initiation, elongation and termination for Class I , II and III genes
4. RNA Processing
   A. Post-transcriptional processes: mRNA capping, poly-adenylation
   B. RNA editing and splicing (spliceosome assembly, mechanisms of splicing, self-splicing, alternate splicing, Trans-splicing)
   C. Structure and function of different types of RNA; RNA transport

5. Transcription inhibitors & their applications
   A. RNA Polymerase inhibitors, CDK inhibitors & their applications
   B. Transcription Factor inhibitors & their applications
   C. Techniques to analyze differential gene expression (Microarrays, qRT-PCR, RNAseq)

UNIT II: PROTEIN SYNTHESIS & PROCESSING

1. Genetic code & its properties
   A. Correspondence of amino acid sequence with nucleotide sequence in DNA
   B. Properties of Genetic code - Universal code, degeneracy, redundancy
   C. Wobble hypothesis & Universality of Genetic code
2. Translation machinery & mechanism in Prokaryotes
   A. Ribosomes, formation of initiation complex, initiation factors and their regulation
   B. Elongation & elongation factors, translocation, t-RNA identity, aminoacyl t-RNA, peptide bond formation
   C. Termination; termination codons
3. Translation machinery & mechanism in Eukaryotes
   A. Ribosomes, formation of initiation complex, initiation factors and their regulation
   B. Elongation & elongation factors
   C. Termination
4. Translation activators & inhibitors
   A. Translation activators
   B. Translation inhibitors
   C. Applications of Translation inhibitors
5. Post translation modifications of proteins
   A. Glycosylation, Lipidation, Acetylation, Ubiqutination
   B. Protein splicing, chaperones, modification of amino acids
   C. Disulphide bond formation, peptide bond cleavage and isomerization

UNIT III: REGULATION OF GENE EXPRESSION & EPIGENETICS

1. Control of gene expression
   A. Control of gene expression at transcription level (Operon concept – Inducible operon - Lac operon; Repressible operon - Trp Operon)
   B. Control of gene expression at translation level
   C. Co-ordinated regulation of gene expression
2. Regulation of gene expression in eukaryotes
   A. Genes controlling yeast mating type
   B. Regulation of *Xenopus* 5s rRNA in oocytes
   C. Enhancer as genetic switch – chicken β globin genes
   D. Gene regulation in eukaryotes (antisense RNA & RNAi)
3. Gene regulation exerted at the level of translation

   A. Regulation at the level of translation - Silk fibroin gene
   B. Regulation at splice site selection – Drosophila sex determination
   C. Regulation at post translation level - Ubiqutination
4. Epigenetics I
   A. Role of chromatin in regulating gene expression and gene silencing
   B. DNA methylation mediated suppression of transcription
   C. Histone modification (acetylation, deacetylation analysis of epigenetic modifications, epigenetic memory)
5. Epigenetics II
   A. Genome wide mapping of chromatin factors and modifications
   B. Role of nutrition in epigenetic modifications
   C. Role of environment in epigenetic modifications

PRACTICALS
BT 252 P – MOLECULAR BIOLOGY – GENES TO PROTEINS

UNIT I:

1. Lactose induction of β-galactosidase
2. Repression of Trp Operon
3. Analysis of DNA sequence for ORF, exons & introns
4. Analysis of DNA sequence for promoter/enhancer sequences
5. PCR amplification of a targeted gene
6. Characterization of a transcription factor using EMSA.

UNIT II:

1. Isolation & analysis of RNA from plant sample
2. Isolation & analysis of RNA from animal/human sample
3. Determination of quantity of RNA using UV/Visible spectrophotometer
4. Isolation of mRNA and cDNA synthesis
5. Gene expression analysis by qRT PCR using SYBR Green dye
6. Gene expression analysis using Northern Blotting
7. Over expression and purification of specific protein using Nickel NTA columns
8. Trypsin cleavage of isolated protein & analysis by SDS electrophoresis

REFERENCE BOOKS

1. Molecular Biology of the Gene by J.D. Watson, N.H. Hopkins, J.W, Robertis
2. A. Steitz & A.M. Weiner, Benjamin Cummings Publ. California
3. Genes VII. Benjamin Lewin, Oxford Univ. Press, Oxford
4. Molecular Biology by D. Freifelder Narosa Publishing house New York, Delhi,
5. Molecular Cell Biology H. Lodish, D. Baltimore, A. Fesk, S.L. Zipursky, P. Matsudaride andDarnel American Scientific Books. W.H. Freeman, New York
6. Advance Molecular Biology R. M. Twyman, Bios Scientific publishers Oxford
7. Molecular Biology by T.A. Brown
8. Essentials of Molecular Biology. D. Freifelder, Panima publishing co-operation

SEMESTER - II
THEORY PAPER - III
BT 203 T - IMMUNOLOGY

1. **Course Objectives (C.Obj):**
   a. To give an overview of different types of immunities, cells & organs involved in theimmune system and to provide the insights into immunogenicity and antigenicity
   b. To understand the structure and function of immunoglobulins and their generation & to gain knowledge on structure and function of Major Histocompatibility Complex
   c. To provide the comprehensive understanding of the cell mediated immune responses &in-depth knowledge about autoimmunity & immunodeficiency disorders

2. **Course Outcomes (C.O):**
   a. Basic understanding and importance of the immune system
   b. The importance and applications of immunoglobulins in therapeutics can be known and appreciate the importance of MHC in organ transplantation
   c. Knowledge about the cell mediated immune responses and creates awareness regarding autoimmune and immunodeficiency disorders.

COURSE PLAN
UNIT I: BASICS PRINCIPLES OF IMMUNOLOGY

1. Immunity– Types of Immunity
   A. Innate immunity - Anatomic barriers, physiological barriers, phagocytic barriers, microbial antagonism, inflammation
   B. Acquired Immunity– Types & characteristics
   C. Deficiencies of innate immune mechanisms– Chronic Granulomatous Disease (CGD), Leukocyte-adhesion deficiency(LAD)
2. Cells of the Immune System
   A. Haematopoiesis and differentiation
   B. Lymphoid cells (B & T-Lymphocytes; T cell subsets; NK cells)
   C. Myleiod cells: Mononuclear phagocytes (monocytes, macrophages) Granulocytes (neutrophils, eosinophils, basophils, mast cells, dendritic cells)
3. Organs of the immune system
   A. Primary lymphoid organs (Bone marrow and Thymus)
   B. Secondary lymphoid organs (Lymph nodes, Spleen)
   C. Mucosal-associated lymphoid tissue and Cutaneous associated lymphoid tissue
4. Antigens & Complement system
   A. Immunogenicity versus Antigenicity, Factors that influence immunogenicity
   B. Epitopes– Properties of B cell epitopes and T cell epitopes & Haptens

C. Functions and components of complement system; complement activation

5. Basic structure of Immunoglobulin & its functions
   A. The role of multiple myeloma in understanding Ig structure
   B. Fine structure of Immunoglobulins– Immunoglobulin domains-variable region and constant region domains
   C. Immunoglobulin classes– IgG, IgM, IgA, IgD and IgE; functions of Ig classes

UNIT II: IMMUNOGLOBULIN ORGANIZATION, B-CELL DEVELOPMENT AND MAJOR HISTOCOMPATIBILITY COMPLEX (MHC)

1. Organization of Immunoglobulins
   A. Antigenic determinants on Immunoglobulins
   B. Effector functions of antibodies
   C. Organization and expression of immunoglobulin light and heavy chain genes
2. B-cell activation & differentiation
   A. B-cell activation and proliferation by Thymus Independent and Thymus Dependent antigens
   B. B-cell differentiation, class switching and generation of plasma cells and memory cells
   C. B-cell immunodeficiency disorders – X-linked gamma globulinemia, selective immunoglobulin deficiency
3. Antibody engineering & its applications
   A. Polyclonal antibodies production & its applications
   B. Monoclonal Antibodies Production & its applications
   C. Antibody engineering– human antibodies from phage display
4. Major Histocompatibility Complex (MHC)
   A. General organization and inheritance of MHC; MHC Haplotypes
   B. The structure of MHC Class I and Class II molecules
   C. Organization of MHC Class I and Class II genes, peptide binding of MHC molecules
5. MHC immune responsiveness & HLA
   A. Polymorphism of MHC Class I and Class II molecules; Cellular distribution of MHC molecules; MHC molecules and immune responsiveness and disease susceptibility
   B. Types of grafts; Mechanism of graft rejection; immunological basis of graft rejection; Graft versus host reactions & Role of HLA typing in organ transplantation
   C. Human leukocyte antigen (HLA) typing by mixed lymphocyte reaction (MLR), microcytotoxicity tests and by PCR

UNIT III: CELL-MEDIATED IMMUNE RESPONSES

1. Antigen presentation
   A. Antigen processing by antigen presenting cells
   B. Structure and functions of T cell receptors (TCR)

C. TCR-peptide-MHC tri-molecular complexes

2. Role of cytokine in immune responses
   A. Cytokines– properties; cytokine receptors
   B. Th1 and Th2 type of cytokines
   C. Therapeutic uses of cytokines
3. Cell- mediated cytotoxic responses
   A. Cell-mediated immune response: General properties of effector T cells
   B. Direct Cytotoxic response
   C. Experimental assessment of cell-mediated Cytotoxicity
4. Hypersensitivity & Autoimmunity
   A. Hypersensitivity and its types
   B. Delayed Type Hypersensitivity (DTH) and cytokines involved in DTH
   C. Auto-immunity– mechanisms and auto-immune diseases-Insulin Dependent Diabetes; Rheumatoid Arthritis, Auto-immune Thyroid disease, Systemic lupus erythematosus (SLE)
5. Immunodeficiency disorders
   A. T cell primary immunodeficiency disorders– Severe combined immunodeficiency (SCID); Di George syndrome
   B. Secondary immunodeficiency disorders- acquired immune deficiency syndrome (AIDS)
   C. Vaccines-Types of vaccines & Adjuvants

PRACTICALS
BT 153 P - IMMUNOLOGY

UNIT I:

1. ABO blood typing
2. Micro-hemagglutination Test
3. Isolation of Plasma
4. Isolation of Serum
5. Serum Protein Electrophoresis
6. Single radial Immunodiffusion
7. Double diffusion

UNIT II:

1. Dot ELISA
2. Western Blot by Enzyme-conjugated antibody
3. Sandwich Enzyme Linked Immunosorbent Assay
4. HLA Typing by PCR
5. Isolation of lymphocytes by histopaque & cell viability test by Trypan Blue

6. MTT Assay
7. Principle and procedure for enumeration of specific cell types by Fluorescent Activated Cell Sorter (FACS)

REFERENCE BOOKS

1. Essential Immunology– By I. Roitt, Publ: Blackwell
2. Immunology– By G. Reever& I. Todd, Publ: Blackwell
3. Immuno diagnostics– By S.C. Rastogi, Publ: New Age
4. Immunology: By Richard A. Golds, Thomas J Kindt, Barbaraa A. Osborne, Janis Kuby
5. Fundamental immunology– By William E.Paul.
6. Basic Immunology– By Bhoosreddy G.L. and Wadher B.J.
7. Text book of immunology– By Baruj Benacerraf

SEMESTER - II
THEORY PAPER - IV
BT 204 T- MICROBIAL TECHNOLOGY

1. **Course Objectives (C.Obj):**
   a) To understand the scope of Microbial Technology
   b) To acquire knowledge and understanding of fermentation processes
   c) To comprehend microbial products and their applications

2. **Course Outcomes (C.O):**
   a) Obtaining skills in isolation, screening and preservation of industrially useful microorganisms
   b) Understanding the methods and operations used in fermentation technology
   c) Acquiring Microbial Technology skills for the production of industrial products

COURSE PLAN

UNIT I: FUNDAMENTALS OF MICROBIAL TECHNOLOGY

1. Introduction to Microbial Technology
   A. Historical developments and scope of microbial technology
   B. Properties of microorganisms of industrial importance
   C. Industrially important bacteria, fungi &algae
2. Isolation, Screening and Strain improvement
   A. Isolation of microorganisms – natural sources, strain selection, selection pressure, selection criteria, identification
   B. Types of industrial microorganisms screening – primary and secondary screening
   C. Strategies of strain improvement - mutation, selection, recombination, use of recombinant DNA technology and protoplast fusion
3. Preservation of microbial strains of industrial importance
   A. Culture storage preservation at reduced temperature
   B. Storage in dehydrated form- overlaying culture with mineral oil, ultra-freezing, lyophilization, storage at very low temperature or in liquid nitrogen
   C. Preserved stock culture – quality control
4. Development of Inoculum & Inoculation
   A. Inoculum - criteria for transfer of inoculum
   B. Development of inoculum- steps involved
   C. Aseptic inoculation
5. Metabolites produced by microorganisms
   A. Metabolites produced by microorganisms – primary and secondary
   B. Primary metabolites of economic importance
   C. Secondary metabolites of economic importance

UNIT II: PROCESSES FOR MICROBIAL FERMENTATION

1. Fundamentals of Fermentation
   A. Fermentation process- components of fermentation process.
   B. Fermentation processes – microbial biomass, enzymes, metabolites, recombinant products, transformation processes.
   C. Process operations – sterilization: heat and filter sterilization.
2. Fermentation Media
   A. Media for industrial fermentations- Typical media – media formulation, water
   B. Media sources - energy sources, carbon sources, nitrogen sources, minerals, growth factors, buffers, antifoams, precursors and metabolic regulators to media
   C. Medium optimization
3. Fermentation Methods
   A. Methods of fermentation- batch, fed batch, semi-continuous and continuous fermentations.
   B. Bioreactors – solid-state cultivation, liquid state bioreactor.
   C. Bioreactor operating conditions - factors affecting microbial growth in fermentation – temperature, pH, oxygen, constituents of medium
4. Fermentation Processes
   A. Growth measurements during fermentation process – growth in SmF.
   B. Fermentation monitoring– process measurements.
   C. Fermentation control– control systems.
5. Recovery of products
   A. Outline of processes for harvesting and recovery of products.
   B. Biomass separation- product extraction from disrupted biomass, product recovery from broth.
   C. Overview of bioseparation processes.

UNIT III: APPLICATIONS OF MICROBIAL TECHNOLOGY

1. Microbial Products I
   A. Production of microbial enzymes– proteases, amylases, lipases, cellulases, pectinases and esterases.
   B. Production of organic acids– citric acid, gluconic acid, lactic acid, acetic acid.
   C. Production of industrial products - alcohol, acetone-butanol fermentation, glycerol from yeasts and bacteria.
2. Microbial Products II
   A. Production of microbial polysaccharides- xanthan, dextran, alginate, cellulose
   B. Microbial production of agricultural products- biofertilizers, biopesticides, recombinant biopesticides. .
   C. Microbial enhanced recovery of mineral resources- bioleaching of metals, oil recovery.

3. Production of Beverages, Dairy and Fermented Foods
   A. Production of alcoholic beverages- beer and wine
   B. Food produced by microbes- cheese, fermented dairy products
   C. Microbial cells as food – yeast single cell proteins, fermented Indian foods, fermented Oriental foods
4. Production of Amino Acids, Antibiotics & Vitamins
   A. Production of amino acids - glutamic acid, lysine, aspartic acid.
   B. Production of antibiotics–penicillin, streptomycin.
   C. Production of vitamins –Vitamin B_{12} , Riboflavin, Cyanocobalamin
5. Production of Therapeutics
   A. Production Monoclonal antibodies
   B. Production of interferons – recombinant IFNs
   C. Production of vaccines – Tetanus, Polio and Rabies, BCG, Hepatitis-B

PRACTICALS:
BT 254 P – MICROBIAL TECHNOLOGY

UNIT I:

1. Dilution and pour plate technique.
2. Isolation of bacteria and fungi from water or soil.
3. Screening for amylase producing organisms.
4. Isolation of bacteria and evaluation of antibiogram.
5. Measurement of microbial growth - standard plate count.
6. Preservation of microbial cultures by making glycerol stocks.
7. Yoghurt or cheese fermentation.
8. Isolation of *Lactobacilli* from curd.

UNIT II:

1. Isolation of *Rhizobium* from root nodules.
2. Production of organic acids.
3. Production and estimation of alcohol.
4. Production and assay of amylase activity.
5. Preparation of wine from grapes.
6. Production of penicillin or ampicillin.
7. Solid state fermentation

REFERENCE BOOKS

1. Text Book of Biotechnology–by H. K. Das (Wiley Publications)
2. Biotechnology–by H. J. Rehm and G. Reed. VIH Publications, Germany
3. Biogas Technology – by B.T. Nijaguna
4. Biotechnology- by K. Trehan
5. Industrial Microbiology – by L. E. Casida
6. Food Microbiology- by M.R. Adams and M.O. Moss
7. Introduction to Biotechnology – by P. K. Gupta
9. Essentials of Biotechnology for Students – by Satya N. Das
10. Bioethics–Readings and Cases-by B. A. Brody and H. T. Engelhardt. Jr.(Pearson Education)
11. Bioprocess Engineering –by Shuler (Pearson Education)
12, Essentials of Biotechnology- by Irfan Ali Khan and Atiya Khanum (Ukaaz Publications)
13. Gene, Genomics and Genetic Engineering – by Irfan Ali Khan and Atiya Khanum (Ukaaz Publications)

MODEL QUESTION PAPER

Code No: ……./CBCS
FACULTY OF SCIENCE
M.Sc. (CBCS) II- Semester Examination, July/August, 2023
Subject: Biotechnology
Paper –No. and : Title

Time: 3 Hours **Max. Marks: 70**

Note: *Missing data, if any, may be* ***suitably assumed.***

PART – A
Short Answer Type (5 x 5 = 25 Marks)
Answer all the questions

1. Question from Unit-I
2. Question from Unit-II
3. Question from Unit-III
4. Question from Unit-I/II or III
5. Question from Unit-I/II or III

PART – B
Essay Answer Type (3 x 15 = 45 Marks)

Answer all the Questions. All questions carry equal marks

6. a) Question from Unit-I
(OR)
b) Question from Unit-I

7. a) Question from Unit-II
(OR)
b) Question from Unit-II

8. a) Question from Unit-III
(OR)
b) Question from Unit-III

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