Parvatibai Chowgule College of Arts and Science

Autonomous

Accredited by NAAC with Grade 'A' (CGPA Score 3.41 on a 4 Point Scale in 3rd cycle)

Best affiliated College-Goa University Silver Jubilee Year Award

B.Sc. Biotechnology Syllabus

(Single Major)

Undergraduate Programme

Course Structure

SEMESTER	CORE COURSES		ELECTIVE COURSES				GEC		SEC
I	**BIO-I.C-1A** Biomolecules	**BIO-I.C-2A** Cell Biology	-	-	-	-	**BIO-GEC-1** Mushroom cultivation and Composting technology	**BCH.GEC-1 *** Contemporary Nutrition	
II	**BIO-II.C-3A** Fundamental Genetics	**BIO-II.C-4A** Basic Microbiology	-	-	-	-	**BIO-GEC-4** Biostatistics	**BCH.GEC-2*** Biochemical Correlation of Diseases	
III	**BIO-III.C-5A** Molecular Biology	-	**BIO-E-1** Basics of Plant and Animal Sciences	**BIO-E-22** Metabolism of Biomolecules	**BIO-E-26** Genomics and Proteomics	**BIO-E-23** Enzymology	-		**BIO-SEC-1** Food and Fermentation technology
IV	**BIO-IV.C-6A** Immunology	-	**BIO-E-5** Plant and Animal Physiology	**BIO-E-24** Tools & Techniques in Biotechnology	**BIO-E-4** Evolution & Anthropology	**BIO-E-7** Molecular Genetics			**BCH-SEC-1*** Nutraceuticals
V	**BIO-V.C-7A** Concepts in Genetic Engineering	-	**BIO-E-9** Molecular Medicine	**BIO-E-18** Environmental Biotechnology	**BIO-E-20** Plant Biotechnology	**BIO-E-12** Bioinformatics	-		
VI	**BIO-VI.C-8B** Industrial Biotechnology	-	**BIO-E-16** Bioethics and Biosafety	**BIO-E-25** Advanced Cell Biology	**BIO-E-13** Food Biotechnology	**BIO-E-21** Animal Cell Culture	-		

***** Offered by Dept. of Biochemistry for First year and Second year students of Biotechnology and Biochemistry respectively.

Note:

Similarly 2 GEC's and 1SEC's will be offered by Dept. of Biotechnology for the First year students of Biotechnology and Biochemistry.

Course Syllabus

Second Year B.Sc. Biotechnology course syllabus

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, regulation of gene expression and mechanism of gene transfer.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Explain the structure of DNA and its properties
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.C-5: MOLECULAR BIOLOGY (THEORY)

Module I **(15 hrs)**

Basic Concepts in Molecular Biology 7 hrs

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

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).

Module II **(15 hrs)**

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, base analog); DNA Repair Mechanisms: Mismatch, photo-reactivation repair, Excision repair.

Transcription - 9 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.

Module III **(15 hrs)**

Protein Synthesis - 9 hrs
Central dogma and 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.
Regulation of Gene Expression - 3 hrs
Lactose operon; Tryptophan operon
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
1. Isolation of genomic DNA from prokaryotes
2. Isolation of genomic DNA from eukaryotes
3. Isolation of genomic RNA
4. Agarose gel electrophoresis
5. Determination of molecular size of DNA by agarose gel electrophoresis
6. Mutagenesis in *E. coli* cells – UV survival or chemical mutagens
7. Purity of DNA by spectrophotometric method

REFERENCES
1. Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
2. Nelson, D. L. & Cox, M.M. (2000). Lehninger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
3. Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.
6. Verma, P.S. &AgarwaL, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.

WEB REFERENCES
1. https://www.elsevier.com › ... › Molecular Biology
2. https://open.umn.edu › opentextbooks › textbooks › cell-and-molecular-bi…
3. https://molbiomadeeasy.files.wordpress.com › 2013/09 › fundamental_mol…
4. https://www.academia.edu › Cell_and_Molecular_Biology_Concepts_and_…
5. https://en.wikipedia.org › wiki › Edward_M._De_Robertis

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 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.

Course Outcome

On the successful completion of the course, students will be able to:
CO1: Explain classification of plant and animal kingdom
CO2: Distinguish between various phyla of the plant and animal kingdoms based on 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-1: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)

Module I **(15 hrs)**

Introduction - 1 hr

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

Plant Kingdom - 7 hrs

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

Morphology and Anatomy in Angiosperms - 7 hrs

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

Module II **(15 hrs)**

Animal Kingdom - Non chordates - 10 hrs

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

Animal Kingdom–Chordates - 5 hrs

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

Module III **(15 hrs)**

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 Echinoderms; Excretion in Aschelminthes and Annelida; torsion in Gastropods (Mollusca); metamorphosis in insects and economic importance (Arthropoda); corals and coral reefs (Cnidaria)

Salient features of Chordates - 7 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

1. Study of algal types through temporary mounting: (Chlorella and *Anabaena)*
2. Microscopy study of thallus structures in Riccia and Cycas
3. Preparation of mycorrhizal slides by trypan blue method
4. T.S of monocot and dicot root
5. T.S of monocot and dicot stem
6. T.S of monocot and dicot leaf
7. Observation of permanent slides: Anther, ovules, embryo sac, embryo
8. Study of specimens with reference to habit, habitat, characteristic features: two examples from each Invertebrate major phylum.

REFERENCES

1. Barnes, R.D. (2000). Invertebrate Zoology, Hall Saunders International Editions.
2. Jordan, E.L. & Verma,P.S. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
3. Jordan, E.L. & Verma, P.S. (2006). Chordate Zoology, New Edition, S. Chand & Co. Pvt. Ltd. New Delhi.
4. Pandey, S.N., Misra, S.P. & P S Trivedi. (2015). A Textbook of Botany, Volume I, Vikas Publishing House Pvt. Ltd.
5. Pandey, S.N., Misra, S.P. & P S Trivedi. (2016). A Textbook of Botany, Volume II, Vikas Publishing House Pvt. Ltd.
6. Verma, V. (2010). Botany, Ane Books, Pvt. Ltd.

WEB REFERENCES

1. https://www.researchgate.net/publication/228542744_Paleobotany_Some_Aspects_of_Non-Flowering_and_Flowering_Plant_Evolution (Angiosperms and Gymnosperms)
2. https://www.journals.elsevier.com/algal-research (Algae)
3. https://academic.oup.com/mbe/article/23/3/541/1110188 (Chordates)
4. https://www.sciencedirect.com/science/article/pii/S0960982211008311 (Metamorphosis)
5. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/echinodermata (Echinodermata)

BIO-III.E-2: METABOLISM OF BIOMOLECULES

COURSE TITLE: 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 objectives

While the core course in Biomolecules explored the different biomolecules, their structure and function, this elective aim to provide clarity to those basics by integrating the processes of metabolism and observing their function under different conditions.

Course Outcomes

On the successful completion of the course, students will be able to:

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-2: METABOLISM OF BIOMOLECULES (THEORY)

Module I **(15 hrs)**

Basic concepts and design of metabolism - 2 hrs

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

Carbohydrate metabolism - 9 hrs

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

Amino acid catabolism and anabolism - 4 hrs

Overview of biosynthesis and catabolism of amino acids; Urea cycle

Module II **(15 hrs)**

Fatty acid synthesis and degradation - 7 hrs

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

Oxidative phosphorylation - 4 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

Nucleotide metabolism - 4 hrs

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

Module III **(15 hrs)**

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.

Metabolic Disorders - 7 hrs

Clinical characteristics; diagnosis and management of: Ehlers Danlos syndrome (Classic type), Lesch-Nyhan syndrome, Alzheimer's disease; Xeroderma pigmentosum; Crutzfeldt-Jakob disease; Gout

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

COURSE TITLE: METABOLISM OF BIOMOLECULES (PRACTICAL)

COURSE CODE: BIO-III.E-2

MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Estimation of protein – Biuret method
2. Estimation of DNA by Diphenylamine method
3. Estimation of Urea (serum/urine)
4. Estimation of Uric acid (serum/urine)
5. Estimation of blood glucose
6. Isolation of lecithin from egg yolk
7. Isolation of cholesterol from egg yolk
8. Separation of fatty acids by TLC
9. Estimation of blood cholesterol
10. Case studies: Clinical Characteristics, Diagnosis and Management of:
11. Alzheimer's Disease and Xeroderma pigmentosum, Ehlers Danlos syndrome, Crutzfeldt-Jakob disease.

REFERENCES

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

WEB REFERENCES

1. https://www.ncbi.nlm.nih.gov/books/NBK22593/ (Glycolysis)
2. https://www.ncbi.nlm.nih.gov/books/NBK21528/ (Oxidative Phosphorylation)
3. https://www.youtube.com/watch?v=J30zpvbmw7s (Oxidative Phosphorylation)
4. https://www.ncbi.nlm.nih.gov/books/NBK513323/ (Urea Cycle)
5. https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/pyruvate-oxidation-and-the-citric-acid-cycle/a/the-citric-acid-cycle (TCA Cycle)
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243375/ (Nucleotide Metabolism)
7. https://www.ncbi.nlm.nih.gov/books/NBK22459/ (Amino Acid Metabolism)

BIO-E-26: GENOMICS & PROTEOMICS

COURSE TITLE: GENOMICS & PROTEOMICS (Theory)
COURSE CODE: BIO-E-26
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

The course will give a detailed description of various wet lab tools for analysis of DNA and physio-chemical properties of proteins. The course also focuses on several in silico tools for large scale analysis of gene and protein expression data.

Course Outcomes
On the successful completion of the course, students will be able to:
CO1: Understand various techniques of DNA sequencing and their analysis.
CO2: Compare genome analysis across model organisms.
CO3: Demonstrate an understanding of physio-chemical properties of proteins and peptides.
CO4: Identify and analyse different proteome using wet lab tools.
CO5: Understand De novo sequencing using mass spectrometric data

BIO-E-26: GENOMICS & PROTEOMICS (THEORY)

Module I (15 hrs)
DNA sequencing methods-9 hrs
Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.
Genome data analysis tools-6hrs
Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.
Module II (15 hrs)
Physico-chemical analysis of proteins (I)
Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, SDS-PAGE); Native PAGE; Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE
Module III (15 hrs)
Physico-chemical analysis of proteins (II)
Determination of covalent structures – Edman degradation. Protein conformational analysis using various spectroscopic technologies, Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

BIO-E-26: GENOMICS AND PROTEOMICS (PRACTICAL)
COURSE TITLE: Genomics and Proteomics (PRACTICAL)
COURSE CODE: BIO-E-26
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Native PAGE

5. SDS-PAGE
6. Proteomics 2D PAGE database
7. Softwares for Protein localization.
8. Hydropathy plots
9. Interpretation of NMR spectroscopic data

REFERENCES:
1. Bioinformatics: Methods And Applications: Genomics, Proteomics And Drug Discovery by S C RASTOGI, PHI.
2. Genomes, 2nd edition. Terence A Brown. Author Information. Authors. Terence A Brown.Oxford: Wiley-Liss; 2002.
3. Proteomics, Methods and Protocols. Jörg Reinders, Albert Sickmann. : Methods in Molecular Biology (MIMB, volume 564).

BIO-III.E-4: ENZYMOLOGY
COURSE TITLE: ENZYMOLOGY (THEORY)
COURSE CODE: BIO-III.E-4
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
Course Objective
This course will provide a comprehensive view of enzyme chemistry and kinetics, methods and strategies for enzyme purification and characterization. One section also deals with the applications of enzymes in diagnostics.

Course Outcomes
On the successful completion of the course, students will be able to:
CO1: Explain the structure of an enzyme and kinetics of enzyme catalysed reactions
CO2: Understand different types of enzyme inhibitions
CO3: Understand the wide applications of enzymes and future potential
CO4: Isolate and purify crude forms of enzyme extract and apply appropriate method for determination of activity of enzyme
CO5: Discuss factors that affect enzymatic activity

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

Module I **(15 hrs)**
Introduction to enzymes - 8 hrs
Nature of enzymes - protein and non-protein (ribozyme); coenzymes, cofactors & prosthetic group; apoenzyme; holoenzyme; ribozymes & isoenzymes; specificity of enzymes; classification of enzymes
Features of enzyme catalysis - 7 hrs
Fischer's lock and key hypothesis; Koshland's induced fit hypothesis; factors affecting the rate of reactions (time, enzyme concentration, substrate concentration, pH and temperature)

Module II **(15 hrs)**
Enzyme kinetics - 8 hrs

Principles of reaction rates; order of reactions and equilibrium constants; derivation of Michaelis-Menten equation and Lineweaver- Burk plot; significance of K m and V max, K cat and turnover number

Enzyme inhibition - 7 hrs

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

Module III **(15 hrs)**

Mechanisms of enzyme action and regulation - 4 hrs

Mechanism of action of chymotrypsin; regulation of enzyme activity and its importance – aspartate transcarboxylase

Enzyme purification - 6 hrs

Purification of enzymes: salt precipitation; dialysis; molecular exclusion chromatography; PAGE; Molecular weight determination by SDS-PAGE

Applications of enzymes - 5 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

1. Effect of pH on enzyme activity
2. Effect of temperature on enzyme activity
3. Effect of substrate concentration and determination of K m and V max
4. Partial purification of any one enzyme from suitable source- ammonium sulphate precipitation, dialysis
5. Assay of enzyme activity and specific activity
6. SDS-PAGE

REFERENCES

1. Nelson, D. L. & Cox, M.M. (2000), Leininger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
2. Jain, J. L (2005), Fundamentals of Biochemistry, S. Chand and Company Ltd., New Delhi.
3. Murray, R.K, Garner, D.K, Mayes, P.A. &Rodwell, V.W. (2003), Harper's Illustrated Biochemistry, McGraw-Hill Companies.
4. Plummer, D.T. (2006). An Introduction to Practical Biochemistry, Sixth Reprint. Tata McGraw-Hill Publishing Company Limited, New Delhi.
5. Harvey, R.A. & Ferrier, D.R. (2011). Lippincott's Illustrated Reviews, Biochemistry Fifth Edition, Lippincott Williams and Wilkins.

WEB REFERENCES

1. https://link.springer.com/chapter/10.1007/978-0-387-72891-9_1 (Introduction to enzymes)

2. https://teachmephysiology.com/basics/enzyme-activity/enzyme-kinetics/ (Enzyme Kinetics)
3. https://chem.libretexts.org/Courses/University_of_California_Davis/UCD_Chem_107B%3A_Physical_Chemistry_for_Life_Scientists/Chapters/3%3A_Enzyme_Kinetics/3.2%3A_The_Equations_of_Enzyme_Kinetics (Enzyme Kinetics)
4. https://en.wikibooks.org/wiki/Structural_Biochemistry/Enzyme/Reversible_Inhibitors (Enzyme inhibition)
5. https://biocyclopedia.com/index/biotechnology/microbial_biotechnology/enzyme_technolog biotech_enzyme_application.php (Applications of enzymes)
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5956270/ (Applications of enzymes)

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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Trace the history of immunology and compare and contrast primary and secondary immune response.
CO2: Gain knowledge of the structure and function of the cells and organs of immune systems
CO3: Describe the mechanisms of Ag-Ab reaction, hypersensitivity reactions and importance of Complement system
CO4: Understand the importance of Monoclonal Ab and various immunodeficiency diseases
CO5: Familiarize various techniques involved in Immunology

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

Module I **(15 hrs)**

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

Cells and organs of the immune system - 7 hrs

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

Module II **(15 hrs)**

B cells and T cells - 4 hrs

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

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

Complement system - 3 hrs

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

Module III **(15 hrs)**

MHC and Hypersensitivity - 5 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

Vaccines & monoclonal antibodies - 5 hrs

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

Autoimmunity and immunodeficiency - 5 hrs

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

1. Study of lymphoid organs and cells of the Immune System
2. Total count of WBC & RBCs using haemocytometer
3. Differential count of WBC
4. Blood grouping & Rh factor
5. Preparation of serum
6. Single Radial Immuno-diffusion
7. Oceanology's double diffusion method and antibody titre calculation
8. Immuno-electrophoresis
9. ELISA (Demonstration)
10. Serological tests involving precipitations (Pregnancy & Widal)

REFERENCES

1. Arora, M.P. (2006). Cell Biology, Immunology and Environmental Biology, Himalaya Publishing House.
2. Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Kuby, J (2007). Immunology, W.H. Freeman & Company, New York.
3. Rao, C.V. (2011). Immunology, Narosa Book Distributors Pvt. Ltd.
4. Roitt, I.M., Brostoff, J. & Male, D.K. (2012). Immunology, Mosby-Elsevier

WEB REFERENCES

5. https://www.elsevier.com › ... › Medicine › Immunology › Immunology
6. http://www.himpub.com/BookDetail.aspx?BookId=1641&NB=&Book_TitleM=Cell%20

Biology-Immunology%20and%20Environmental%20Biology
7. https://www.roswellpark.org/sites/default/files/thanavala_9-4-14_innate_immunity_part_1.pdf
8. https://www.elsevier.com › ... › Veterinary Immunology

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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the physiological aspects of plants and animals.
CO2: Explain the parts/organs and processes involved.
CO3: Comprehend and distinguish between the organs and organs systems while understanding the biological functions associated with every system.
CO4: Perform basic experiments like blood counts or checking pressure.
CO5: Understand the effect of hormones on plant growth or assess the metabolites in the plant.

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

Module I **(15 hrs)**

Plant – Water Relations -3 hrs

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

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

Physiology of flowering in angiosperms - 4 hrs

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

Module II **(15 hrs)**

Plant hormones and regulation of plant growth - 4 hrs

Hormonal; (auxin, cytokinin, gibberellins, ethylene and abscisic acid); regulation of plant growth and development)

Secondary metabolites in plant - 3 hrs

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

Digestive system- 3 hrs

The digestive system and associated glands in mammals

Muscular system - 2 hrs

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

Excretory system - 3 hrs

The excretory system and associated functions

Module III **(15 hrs)**

Respiration and circulation - 5 hrs

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

Nervous system - 4 hrs

The nervous system and associated functions

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

1. Study of the physiology of plants using charts
2. Study of the rate of photorespiration in plants
3. Study of osmosis: endosmosis and exosmosis in plants
4. Osmolarity of RBCs (Effect of different salt solutions of RBCs)
5. Isolation of Rhizobium from root nodules and Gram's staining
6. Qualitative phytochemical analysis in medicinal plants
7. Analysis of the animal physiology systems in man using charts – the reproductive, digestive, respiratory, circulatory, excretory, nervous and muscular systems.
8. Observation of permanent slides – Transverse section of mammalian gonads
9. Developmental stages in Frog (cleavage, blastula, gastrula)
10. Analysis of components of blood
11. Analysis of human blood pressure and pulse rate in man

REFERENCES

Plant physiology

1. Galston, A.W. (1989). Life Processes in Plants, Scientific American Library, Springer-Verlag., New York, USA.
2. Hopkins, W.G. (1995). Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
3. Moore, T.C. (1989). Biochemistry and Physiology of Plant Hormones (Second edition), Springer-Verlag., New York.
4. Pandey, S.N., Mishra, S.P. & Trivedi, P.S. (1982), College Botany, Tata McGraw-Hill, New Delhi.

Animal Physiology

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

WEB REFERENCES

Plant Physiology

1. https://www.khanacademy.org/science/biology/photosynthesis-in-plants/the-calvin-cycle-reactions/a/calvin-cycle (Calvin Cycle)
2. http://ijpsr.com/bft-article/bioactivity-of-secondary-metabolites-of-various-plants-a-review/?view=fulltext (Secondary Metabolites)
3. https://www.khanacademy.org/science/biology/plant-biology/plant-responses-to-light-cues/a/phototropism-photoperiodism (Photoperiodism)

Animal Physiology

4. https://www.ncbi.nlm.nih.gov/books/NBK442010/ (The Nervous System)
5. https://www.youtube.com/watch?v=jmD0LBdAvlE (The Nervous System)
6. https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-musculoskeletal-system/a/hs-the-musculoskeletal-system-review (The Muscular System)

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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Explain the principle, types of centrifugation and their functions in biological sciences
CO2: Understand the basic differences between agarose electrophoresis, SDS and native PAGE
CO3: Explain the principle and applications of various spectroscopic and chromatographic techniques used in industries
CO4: Discuss radioactivity, radioactivity techniques used in biomedical research
CO5: Perform purification and separation of proteins.

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

Module I **(15 hrs)**

Basics of biochemical studies - 5 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

Centrifugation - 5 hrs

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

Spectroscopy - 5 hrs

Principle and technique of UV, Fluorescence, Infrared, Raman and AAS

Module II **(15 hrs)**

Chromatography - 7 hrs

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

Electrophoresis - 8 hrs

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

Module III **(15 hrs)**

Probes and hybridization - 8 hrs

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

Radioisotopes techniques - 7 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

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

REFERENCES

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

WEB REFERENCES

9. https://www.kopykitab.com › Laboratory-Manual-For-Biotechnology-by-..
10. https://www.sanfoundry.com › analytical-instrumentation-questions-answer…
11. https://www.miniphysics.com › O Level › O Level Quiz
12. wps.pearsoned.co.uk › ema_uk_he_housecroft_chemistry_4
13. https://www.mcqslearn.com/chemistry/spectrometer-multiple-choice-questions.php

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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand basic concepts of evolution and anthropology and importance in biotechnology
CO2: Explain the evolutionary history and describe the historical development of anthropology
CO3: Explain past and present cultures including ecological adaptations with scientific approach
CO4: Describe quantitative and qualitative methods in the analysis of anthropological data
CO5: 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)

***Module I* (15 hrs)**

Evolution of Life - 5 hrs

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

Evolution of Species - 5 hrs

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

Evolution above the species level - 5 hrs

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

***Module II* (15 hrs)**

Speciation - 5 hrs

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

Selection 4 hrs

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

Fossils - 6 hrs

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

Module III **(15 hrs)**

Geographical and Geological Time Scale - 2 hrs

An overview of the geographical and geological time scale

Introduction to anthropology- 2 hrs

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

Evolution of Man - 6 hrs

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

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

1. Study of the various theories of evolution
2. Evidence for Evolution - Study of Darwin's theory of evolution with examples
3. Evidence for Evolution - Study of L.S.B. Leakey's work in establishing human evolutionary development in Africa
4. Problems based on Selection
5. Study of genetic evolution across species
6. Construction of phylogenetic trees
7. Study of types of fossils
8. Study of dentition of different types of mammals – (Herbivores, Carnivores & Omnivores)
9. Visit to museum in Old Goa for anthropological studies
10. Comparative studies of pre-hominids and hominids
11. Comparative studies of haemoglobins

REFERENCES

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

WEB REFERENCES

1. https://www.livinganthropologically.com/biological-anthropology/ (Introduction to

Anthropology and types)
2. https://www.mcqslearn.com/anthropology/basics/quiz/quiz-questions-and-answers.php? (Anthropological Studies and their applications)
3. https://www.dk.com/us/book/9781465462558-dk-eyewitness-books-fossil/ (Examples on fossils and preservation methods)
4. https://www.cambridge.org/core/books/genetics-paleontology-and-macroevolution/E1806891821199EF032AB6EA3A8FD03D (Organic Evolution)
5. https://www.mnn.com/earth-matters/animals/blogs/facts-about-lucy-australopithecine (Fossils of *Australopithecus afarensis)*

BIO-IV.E-8: MOLECULAR GENETICS
COURSE TITLE: MOLECULAR GENETICS (THEORY)
COURSE CODE: BIO-IV.E-8
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45
PRE-REQUISITES: Completion of BIO-II.C-3 and BIO-III.C-5

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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Explain the methods of chromosome analysis and cell division
CO2: Understand the various molecular aspects of human genetics including DNA variation and mutations.
CO3: Apply their knowledge of various molecular techniques in order to diagnose specific genetic disorders.
CO4: Calculate the risk factors in genetic counselling for individuals with a family history of these disorders
CO5: Explain concepts in forensics genetics

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

***Module I* (15 hrs)**

Introduction - 2 hrs

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

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 – nondisjunction; 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

Review of central dogma of molecular biology - 1 hr

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

DNA Variation - 3 hrs

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

Module II **(15 hrs)**

Techniques and tools in molecular biology - 8 hrs

Techniques and Tools in Molecular Biology used in Genetic Diagnoses: genetic material studied for diagnosis– 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: Labelled probes, fluorescence in situ hybridization (FISH),southern blot hybridization, dot blot and reverse dot blot, DNA microarrays.

Genetic counselling - 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 counselling; special problems in genetic counselling

Module III **(15 hrs)**

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

Gene Therapy - 3 hrs

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

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

1. Extraction of DNA from human blood and saliva
2. Visualization of extracted DNA on agarose gels
3. Principle of Southern blot
4. Study of diagnostic tools based on DNA polymorphisms
5. Principle of preparation of human metaphase chromosomes
6. Steps in molecular diagnosis of and further genetic counselling for:
   a) Cystic fibrosis
   b) α-thalassemia and β-thalassemia
   c) Duchenne muscular dystrophy
   d) Huntington's disease

7. Risk calculation: using Bayes method for any two clinical case studies
8. Clinical features of Down's syndrome, Edward's syndrome and Patau syndrome and mechanisms leading to aneuploidy
9. Research: Current status of gene therapy for any two genetic disorders

REFERENCES

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

WEB REFERENCES

1.https://www.lbwcc.edu/Content/Uploads/lbwcc.edu/files/Cell%20Division-Binary%20Fission%20and%20Mitosis%20Answered%20Review%20F%2007.pdf (Mitosis)
2. https://journals.plos.org/plosgenetics/article?id=10.1371/journal.pgen.1006960 (Forensic Genetics)
3. https://www.annualreviews.org/doi/10.1146/annurev-med-012017-043332 (Gene Therapies)
4. https://www.intechopen.com/books/genetic-diversity-and-disease-susceptibility/dna-polymorphisms-dna-based-molecular-markers-and-their-application-in-medicine (Genetic Diversity)
5. https://www.jove.com/science-education-library/2/basic-methods-in-cellular-and-molecular-biology (Basic Methods in cellular and Molecular Biology)
6. https://academic.oup.com/bmb/article/126/1/27/4958384 (Genetic Counselling)

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 Objective

The course 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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: understand the functions of several enzymes and vectors used in cloning.
CO2: acquaint to the versatile tools and techniques employed in recombinant DNA technology.
CO3: Explain the construction of DNA & c DNA library
CO4: Procure skills for selection of recombinants
CO5: Acquire skills on techniques of plasmid isolation

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

Module I **(15 hrs)**

Introduction to genetic engineering - 2 hrs

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

DNA modifying enzymes - 3 hrs

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

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 cerevisiae* (examples and features)**;** shuttle vectors - any one example; vectors for plant – *Ti* plasmid

Module II **(15 hrs)**

DNA insertion into vector - 3 hrs

Ligation; linkers; adaptors, homopolymer tailing

Transformation methods - 8 hrs

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

Identification of recombinants - 4 hrs

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

Module III **(15 hrs)**

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

Amplification of nucleotide sequences - 3 hrs

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

DNA sequencing - 5 hrs

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

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

1. Plasmid DNA isolation by alkaline lysis method
2. Plasmid DNA isolation by boiling method
3. Plasmid DNA separation on agarose gel
4. Molecular size determination of the plasmid
5. Preparation of competent cells in bacteria
6. Transformation in bacteria using suitable plasmid (pUC 18)
7. Selection of transformed colonies
8. Deciphering the DNA sequence from a sequencing gel photograph by Maxam and Gilbert's method and Sanger's method
9. Demonstration of Polymerase Chain Reaction (PCR)

REFERENCES

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

WEB REFERENCES

1. https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/biotechnology/v/dna-sequencing (DNA sequencing)
2. https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-biotechnology/v/the-polymerase-chain-reaction-pcr (PCR)
3. https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-cloning-tutorial/a/bacterial-transformation-selection (Transformation in bacteria using pUC 18)

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

Course Outcomes

On the successful completion of the course, students will be able to:
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 a basic knowledge on cancer genetics and pharmaco-genetics
CO5: Understand the importance of maintaining public health

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

Module I **(15 hrs)**

Historical aspects - 2 hrs

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

Gene structure and expression - 3 hrs

Exons, introns, alternative splicing, epigenetic changes

Genetic factors in common diseases - 6 hrs

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

Complex genetic traits - 4 hrs

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

Module II **(15 hrs)**

Cancer genetics - 5 hrs

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

Introduction to Omics - 3 hrs

Genomics, Proteomics, Metabolomics, Phenomics, Metagenomics

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

Delivering genetics and genomics to consumers - 3 hrs

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

Module III **(15 hrs)**

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.

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

Public health - 4 hrs

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

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

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

REFERENCES

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

WEB REFERENCES

1. https://www.khanacademy.org/science/biology/gene-regulation/gene-regulation-in-eukaryotes/a/overview-of-eukaryotic-gene-regulation (Eukaryotic gene expression)
2. https://onlinelibrary.wiley.com/doi/abs/10.1002/bies.201400138 (Eukaryotic gene expression)
3. https://onlinelibrary.wiley.com/doi/full/10.1002/wrna.1276 (Alternative splicing)
4. http://journals.tubitak.gov.tr/medical/issues/sag-15-45-5/sag-45-5-3-1406-146.pdf

(genetic factors in Alzheimer's disease and age-related macular degeneration)
5. https://www.spandidos-publications.com/br/7/2/105 (genetic factors in Alzheimer's disease)
6. https://www.sciencedirect.com/science/article/pii/S014067361501315X (genetic factors in hemochromatosis)
7. https://link.springer.com/article/10.1007/s10815-017-0895-5 (Genomic imprinting)
8. https://www.sciencedirect.com/science/article/abs/pii/S0168952515000669 (Mosaicism review)
9. https://www.sciencedirect.com/science/article/abs/pii/S0090825817300744 (Cancer genetics)
10. https://www.nature.com/articles/nrg.2018.4 (Omics)
11. https://www.nature.com/articles/nrg3908 (DNA testing Linkage analysis)
12. https://onlinelibrary.wiley.com/doi/abs/10.1002/ajmg.c.31390 (Pharmacogenetics)

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 Objective
The main aim of this course 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.
Course Outcomes
On the successful completion of the course, students will be able to:
CO1: Explain the scope of Environmental Biotechnology.
CO2: Understand the basic ecological concepts, various pollution, its measurements & remediation.
CO3: Describe the various eco-friendly bio-products.
CO4: Assess the quality of the water sample through various parameters like 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-10: ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

Module I **(15 hrs)**
Basic ecological concepts and principles - 3 hrs
Structure (biotic and abiotic components); food chains and food webs; ecological pyramids; productivity and eco-energetic (10% law)
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: bio scrubbers, bio trickling filters and biofilters/ bio beds
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 vermi-technology

Module II **(15 hrs)**

Pollution monitoring - 10 hrs

Bio indicators: concept and examples (indicators of water quality; air pollution indicators); 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; cytogenetic assay; membrane damage; concept and applications of molecular biology in environmental monitoring: reporter gene: concept and applications of biosensors in pollution detection

Pollution abatement: Bioremediation - 5 hrs

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

Module III **(15 hrs)**

Pollution abatement: biodegradation - 6 hrs

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 - superbug (*Pseudomonas* sp.)

Eco-friendly Bio-products - 7 hrs

Biogas (bio-methanization) production; bioethanol production; bio hydrogen production: anaerobic bacteria and photolysis photosynthetic algae; biodiesel production; bioplastics: bio-pol and bio-lac; biopesticide

Scope of environmental biotechnology - 2 hrs

Scope of environmental biotechnology

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

1. Determination of dissolved oxygen concentration of water sample by Winkler's method
2. Determination of biological oxygen demand (BOD) of the given sample
3. Determination of chemical oxygen demand (COD) of the given sample ($KMnO_4$ /$K_2Cr_2O_7$ method)
4. Determination of TS (total solids) of the given water sample
5. Isolation of xenobiotic degrading bacteria by selective enrichment
6. Determination of nitrates from water sample
7. Visit to an effluent /sewage treatment plant and preparation of report
8. Detection of coliforms for determination of the purity of potable water (MPN, Presumptive, confirmatory and confirmed tests)

REFERENCES

1. Agarwal S.K. (2009). Environmental Biotechnology, APH Publishing Corporation New Delhi.
2. Anjaneyulu Y. (2005). Introduction to environmental Science, BS publications, India.
3. Chatterji A.K. (2009). Introduction to Environmental Biotechnology, 2nd ed, Prentice Hall of India Pvt. Ltd. New Delhi.
4. Jogdand B.N. (2008). Environmental Biotechnology (Industrial Pollution Management), Himalaya Publishing House, Mumbai.

5. Santra S.C. (2001). Environmental Science, New central book agency (P) Ltd. Calcutta.
6. Singh B.D. (2008). Biotechnology, 3 rd edition, Kalyani Publishers.
7. Thakur I.S. (2006). Environmental Biotechnology: Basic concepts and applications, I.K. International Pvt. Ltd. New Delhi.

WEB REFERENCES

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2781844/ (Anthropogenic activities and its effects)
2. https://www.khanacademy.org/science/high-school-biology/hs-ecology/hs-human-impact-on-ecosystems/a/hs-human-impact-on-ecosystems-review (Anthropogenic activities and its effects)
3. https://www.sciencedirect.com/book/9780128000212/microbial-biodegradation-and-bior emediation (Anthropogenic activities and its effects)
4. https://www.intechopen.com/books/biodegradation-life-of-science/biodegradation-involved-microorganisms-and-genetically-engineered-microorganisms (Bioremediation & biodegradation)
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4463667/ (Bioremediation & biodegradation)
6. https://www.intechopen.com/books/biofuels-state-of-development/prospective-biodegradable-plastics-from-biomass-conversion-processes (Eco-friendly Bio-products)
7. https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides (Eco-friendly Bio-products)
8. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/biopesticide (Eco-friendly Bio-products)

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 Objective

This course 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 course 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.

Course outcomes

On the successful completion of the course, students will be able to:
CO1: 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.
CO2: 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.
CO3: Plant tissue culture also lends itself for production of transgenic plants which have various applications.
CO4: 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

CO5: In addition, the students will be able to understand genetic engineering methods for production of transgenic plants.

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

Module I **(15 hrs)**

History of plant tissue culture - 2 hrs

International and Indian scientists

Laboratory organization - 4 hrs

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

Sterilization techniques - 2 hrs

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

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's B5

Totipotency - 2 hrs

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

Organogenesis - 1 hr

Root and shoot regeneration and applications

Module II **(15 hrs)**

Organ culture and its applications - 5 hrs

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

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

Soma clonal variation - 2 hrs

Concept; isolation of variants; mechanisms of soma clonal variation and applications

Somatic embryogenesis and artificial seeds - 2 hrs

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

Applications of Tissue Culture in Plant Sciences - 2 hrs

Micropropagation; gene conservation banks; forestry

Module III **(15 hrs)**

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

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

Gene transfer in plants - 4 hrs

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

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

1. Washing, Packing and Sterilization of Glassware
2. Preparation of Stock solutions for Murashige and Skoog (MS) medium
3. Preparation, sterilization and pouring of MS medium
4. Aseptic germination of seedling
5. Callus induction from hypocotyl and carrot cambial explants and subculturing
6. Shoot tip culture
7. Regeneration of shoot/root from callus
8. Setting up of cell suspension culture and checking viability by Evan's blue method
9. Setting up an in vitro culture from seed embryo (embryo culture)
10. Encapsulation of somatic/true embryo (synthetic seeds) and Regeneration of Plants from Synthetic Seeds

REFERENCES

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

WEB REFERENCES

1. https://www.sciencedirect.com/science/article/abs/pii/S0140196301908845 (Tissue culture technology)
2. https://www.researchgate.net/publication/272493719_Plant_Cell_Tissue_and_Organ_Culture_Biotechnology_and_Its_Application_in_Medicinal_and_Aromatic_Plants (organ culture)
3. https://link.springer.com/article/10.1007/BF02632054 (transgenic plants)
4. https://www.nature.com/articles/nbt0188-56 (protoplast culture)
5. https://link.springer.com/chapter/10.1007/978-981-10-2961-5_2 (applications)

BIO-V.E-12: BIOINFORMATICS

COURSE TITLE: BIOINFORMATICS (THEORY)
COURSE CODE: BIO-V.E-12
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This Course 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.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Explain the scope of Bioinformatics

CO2: Understand the basic concept of biological databases, various types and applications of biological databases.

CO3: Describe the various applications of BLAST and FASTA in understanding differences in evolutionary patterns

CO4: Assess the mutations, genetic disorders and understand importance of drug design *In silico*

CO5: Will be able to construct evolution tree, cladogram, retrieve and biological information accessed through various information resources.

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

Module I **(15 hrs)**

Introduction to Computers in Biology - 3 hrs

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

DNA, RNA and Proteins and HGP - 5 hrs

Background of DNA, RNA and Proteins, ORF; Review of transcription and translation;
Introduction to HGP; objectives; achievements of HGP; Ethical and Social issues

Introduction to bioinformatics - 3 hrs

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

Information resources - 4 hrs

Introduction and objectives of NCBI, NLM, NIH, EBI and SRS

Module II **(15 hrs)**

Biological databases - 7 hrs

Types of data and biological databases; Primary databases: GenBank, EMBL, DDBJ; Secondary databases: Swiss-PROT, PDB & PIR; Composite databases: OWL & PROSITE

Structural databases - 5 hrs

X-ray crystallography, PDB, MMDB, CATH, SCOP; Visualization of proteins -Cn3D & Rasmol

Literature databases - 3 hrs

PubMed; Medline and OMIM

Module III **(15 hrs)**

BLAST and FASTA - 4 hrs

Introduction to BLAST and FASTA and their types

Sequence alignment tools - 6 hrs

Sequence alignment - Pairwise and Multiple; Clustal-W Omega; T-coffee

Phylogeny - 5 hrs

Introduction to phylogeny and cladistics; Cladogram and Phylogenetic tree construction; structure and types of phylogenetic trees; differences between cladogram and phylogenetic tree; Applications of phylogeny.

BIO-V.E-12: BIOINFORMATICS (PRACTICAL)
COURSE TITLE: BIOINFORMATICS (PRACTICAL)
COURSE CODE: BIO-V.E-12
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Primary Nucleotide Sequence Databases: NCBI, EMBL, GenBank, DDBJ
2. Protein Sequence Databases: PIR, Swiss-Prot, TrEMBL
3. Human Genome Project (HGP) & Database of Essential Genes (DEG)
4. DNA or gene sequence search
5. Protein or amino acid sequence search
6. Literature database search
7. Structure database search
8. Protein Structure Databases: RCSB - Protein Data Bank and NCBI - MMDB
9. Protein Visualization Tools: Cn3D and Rasmol
10. Multiple Sequence Alignment Tools: Clustal W and Clustal X.
11. Phylogenetic Tree Construction Tool: MEGA and PHYLIP

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

WEB REFERENCES
1. www.ncbi.nlm.nih.gov (NCBI resources)
2. www.pellegrini.mcdb.ucla.edu › wp-content › uploads › sites › 2017/07 (Phylogenetic tree construction)
3. https://vlab.amrita.edu/?sub=3&brch=273&sim=1432&cnt=1 (Phylogenetic tree construction)
4. https://www.ck12.org/biology/phylogeny-and-cladistics/lesson/Cladistics-Advanced-BIO-ADV/ (Phylogeny and Cladistics)
5. https://science.jrank.org/pages/5210/Phylogeny / (Phylogeny and Cladistics)
6. https://pediaa.com/difference-between-cladogram-and-phylogenetic-tree/ (Phylogeny and Cladistics)
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1186895/ (X-ray crystallography and protein structure determination)

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 Objective

This course 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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand and explain various features of a fermenter.
CO2: Comprehend various concepts of Upstream and Downstream processes.
CO3: Describe the production processes of fermentation products like wine or vinegar at the industrial level.
CO4: Design small scale experiments to produce common enzymes like amylase.
CO5: Prepare basic fermentation products like wine, vinegar, etc.

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

Module I **(15 hrs)**

Fermentation equipment and its use - 10 hrs

Definition of fermenter/bioreactors; structure of ideal fermenter; definition and uses of impellers and their types; sparger's 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

Screening and selection of microorganisms - 3 hrs

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

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

Module II **(15 hrs)**

Types of fermentation processes - 3 hrs

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

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

Detection and assay of fermentation products - 5 hrs

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

Scale up of fermentations and increasing product yields - 2 hrs

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

Module III **(15 hrs)**

Downstream processing - 10 hrs

Biomass: separation of cells – flocculation; floatation; filter aids and filtration (surface, depth); centrifugation- batch centrifuge Ex: tubular bowl centrifuge; continuous centrifuge Ex: Basket centrifuge; disintegration in brief: mechanical Ex: ultrasonication; homogenisers and use of ballotine; non mechanical Ex: thermal lysis; chemical detergent solubilisation, organic solvents; enzymatic methods Ex: Lysozyme

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

Purification: chromatography

Formulation - crystallization and drying (convection drying Ex: spray dryers, freeze drying)

Industrial production - 5 hrs

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

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

1. A study on the phases of growth of microorganisms during batch fermentation (equipment: Erlenmeyer flask, medium: nutrient broth, inoculum: *E. coli*).
2. Parts of a fermenter
3. Preparation and sterilization of medium for batch fermentation process
4. Batch fermentation using fermenter
5. Preparation and sterilization of medium for fed-batch fermentation process
6. Fed-batch fermentation
7. Decontamination and sterilization of the fermenter
8. Primary screening of antibiotic producing bacteria by crowded plate technique
9. Secondary screening for antibiotic producers by Giant Colony Technique
10. Production of wine (from pineapple or any other fruit/vegetable) using yeast
11. Production of vinegar from toddy
12. Estimation of total reducing sugars and acidity (total and volatile) in wine and vinegar (before and after fermentation)

REFERENCES

1. Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
2. Patel A.H. (2012). Industrial Microbiology, MacMillan Publishers India Ltd.
3. Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishing Co.
4. Rutledge C. & Kristiansen B. (2001). Basic Biotechnology, 2nd edition. Cambridge press.
5. Stanbury P. F, Whitaker A. & Hall. (1997). Principles of fermentation technology, 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
6. WulfCruger and Anneliese Cruger, A Textbook of Industrial Microbiology. 2007. Sinauer associates pub.
7. Prave P., Faust U., Sitting W., Sukatsch D.A., Fundamentals of Biotechnology. 2004. VCH publishers.

8. Prescott and Dunn, Industrial Microbiology. 4 th ed, 1982. AVI Pub Co.
9. Sivasankar B., Bioseparations: Principles and techniques. 2005. Prentice hall of India Ltd. Delhi.
10. Collin Ratlege, Basic Biotechnology. 2006. Cambridge university press.

WEB REFERENCES

1. https://www.ncbi.nlm.nih.gov/books/NBK234683/ (Wine Fermentation)
2. https://www.ncbi.nlm.nih.gov/books/NBK236005/ (Downstream processing)
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4027325/ (Isolation and Screening)
4. https://www.youtube.com/watch?v=3pL2X-8-eVk (Fractional Distillation)
5. https://www.sciencedirect.com/science/article/pii/S2095809917304241 (Photobioreactors)

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 Objective

This course aims at introducing the importance of the basic concepts of bioethics and biosafety 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 life sciences and their importance in the field of biotechnology.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the importance of general safety measures in laboratories and biosafety guidelines
CO2: Justify the design of confinement facilities at different Biosafety levels,
CO3: Demonstrate good laboratory practices
CO4: Discuss the relevance of intellectual property rights to biotechnological innovations,
CO5: Describe the standard operating procedures for disposal of various types of wastes from the Biotechnology laboratory

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

Module I **(15 hrs)**

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

Safety in Laboratories - 4 hrs

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

International and Indian biosafety guidelines - 5 hrs

Biosafety guidelines in India; International biosafety guidelines: OECD, FAO, WHO, CAC and other organisations

Module II **(15 hrs)**

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

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, breeder's 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

Module III **(15 hrs)**

Case studies - 3 hrs

Patenting Basmati rice; Revocation of patents-turmeric and neem

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

Regulatory affairs - 3 hrs

Good laboratory practices; good manufacturing practices

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

1. General safety measures and study of safety notices
2. Study of preventive measures and first aid during laboratory hazards
3. Case study on handling and disposal of radioactive waste
4. Case study on handling and disposal of medical/microbial waste
5. Study of Good Laboratory Practices
6. Study of Good Manufacturing Practices
7. Study of components and design of a Biosafety laboratory
8. A case study on clinical trials in India with emphasis to ethical issues
9. Planning of establishment of a hypothetical biotechnology industry in India
10. Study of steps of a patenting process

REFERENCES

1. Das H.K. (2008). Textbook of Biotechnology, 3rd edition, Wiley India Pvt. Limited, New Delhi.
2. Dubey R.C. (1993). A Textbook of Biotechnology, S.Chand and Company, New Delhi.
3. Krishna V.S. (2007). Bioethics & Biosafety in Biotechnology, New Age Publishers, Bangalore.
4. Plummer D.T. (1988). An Introduction to Practical Biochemistry, 3 rd Edition, Tata McGraw, New York.
5. Singh B.D. (2003). Biotechnology - Expanding Horizons, 1 st edition, Kalyani Publishers, Ludhiana.
6. Thomas J.A. &Fush R.L. (2002). Biotechnology & Safety Assessment, 3 rd Edition, Academic press.

WEB REFERENCES

1. http://www.iitb.ac.in/safety/sites/default/files/BIO%20SAFETY%20IITB_1.pdf (Introduction to Bio-safety)
2. https://www.ncbi.nlm.nih.gov/books/NBK218625/ (Introduction to Bio-safety)
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3217699/ (Introduction to IPR)
4. https://www.wipo.int/export/sites/www/about-ip/en/iprm/pdf/ch1.pdf (Introduction to IPR)
5. http://www.fao.org/fileadmin/user_upload/gmfp/docs/Biosafety%20Brochure.pdf (Biosafety of GMOs)
6. https://www.hindawi.com/journals/isrn/2011/369573/ (Biosafety of GMOs)

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 Objective

The course will give a detailed description of 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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the theory behind the working of various techniques in cell biology.
CO2: Explain the processes of membrane transport and signal transduction.
CO3: Describe the regulation of the cell cycle events.
CO4: Isolate and visualize the subcellular organelles.
CO5: Prepare slides and identify various stages of Mitosis and Meiosis.

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

Module I **(15 hrs)**

Techniques in cell biology - 10 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

Membrane potentials and nerve impulses - 5 hrs

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

Module II **(15 hrs)**

Cell cycle and programmed cell death - 10 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)

Membrane transport - 5 hrs

Review of structure and composition of cell membrane; transport across the 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)

Module III **(15 hrs)**

Signal transduction - 11 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); Ligand-gated channels; steroid hormone receptors; second messengers- cyclic AMP, phosphatidylinositol derived second messengers; role of calcium and NO as intracellular messengers

Cancer biology - 4 hrs

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

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

COURSE TITLE: ADVANCED CELL BIOLOGY (PRACTICAL)
COURSE CODE: BIO-VI.E-14
MARKS: 25
CREDITS: 1
TOTAL HOURS: 30

1. Identification of different stages of mitosis (in garlic root tip) `
2. Identification of different stages of meiosis (flower buds/ grasshopper testes)
3. Study of cell viability by trypan blue
4. Identification and study of cancerous cells using permanent slides/ photomicrographs
5. Study of plant, animal and human tumour viruses using photomicrographs
6. Differential centrifugation for separation of cellular components
7. Preparation of sucrose density gradient and separation of subcellular organelles
8. Visualization of nuclear fraction by acetocarmine stain and mitochondria by Janus green stain
9. Study of electron micrographs of subcellular organelles
10. Separation of photosynthetic pigments by TLC

REFERENCES

1. Karp, G. & Harris, D. (2008) Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons Inc, New York.
2. Krebs, J.E., Goldstein, E.S. & Kilpatrick, S.T. (2014). Lewin's Genes XI, Jones and Bartlett India Pvt. Ltd.
3. Nelson, D. L. & Cox, M.M. (2000). Leininger's Principles of Biochemistry (3rd Edition), Worth Publishers, New York, USA.
4. Roberti's, E.D.P. & Roberti's, E.M.F. (1998). Cell Biology and Molecular Biology, 8th edition, Sauder College.
5. Watson, J.D., Hopkins, N.H. et al. (2008). Molecular Biology of the Gene, Garland Publishing (Taylor & Francis Group), New York & London.

6. Verma, P.S. & Agarwal, V.K. (2013). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand & Company Pvt. Ltd.
7. Verma, A.S., Das, S. & Singh, A. (2014). Laboratory Manual for Biotechnology, 1 st Edition, S. Chand & Company Pvt. Ltd.

WEB REFERENCES

1. https://www.khanacademy.org/science/biology/cell-signaling/mechanisms-of-cell-signaling/a/signal-perception (Ligands and Receptors)
2. https://www.khanacademy.org/test-prep/mcat/cells/transport-across-a-cell-membrane/a/passive-transport-and-active-transport-across-a-cell-membrane-article (Active, Passive transport)
3. https://www.ncbi.nlm.nih.gov/books/NBK12959/ (Genetic Basis of Cancer)
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4990352/ (Cell Cycle Checkpoints)
5. https://www.ncbi.nlm.nih.gov/books/NBK21466/ (Cell cycle Control)
6. https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-sequencing-pcr-electrophoresis/a/gel-electrophoresis (Gel Electrophoresis)

BIO-VI.E-15: FOOD BIOTECHNOLOGY

COURSE TITLE: FOOD BIOTECHNOLOGY (THEORY)
COURSE CODE: BIO-VI.E-15
MARKS: 75
CREDITS: 3
TOTAL HOURS: 45

Course Objective

This course 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 in both beneficial and harmful ways.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the important spoilage microorganisms in foods and the factors influencing their growth
CO2: Demonstrate the principles of various food preservation techniques and the importance of food quality assurance
CO3: Appreciate the importance of microorganisms as food and fermented food
CO4: Assess the quality of the milk through various tests
CO5: Debate on the Pros and cons of GM foods

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

Module I **(15 hrs)**

History and development of food microbiology - 2 hrs

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

Factors influencing microbial growth in food - 4 hrs

Intrinsic and extrinsic factors responsible for food spoilage

Microorganisms involved in food spoilage - 2 hrs
Microorganisms involved in food spoilage: fruits vegetables, meat, eggs, bread
Food borne diseases - 4 hrs
Food poisoning: (bacterial toxin botulism and Staphylococcal toxin); fungal toxins: aflatoxin; food borne infections: gastroenteritis and Salmonellosis
Microorganisms as source of food - 3 hrs
Nutritive value and use of: Mushrooms Ex: Spirulina

Module II **(15 hrs)**
Milk Microbiology - 6 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
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)
Food quality assurance - 3 hrs
Food safety: HACCP system to food protection

Module III **(15 hrs)**
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: freezing preservation 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
Fermentation technology - 3 hrs
Fermented Food: process, microbiology involved and changes during fermentation of fermented food: sauerkraut; milk products: yogurt
GM foods - 4 hrs
Pros and cons of GM foods Eg: Golden rice, FlavrSavr tomato and Bt Brinjal

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

1. Plating of spoiled food on selective media
2. MIC of common food preservatives – (sugar/ salt)
3. MIC of chemical food preservatives – (sodium benzoate/ potassium meta-bisulphite) Milk Microbiology
4. Standard plate count
5. Grading of quality of milk using dye reduction test (MBDRT / Resazurin)

6. Pasteurisation of milk
7. Determination of efficiency of pasteurisation by phosphatase test
8. Determination of TDP and TDT

REFERENCES

1. Das H.K. (2007). Textbook of Biotechnology, 3 rd Edition, Wiley India (P) Ltd, New Delhi.
2. Frazier W.C & Westhoff D.C. (2015). Food Microbiology. 5 th edition. McGraw Hill Education
3. (India) Private Limited: New Delhi
4. Jay J.M., Loessner, M.J. & Golden D. A. (2005). Modern Food Microbiology, 7th edition. United States: Springer science business media
5. Jogdand S. N. (2004). Medical Biotechnology, Himalaya publishing house Pvt. Ltd, India.
6. Purohit S.S. (2004). Biotechnology: Fundamentals and applications Agrobios, Jodhpur.
7. Ray B. (2004). Fundamental food microbiology, 3rd edition. CRC press: WashingtonD.C
8. Satyanarayan U. (2009). Biotechnology, Books and Allied Pvt Ltd, Calcutta.
9. Singh B.D. (2004). Biotechnology: Expanding horizons, Kalyani Publishers, New Delhi.
10. Tiwari R.P., Hoondal G.S. &Tewari R. (2009). Laboratory Techniques in Microbiology and Biotechnology, Abhishek Publications Chandigarh (India).

WEB REFERENCES

1. https://www.britannica.com/topic/food-preservation (Food Preservation)
2. https://www.sciencedirect.com/topics/food-science/food-borne-disease (Food borne diseases)
3. https://dairyprocessinghandbook.tetrapak.com/chapter/microbiology (Milk Microbiology

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 Objective

This course 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.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the basic concepts of animal cell culture.
CO2: Comprehend the various requirements and techniques for animal cell culture and importance of the same.
CO3: Understand the importance of primary and established cell lines for biotechnological applications.
CO4: Appreciate the various methods of characterization and growth assessment techniques in culturing animal cells.
CO5: Understand the applications of animal cells in the development of disease diagnostics and therapeutics.

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

Module I **(15 hrs)**

Introduction to animal cell culture - 2 hrs

Animal Tissue and Cell Culture (Definition and Concepts in brief), History and Scope of Animal Tissue Culture

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); equipment; culture vessels for tissue culture

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)

Media in animal cell culturing - 6 hrs

Physicochemical properties of culture media (pH, CO_2, O_2 and 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)

Module II **(15 hrs)**

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)

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**)**

Normal cell growth, phases of growth in culture and synchronization of cells - 3 hrs

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

Module III **(15 hrs)**

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)

Cell separation methods - 3 hrs

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

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

1. Washing of glassware and culture wares, preparation of animal cell culture media, sterilization
2. Introduction to use of instruments and sterile techniques in animal cell culture
3. Preparation of Basal Salt Solutions (DPBS) and filter sterilization
4. Preparation of culture media for animal cell culture (DMEM / RPMI 1640) using BSS.
5. Preparation of serum from goat blood & filter sterilization for animal cell culture
6. Dissection of chick embryo for culturing fibroblast cells
7. Estimation of cell viability using MTT & calculations of seeding density for animal cell cultures
8. Establishing a monolayer culture using warm trypsinization method
9. Establishing a monolayer culture using cold trypsinization method
10. Subculture of monolayer culture

REFERENCES

1. Das, H.K. (2005). Textbook of Biotechnology, Wiley India Pvt. Ltd.
2. Freshney, I.R. (2005). Culture of animal cell –A Manual of Basic Techniques, 5th Edition, Wiley- Liss Publications.
3. Gangal, S. (2010). Principles and Practice of Animal Tissue Culture, 2nd edition, Universities Press.
4. Shivangi, M. (2006). Animal Cell and Tissue Culture, Agrobios, India.
5. Singh, B.D (2013). Biotechnology, Expanding horizons, Kalyani Publishers, New Delhi.

WEB REFERENCES

1. https://onlinelibrary.wiley.com/doi/full/10.1002/rmb2.12024 (Requirements and media for animal cell culture)
2. https://books.google.com/books?hl=en&lr=&id=GyfLBAAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEmHDDwriHhMLATOlY (Techniques in animal cell culture)
3. https://link.springer.com/book/10.1007%2F978-3-319-10320-4 (Techniques in animal cell culture)
4. https://link.springer.com/protocol/10.1007/978-1-62703-733-4_7 (Media for animal cell Culture
5. https://books.google.co.in/books?hl=en&lr=&id=GyfLBAAAQBAJ&oi=fnd&pg=PP1&dq=requirements+of+animal+cell+culture&ots=G6-CoDHnJW&sig=Zyukoy1RdMEmHDDwriHhMLATOlY&redir_esc=y (Methods in animal cell culture)
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3931621/ (Characterisation of animal cells)
7. https://link.springer.com/article/10.1007/s11051-015-2958-9 (Growth assessment of animal cells)
8. https://link.springer.com/protocol/10.1007/978-1-4939-2074-7_26 (Viability assays for animal cell culture)
9. https://www.hindawi.com/journals/bmri/2015/285869/ (Applications of animal cell culture)
10. https://www.liebertpub.com/doi/abs/10.1089/ten.TEB.2014.0086 (Application of animal cell culture in tissue engineering)

SKILL ENHANCEMENT COURSE (BIO-SEC-1)

FOOD AND FERMENTATION TECHNOLOGY

SEMESTER: III
COURSE TITLE: FOOD AND FERMENTATION TECHNOLOGY
COURSE CODE: BIO- SEC-1
CREDITS: 4
TOTAL HOURS: 60

Module 1: Introduction to Fermentation technology and production of foods from cereals (15 hours)

1.1: Introduction to fermentation technology (fermenters, microorganisms) and significance of fermented foods (2h)

1.2: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (3h)

(a) Idli/Dosa/sanna

(b) Bread

(c) Dhokla

1.3: Activities based on the above 2 units (10h)

Module 2: Fermented Beverages (15 hours)

2.1: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (4h)

(a) Beer

(b) Fermented juices (eg. apple)

(c) Vinegar

(d) Wine

2.2: Activities based on the above unit (11h)

Module 3: Fermented Non-dairy products (15 hours)

3.1: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (3h)

(a) Tofu

(b) Sauerkraut

(c) Miso

3.2: Activities based on the above unit (12h)

Module 4: Fermented Dairy products (15 hours)

4.1: Introduction, History, Action of microorganisms/ metabolites/ enzymes, Processing and storage of: (3h)

(a) Yoghurt

(b) Cheese

(c) Cultured buttermilk

4.2: Activities based on the above unit (10h)

4.3: Fermented foods for better gut health (2h)