Dept of Biotechnology

PROGRAMME OUTCOMES

Programme Outcomes (PO)	Short Title of the POs	Description of the Programme Outcomes Graduates will be able to :
PO-1	Problem Analysis and Solutions	Think critically, identify, analyze problems/ situations and further attempt to design/ develop solutions that meet the specified goals.
PO-2	Use of Technology	Apply appropriate IT tools efficiently in their daily activities of communication and academics.
PO-3	Environment and Sustainability	Analyze and attempt solutions to environmental issues and commit themselves to sustainable development in the local/ national and global context.
PO-4	Ethics	Recognize and understand professional ethics /human values and be responsible for the same.
PO-5	Individual and Team work	Function effectively at various levels, capacities and situations.
PO-6	Communication	Communicate proficiently (oral and written) as a responsible member of society.
PO-7	Research Aptitude	Understand general research methods and be able to analyse, interpret and derive rational conclusions.
PO-8	Life Skills	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of domain specific change.
PROGRAMME SPECIFIC OUTCOMES (PSO) After successful completion of a Bachelor's degree in Biotechnology, the students will:		
PSO-1	Fundamental Knowledge of Biotechnology	Possess a fundamental knowledge of the different aspects of Biotechnology, with the means and ability to specialize in a particular field.
PSO-2	Development of practical skills	Be equipped with practical skills and the ability to apply their theoretical concepts to design, perform experiments, analyze and interpret data and thus develop proficiency in laboratory management.

PSO-3	Critical thinking and analytical skills	Be able to demonstrate proficiency in quantitative reasoning (critical thinking) and analytical skills.
PSO-4	Analysis and Problem Solving	Be able to use these skills to analyze and solve industry related problems, thus preparing them for a successful career in industry and research institutes.
PSO-5	Understanding the need for sustainable solutions	Be able to understand the need and impact of biotechnological solutions on environment and societal context, keeping in view the need for sustainable solutions.
PSO-6	Developing an inclination towards research	Develop an inclination towards research through the compulsory internship in industry/research/academic institutes which promote and inculcate professional ethics and code of practice among students, enabling them to work in a team with a multidisciplinary approach.

COURSE OUTCOMES (Sem I, III and V)

Sem	Course Code	Course Title	Course Outcomes
I	BIO-I.C-1	Biomolecules	On the successful completion of the course, the students will be able to: CO1: Explain the various molecular interactions, structure and importance of biomolecules in a living system. CO2: Describe the concepts of enzyme kinetics in a living system CO3: Understand and practice general laboratory safety measures CO4: Prepare different solutions such as buffers, reagents and stock solutions for experiments independently. CO5: Estimate various biomolecules using lab instruments such as weighing balance, water bath, centrifuge, pH meter, spectrophotometer etc.
	BIO-I.C-2	Cell Biology	CO1: Correlate the function of each cell organelle with proper coordination. CO2: Demonstrate an understanding of cell communication. CO3: Prepare various plant and animal specimen for observation of cell structures CO4: Identify and analyze different biological cells using a compound microscope. CO5: Identify different stages of cell division
	BIO-III.C-5	Molecular	CO1: Explain the structure of DNA and its properties

III		Biology	CO2: Distinguish between DNA, RNA and Proteins CO3: Understand basic concepts in molecular biology CO4: Compare differences between replication, transcription and translation processes in prokaryotes and eukaryotes. CO5: Describe the mechanism of gene transfer and regulation
	BIO-III.E-1	Basics of plant and animal sciences	CO1:Explain classification of plant and animal kingdom CO2: Distinguish between various phyla of the plant and animal kingdoms based on their characteristics CO3: Compare and contrast the differences in morphology and anatomy in Angiosperms CO4: Explain features of the non-chordates and chordates CO5: Sketch the morphology and anatomy of selected plant and animal specimens.
	BIO-III.E-2	Metabolism of Biomolecules	CO1: Understand and explain the metabolic processes of the human body CO2: Explain the interconnections of metabolic pathway. CO3: Explain the effect of diet on metabolism and defects caused due to improper metabolism. CO4: Estimate and isolate various biomolecules using spectrophotometry, Thin layer chromatography & centrifugation techniques. CO5: Understand and describe the causes and treatment of various metabolic disorders through case studies.
	BIO-III.E-3	Biostatistics	CO1: Explain the importance of Biostatistics in biology. CO2: Explain the concepts of Sampling CO3: Represent and Interpret the data using graphical method and MS Excel CO4: Solve problems on measures of central tendency, dispersion and about hypothesis testing CO5: Able to apply appropriate statistical tool in their project work
	BIO-V.C-7	Industrial Biotechnology - Basic	CO1: Explain the concept of a bio-process and its importance in today's world of fast paced technology. CO2: Explain the instrumentation of a Fermenter and components of large scale fermentation media CO3: Demonstrate the production of simple fermentation based products like wine and vinegar.

V			CO4: Determine the progress of fermentation process CO5: Screen micro-organisms that are capable of producing industrially important products like antibiotics.
	BIO-V.E-9	Molecular medicine	CO1: Understand the historical aspects of molecular medicine CO2: Understand the underlying genetic factors of common diseases CO3: Describe molecular and cellular therapies for the same CO4: Gain basic knowledge on cancer genetics and pharmaco-genetics CO5: Understand the importance of maintaining public health
	BIO-V.E-10	Environmental Biotechnology	CO1:Explain the scope of Environmental Biotechnology CO2: Understand the basic ecological concepts, various pollutions and its measurements CO3: Describe the various eco-friendly bio-products CO4: Assess the quality of the water sample by MPN test, dissolved oxygen concentration, biological oxygen demand, chemical oxygen demand and nitrates of water sample CO5: Understand the working of sewage treatment plant
	BIO-V.E-12	Bioinformatics	CO1: Explain the importance of Human Genome Project CO2: Understand the need and use of biological databases CO3: Distinguish the bioinformatics tools and techniques used for various retrieval of biological information. CO4: Solve interesting and scientific problems. CO5: Retrieval of biological information using bioinformatics tools

B.SC. DEGREE COURSE IN BIOTECHNOLOGY - COURSE STRUCTURE

(To be applicable from the academic year 2018 - 2019)

SEMESTER	CORE		ELECTIVE			
I	**BIO-I.C-1** Biomolecules	**BIO-I.C-2** Cell Biology	--------	--------	--------	--------
II	**BIO-II.C-3** Fundamental Genetics	**BIO-II.C-4** Basic Microbiology	--------	--------	--------	--------
III	**BIO-III.C-5** Molecular Biology		**BIO-III.E-1** Basics of Plant and Animal Sciences	**BIO-III.E-2** Metabolism of Biomolecules	**BIO-III.E-3** Biostatistics	**BIO-III.E-4** Enzymology
IV	**BIO-IV.C-6** Immunology		**BIO-IV.E-5** Plant and Animal Physiology	**BIO-IV.E-6** Tools & Techniques in Biotechnology	**BIO-IV.E-7** Evolution and Anthropology	**BIO-IV.E-8** Molecular genetics
V	**BIO-V.C-7** Concepts in Genetic Engineering		**BIO-V.E-9** Molecular medicine	**BIO-V.E-10** Environmental Biotechnology	**BIO-V.E-11** Plant Biotechnology	**BIO-V.E-12** Bioinformatics
VI	**BIO-VI.C-8** Industrial Biotechnology		**BIO-VI.E-13** Bioethics and Bio-safety	**BIO-VI.E-14** Advanced Cell Biology	**BIO-VI.E-15** Food Biotechnology	**BIO-VI.E-16** Animal Cell Culture

Generic Elective Course

Mushroom Cultivation and Vermicomposting technology

SEMESTER I

CORE COURSE: BIOMOLECULES	
COURSE CODE:	**BIO-I.C-1**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: CO1: Explain the various molecular interactions, structure and importance of biomolecules in a living system. CO2: Describe the concepts of enzyme kinetics in a living system CO3: Understand and practice general laboratory safety measures CO4: Prepare different solutions such as buffers, reagents and stock solutions for experiments independently. CO5: Estimate various biomolecules using lab instruments such as weighing balance, water bath, centrifuge, pH meter, spectrophotometer etc.

BIO-I.C-1: BIOMOLECULES (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: The foundations of Biochemistry, Carbohydrates and Proteins	**1.1 : The foundations of Biochemistry** Landmarks in the history of Biochemistry (contributions particularly by Louis Pasteur, Carl Neuberg, Wilhelm Kuhne, Eduard Buchner); Urey-Miller's experiment. **1.2 : Carbohydrates** Monosaccharides: Structure of aldoses and ketoses, ring structure of sugars; Stereochemistry: mutarotation, anomers, epimers and enantiomers; formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides. **1.3 : Proteins** Amino acids**:** Structure and nomenclature, General properties, Zwitter ions, derivatives of amino acids and their biological role; Proteins**:** Peptide bond formation, structural Levels of protein; Polypeptides: Structure and function of Collagen, Elastin, Myoglobin and Haemoglobin; binding of oxygen to Myoglobin and Haemoglobin; Protein folding and misfolding; denaturation of Proteins.	**02** **06** **07**	**15**
MODULE 2: Lipids and Nucleic Acids	**2.1 : Lipids** Fatty acids (saturated & unsaturated); Simple Lipids: Fats, oils, waxes; Compound Lipids: Phospholipids & Glycolipids; Derived Lipids: Steroids. **2.2 : Nucleic acids** DNA structures and their importance, different types of RNA, unusual DNA structures, other functions of nucleotides: source of energy, component of coenzymes, second messengers.	**07** **08**	**15**

MODULE 3: Water and Molecular Interactions, Vitamins, Hormones and Enzymology	**3.1 : Water and Molecular interactions** Structure and unique properties; Covalent bonds, Hydrogen bonds, Ionic bonds, Hydrophobic bonds and Vander waal's interactions. **3.2 : Vitamins** Structure and active forms of water soluble and fat soluble vitamins; deficiency diseases and hypervitaminosis **3.3 : Hormones** Classification and functions **3.4 : Enzymology** Classification of enzymes; Mechanism of enzyme action, Lock & key theory & Induced fit theory; Factors affecting enzymes activity (pH, temperature enzyme concentration, substrate concentration); MM equation, Lineweaver-Burk plot; Enzyme Inhibition and its types; Ribozymes & Isoenzymes.	**03** **05** **02** **05**	**15**

BIO-I.C-1: BIOMOLECULES (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Introduction to safety measures in laboratories	01
2.	Preparation of buffers &solutions (normal, molar, ppm , %)	01
3.	Qualitative tests for carbohydrates, lipids, proteins and nucleic acids	04
4.	Principle and working of a colorimeter and spectrophotometer	01
5.	Determination of λmax and Molar extinction coefficient of a given compound	01
6.	Estimation of reducing sugar - DNSA method	01
7.	Estimation of protein – Folin Lowry's method	01
8.	Titration curve of any one amino acid	01
9.	Determination of peroxide value of oil	01
10.	Effect of pH and temperature on amylase activity	02

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Murray, R.K, Granner, D.K, Mayes, P.A. & Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Sadasivam, S. And Manickam, A. (1996), Biochemical Methods, New Age International (P) Limited
- Jayaraman, J. (1971), Laboratory Manual in Biochemistry, John Wiley & Sons, Limited.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

CORE COURSE: CELL BIOLOGY	
COURSE CODE:	**BIO-I.C-2**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: CO1: Correlate the function of each cell organelle with proper coordination. CO2: Demonstrate an understanding of cell communication. CO3: Prepare various plant and animal specimen for observation of cell structures CO4: Identify and analyze different biological cells using a compound microscope. CO5: Identify different stages of cell division

BIO-I.C-2: CELL BIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: Introduction to Cell Biology, Cell Wall and Plasma Membrane	**1.1 : Introduction to cell biology** Cell theory; ultra-structure of prokaryotic and eukaryotic cell; cell matrix proteins; components of extracellular matrix. **1.2 : Cell wall & Plasma membrane** Chemical composition; structure and functions of the cell wall and plasma membrane; monolayer; planer bilayer and liposomes as model membrane systems; Fluid mosaic mode; lipid rafts; membrane fluidity; factors affecting membrane fluidity; techniques used to study membrane dynamics – FRAP	**06** **09**	**15**
MODULE 2: Ultrastructure and Function of Organelles	**2.1 : Ultra-structure and function of organelles** Cilia and Flagella; Endoplasmic reticulum; Golgi apparatus; lysosomes; Microbodies; Mitochondria; Ribosomes; Centrioles and basal bodies; Nucleus; Chloroplasts and Peroxisomes.	**15**	**15**
MODULE 3: Cell Cycle and Cell-cell Interactions	**3.1 : Cell Cycle** Overview of the cell cycle; prokaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis. **3.2 : Cell-Cell interaction** Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; interactions of cells with other cells: selectins, the immunoglobulin superfamily, cadherins, adheren junctions and desmosomes; tight junctions, gap junctions and plasmodesmata.	**05** **10**	**15**

BIO-I.C-2: CELL BIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Examination of prokaryotic cell, eukaryotic cell and cell organelles using Photomicrographs	01
2.	Visualization of animal and plant cell using methylene blue	01
3.	Study of cell viability using phenol red / trypan blue	01
4.	Visualization of Permanent slides of: A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell B. Different stages of cell division	02
5.	Identification of different stages of mitosis in onion root tip	01
6.	Identification of different stages of meiosis in onion flower buds	01
7.	Isolation of chloroplast from spinach leaves	02
8.	Prokaryotic cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods	03

REFERENCES

- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- Robertis, E.D.P. &Robertis, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5thedition. ASM Press & Sunderland, Washington, D.C.
- Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution and ecology. 14 thed

SEMESTER II

CORE COURSE: FUNDAMENTAL GENETICS	
COURSE CODE:	**BIO-II.C-3**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Outline the basic principles of Mendelian genetics and compare and analyze different inheritance patterns as well as solve problems based on genetic principles. **CO2:** Compare and contrast different mutations, their effects on cells and the application of the same to research. **CO3:** Differentiate between the structure and working of a compound and dissection microscope. **CO4**: Construct and interpret a karyotype prepared from a spread of metaphase chromosomes.

BIO-II.C-3: FUNDAMENTAL GENETICS (THEORY)

MODULE	TOPIC	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: Introduction to Genetics, Mendelian Genetics and Chromosomes	**1.1 : Introduction to Genetics** Scope and importance of Genetics; terminology. **1.2 : Mendelian Genetics** Mendel's experiments; principle of segregation; monohybrid crosses (dominance, recessiveness, co-dominance, incomplete dominance); principle of independent assortment; multiple alleles – ABO blood type and Rh factor alleles in humans; genotypic interaction – epistasis, pleiotropy and extra-nuclear inheritance. **1.3 : Chromosomes** Chromosome number; morphology; chromosome material and chemical composition; giant chromosomes.	**02** **09** **04**	**15**

MODULE 2: Concepts in Breeding, Cell Division, Linkage and Crossing Over, Population Genetics	**2.1 : Introduction to the concepts of:** Inbreeding, heterosis, hybrid vigour. **2.2 : Cell Cycle and cell division** Cell cycle - The G1, S and G2 phase; Mitosis and Meiosis, Cell cycle checkpoints. **2.3 : Linkage and Crossing Over** Concept of linkage and crossing over, Sutton-Boveri Chromosome theory of inheritance; coupling and repulsion hypothesis; types of linkage (complete and incomplete); types of crossing over; mechanism of meiotic crossing over & significance. **2.4 : Population Genetics** Gene pool; theory of allele frequencies (gene and genotypic frequencies); the Hardy-Weinberg principle and its application; exceptions to the Hardy-Weinberg principle -natural selection; random genetic drift; problems on Hardy-Weinberg principle; speciation-definition of species and mode of speciation (allopatric, sympatric).	**02** **04** **04** **05**	**15**
MODULE 3: Sex Determination, Chromosomal Mutations and Human Genetics	**3.1 : Sex Determination, Sex Linkage and Pedigree Analysis** Sex determination (pattern and sex chromosomes); sex determination in human beings and flowering plants; dosage compensation; sex-linked inheritance – Haemophilia, Duchenne Muscular Dystrophy, Fragile X Syndrome, Colour blindness; pedigree Analysis – penetrance and expressivity; family tree; dominant inheritance; recessive inheritance. **3.2 : Structural and Numerical Chromosomal Mutations** Types of structural changes (deletion, duplication, inversion, translocation, variation in chromosome morphology); types of numerical changes (euploidy and aneuploidy). **3.3 : Human Genetics** Gene action and related diseases (Alkaptonuria,	**08** **04** **03**	**15**

	Phenylketonuria, Sickle Cell Anaemia); autosomal and sex chromosomal anomalies involving numerical and structural aberrations. (Down's, Cri-du-chat, Klinefelter's and Turner's syndromes).		

BIO-II.C-3: FUNDAMENTAL GENETICS (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Study of a dissection microscope.	01
2.	Study of Barr bodies in sex determination.	01
3.	Study of Polytene chromosomes.	02
4.	Study of Mendelian traits in human population	02
5.	Problem solving on Mendel's Laws & Hardy-Weinberg's Law	02
6.	Karyotype analysis of chromosomal abnormalities.	02
7.	Pedigree analysis and problem solving.	02

REFERENCES

- Gardner, E. J., Simmons, M. J. &Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.
- Hotter, P. (2007. Dictionary of Genetics, IVY Publishing House, Delhi
- Jayaraman, K. &Jayaraman, R. (1979). Laboratory manual in Molecular Genetics, John Wiley and Sons.
- Tamarin, R.H. (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.
- Verma, P.S. &Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

CORE COURSE: BASIC MICROBIOLOGY	
COURSE CODE:	**BIO-II.C-4**
MARKS:	**100** (75 – Theory, 25 – Practical)
CREDITS:	**04** (03 – Theory, 01 – Practical)
CONTACT HOURS:	**Theory:** 45 Hours (3 Lectures per week) **Practical:** 30 Hours (1 Practical per week)
COURSE OUTCOMES:	On the successful completion of the course, the students will be able to: **CO1:** Understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of the microbial cultures. **CO2:** Discriminate between various groups of microorganisms and also comprehend thei beneficial and harmful effects. **CO3:** Compare, analyze and apply concepts of the principle and working of various types of microscopes. **CO4:** Adhere to strict laboratory safety measures to be followed in a microbiology laboratory. **CO5:** Master skills in aseptic techniques as well comprehend the importance of cleaning and decontamination.

BIO-II.C-4: BASIC MICROBIOLOGY (THEORY)

MODULE	TOPICS	CONTACT HOURS	TOTAL CONTACT HOURS
MODULE 1: Scope & historical perspective, basics of microscopy, taxonomy and reproduction in bacteria	**1.1 : History and Scope of Microbiology** Historical account from 16^{th} – 19^{th} century	**02**	**15**
	.**1.2 : Basics of Microscopy** Principle of working of light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence).	**03**	
	1.3 : Bacterial Taxonomy Introduction to Archaea; taxonomic ranks; classification systems (Phenetic, Numerical, Phylogenetic); Bergey's Manual of Systematic/ Determinative Bacteriology and rDNA sequencing.	**08**	
	1.4 : Reproduction in bacteria – 1 Binary fission; definitions: cell growth, growth rate,	**02**	

	generation time		
MODULE 2: Methods of cultivating and preserving bacteria and an introduction to extremophiles	**2.1 : Cultivation of microorganisms** Sterilisation; disinfection; decontamination: principle and methods; types of culture media: synthetic/defined, complex solid, liquid, enrichment, selective, differential; cultivation of microorganisms: broth culture, agar plate, pour plate; determination of viable count: serial dilution; spread plating; determination of colony forming units (cfu) and calculation of viable count; isolation of pure cultures: streak plate; colony morphology. **2.2 : Maintenance and preservation of microbial cultures** Slant and stab cultures; periodic transfer; storage in sterile soil; overlaying with mineral oil; glycerol stocks; preservation in liquid nitrogen; lyophilisation. **2.3 : Bacteria in Extreme Environments** Thermophiles, barophiles, halophiles, acidophiles and alkaliphiles.	**08** **04** **03**	**15**
MODULE 3: Ultrastructure of a bacterial cell, growth curve – types, characteristics and an introduction to viruses	**3.1 : Organization and Ultrastructure of a Bacterial cell** Cell wall: structure and chemical composition in Gram positive and Gram negative bacteria; introduction to cell membrane, pili, fimbriae and capsule; flagella structure and function; nucleoid and plasmids: nature and function; endospore: structure, sporulation and germination; reserve materials. **3.2 : Reproduction in bacteria – 2** Bacterial growth curve; characteristics of growth phases; diauxic growth curve, continuous and synchronous growth **3.3 : Viruses** Basic classification and structure of viruses (prokaryotic and eukaryotic); characteristic features of λphage; viral replication (lytic and lysogenic).	**08** **02** **05**	**15**

BIO-II.C-4: BASIC MICROBIOLOGY (PRACTICAL)

SR. NO.	PRACTICAL	NO. OF PRACTICALS
1.	Introduction to laminar air flow unit, autoclave, pH meter, incubator, microwave & Introduction to microscope	01
2.	Preparation and sterilization of glassware	01
3.	Preparation of media and autoclaving	02
4.	Preparation of agar plates and open air cultures	01
5.	Serial dilution technique and spread plating	02
6.	Bacterial isolation techniques: streaking methods - simple continuous, T-streak, quadrant, radiant.	01
7.	Preparation and staining of specimen- simple staining, Gram staining, endospore staining	03
8.	Biochemical tests for bacterial identification: sugar fermentation and IMViC tests	02
9.	Isolation and staining of Fungi by lactophenol cotton blue	01
10.	Cleaning and decontamination	01

REFERENCES

- Anantnaryan, R. &Paniker, C.K.J. (2005). Text book of Microbiology, 7th edition, Orient Blackswan.
- Aneja, K. R. (2007). Experiments in Microbiology, Plant Pathology and Plant Tissue Culture, New Age International.
- Gunasekaran, P. (1995). Laboratory Manual in Microbiology, New Age International.
- Madigan, M. T., Martinko. J. M. & Parker J. (2007). Brock's Biology of Microorganisms, Pearson Prentice Hall.
- Pelczar, M.J., Chan E, C.S. & Krieg, N.R. (1993). Microbiology, Fong and Sons Printers Pvt. Ltd.
- Stanier, R.Y. (1993) General Microbiology, Cambridge University.
- Willey, J. M., Sherwood, L., Woolverton, C. J. & Prescott, L. M. (2008). Prescott, Harley, and Klein's Microbiology, New York, McGraw-Hill Higher Education.

BIO-III.C-5: MOLECULAR BIOLOGY

COURSE TITLE: MOLECULAR BIOLOGY (THEORY)

COURSE CODE: BIO-III.C-5

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

COURSE OBJECTIVE: This paper provides insight on replication, transcription and translation process in prokaryotes and eukaryotes, various mutations and their repair mechanisms.

LEARNING OUTCOME: On completion of this module, students will be able to understand the nature of genetic materials and the basic concepts in Molecular Biology.

BIO-III.C-5: MOLECULAR BIOLOGY (THEORY)

Unit 1: Basic Concepts in Molecular Biology 8 hrs

Experiments proving DNA as genetic material: S. F. Griffith's transforming principle; Avery and Hershey and Chase Experiment; evidences for RNA as the genetic material of some viruses; Chargaff's experiments and law; Watson – Crick Model.

Unit 2: DNA Replication 8 hrs

Experimental evidence for semi-conservative DNA replication in *E.coli*- Meselson and Stahl's experiment; the basic requirements of DNA replication: template, DNA polymerases: structure and function, ancillary proteins associated with replication; mechanism of replication in prokaryotes: initiation, elongation and termination; mechanism of DNA replication in eukaryotes; replication of circular DNA (rolling circle model).

Unit 3: Transcription 8 hrs

Mechanism of prokaryotic transcription- transcription factors and machinery;formation of initiation complex; RNA polymerase enzyme; initiation; elongation and termination;transcription in eukaryotes- eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription;RNA processing: capping, splicing, polyadenylation.

Unit 4: Protein Synthesis **9 hrs**

Central dogmaand genetic code;mechanism of protein synthesis in prokaryotes - initiation, elongation and termination;mechanism of protein synthesis in eukaryotes- activation of amino acids, initiation, elongation and termination; post-translational modifications- phosphorylation, acylation, glycosylation & disulphide linkage.

Unit 5: DNA Damage and its Repair **6 hrs**

Mutations and types of mutations: spontaneous and induced mutation, missense, silent, frameshift, reversion; physical and chemical mutagens (ethidium bromide, alkylating agents, baseanalogs); DNA Repair Mechanisms: Mismatch, photo-reactivation repair, Excision repair.

Unit 6: Regulation of Gene Expression **3 hrs**

Lactose operon; Tryptophan operon

Unit7: Mechanism of Gene transfer **3 hrs**

Conjugation; transformation; transduction

BIO-III.C-5: MOLECULAR BIOLOGY (PRACTICAL)

COURSE TITLE: MOLECULAR BIOLOGY (PRACTICAL)

COURSE CODE: BIO-III.C-5

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Isolation of genomic DNA from prokaryotes

Isolation of genomic DNA from eukaryotes

Isolation of genomic RNA

Agarose gel electrophoresis

Determination of molecular size of DNA by agarose gel electrophoresis

Mutagenesis in *E.coli* cells – UV survival or chemical mutagens

Purity of DNA by spectrophotometric method

REFERENCES

- Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.

- Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.
- Verma, P.S. &AgarwaL, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)

COURSE CODE: BIO-III.E-1

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

COURSE OBJECTIVE: This paper will provide students with an insight into the Plant and Animal Kingdoms and their classification into different phyla. They will understand the variety of habitats that support the growth and reproduction of different plants and animals and will also look into the general characteristics and adaptations exhibited by these organisms.

LEARNING OUTCOME: On completion of this module, students will be able to distinguish between various phyla of the plant and animal kingdom and will also delve into the characteristics of these phyla. They will understand the differences in morphology and anatomy in Angiosperms and specific features present in non-chordates and chordates.

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)

Unit 1: Introduction **2 hrs**

Introduction to the plant and animal kingdom; introduction to classification systems

Unit 2: Plant Kingdom **8 hrs**

Study of the general characteristics of Algae, Fungi, Lichens, Bryophytes, Pteridophytes, Gymnosperms

Unit 3: Morphology and Anatomy in Angiosperms **10 hrs**

Vegetative morphology of roots; stem and leafreproductive morphology of flower; inflorescence, fruits; comparative anatomy of roots, stem and leaves in monocots and dicots; secondary growth in angiosperms

Unit 4: Animal Kingdom - Non chordates **7 hrs**

Study of habitat and general characteristics of Protozoa, Porifera, Cnidaria, Platyhelminthes Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata

Unit 5: Animal Kingdom–Chordates **4 hrs**

Study of habitat and general characteristics of: superclass Pisces; class Amphibia; class Reptilia; class Aves; class Mammalia

Unit 6: Salient features of non-chordates **8 hrs**

Study of salient features of non-chordates: disease-causing Protozoa, Platyhelminthes and nematodes (Aschelminthes); circulation in Porifera -water vascular system in Echinodermata; Excretion in Aschelminthes and Annelida; torsion in Gastropoda (Mollusca); metamorphosis in insects and economic importance (Arthropoda); corals and coral reefs (Cnidaria)

Unit 7: Salient features of Chordates **6 hrs**

Study of salient features of chordates: economic importance of fishes; parental care in amphibians; venomous and non-venomous reptiles; migration in birds; dentition in mammals

BIO-III.E-1: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)
COURSE CODE: BIO-III.E-1
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Study of algal types through temporary mounting: (*Chlorella* and *Anabaena*)

Microscopy study of thallus structures in Riccia and Cycas

Preparation of mycorrhizal slides by trypan blue method

T.S of monocot and dicot root

T.S of monocot and dicot stem

T.S of monocot and dicot leaf

Observation of permanent slides: Anther, ovules, embryo sac, embryo

Study of specimens with reference to habit, habitat, characteristic features: two examples from each Invertebrate major phyla

REFERENCES

- Barnes, R.D. (2000). Invertebrate Zoology, Hall Saunders International Editions.
- Jordan, E.L. &Verma, P.S. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
- Jordan, E.L. &Verma, P.S. (2006). Chordate Zoology, New Edition, S. Chand & Co. Pvt. Ltd. New Delhi.
- Pandey, S.N. &Chadha, A. (1993). A Textbook of Botany, Plant Anatomy and Economic Botany, Volume III, Vikas Publishing House Pvt. Ltd.
- VERMA, V. (2010). Botany, Ane Books, Pvt. Ltd.

BIO-III.E-2: METABOLISM OF BIOMOLECULES

COURSETITLE: METABOLISM OF BIOMOLECULES (THEORY)
COURSE CODE: BIO-III.E-2
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-I.C-1- Biomolecules

COURSE OBJECTIVE: The aim of this paper is to understand simple concepts related to metabolism, its importance in the proper functioning of each cell and its regulation by enzymes.

LEARNING OUTCOME: On completion of this course, students will be able to understand the metabolism of biomolecules of life and comprehend how any defect in a pathway could lead to diseases. They will be equipped with the knowledge, skills and understanding of clinical aspects of biochemistry.

BIO-III.E-2: METABOLISM OF BIOMOLECULES (THEORY)

Unit 1: Basic concepts and design of metabolism **2 hrs**

Definition of metabolism; catabolism; anabolism; ATP as energy currency; energy relationship between catabolic and anabolic pathways

Unit 2: Carbohydrate metabolism **8 hrs**

Glycolysis; gluconeogenesis; pentose-phosphate pathway; glycogen synthesis and breakdown and its regulation;tri-carboxylic acid cycle;glyoxylate pathway

Unit 3: Oxidative phosphorylation **5 hrs**

The respiratory chain in mitochondria; proton gradient powering ATP synthesis; Transfer of cytosolic reducing equivalents to mitochondria: glycerol-3- phosphate and malate-aspartate shuttle

Unit 4: Fatty acid synthesis and degradation **8 hrs**

Digestion; mobilisation and transport of cholesterol and triacylglycerols;oxidation of fatty acids; ketone bodies; biosynthesis of fatty acids - elongation and unsaturation of fatty acids.

Unit 5: Amino acid catabolism and anabolism **4 hrs**

Overview of biosynthesis and catabolism of amino acids; Urea cycle

Unit 6: Nucleotide metabolism **4 hrs**

Biosynthesis - *de novo* and salvage pathways; degradation.

Unit 7: Integration of Metabolism **8 hrs**

The Feed-Fast Cycle: overview; enzymatic changes; activity in the liver; adipose tissue; resting skeletal muscle and brain during absorptive state;overview; activity in liver, adipose tissue, resting skeletal muscle, brain and kidney during fasting.

Unit 8: Metabolic Disorders **6 hrs**

Clinical characteristics; diagnosis and management of: Ehler'sDanlos syndrome (Classic type), Lesch-Nyhan syndrome, Alzheimer's disease; Xerodermapigmentosum; Crutzfeldt-Jakob disease; Gout

BIO-III.E-2: METABOLISMOFBIOMOLECULES (PRACTICAL)

COURSE TITLE: METABOLISMOFBIOMOLECULES (PRACTICAL)

COURSE CODE: BIO-III.E-2

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Estimation of protein – Biuret method

Estimation of DNA by Diphenylamine method

Estimation of Urea (serum/urine)

Estimation of Uric acid (serum/urine)

Estimation of blood glucose

Isolation of lecithin from egg yolk

Isolation of cholesterol from egg yolk

Separation of fatty acids by TLC

Estimation of blood cholesterol

Case studies: Clinical Characteristics, Diagnosis and Management of:

Alzheimer's Disease and Xerodermapigmentosum ,Ehler'sDanlos syndrome, Crutzfeldt-Jakob disease

REFERENCES

- Jain, J.L (1999). Fundamentals of Biochemistry, S.Chand and Company, Ltd., New Delhi.
- Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
- Stryer, L. (1995). Biochemistry, W.H. Freeman and Co., New York, USA.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins
- Plummer, D.T. (2008). An Introduction to Practical Biochemistry, Third Edition, Tata McGraw-Hill.
- NCBI GeneReviews (1993 – 2015), University of Washington, Seattle

BIO-III.E-3: BIOSTATISTICS

COURSE TITLE: BIOSTATISTICS (THEORY)
COURSE CODE: BIO-III.E-3
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the concept of Biostatistics. This paper covers a range of topics which will introduce the theory behind each topic and the concept in each case through problem solving.

LEARNING OUTCOME: On completion of this module, students will be able to understand the importance of Biostatistics and the application of the same to the field of Biotechnology. They paper is so designed so as to understand the concepts that can be applied to relevant research work and to evaluate different parameters that are studied in quantitative research.

BIO-III.E-3: BIOSTATISTICS (THEORY)

Unit 1: Scope & importance of Biostatistics **2 hrs**

Definition; importance and applications of Biostatistics

Unit 2: Introduction to Sampling **3 hrs**

Concepts of: statistical population, sample; advantages and disadvantages of sampling; types of data; collection of data: primary & secondary data; types of sampling – simple; random sampling; stratified random sampling; systematic sampling; cluster sampling.

Unit 3: Graphical & Diagrammatic representation of data **3 hrs**

Tabulation of data; graphical and diagrammatic representation of data; construction of graphs using MS Excel

Unit 4: Measures of central tendency **8 hrs**

Characteristics of ideal measure; arithmetic mean – simple, weighted, combined, and corrected mean; limitations of arithmetic mean; median – calculation for raw data, for grouped data, for continuous series, limitations of median; mode –computation of mode for

individual series, by grouping method in a continuous frequency distribution, limitations of modes; relationship between mean, median and mode; geometric mean; harmonic mean; quartiles; deciles; percentiles

Unit 5: Measure of dispersion **8 hrs**

Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation; Skewness – definition; positive; negative; Karl pearson's coefficient, Bowley's Coefficient

Unit 6: Correlation & regression analysis **12 hrs**

Correlation; covariance; correlation coefficient for ungrouped data; Spearson's rank correlation coefficient; scatter and dot diagram (graphical method); regression; examples from biological sciences

Unit 8: Hypothesis testing **10 hrs**

Parameter and statistics; sampling theory;sampling and non-sampling error; confidence limits testing of hypothesis; test of significance; students' T-test; paired t-test;F test; Chi-square test and ANOVA

BIO-III.E-3: BIOSTATISTICS (PRACTICAL)

COURSE TITLE: BIOSTATISTICS (PRACTICAL)

COURSE CODE: BIO-III.E-3

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Problem solving on arithmetic mean, median, mode (measures of central tendency) with reference to biological data

Problem solving on measures of central tendency with reference to biological data using MS Excel

Problem solving on measures of dispersion with reference to biological data

Graphical presentation of data – Construction of various types of graphs and charts based on the given data (Manually and using MS Excel)

Problem solving on ANOVA and Chi square test

REFERENCES

- Banerjee, P.K. (2011). Introduction to Biostatistics, A textbook of biometry, New Delhi, India: S. Chand & Company Ltd.
- Khan &Khanum (2004). Fundamentals of Biostatistics, Delhi: Ukaaz publications.
- Rajan, K. (2007). Biostatistics Theory and Problems, New Delhi: India, Himalaya Publishing House.
- Rastogi, V.B. (2011). Fundamentals of Statistics, Ane Books Pvt. Ltd.
- Ross, S. M. (2010). Introductory Statistics. Third edition, Academic press.

BIO-III.E-4: ENZYMOLOGY

COURSE TITLE: ENZYMOLOGY (THEORY)
COURSE CODE: BIO-III.E-4
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: The objective of the course is to provide a basic concept of the enzyme structure, function, kinetics, inhibition and their applications of in diagnostics.

LEARNING OUTCOME: The student will be able to describe structure, functions and the mechanisms of action of enzymes. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.

BIO-III.E-4: ENZYMOLOGY (THEORY)

Unit 1: Introduction to enzymes **6 hrs**

Nature of enzymes - protein and non-protein (ribozyme); co-enzymes, cofactor & prosthetic group; apoenzyme;holoenzyme;ribozymes &isoenzymes;specificity of enzymes; classification of enzymes

Unit 2: Features of enzyme catalysis **6 hrs**

Fischer's lock and key hypothesis; Koshland's induced fit hypothesis; factors affecting the rate of reactions (time, enzyme concentration, substrate concentration, pH, temperature)

Unit 3: Enzyme kinetics **10 hrs**

Principles of reaction rates; order of reactions and equilibrium constants; derivation of Michaelis-Menten equation and Lineweaver- Burk plot; significance of Km and Vmax, Kcat and turnover number

Unit 4: Enzyme inhibition **10 hrs**

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and suicide, end product); mechanism based inhibitors - antibiotics as inhibitors; types of irreversible inhibition; allosteric inhibition

Unit 5: Mechanisms of enzyme action and regulation **6 hrs**

Mechanism of action of chymotrypsin; regulation of enzyme activity and its importance - aspartate transcarbamoylase

Unit 6: Applications of enzymes **7 hrs**

Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); enzyme immunoassay (HRPO); applications of enzymes in industry – detergents, leather, food

BIO-III.E-4: ENZYMOLOGY (PRACTICAL)

COURSE TITLE: ENZYMOLOGY (PRACTICAL)

COURSE CODE: BIO-III.E-4

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Partial purification of any one enzyme from suitable source- ammonium sulphate precipitation, dialysis

Assay of enzyme activity and specific activity

Effect of pH on enzyme activity

Effect of temperature on enzyme activity

Effect of substrate concentration and determination of Km and V_{max}

SDS-PAGE

REFERENCES

- Nelson, D. L. & Cox, M.M. (2000), Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.

- Jain, J.L (1999), Fundamentals of Biochemistry, S.Chand and Company Ltd., New Delhi.
- Murray, R.K, Granner, D.K, Mayes, P.A. &Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

BIO-IV.C-6: IMMUNOLOGY

COURSE TITLE: IMMUNOLOGY (THEORY)
COURSE CODE: BIO-IV.C-6
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the basic concepts of the immune system and its defense mechanisms. This will help them understand and reason out concepts related to diseases. A section on vaccination, monoclonal and polyclonal antibodies stresses on the importance of these for treatment of lethal diseases.

LEARNING OUTCOME: On completion of this module, the student will be able to understand all about the immune system and various antigen-antibody interactions involved in certain immune reactions.

BIO-IV.C-6: IMMUNOLOGY (THEORY)

Unit 1: Immune system **8 hrs**

Introduction to the immune system - historical perspective; types of immunity (innate and acquired); barriers of innate immunity – anatomic, physiologic, phagocytic, inflammatory; collaboration between innate and adaptive immunity; introduction to humoral and cell mediated immunity

Unit 2: Cells and organs of the immune system **8hrs**

Cells (myeloid and lymphoid lineage); immunoreactive cells (macrophages, granulocytes, NK Cells); primary lymphoid organs (bone marrow and thymus); secondary lymphoid organs; (spleen, lymph nodes, GALT and MALT).

Unit 3: B cells and T cells **5hrs**

B-cells & T-cells – structure; function and significance; maturation, activation of B-cells and T-cells

Unit 4: Antigen-antibody interactions **8 hrs**

Introduction to antigens and antibodies; structure, types, classes, properties and variants (e.g. immunogens, antigens, haptens, adjuvants); paratope and epitope; antigen – antibody interaction; forces involved in antigen-antibody reaction; concept of affinity, avidity, precipitation, agglutination reactions; applications in diagnostics

Unit 5: MHC and Hypersensitivity **4 hrs**

Major histocompatibility complex (MHC); introduction and discovery of human histocompatibility complex; structure of MHC I and II; presence of MHC I and II on different cells and their significance; hypersensitivity - Introduction

Unit 6: Complement system **4 hrs**

The complement system; functions, components and activation pathways (classical, alternate &lectin)

Unit 7: Vaccines & monoclonal antibodies **4 hrs**

Introduction to vaccines and types of vaccines; Polyclonal & Monoclonal antibodies (hybridoma technology)

Unit 8: Autoimmunity and immunodeficiency **4hrs**

Introduction to autoimmunity with examples; introduction to immunodeficiency types with examples

BIO-IV.C-6: IMMUNOLOGY (PRACTICAL)

COURSE TITLE: IMMUNOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.C-6

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Study of lymphoid organs and cells of the Immune System

Total count of WBC & RBCs using haemocytometer

Differential count of WBC

Blood grouping & Rh factor

Preparation of serum

Single Radial Immunodiffusion

Ouchterolony's double diffusion method

Immunoelectrophoresis

ELISA (Demonstration)

Serological tests involving precipitations (Pregnancy &Widal)

Estimation of Haemoglobin by Sahali's method

REFERENCES

- Arora, M.P. (2006). Cell Biology, Immunology and Environmental Biology, Himalaya Publishing House.
- Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Kuby, J (2000).Immunology, W.H. Freeman & Company, New York.
- Rao, C.V. (2011). Immunology, Narosa Book Distributors Pvt. Ltd.
- Roitt, I.M., Brostoff, J. & Male, D.K. (1993). Immunology, Mosby-Year book Europe Limited.

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY

PAPER TITLE: PLANT AND ANIMAL PHYSIOLOGY (THEORY)

PAPER CODE: BIO-IV.E-5

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-III.E-1- Basics of Plant and Animal Sciences

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the physiology of plant and animal systems with special emphasis on humans, thereby allowing them to understand how plant and animal systems function.

LEARNING OUTCOME: On completion of this module, students will be able to understand plant and animal physiology. The organs and processes involved in each case.

They will also be able to comprehend and distinguish organs and organs systems while understanding the biological functions associated with every system.

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY (THEORY)

PLANT PHYSIOLOGY

Unit 1: Plant – Water Relations **2 hrs**

Absorption (passive and active); ascent of sap and transpiration

Unit 2: Photosynthesis & photorespiration **8 hrs**

Chloroplast pigments; photosystem I and II; electron flow through cyclic and non-cyclic; photophosphorylation; CO_2 fixation in C3 and C4 plants; CAM and glycolate pathways

Unit 3: Physiology of flowering in angiosperms **3 hrs**

Photoperiodism; vernalization and dormancy; molecular models of flowering: ABC model

Unit 4: Plant hormones and regulation of plant growth **4 hrs**

Hormonal; (auxin,cytokinin, gibberllins, ethylene and abscissic acid); regulation of plant growth and development

Unit 5: Secondary metabolites in plant **4 hrs**

Classification of secondary metabolites and sources of: phenolics, porphyrins ,terpenoids , alkaloids

ANIMAL PHYSIOLOGY

Unit 6: Digestive system **3 hrs**

The digestive system and associated glands in mammals

Unit 7: Muscular system **2 hrs**

Introduction to the muscular system; types of muscles, muscle movement

Unit 8: Respiration and circulation **5 hrs**

The respiratory system – organs and their function; the circulatory system – components and their function

Unit 9: Excretory system **3 hrs**

The excretory system and associated functions

Unit 10: Nervous system **5 hrs**

The nervous system and associated functions

Unit 11: Gametogenesis and reproductive physiology **6 hrs**

Spermatogenesis and oogenesis; mammalian reproductive physiology – male and female reproductive system; an overview of developmental biology and regulatory mechanisms

BIO-IV.E-5: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)

COURSE TITLE: PLANT AND ANIMAL PHYSIOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.E-5

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Study of physiology of plants using charts

Study of rate of photorespiration in plants

Study of osmosis: endosmosis and exosmosis in plants

Osmolarity of RBC's (Effect of different salt solutions of RBC's)

Isolation of Rhizobium from root nodules and Gram's staining

Qualitative phytochemical analysis in medicinal plants

Analysis of the animal physiology systems in man using charts – the reproductive, digestive, respiratory, circulatory, excretory, nervous and muscular systems.

Observation of permanent slides – Transverse section of mammalian gonads

Developmental stages in Frog (cleavage, blastula, gastrula)

Analysis of components of blood – WBC's and RBC's & observations on each

Analysis of human blood pressure and pulse rate in man

REFERENCES

Plant physiology:

- Galston, A.W. (1989). Life Processes in Plants, Scientific American Library, Springer-Verlag., New York, USA.
- Hopkins, W.G. (1995). Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
- Moore, T.C. (1989). Biochemistry and Physiology of Plant Hormones (Second edition), Springer-Verlag., New York.

- Pandey, S.N., Mishra, S.P. &Trivedi, P.S. (1982), College Botany, Tata McGraw-Hill, New Delhi.

Animal Physiology:

- Arora, M.P. (2011). Animal physiology, Himalaya publishing house.
- Sembulingam, K. &Sembulingam, P. (2012). Essentials of Medical Physiology, Sixth edition., Jaypee brothers medical publishers (P) Ltd, New Delhi
- Verma, S.K., Tyagi, A.K. &Agarwal, B.B.L. (2000). Animal Physiology, S. Chand and Company

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-IV.E-6
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of instruments and their applications in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the various principles and applications of separation & spectroscopic techniques along with the uses of radioactivity which have wide applications in biomedical research.

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)

Unit 1: Basics of biochemical studies **6 hrs**

Units of measurement; weak electrolytes- the biochemical importance of weak electrolytes; ionisation of weak acids and bases; calculation of pH; ionisation of a weak electrolyte; buffer solutions;buffer capacity;buffer action; measurement of pH

Unit 2: Centrifugation **5 hrs**

Principle of centrifugation; centrifugal force and sedimentation rate; preparative and analytical ultracentrifuges; differential and density gradient centrifugation

Unit 3: Chromatography **7 hrs**

Principle and technique of : paperchromatography, TLC, gel filtration chromatography, ion exchange chromatography, affinity chromatography, HPLC, GLC

Unit 4: Spectroscopy **5 hrs**

Principle and technique of UV, fluorescence, infrared, Raman and AAS

Unit 5: Electrophoresis **8 hrs**

Gel electrophoresis- agarose and PAGE (SDS and native); isoelectric focusing and 2D PAGE

Unit 6: Probes and hybridization **8 hrs**

Introduction to hybridization probes; radioactive and non-radioactive probes; FISH; southern; northern; western blotting and hybridization

Unit 7: Radioisotopes techniques **6 hrs**

Radiation – sources; types and applications of isotopes; radioactive decay – alpha, beta, gamma and x-rays; rate of radioactive decay and radioactive units; Geiger Muller counter and scintillation

BIO-IV.E-6: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: BIO-IV.E-6
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Comparison of absorption curves of any two coloured compounds
Isolation of plant chloroplasts by density gradient centrifugation
Preparation of TLC plates & separation of plant pigments
Gel filtration chromatography- Demonstration
Review of HPLC technique
Study of Atomic Absorption Spectroscopy
Dialysis of protein and SDS-PAGE
Southern blotting technique- Demonstration

REFERENCES

- Mahesh, S. (2003) Biotechnology-3 Including Molecular Biology and Biophysics, New Age International Private Limited, Publishers New Delhi.
- Arora, M.P. (2006) Biophysics, Himalaya Publishing House, New Delhi.
- Bajpai, P. K. (2010). Biological Instrumentation and Methodology, Second Revised Edition. S. Chand and Company Limited.
- Upadhyay, Upadhyay& NATH (2010) Biophysical Chemistry Principles and Techniques, Fourth Revised Edition, Himalaya Publishing House, New Delhi.
- Sivasankar, B. (2009). Bioseparations Principles and Techniques, PHI Learning Private Limited, New Delhi.
- Plummer, D.T. (1993). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Jayaraman, J. (2011). Laboratory Manual for Biotechnology, Second Edition. New Age International Private Limited, Publishers New Delhi.
- Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, First Edition, S. Chand and Company Private Limited.

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (THEORY)
COURSE CODE: BIO-IV.E-7
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVE: This paper aims at introducing the importance of the basic concepts of Evolution and anthropology and its importance in the field of biotechnology which will increase the awareness of the principles of human evolution and the biological adaptations that humans have made through time to various biotic and abiotic factors. .

LEARNING OUTCOME: On completion of this paper the students will be able to understand the evolutionary history, describe the historical development of anthropology and be able to characterize how each subfield contributes to the unified discipline,compare past and present cultures, including ecological adaptations with a scientific approach. The students would be able to explain quantitative and qualitative methods in the analysis of

anthropological data and critically evaluate the logic of anthropological research and apply anthropological research to contemporary environmental, social, or health issues worldwide.

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (THEORY)

Unit 1: Evolution of Life **5 hrs**

Organic evolution; evidences; mechanism & theories; chemical evolution; biological evolution; types of Organic evolution

Unit 2: Evolution of Species **5 hrs**

Lamarckism; Darwinism; modern synthetic theory; mutational theory**;** introduction to molecular clock

Unit 3: Evolution above species level **5 hrs**

Adaptive radiations with examples macroevolutions**;** microevolution**;** Simpson's adaptive grid; macroevolution

Unit 4: Speciation **4 hrs**

Nature of Speciation**;** modes of speciation (instantaneous and gradual)**;** types of barriers and isolation

Unit 5: Selection **4 hrs**

Types – selection; natural selection (directional, disruptive, stabilizing) and artificial

Unit 6: Geographical and Geological Time Scale **3 hrs**

An overview of the geographical and geological time scale

Unit 7: Fossils **6 hrs**

Formation; conditions; nature and types of fossils; determination of age of rocks and fossils (carbon dating); evidences of evolution from fossils

Unit 8: Introduction to anthropology **2 hrs**

Definition; areas and applications; relationship of biological anthropology with other sciences

Unit 9: Evolution of Man **6 hrs**

Phylogenetic status; characteristics and geographical distribution of the following: Homo erectus, Neanderthal man, Rhodesian man, Homo sapiens

Unit 10: The role of biotechnology in anthropology **5 hrs**

Phylogenetic trees; mitochondrial DNA; Y chromosome analysis

BIO-IV.E-7: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)

COURSE CODE: BIO-IV.E-7

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Study of the various theories of evolution

Evidences for Evolution - Study of Darwin's theory of evolution with examples

Evidences for Evolution - Study of L.S.B. Leakey's work in establishing human evolutionary development in Africa

Problems based on Selection

Study of genetic evolution across species

Construction of phylogenetic trees

Study of types of fossils

Study of dentition of different types of mammals – (Herbivores, Carnivores and Omnivores)

Visit to museum in Old Goa for anthropological studies

Comparative studies of prehominids and hominids

Comparative studies of haemoglobins

REFERENCES

- Bhasin M.K. &Chahal, S.M.S.(1996), Manual of Human Blood Analysis, Delhi.
- Haviland. (2008). Introduction to Anthropology, Paperback.
- Routlege& Paul, K. (1971), Notes and Queries in Anthropology, London.
- Srivastava, V.K. (2004), Methodology and Fieldwork, Oxford.
- Stanford, C., Allen, J.S. & Anton, S.C. (2009), Exploring Biological Anthropology: The Essentials, Prentice Hall.
- Verma, P.S. and Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Private limited, New Delhi.

BIO-IV.E-8: MOLECULAR GENETICS

COURSE TITLE: MOLECULAR GENETICS (THEORY)

COURSE CODE: BIO-IV.E-8

MARKS: 75

CREDITS: 3

PRE-REQUISITES: Completion of BIO-II.C-3 and BIO-III.C-5

TOTAL HOURS: 45

COURSE OBJECTIVE: Having completed the two prerequisite courses - Fundamental Genetics and Molecular Biology, students will be able to apply their knowledge and skills to this paper. It focuses on various aspects of human genetics and explores the techniques and tools at the molecular level that can be used to identify them.

LEARNING OUTCOME: On completion of this course, students will understand the molecular aspects of genetics including DNA variation and mutations. They will also be able to apply their knowledge of various molecular techniques in order to diagnose specific genetic disorders and to calculate risk factors in genetic counseling for individuals with a family history of these disorders.

BIO-IV.E-8: MOLECULAR GENETICS (THEORY)

Unit 1: Introduction **2 hrs**

Introduction to molecular genetics – organization of a eukaryotic genome (human genome)

Unit 2: Chromosomes and cell division **9 hrs**

Classification and nomenclature of chromosomes; methods of chromosome analysis (chromosome banding techniques – G, R, Q, C and high resolution banding); brief account of cell cycle; mitosis and meiosis; mechanisms of aneuploidy – non-disjunction; non-conjugation; anaphase lag; premature division of centromere; syndromes caused by aneuploidy – prevalence, causes and clinical features of Down's syndrome, Edward's syndrome and Patau syndrome; causes of polyploidy; structural abnormalities – reciprocal and Robertsonian translocations; Brief account of mosaicism and Chimerism

Unit 3: Review of central dogma of molecular biology **1 hr**

Brief review of structure of DNA and replication, transcription and translation processes

Unit 4: DNA Variation **3 hrs**

Variation in DNA: genetic polymorphism; restriction Fragment Length Polymorphism (RFLP); short tandem repeat polymorphism (STR); variable number tandem repeat (VNTR)

Unit 5: Techniques and tools in molecular biology **8 hrs**

Techniques and Tools in Molecular Biology used in Genetic Diagnoses: genetic material studied for diagnoses– DNA, RNA and cDNA;DNA fragmentation and separation by electrophoresis and membrane transfer; selective amplification of a nucleotide sequence using PCR; molecular hybridization techniques and applications:Labeled probes,fluorescence in situ hybridization (FISH),southern blot hybridization, dot blot and reverse dot blot, ARMS and OLA techniques, DNA microarrays

Unit 6: The Diagnosis of Inherited Diseases **6 hrs**

Clinical description; molecular basis and genotype-phenotype correlation of:cystic fibrosis, α-thalassemia and β-thalassemia, duchenne Muscular dystrophy, Huntington's disease

Unit 7: Genetic counseling **7 hrs**

Screening (pre and post natal) for genetic abnormalities; establishing the diagnosis (family history and pedigree chart); calculation, presentation and quantification of risk (Bayesian determination of recurrent risks for genetic disorders within families); placing risks in context and discussion of options; patient support groups; directive and non-directive genetic counseling; special problems in genetic counseling

Unit 8: Gene Therapy **3 hrs**

An overview of gene therapy and its applications in treating genetic disorders e.g. SCID

Unit 9: Forensic genetics **6 hrs**

Brief History; biological evidence – sources, collection, identification, characterization; DNA fingerprinting using PCR-based and non-PCR-based techniques

BIO-IV.E-8: MOLECULAR GENETICS (PRACTICAL)

COURSE TITLE: MOLECULAR GENETICS (PRACTICAL)

COURSE CODE: BIO-IV.E-8

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Extraction of DNA from human blood and saliva

Visualization of extracted DNA on agarose gels

Principle of Southern blot

Study of diagnostic tools based on DNA polymorphisms

Principle of preparation of human metaphase chromosomes

Steps in molecular diagnosis of and further genetic counseling for:

1) Cystic fibrosis

2) α-thalassemia and β-thalassemia

3) Duchene muscular dystrophy

4) Huntington's disease

Risk calculation: using Bayes method for any two clinical case studies

Clinical features of Down's syndrome, Edward's syndrome and Patau syndrome and mechanisms leading to aneuploidy

Research: Current status of gene therapy for any two genetic disorders

REFERENCES

- Goodwin, W., Linacre, A. &Hadi, S. (2007). An Introduction to Forensic Genetics, John Wiley & Sons, Ltd.
- Pasternak, J.J. (2005). An Introduction to Human Molecular Genetics, Mechanisms of Inherited Diseases, Second Edition, John Wiley % Sons, Inc.
- Serre, J.L. (2006). Diagnostic Techniques in Genetics, John Wiley & Sons, Ltd.
- Turnpenny, P.D. &Ellard, S. (2007). Emery's Elements of Medical Genetics, 13th Edition, Churchill Livingstone Elsevier.

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (THEORY)

COURSE CODE: BIO-V.C-7

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-III.C-5- Molecular Biology

COURSE OBJECTIVES: The paper aims to introduce the students to the principles and techniques involved in Genetic Engineering through the use of genetic material and vehicles for suitable manipulation of genes.

LEARNING OUTCOME: On completion of this module, students will be able to understand how genes are genetically engineered and the need for the same. The practical component will train them towards performing with understanding genetic manipulations of genes.

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (THEORY)

Unit 1: Introduction to genetic engineering **2 hrs**

Aims; principles; applications; ethical issues involving recombinant DNA technology and genetic engineering

Unit 2: DNA modifying enzymes **3 hrs**

Nucleases- endonucleases (restriction enzymes recognition sequences, cleavage pattern); exonucleases**;**DNA ligases**;**reverse transcriptases**;**polynucleotide kinases**;**alkaline phosphatases**;**nucleotidyltransferases

Unit 3: Vehicles for gene cloning **10 hrs**

Vectors - properties of ideal cloning vectors**;** plasmids – properties, classification**;** Vector for Prokaryotes - pBR322, pUC 18**;** bacteriophages as cloning vectors - lambda bacteriophages; features-insertional vectors and replacement vectors & M13 Bacteriophage; cosmids, phagemids and phasmids- definition, features with examples; vectors for cloning in *Saccharomyces cerevesiae* (examples and features)**;** shuttle vectors - any one example; vectors for plant – Ti plasmid

Unit 4: DNA insertion into vector **3 hrs**

Ligation; linkers; adaptors, homopolymer tailing

Unit 5: Transformation methods **8 hrs**

Methods, advantages and disadvantages: competence (transformation in bacteria); microinjection; lipofection; electroporation; macroinjection; sonication; silicon carbide fibre vortex; DNA co-precipitation; ultrasonication; laser induced; *Agrobacterium* mediated transfers

Unit 6: Identification of recombinants **4 hrs**

Principle and importance of identification of recombinants; antibiotic resistance (amp, tet resistance); lac Z selection; colony hybridization;*cI*selection

Unit 7: DNA isolation methods and analysis **5 hrs**

Isolation of genomic DNA & plasmid DNA; principle of plasmid isolation; spectrophotometric analysis of DNA; agarose gel electrophoresis; purification of DNA

Unit 8: Amplification of nucleotide sequences **3 hrs**

Polymerase chain reaction (principles, components & method of PCR)

Unit 9: DNA sequencing **5 hrs**

Significance and importance of DNA sequencing**;** Maxam Gilbert's method**,** Sanger's method**,** Automatic DNA sequencer

Unit 10: Genomic / cDNA libraries **2 hrs**

Preparation of genomic library;cDNA library**;**screening of libraries

BIO-V.C-7: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)

COURSE TITLE: CONCEPTS IN GENETIC ENGINEERING (PRACTICAL)
COURSE CODE: BIO-V.C-7
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Plasmid DNA isolation by alkaline lysis method
Plasmid DNA isolation by boiling method

Plasmid DNA separation on agarose gel

Molecular size determination of the plasmid

Preparation of competent cells in bacteria

Transformation in bacteria using suitable plasmid (pUC 18)

Selection of transformed colonies

Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method

Demonstration of Polymerase Chain Reaction (PCR)

REFERENCES

- Brown, T.A. (2006) Manipulation of purified DNA. In:Gene cloning & DNA analysis An Introduction, 5th Ed. Blackwell publishing, Ltd, UK
- Jogdand, S.N. (2008). Gene Biotechnology, 2nd edition, Himalaya Publishing House, Mumbai.
- Primrose, S.B. & Twyman, R.M. (2009). Principles of Gene Manipulation and Genomics, Blackwell Publishing.
- Purohit, S.S. (2009). Biotechnology: Fundamentals and Applications, Student Edition.
- Singh, B.D. (2008). Biotechnology: Expanding Horizons, Kalyani publishers.
- Watson, J.D., Tooze, J. & Kurtz, D.T. (1983). Recombinant DNA: A short Course, Scientific American Books (WH Freeman), New York.

BIO-V.E-9 MOLECULAR MEDICINE

COURSE TITLE: MOLECULAR MEDICINE (THEORY)

COURSE CODE: BIO-V.E-9

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-IV.E-8 -Molecular Genetics

COURSE OBJECTIVE: Molecular medicine is the application of molecular biology and molecular genetics to the understanding of human health and disease. It aims to understand the underlying origins and mechanisms of human diseases and to find novel ways of preventing, diagnosing and treating diseases.

LEARNING OUTCOME: On completion of this module, students will be able to understand the underlying genetic factors of common diseases, complex genetic traits and molecular and cellular therapies for the same. They will also gain more clarity on cancer genetics, pharmacogenetics and maintenance of public health.

BIO-V.E-9 MOLECULAR MEDICINE (THEORY)

Unit 1: Historical aspects **2hrs**

History of molecular medicine – the foundations (1869 – 1980s); the modern era (1980s – 2000s)**;** The Human Genome project (1990 – 2000)

Unit 2: Gene structure and expression **3 hrs**

Exons, introns, alternative splicing**,** epigenetic changes

Unit 3: Genetic factors in common diseases **6 hrs**

Hypertension; coronary heart disease; autism; alzheimer disease; haemochromatosis; age-related macular degeneration

Unit 4: Complex genetic traits **4 hrs**

Multifactorial disorders – diabetes, dementia, schizophrenia; novel mechanisms for DNA and disease – mitochondrial inheritance, genomic imprinting, mosaicism, chimerism

Unit 5: Cancer genetics **5 hrs**

Differentiation between genetic and environmental factors in cancer; oncogenes – types and function; tumour-suppressor genes – "two hit hypothesis"; genetics of common cancers – breast, ovarian and prostate cancer

Unit 6: Introduction to omics **3 hrs**

Genomics, Proteomics, Metabolomics, Phenomics, Metagenomics

Unit 7: DNA Tests **4 hrs**

Direct Detection; indirect detection - DNA scanning; linkage analysis; classes of DNA tests and function of each type; validity of DNA tests

Unit 8: Molecular and cellular therapies **8 hrs**

Recombinant DNA products – Factor VIII (Haemophilia); vaccines; somatic cell gene therapy; examples of gene therapy trials – ADA, haemophilia, cancer, eye disease, HIV;

RNA therapies – RNA interference (RNAi), ribozymes; regenerative medicine – cloning, stem cells

Unit 9: Pharmacogenetics **3 hrs**

Drug metabolism; genetic variations revealed by effects of drugs; pharmacogenetics – maturity-onset diabetes of the young (MODY); neonatal diabetes; pharmacogenomics; adverse effects; efficacy

Unit 10: Public health **4 hrs**

Preventive medicine; population screening (cystic fibrosis, sickle cell anaemia, newborn screening); changing behaviour (familial hypercholesterolemia); DNA testing in the workplace – predisposition to disease; detecting exposure to toxins; litigation, identity

Unit 11: Delivering genetics and genomics to consumers **3 hrs**

Definitions and marketplace, types of direct-to-consumer (DTC) DNA tests; Pros and Cons of DTC DNA Tests

BIO-V.E-9: MOLECULAR MEDICINE (PRACTICAL)

COURSE TITLE: MOLECULAR MEDICINE (PRACTICAL)
COURSE CODE: BIO-V.E-9
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Investigation of Genetic Factors in any four common diseases
Study of mitochondrial inheritance, genomic imprinting, mosaicism and chimerism with one example of each
A study on the types of DNA tests for diagnosis of diseases
Investigation of Molecular Mechanisms of any one type of Cancer
Understanding concepts relating to genomics and proteomics
A study on RNA therapies and regenerative medicine
Application of pharmacogenetics in drug metabolism
An investigation into the screening programmes adopted in various countries
Submission of a report on the molecular mechanisms and therapy for any one disease

REFERENCES

- Trent, R.J. (2005). Molecular Medicine – an Introductory Text, Elsevier Academic Press.
- Trent, R.J. (2012). Molecular Medicine – Genomics to Personalized Health Care, Fourth Edition, Elsevier Inc.
- Turnpenny, P.D. &Ellard, S. (2007). Emery's Elements of Medical Genetics, 13th Edition, Churchill Livingstone Elsevier.

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-V.E-10
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

COURSE OBJECTIVES: The main aim of this paper is to introduce the students to the hazards of our environment, the effects of pollution on living systems, solutions to protect the environment for sustainable development.

LEARNING OUTCOME: On completion of this module, students will be able to understand the effects of various types of pollution and gain knowledge in areas like development of biological systems for remediation of contaminated environments and environment-friendly processes such as green manufacturing technologies and sustainable development.

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

Unit 1: Introduction **2 hrs**

The scope of environmental biotechnology

Unit 2: Basic ecological concepts and principles **4 hrs**

Structure (biotic and abiotic components); food chain and food webs; ecological pyramids; productivity and eco-energetic (10% law)

Unit 3: Anthropogenic activities, its effects and control **12 hrs**

Air pollution: Major air pollutants and their sources, Impacts of air pollution on human health, animals, plants and climate; removal of gaseous contaminants and odour: bioscrubbers, biotrickling filters and biofilters/biobeds

Water pollution: Principal forms of water pollutants and their sources;wastewater treatment: activated sludge process, rotating biological discs, oxidation ponds, trickling filters

Soil pollution: Soil pollution and their sources; treatment of solid wastes: hazardous; non-hazardous; composting and vermitechnology

Unit 4: Pollution monitoring **10 hrs**

Bio indicators: concept and examples (indicators of water quality; air pollution indictors); choice of criteria: visual rating; genotoxicity; metabolic rating; applications (two each); using plant test systems and animal test systems; tests for assessing Genetic damage: AMES test; cyto-genetic assay; membrane damage; concept and applications of molecular biology in environmental monitoring: reporter gene: concept and applications of biosensors in pollution detection

Unit 5: Pollution abatement: Bioremediation and biodegradation **10 hrs**

Bioremediation: definition, microbial bioremediation, phytoremediation; microbial desulphurization of coal (direct and indirect mechanisms)

Biodegradation: basis of biodegradation, concepts of use of mixed microbial populations; Biodegradation of two xenobiotics: aromatic hydrocarbons (benzene) and alkanes

Biosorption: principle; use of fungi and algae (2 examples each); genetically engineered microorganisms - super bug (*Pseudomonas* sps.)

Unit 6: Ecofriendly Bio-products **7 hrs**

Biogas (biomethanisation) production; bioethanol production; bio hydrogen production: anaerobic bacteria and photolysis photosynthetic algae; biodiesel production; bioplastics: biopol and biolac; biopesticide

BIO-V.E-10: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: ENVIRONMENTAL BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-V.E-10

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Determination of dissolved oxygen concentration of water sample by Winkler's method

Determination of biological oxygen demand (BOD) of the given sample

Determination of chemical oxygen demand (COD) of the given sample ($KMnO_4$/ $K_2Cr_2O_7$ method)

Determination of TS (total solids) of the given water sample

Isolation of xenobiont degrading bacteria by selective enrichment

Determination of nitrates from water sample

Visit to an effluent /sewage treatment plant and preparation of report

Detection of coliforms for determination of the purity of potable water (MPN, Presumptive, confirmatory and confirmed tests)

REFERENCES

- Agarwal S.K. (2009). Environmental Biotechnology, APH Publishing Corporation New Delhi.
- Anjaneyulu Y. (2005). Introduction to environmental Science, BS publications, India.
- Chatterji A.K. (2009). Introduction to Environmental Biotechnology, 2nded, Prentice Hall of India Pvt. Ltd. New Delhi.
- Jogdand B.N. (2008). Environmental Biotechnology (Industrial Pollution Management), Himalaya Publishing House, Mumbai.
- Santra S.C. (2001). Environnemental Science, New central book agency (P) Ltd. Calcutta.
- Singh B.D. (2008). Biotechnology, 3rd edition, Kalyani Publishers.
- Thakur I.S. (2006). Environmental Biotechnology: Basic concepts and applications, I.K. International Pvt. Ltd. New Delhi.

BIO-V.E-11: PLANT BIOTECHNOLOGY

COURSE TITLE: PLANT BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-V.E-11

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the concept of *in vitro* culture of plants including set up of a plant tissue culture laboratory, instruments and sterilization techniques. This paper will help the students to understand that various parts of the plant may

be cultured, with each type of culture having specific applications. Plant tissue culture also lends itself for production of transgenic plants which have various applications.

LEARNING OUTCOME: On completion of this module, the student will be able to understand all about plant biotechnology in terms of set up of a laboratory, culture of explants and genetic engineering methods for production of transgenic plants.

BIO-V.E-11: PLANT BIOTECHNOLOGY (THEORY)

Unit 1: History of plant tissue culture **2 hrs**

International and Indian scientists

Unit 2: Laboratory organization **4 hrs**

Washing and drying facility; general laboratory and media preparation area; transfer area; **c**ulture room; growth chambers and green house (ideal conditions for incubation and maintenance of cultures/plants).

Unit 3: Sterilization techniques **2 hrs**

Sterilization techniques used in plant tissue culture – steam, dry, filter, ultra violet, alcohol, flame and chemical (explants)

Unit 4: Plant tissue culture media **4 hrs**

Major and minor inorganic nutrients; vitamins; carbon source; hormones; complex organic additives and their functions**;**composition of some commonly used plant tissue culture media – MS, White's, Nitsch, Gamborg B5

Unit 5:Totipotency **2 hrs**

Totipotency and its Importance**;** Various parts of the plant serving as Explants

Unit 6: Organ culture and its applications **5 hrs**

Root; shoot tip/meristem; anther and pollen; ovary and ovule embryo

Unit 7: Callus and cell suspension cultures **4 hrs**

Callus culture – principle; characteristics of callus tissue; applications; cell suspension culture – principle; isolation; growth patterns; concept of batch and continuous culture; viability testing

Unit 8: Somaclonal variation **2 hrs**

Concept; isolation of variants; mechanisms of somaclonal variation and applications

Unit 9: Organogenesis **1 hr**

Root and shoot regeneration and applications

Unit 10: Somatic embryogenesis and artificial seeds **2 hrs**

Somatic embryogenesis – principle; procedure and applications**;** artificial seeds – methods of production and applications

Unit 11: Protoplast culture and somatic hybridization **4 hrs**

Protoplast culture – principle; isolation of protoplasts (mechanical and enzymatic); methods of culture; checking viability**;** somatic hybridization - protoplast fusion (spontaneous and induced); selection of hybrid protoplasts; applications of somatic hybridization

Unit 12: Applications of Tissue Culture in Plant Sciences **2 hrs**

Micropropagation; gene conservation banks; forestry

Unit 13: Production of secondary metabolites **2 hrs**

Classification of secondary metabolites with examples**;** production using culture methods - callus culture; cell suspension culture; hairy root culture (*A. rhizogenes*); immobilized cell systems

Unit 14: Gene transfer in plants **4 hrs**

Introduction to *Agrobacterium tumefaciens* and Ti plasmid; *Agrobacterium* based vectors (co-integrate and binary vectors); co-culture method and in plant transformation; direct methods of gene transfer – electroporation, chemical methods, particle gun method and microinjection

Unit 15: Applications of transgenic plants **5 hrs**

Insect resistance (BT toxin); drought and salt tolerance; herbicide resistance; increasing shelf life of fruits; improvement of vitamin content (golden rice) and edible vaccines

BIO-V.E-11: PLANT BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: PLANT BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-V.E-11

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Washing, Packing and Sterilization of Glassware

Preparation of Stock solutions for Murashige and Skoog (MS) medium

Preparation, sterilization and pouring of MS medium

Aseptic germination of seedling

Callus induction from hypocotyl and carrot cambial explants and subculturing

Shoot tip culture

Regeneration of shoot/root from callus

Setting up of cell suspension culture and checking viability by Evan's blue method

Setting up an in vitro culture from seed embryo (embryo culture)

Encapsulation of somatic/true embryo (synthetic seeds)

Regeneration of Plants from Synthetic Seeds

REFERENCES

- Chawla, H.S. (2002) Introduction to Plant Biotechnology, Science Publishers Inc. USA.
- De, K.K. (2008) Plant Tissue Culture, New Central Book Agency Pvt. Ltd.
- Jha, T.B. &Ghosh,B. (2005) Plant Tissue Culture, University Press (India) Pvt. Ltd.
- Singh, B.D. (2005) Plant Biotechnology, Kalyani Publishers.

BIO-V.E-12: BIOINFORMATICS

COURSE TITLE: BIOINFORMATICS (THEORY)

COURSE CODE: BIO-V.E-12

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the importance of the basics of computers, concept of Human Genome Project, storage of biological information and tools and techniques of bioinformatics used and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of computers and networking and the various types of biological databases used for storing genetic information of various organisms and the use of various tools and techniques used for retrieving the same that maybe used in present life and be able to solve interesting and novel scientific problems.

BIO-V.E-12: BIOINFORMATICS (THEORY)

Unit 1: Introduction to Computers in Biology **5 hrs**

Introduction to use of computers, internet and software in biology; medicine and research; historical developments in biology

Unit 2: DNA, RNA and Proteins & HGP **4 hrs**

Background of DNA, RNA and Proteins, ORF**;** review of transcription and translation**;** introduction to HGP; objectives; achievements of HGP; ethical and social issues

Unit 3: Introduction to bioinformatics **3 hrs**

Definition; scope of bioinformatics; bioinformatics vs computational biology; components of bioinformatics and applications

Unit 4: Information resources **6 hrs**

Introduction; aim and objectives (NCBI, NLM, NIH, EBI and SRS)

Unit 5: Biological databases **6 hrs**

Types of data; types of biological databases; primary databases: Gen Bank and EMBL, DDBJ secondary databases:swiss-PROT, PDB & PIR; composite databases: OWL & PROSITE

Unit 6: Structural databases **5 hrs**

X ray crystallography; PDB; MMDB;CATH & SCOP; Visualization of proteins – Cn3D and rasmol

Unit 7: Literature databases **3 hrs**

Pubmed;MedLINE& OMIM

Unit 8: BLAST & FASTA **4 hrs**

Introduction; BLAST & FASTA and their types

Unit 9: Sequence alignment tools and phylogeny **6 hrs**

Pairwise sequences alignment; multiple sequence alignment using Clustal-W Omega; introduction; definition; construction; structure and types of phylogenetic trees; differences between cladogram and phylogenetic tree

BIO-V.E-12: BIOINFORMATICS (PRACTICAL)

COURSE TITLE: BIOINFORMATICS (PRACTICAL)

COURSE CODE: BIO-V.E-12

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Introduction to Bioinformatics & its Applications

Study of Human Genome Project

Usage of NCBI resources

Biological data search using NCBI – Protein or amino acid sequences

Biological data search using NCBI – DNA or gene sequences

Biological data search using NCBI – Literature & Structure databases

Database search & Pairwise sequence alignment using NCBI BLAST :BLASTp&BLASTn

Multiple sequence alignment using Clustal-W

Construction of phylogenetic tree using Clustal-W

DNA sequence analysis to find restriction enzymes sites using NEBcutter

Visualization of protein structures using Cn3D/ Rasmol

REFERENCES

- Harisha, S. (2007). Fundamentals of Bioinformatics, I.K. International Publishing House, Mumbai.
- Ignacimuthu, S. (2005). Basic Bioinformatics, Narosa Publishing House, New Delhi.
- Mount, D.W. (2004). Bioinformatics – sequence and Genome analysis, CBS Publishers.
- Murthy,C.S.V. (2003). Bioinformatics, Himalaya Publishing House, Mumbai.
- Rastogi, S.C., Mendiratta, N. &Rastogi, P. (2004). Bioinformatics: Concepts, Skills and Applications, CBS Publishers.
- Xiong, J. (2006). Essential Bioinformatics, Cambridge University Press.

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-VI.C-8

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

PRE-REQUISITES: Completion of BIO-II.C-4-Basic Microbiology

COURSE OBJECTIVES: This paper is designed to introduce the students to the basic concepts in Industrial Biotechnology. The paper covers concepts in Industrial Biotechnology, mainly introducing the basics of upstream processes in fermentation technology on an industrial scale.

LEARNING OUTCOME: On completion of this module, students will be able to understand the concept of a bioprocess and its importance in today's world of fast pacing technology. They will be able to apply concepts of fermentation technology to the industrial sector and understand how large scale bioprocesses are carried out. This module will be a pre-requisite to the module Industrial Biotechnology (advanced) of semester VI.

BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (THEORY)

Unit 1: Fermentation equipment and its use **10 hrs**

Definition of fermentor/bioreactors; structure of ideal fermentor**;** definition and uses of impellers and their types; spargers and their types;baffles; headspace**;** controls and sensors (temperature, pH, antifoam, dissolved oxygen and carbon dioxide sensor)**;** types of reactors (definition, description, diagram and uses)-stirred tank reactors; bubble columns; airlift bioreactors (internal and external loop); fluidised bed; packed bed column, photobioreactors; tray bioreactors

Unit 2: Screening and selection of micro-organisms **3 hrs**

Primary screening-definition; techniques; crowded Plate; auxanography; enrichment; indicator dye; secondary screening- definition and features; giant colony technique

Unit 3: Stock cultures **2 hrs**

Cryogenic preservation**;**aims of preservation of cultures; definition of working and primary stock cultures**;** techniques of preservation- serial subculture , sterile soil, water , silica gel; sterile mineral oil; lyophilisation

Unit 4: Types of fermentation processes **3 hrs**

Continuous; submerged; surface/solid state; batch; fed-batch

Unit 5: Fermentation media **5 hrs**

Characteristics of an ideal; production media; media composition – crude, synthetic; media; sterilization -Heat, radiation, chemical methods and filtration; batch and continuous sterilization, inoculum preparation

Unit 6: Detection and assay of fermentation products **5 hrs**

Physical or chemical assay- titration and gravimetric assay; turbidity analysis and cell determination; spectrophotometric assay; chromatographic partition assay; biological assay-concept benefits and drawbacks; diffusion assay;turbidometric and growth assay; end point assay; metabolic response assay; enzymatic assay

Unit 7: Scale up of fermentations and increasing product yields **3 hrs**

Significance of scale up; pilot fermenters**;** increasing product yields by mutagens-physical and chemical mutagens/strain improvement

Unit 8: Downstream processing **4 hrs**

Biomass: separation of cells – flocculation; floatation; filter aids and filtration (surface, depth); centrifugation- batch centrifuge eg. tubular bowl centrifuge; continuous centrifuge eg. basket centrifuge; disintegration in brief: mechanical eg: ulltrasonication; homogenisers and use of ballotini; non mechanical eg. thermallysis; chemicaleg.detergent solubilisation, organic solvents; enzymatic methods eg. lysozyme

Broth: Enrichment: evaporation, membrane filtration, liquid-liquid extraction, precipitation, adsorption

Purification: chromatography

Formulation - crystallization and drying (convection drying eg. spray dryers, freeze drying)

Unit 9: Industrial production **4 hrs**

Organisms; fermentation media and conditions;downstream processing and uses -alcohol /Wine; penicillin,vinegar

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BIO-VI.C-8: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: INDUSTRIAL BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-VI.C-8

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

A study on the phases of growth of microorganisms during batch fermentation (equipment: Erlenmeyer flask, medium: nutrient broth, inoculum: *E.coli*).

Parts of a fermentor

Preparation and sterilization of medium for batch fermentation process

Batch fermentation using fermentor

Preparation and sterilization of medium for fed-batch fermentation process

Fed-batch fermentation

Decontamination and sterilization of the fermentor

Primary screening of antibiotic producing bacteria by crowded plate technique

Secondary screening for antibiotic producers by Giant Colony Technique

Production of wine (from pineapple or any other fruit/vegetable) using yeast

Production of vinegar from toddy

Estimation of total reducing sugars and acidity (total and volatile) in wine and vinegar (before and after fermentation)

REFERENCES

- Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
- Patel A.H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.
- Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co.
- Ratlege C. & Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge university press.
- Stanbury P. F, Whitaker A. & Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
- WulfCruger and AnnelieseCruger, A Text book of Industrial Microbiology. 2007. Sinauer associates pub.
- Prave P., Faust U., Sitting W., Sukatsch D.A., Fundamentals of Biotechnology. 2004. VCH publishers.
- Prescott and Dunn, Industrial Microbiology. 4thed, 1982. AVI Pub Co.

- Sivasankar B., Bioseparations: Principles and techniques. 2005. Prentice hall of indiapvt ltd New Delhi.
- Collin Ratlege, Basic Biotechnology. 2006. Cambrige university press.

BIO-VI.E-13: BIOETHICS AND BIOSAFETY

COURSE TITLE: BIOETHICS AND BIOSAFETY (THEORY)

COURSE CODE: BIO-VI.E-13

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

COURSE OBJECTIVES: This paper aims at introducing the importance of the basic concepts of bioethics and bio-safety and their relationship with several fields such as ecology, agriculture, medicine, chemistry and advances brought about in the field of biology and medicine. The course deals with answers to ethical questions that arise in the relationships among the life sciences and their importance in the field of biotechnology.

LEARNING OUTCOME: On completion of this paper the students will be able to understand the importance of bioethics and biosafety procedures to be followed and describe the basic concepts, its principles, and use in the present life and be able to solve novel scientific problems.

BIO-VI.E-13: BIOETHICS AND BIOSAFETY (THEORY)

Unit 1: Introduction to Bio-safety **6 hrs**

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels: Physical containment, Biological containment, Biosafety Levels of Specific Microorganisms; Recommended Biosafety levels for infectious agents and infected animals

Unit 2: Safety in Laboratories **4 hrs**

General safety measures, Hazards: Physical, Biological and Chemical, Spillage and waste disposal

Unit 3: International and Indian bio-safety guidelines **5 hrs**

Bio-safety guidelines in India; International bio-safety guidelines: OECD, FAO, WHO, CAC and other organisations

Unit 4: Introduction to bioethics **5 hrs**

Introduction to bioethics; social and ethical issues in biotechnology: issues related to test tube babies; bioethics in plant genetic engineering; bioethics in animal genetic engineering

Unit 5: Introduction to IPR **10 hrs**

Introduction to intellectual property; protection of intellectual property; property rights: trade secret, patent, copyright, plant variety protection; plant breeders' right: history, PPVFR, UPOV, requirements for PBR, need and benefit for PBR, breeders exemption, farmer's privilege, farmer's right; world intellectual property organization (WIPO), GATT & TRIPs ; patent status – international Scenario; patenting of biological materials; significance of patents in India

Unit 6: Case studies **3 hrs**

Patenting Basmati rice; Revocation of patents-turmeric and neem

Unit 7: Protection of biotechnological inventions **6 hrs**

Patenting of genes and DNA sequences; gene patents and genetic resources; farmers rights; plant breeder's rights; patenting of life forms;broad patents in biotechnology

Unit 8: Regulatory affairs **3 hrs**

Good laboratory practices; good manufacturing practices

Unit 9: Biosafety of GMOs and GEMs **3 hrs**

Planned introduction and field trials of: GMOs and GEMs

BIO-VI.E-13: BIOETHICS AND BIOSAFETY (PRACTICAL)

COURSE TITLE: BIOETHICS AND BIOSAFETY (PRACTICAL)

COURSE CODE: BIO-VI.E-13

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

General safety measures and study of safety notices

Study of preventive measures and first aid during laboratory hazards

Case study on handling and disposal of radioactive waste

Case study on handling and disposal of medical/microbial waste

Study of Good Laboratory Practices

Study of Good Manufacturing Practices

Study of components and design of a Biosafety laboratory

A case study on clinical trials in India with emphasis to ethical issues

Planning of establishment of a hypothetical biotechnology industry in India

Study of steps of a patenting process

REFERENCES

- Das H.K. (2008). Text book of Biotechnology, 3rd edition, Wiley India Pvt. Limited, New Delhi.
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- Krishna V.S. (2007). Bioethics & Biosafety in Biotechnology, New Age Publishers, Bangalore.
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- Thomas J.A. &Fush R.L. (2002). Biotechnology & Safety Assessment, 3rd Edition, Academic press.

BIO-VI.E-14 ADVANCED CELL BIOLOGY

COURSE TITLE: ADVANCED CELL BIOLOGY (THEORY)
COURSE CODE: BIO-VI.E-14
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-I.C-2- Cell Biology

COURSE OBJECTIVES: The course will give a detailed description of the how eukaryotic cells receive, transmit and respond to environmental signals, cellular regulation of cell cycle progression and cell death. The principal and working of the essential tools used in cell biology will also be covered.

LEARNING OUTCOMES: Students will develop insight into the complexities of cell structure and function, the molecular controls that govern the cells' dynamic properties, and cellular interactions with the organism as a whole.

BIO-VI.E-14 ADVANCED CELL BIOLOGY (THEORY)

Unit 1:Techniques in cell biology **9 hrs**

Review of 2D microscopy; confocal microscopy;transmission electron microscopy; scanning electron and atomic force microscopy; the use of radioisotopes; differential centrifugation; purification of proteins – precipitation;ion-exchange chromatography;gel filtration chromatography;affinity chromatography; polyacrylamide gel electrophoresis; two-dimensional gel electrophoresis; purification of nucleic acids-agarose, gel electrophoresis; ultracentrifugation, blotting techniques

Unit 2: Cell cycle and programmed cell death **12 hrs**

Overview of the cell cycle; regulation of cell cycle;events of mitotic phase; cytokinesis; events of meiosis; regulation of cell division; apoptosis (extrinsic and intrinsic pathway)

Unit 3:Signal transduction **10 hrs**

The basic elements of cell signalling systems-autocrine, paracrine and endocrine types ; an overview of the major signalling pathways; mechanism and signal transduction of G protein-coupled receptors (GPCRs); Receptor protein-tyrosine kinases (RTKs);Lligand-gated channels; steroid hormone receptors; second messengers- cyclic AMP, phosphatidylinositol derived second messengers;role of calcium and NO as intracellular messengers

Unit 4: Membrane transport **6hrs**

Review of structure and composition of cell membrane; transport across nuclear envelope - simple diffusion and facilitated diffusion; passive transport - glucose transporter, anion transporter; primary active transporters - P type ATPases, V type ATPases, F type ATPases; secondary active transporters –Na+-glucose symporter; ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel)

Unit 5: Membrane potentials and nerve impulses **4 hrs**

The resting potential; the action potential; propagation of action potentials; neurotransmission

Unit 6: Cancer biology **4hrs**

Development and causes of cancer; genetic basis of cancer; oncogenes; tumor viruses

BIO-VI.E-14 ADVANCED CELL BIOLOGY (PRACTICAL)

COURSE TITLE: ADVANCED CELL BIOLOGY (PRACTICLAL)

COURSE CODE: BIO-VI.E-14

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Identification of different stages of mitosis (in garlic root tip) `

Identification of different stages of meiosis (flower buds/ grasshopper testes)

Study of cell viability by trypan blue

Identification and study of cancerous cells using permanent slides/ photomicrographs

Study of plant, animal and human tumour viruses using photomicrographs

Differential centrifugation for separation of cellular components

Preparation of sucrose density gradient and separation of sub cellular organelles

Visualization of nuclear fraction by acetocarmine stain and mitochondria by Janus green stain

Study of electron micrographs of sub-cellular organelles

Separation ofphotosynthetic pigments by TLC

REFERENCES

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- Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
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- Verma, P.S. &Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.
- Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, 1st Edition, S. Chand & Company Pvt. Ltd.

BIO-VI.E-15: FOOD BIOTECHNOLOGY

COURSE TITLE: FOOD BIOTECHNOLOGY (THEORY)

COURSE CODE: BIO-VI.E-15

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

OBJECTIVE: This paper adds information about the role of microorganisms in many food industries both in production and spoilage processes and to understand the importance of the role of microorganisms in food industries both in beneficial and harmful ways.

LEARNING OUTCOME: The students will be able to apply this knowledge in prevention of microbial spoilage and also exploit the microbes for improved food quality. They will also learn the key role and mechanisms of microorganisms, enzymes in biodegradation of hazardous compounds

BIO-VI.E-15: FOOD BIOTECHNOLOGY (THEORY)

Unit 1: History and development of food microbiology **2 hrs**

History of microorganisms in food**;** role and significance of microorganisms in foods

Unit 2: Factors influencing microbial growth in food **4 hrs**

Intrinsic and extrinsic factors responsible for food spoilage

Unit 3: Microorganisms involved in food spoilage **2 hrs**

Microorganisms involved in food spoilage: fruits vegetables, meat, eggs, bread

Unit 4: Food borne diseases **5 hrs**

Food poisoning: (bacterial toxin botulism and Staphylococcal toxin); fungal toxins: aflatoxin; food borne infections: gastroenteritis and Salmonellosis

Unit 5: Milk technology and diseases **5 hrs**

Sources of contamination;different microorganisms implicated in spoilage; milk borne diseases: listeriosis and scarlet fever; grading of milk by dye reduction test – MBRT and resazurin

Unit 6: Detection of food spoilage **6 hrs**

Methods of detection of food spoilage in any 1 type of food (example milk); traditional approaches in detection of spoilage (SCP, breeds smear, identification of specific; organisms

by using selective and differential media); new approaches (examples gene probes, bioluminescence)

Unit 7: Microorganisms as source of food **3 hrs**

Nutritive value and use of:Mushroom,SCP eg. Spirullina

Unit 8: Food preservation **8 hrs**

Preservation by drying: solar drying, mechanical drying, salting, smoking)**;** preservation at high temperature: concept of TDP and TDT**;** pasteurization (LTHT, HTST, UHT processes); efficiency of pasteurization – phosphatase test, canning, hurdle technology**;** preservation at low temperature: freezingpreservation by use of additives: acids, salts, sugars, antibiotics, ethylene oxide, antioxidants; preservation by radiation: UV, ionizing radiations,gamma and cathode rays, microwave processing; other methods: hydrostatic pressure cooking,modified atmosphere

Unit 9: Fermentation technology **3 hrs**

Fermented Food: process, microbiology involved and changes during fermentation of fermented food: sauerkraut; milk products: yogurt

Unit 10: Food quality assurance **3 hrs**

Food safety: HACCP system to food protection

Unit 11: GM foods **4 hrs**

Pros and cons of GM foods Eg: Golden rice, FlavrSavr tomato and BtBrinjal

BIO-VI.E-15: FOOD BIOTECHNOLOGY (PRACTICAL)

COURSE TITLE: FOOD BIOTECHNOLOGY (PRACTICAL)

COURSE CODE: BIO-VI.E-15

MARKS: 25

CREDITS: 1

TOTAL HOURS: 30

Plating ofspoiled food on selective media

MIC of common food preservatives – (sugar/ salt)

MIC of chemical food preservatives – (sodium benzoate/ potassium metabisulphite)

Milk Microbiology

Standard plate count

Grading of quality of milk using dye reduction test (MBDRT / Resazurin)

Pasteurisation of milk

Determination of efficiency of pasteurisation by phosphatase test

Determination of TDP and TDT

REFERENCES

- Das H.K. (2007). Text book of Biotechnology, 3rd Edition, Wiley India (P) Ltd, New Delhi.
- Frazier W.C &Westhoff D.C. (2015). Food Microbiology. 5th edition. McGraw Hill Education (India) Private Limited: New Delhi
- Jay J.M., Loessner, M.J. & Golden D. A. (2005). Modern Food Microbiology, 7th edition. United States: Springer science business media
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- Tiwari R.P., Hoondal G.S. &Tewari R. (2009). Laboratory Techniques in Microbiology and Biotechnology, Abhishek Publications Chandigarh (India).

BIO-VI.E-16: ANIMAL CELL CULTURE

COURSE TITLE: ANIMAL CELL CULTURE (THEORY)

COURSE CODE: BIO-VI.E-16

MARKS: 75

CREDITS: 3

TOTAL HOURS: 45

COURSE OBJECTIVES: This paper is designed to introduce the students to the basic concepts of Animal Cell Culture. The paper covers topics that explain animal cell culturing and methods involved in basic culturing of animal cells with a few applications to life sciences.

LEARNING OUTCOME: On completion of this module, students will be able to understand the basics in animal cell culture, comprehend methods used in culturing animal cells and the importance of the same. They will be able to apply concepts related to culturing animal cells to the latest developments made in this field. They will also understand the impact it has made to the development of mankind, especially in development of disease diagnostics and therapeutics.

BIO-VI.E-16: ANIMAL CELL CULTURE (THEORY)

Unit 1: Introduction to animal cell culture **3 hrs**

Animal Tissue and Cell Culture (Definition and Concepts in brief)

History and Scope of Animal Tissue Culture

Unit 2: Requirements for animal cell culture **4 hrs**

Basic layout of an animal cell culture laboratory (washing room, media preparation & sterilization room, inoculation and aseptic culture room)**;** equipments; culture vessels for tissue culture

Unit 3: Basics of an animal Cell **3 hrs**

Structure and organization of animal cell; an overview of developmental biology (importance in understanding differentiation of cells in culture)

Unit 4: Media in animal cell culturing **6 hrs**

Physico-chemical properties of culture media (pH, CO_2, O_2& Temperature); growth media – (types, advantages and disadvantages of each type); natural and artificial media; natural media – clots, biological fluid, tissue extracts, complex natural media; artificial media – serum containing, serum- free media, chemically defined and protein- free media; basal salt solutions (BSS) – constituents (vitamins, amino acids, trace elements, inorganic ions); importance; uses and examples; serum as a complex supplement; growth factors in promoting proliferation of cells – uses and examples (EGF, FGF, PDGF)

Unit 5: Basic techniques in animal cell culture **6 hrs**

Techniques in mammalian cell culture – source of cells; dissection/isolation of cells; mechanical and enzymatic disaggregation; types of cell cultures (organ culture, whole embryo culture, histotypic cultures, explants cultures)

Unit 6: Cell line cultures **6 hrs**

Primary and established cell line cultures; establishment of continuous cell lines – spontaneous transformation; chemical transformation; viral transformation; non- chemical methods; characteristics & maintenance of established / continuous cell lines; characteristics of normal and transformed cells (properties of transformed cells)

Unit 7: Characterization and growth measurement of cultured cells **6 hrs**

Characterization – genetic and enzymatic methods (cytogenetics, karyotyping, Isoenzymes and immunological tests)**;** growth measurement – direct method (particle counter, dye exclusion test, cytotoxicity assay)**;** growth measurement – indirect method (MTT assay)

Unit 8: Normal cell growth, phases of growth in culture and synchronization of cells 3h

Eukaryotic cell cycle and basics of cell synchronization**;** apoptosis in cultured cells – Reasons for cell suicide**;** phases of cell growth (lag, log, stationary, decline); population doubling level; morphology

Unit 9: Cell separation methods **2 hrs**

Physical method of cell separation – separation based on cell size; cell density; cell surface charge; cell affinity; separation by flow cytometry

Unit 10: Applications of animal cell culture **6 hrs**

Stem cell culture (applications in Animal Cell Culture); artificial skin; artificial cartilage**;** special secondary metabolites / products (insulin, growth hormone, interferon, t-plasminogen)**;** other valuable products obtained using animal cell cultures (emphasis on monoclonal and polyclonal antibodies)

BIO-VI.E-16: ANIMAL CELL CULTURE (PRACTICAL)

COURSE TITLE: ANIMAL CELL CULTURE (PRACTICAL)
COURSE CODE: BIO-VI.E-16
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

Washing of glassware and culture wares, preparation of animal cell culture media, sterilization

Introduction to use of instruments and sterile techniques in animal cell culture

Preparation of Basal Salt Solutions (DPBS) and filter sterilization

Preparation of culture media for animal cell culture (DMEM / RPMI 1640) using BSS.

Preparation of serum from goat blood & filter sterilization for animal cell culture

Culturing lymphocytes from blood cells using RPMI 1640

Dissection of chick embryo for culturing fibroblast cells

Estimation of cell viability using MTT& calculations of seeding density for animal cell cultures

Establishing a monolayer culture using warm trypsinization method

Establishing a monolayer culture using cold trypsinization method

Subculture of monolayer culture

REFERENCES

- Das, H.K. (2005). Text book of Biotechnology, Wiley India Pvt. Ltd.
- Freshney, I.R. (2005). Culture of animal cell –A Manual of Basic Techniques, 5th Edition, Wiley- Liss Publications.
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- Shivangi, M. (2006). Animal Cell and Tissue Culture, Agrobios, India.
- Singh, B.D (2013). Biotechnology, Expanding horizons, Kalyani Publishers, New Delhi.

GENERIC ELECTIVE

MUSHROOM CULTIVATION &VERMICOMPOSTING TECHNOLOGY

SEMESTER: V / VI

COURSE TITLE: MUSHROOM CULTIVATION &VERMICOMPOSTING TECHNOLOGY (THEORY)

COURSE CODE: BIO- GE-1

CREDITS: 4

TOTAL HOURS: 60

COURSE OBJECTIVE: This paper provides an insight to create awareness among students on mushroom cultivation and organic vermicompost production from biodegradable wastes using earthworms.

LEARNING OUTCOME: On completion of this module, students will be able to understand the importance of mushroom cultivation and vermicompost production for sustainable environment management.

MUSHROOM CULTIVATION &VERMICOMPOSTING TECHNOLOGY

MUSHROOM CULTIVATION

Unit 1: Introduction & History **5 hrs**

Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.

Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

Unit 2: Cultivation Technology **10 hrs**

Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray

Culture media preparation; Selection of mushrooms to be cultivated

Production of the starter – Preparation of spawn

Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves

Factors affecting the mushroom bed preparation

Preparation of the compost – Spawning, harvesting, post harvesting technology

Unit 3: Storage and nutrition **15 hrs**

Short-term storage (Refrigeration - up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions

Nutrition - Proteins - amino acids, minerals, Carbohydrates, Crude fibre content, Vitamins

Types of foods prepared from mushroom

Research Centres - National level and Regional level

Major pests: Insect Pests, Mite Pests, Viral, Bacterial, fungal

Mushroom insect diseases – Prevention and Control measures

VERMICOMPOSTING TECHNOLOGY

Unit 4 Introduction to Vermicomposting **5hrs**

Meaning, history, economic importance, value in maintenance of soil structure, role in recycling of organic wastes

Unit 5 Selection of the worms **10hrs**

Choosing the right worm; Useful species of earthworms; Local species of earthworms; Exotic species of earthworms; working with worms: bedding; food source; moisture, aeration; protection against predators

Unit 6 Vermicomposting technology **15hrs**

Requirements for vermicompost production- site selection, selection of suitable earth worm, selection of food, selection of bedding material

Methods of vermicomposting-Pit or pot method- Heap method, Bin or tray method, Windrow method, Wedge system, Vermi reactor system

Harvesting - Manual methods, Self-Harvesting (migration) methods, Mechanical methods

Nutritive value of vermicompost, Overview of Potential Benefits and Constraints

Vermiwash collection, composition & use

General problems in vermicomposting, Prospects of vermicomposting as self employment venture.

REFERENCES

A. Mushroom cultivation

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- V.N.Pathak, Nagendra Yadav & Maneesha Gaur, Mushroom Production and Processing Technology. Agrobios (India) Jodhpur.

B. **Vermicomposting technology**

- R.K. Bhatnagar & R.K. Palta, Earthworm Vermiculture and Vermicomposting. Kalyani Publishers, Chennai.
- P.K. Gupta, Vermi Composting for Sustainable Agriculture. Agrobios (India), Jodhpur.