Parvatibai Chowgule College of Arts and Science
(Autonomous)
Accredited by NAAC with Grade 'A+'
Best Affiliated College-Goa University Silver Jubilee Year Award

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS FOR THREE/FOUR YEAR UNDERGRADUATE DEGREE HONOURS OR HONOURS WITH RESEARCH PROGRAMME IN BIOTECHNOLOGY

(Implemented from the Academic Year 2023-2024 onwards)

COURSE STRUCTURE

SEMESTER	MAJOR CORE	MINOR/ VOCATIONAL	MULTIDISCIPLINARY COURSE (MDC)	VALUE ADDED COURSES (VAC)	ABILITY ENHANCEMENT COURSE (AEC)	SKILL ENHANCEMENT COURSE (SEC)
I	UG-BIO-101: Biomolecules	UG-BIO-102: Cell biology	UG-BIO-MDC1: Food and Fermentation technology			UG-BIO-SEC1: Mushroom cultivation
II	UG-BIO-103: Basic Microbiology	UG-BIO-104: Fundamental Genetics	UG-BIO-MDC2: Basics of Biodiversity			UG-BIO-SEC2: Elementary tools for visualisation of biological data
III	UG-BIO-201: Molecular Biology	UG-BIO-203: Metabolism of Biomolecules	UG-BIO-MDC3: Composting technology			UG-BIO-SEC3: Biostatistics:
	UG-BIO-202: Enzymology					
IV	UG-BIO-204:Immunology	UG-BIO-VOC1: Evolution and Anthropology				
	UG-BIO-205:Molecular Genetics					
	UG-BIO-206: Basics of Plant and Animal Sciences					
	UG-BIO-207: Tools and Techniques in Biotechnology					
V	UG-BIO-301: Concepts in Genetic Engineering	UG-BIO-VOC2: Bioethics and Biosafety				
	UG-BIO-302: Environmental Biotechnology					
	UG-BIO-303: Plant Biotechnology					

*** Implementation of fourth year (Semester VII & VIII) is subject to approval from DHE**

VI	**UG-BIO-304: Industrial Biotechnology**	**UG-BIO-VOC3: Advanced Cell Biology**				
	UG-BIO-305: Bioinformatics					
	UG-BIO-306: Animal Cell culture					
	PROJECT (from Major discipline):04 credits					
VII	**UG-BIO-401: Plant and Animal Physiology**	**UG-BIO-308: Human Physiology**				
	UG-BIO-402: Genomics and Proteomics					
	UG-BIO-403: Forensic Sciences					
	UG-BIO-404: Molecular medicine					
VIII	**UG-BIO-405: Medical Biotechnology**	**UG-BIO-309: Advanced Microbiology**				
	UG-BIO-406: Basics of Pharmacology					
	UG-BIO-407: Food Biotechnology					
	UG-BIO-408: Basics of Marine Biotechnology					

SEMESTER I

DISCIPLINE SPECIFIC CORE COURSE

UG-BIO-101: BIOMOLECULES (MAJOR CORE)

COURSE TITLE: BIOMOLECULES (THEORY)
COURSE CODE: UG-BIO-101
CREDITS: 3
MARKS: 75
TOTAL HOURS: 45

Course Objective

This course provides basic foundation on biomolecules of life with reference to their properties, and biological functions. The course also provides detailed knowledge on how cellular structure and function arise as a result of the properties of cellular macromolecules.

Course Outcomes

On the successful completion of this course the students will be able to:
CO1: Discuss the structure of atoms, biomolecules and chemical bonds.
CO2: Understand concepts of enzyme kinetics, bio-polymers and metabolic reactions in a living system.
CO3: Understand and apply general laboratory safety measures as well as calculate for preparation of various chemicals for experiments.
CO4: Prepare different solutions such as buffers, reagents and stock solutions for experiments independently.
CO5: Operate various lab instruments such as weighing balance, water bath and spectrophotometer.

UG-BIO-101: BIOMOLECULES (THEORY)

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

The foundations of Biochemistry - 2 hrs

Landmarks in the history of Biochemistry (contributions particularly by Louis Pasteur, Carl Neuberg, Wilhelm Kuhne, Eduard Buchner); Urey-Millers experiment.

Carbohydrates 6 hrs

Monosaccharides: Structure of aldoses and ketoses, ring structure of sugars; Stereochemistry: mutarotation, anomers, epimers and enantiomers; formation of disaccharides, reducing and non-reducing disaccharides; Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides.

Proteins - 7 hrs

Amino acids: Structure and nomenclature, General properties, Zwitterions, derivatives of amino acids and their biological role; Proteins: Peptide bond formation, structural Levels of protein; Polypeptides: Structure and function of Collagen, Elastin, Myoglobin and Haemoglobin; binding of oxygen to Myoglobin and Haemoglobin; Protein folding and misfolding; denaturation of Proteins.

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

Lipids - 7 hrs

Fatty acids (saturated & unsaturated); Simple Lipids: Fats, oils, waxes; Compound Lipids: Phospholipids & Glycolipids; Derived Lipids: Steroids.

Nucleic acids - 8 hrs

DNA structures and their importance, different types of RNA, unusual DNA structures, other functions of nucleotides: a source of energy, component of coenzymes, second messengers.

Module III **(15 hrs)**

Water and Molecular interactions - 3 hrs

Structure and unique properties; Covalent bonds, Hydrogen bonds, Ionic bonds, Hydrophobic bonds and Vander waals interactions.

Vitamins - 5 hrs

Structure and active forms of water soluble and fat-soluble vitamins; deficiency diseases and hypervitaminosis

Hormones - 2 hrs

Classification and functions

Enzymology 5 hrs

Classification of enzymes; Mechanism of enzyme action, Lock & key theory & Induced fit theory; Factors affecting enzymes activity (pH, temperature, enzyme concentration, substrate concentration); MM equation, Lineweaver-Burk plot; Enzyme Inhibition and its types; Ribozymes & Isoenzymes.

UG-BIO-101: BIOMOLECULES (PRACTICAL)

COURSE TITLE: BIOMOLECULES (PRACTICAL)
COURSE CODE: UG-BIO-101
CREDITS: 1
MARKS: 25
TOTAL HOURS: 30

1. Introduction to safety measures in laboratories
2. Preparation of buffers & solutions (normal, molar, ppm, %)
3. Qualitative tests for carbohydrates, lipids, proteins and nucleic acids
4. Principle and working of a colorimeter and spectrophotometer
5. Determination of λmax and Molar extinction coefficient of a given compound
6. Estimation of reducing sugar - DNSA method
7. Estimation of protein – Folin Lowry's method
8. Titration curve of any one amino acid
9. Determination of peroxide value of oil
10. Effect of pH and temperature on amylase activity

REFERENCES

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

WEB REFERENCES

1. https://www.ncbi.nlm.nih.gov/books/NBK21139/ (Carbohydrates)
2. https://www.ncbi.nlm.nih.gov/books/NBK173989/ (vitamins)
3. nature.com/scitable/topicpage/protein-structure-14122136/ (proteins)
4. https://www.sciencedirect.com/topics/neuroscience/enzymes (Enzymes)
5. https://www.britannica.com/science/hormone (hormones)

UG-BIO-102: CELL BIOLOGY (MINOR CORE)

COURSE TITLE: CELL BIOLOGY (THEORY)
COURSE CODE: UG-BIO-102
CREDITS: 3
MARKS: 75
TOTAL HOURS: 45

Course Objective

The course will give a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on the communication cells and the importance of cell division

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the structure and functional aspects of the Cell wall and plasma membrane.
CO2: Correlate the function of each cell organelle with proper coordination.
CO3: Demonstrate an understanding of cell communication.
CO4: Prepare various plant and animal specimens for observation of cell structures
CO5: Identify and analyse different biological cells using a compound microscope.

UG-BIO-102: CELL BIOLOGY (THEORY)

Module I **(15 hrs)**

Introduction to cell biology - 6 hrs

Cell theory; ultrastructure of prokaryotic and eukaryotic cell; cell matrix proteins; components of extracellular matrix.

Cell wall & Plasma membrane - 9 hrs

Chemical composition; structure and functions of the cell wall and plasma membrane; monolayer; planar bilayers and liposomes as model membrane systems; Fluid mosaic model; lipid rafts; membrane fluidity; factors affecting membrane fluidity; techniques used to study membrane dynamics – FRAP.

Module II **(15 hrs)**

Ultrastructure and function of organelles - 15 hrs

Cilia and Flagella; Endoplasmic reticulum; Golgi apparatus; lysosomes; Microbodies; Mitochondria; Ribosomes; Centrioles and basal bodies; Nucleus; Chloroplasts and Peroxisomes.

Module III **(15 hrs)**

Cell Cycle - 5 hrs

Overview of the cell cycle; prokaryotic & eukaryotic cell cycle; events of mitotic & meiotic phases, cytokinesis.

Cell-Cell interaction - 10 hrs

Interactions of cells with extracellular materials: integrins, focal adhesions and hemidesmosomes; interactions of cells with other cells: selectins, the immunoglobulin superfamily, cadherins, adheren junctions and desmosomes; tight junctions, gap junctions and plasmodesmata.

UG-BIO-102: CELL BIOLOGY (PRACTICAL)

COURSE TITLE: MOLECULAR MEDICINE (PRACTICAL)
COURSE CODE: UG-BIO-102
CREDITS: 1
MARKS: 25
TOTAL HOURS: 30

1. Examination of prokaryotic cell, eukaryotic cell and cell organelles using Photomicrographs
2. Visualization of animal and plant cell using methylene blue
3. Study of cell viability using phenol red / trypan blue
4. Visualization of Permanent slides of:
a. A. Different cell types: Epithelium, Endothelium, Muscle cells, Nerve cell
b. B. Different stages of cell division
5. Identification of different stages of mitosis in onion root tip
6. Identification of different stages of meiosis in onion flower buds
7. Isolation of chloroplasts from spinach leaves
8. Prokaryotic cell harvesting & lysis using osmotic (salt) and Chemical (detergent) methods

REFERENCES

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

WEB REFERENCES

1. https://www.ncbi.nlm.nih.gov/books/NBK9851/ (Cell - Cell Interaction)
2. https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article (Cell Organelles and Structures)
3. https://www.ncbi.nlm.nih.gov/books/NBK9876/ (Phases of the cell cycle)
4. https://www.ncbi.nlm.nih.gov/books/NBK10019/ (Meiosis)
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC158550/ (Effect of temperature on Membrane Fluidity)

MULTDISCIPLINARY COURSES (MDC)

UG-BIO-MDC1: FOOD AND FERMENTATION TECHNOLOGY

COURSE TITLE: FOOD AND FERMENTATION TECHNOLOGY
COURSE CODE: UG-BIO-MDC1
CREDITS: 3
MARKS: 100
TOTAL HOURS: 60

Course Objective
This paper provides an insight about the role of microorganisms in fermentation and use of this technology in food production industries.

Course Outcome
On the successful completion of the course, students will be able to understand the significance of fermentation technology They would also be enlightened about the application of fermentation technology in the production of beverages, dairy and non-dairy products and creation of fermented foods from cereals which are of economic significance that could instil potential business ideas. Additionally they would appreciates the health implication of various fermented foods as well.

FOOD AND FERMENTATION TECHNOLOGY

Module 1:Introduction to Fermentation technology & production of foods from cereals ***(20 hours)***
Introduction to fermentation technology (fermenters, microorganisms) and significance of fermented foods. Introduction, History, Processing and storage of: (a) Idli/Dosa/sanna (b) Bread (c) Dhokla ; Fermented foods for better gut health . Activities based on the above concepts.

Module 2: Fermented Beverages ***(20 hours)***
Introduction, History, Processing and storage of: (a) Beer (b) Fermented juices (eg. apple) (c) Vinegar (d) Wine. Activities based on the above concepts.

Module 3: Fermented Non-dairy and dairy products ***(20 hours)***
Introduction; History; Processing and storage of non-dairy products: (a) Tofu (b) Sauerkraut (c) Miso ; Processing and storage of dairy products: (a) Yoghurt (b) Cheese (c) Cultured buttermilk . Activities based on the based on the above concepts.

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 (India) Private Limited: New Delhi
3. Jay J.M., Loessner, M.J. & Golden D. A. (2005). Modern Food Microbiology, 7th edition. United States: Springer science business media
4. Jogdand S. N. (2004). Medical Biotechnology, Himalaya publishing house Pvt. Ltd, India.
5. Purohit S.S. (2004). Biotechnology: Fundamentals and applications Agrobios, Jodhpur.
6. Ray B. (2004). Fundamental food microbiology, 3rd edition. CRC press: WashingtonD.C

7. Satyanarayan U. (2009). Biotechnology, Books and Allied Pvt Ltd, Calcutta.
8. Singh B.D. (2004). Biotechnology: Expanding horizons, Kalyani Publishers, New Delhi.
9. 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
2. https://dairyprocessinghandbook.tetrapak.com/chapter/microbiology.

SKILL ENHANCEMENT COURSE (SEC)

UG-BIO-SEC1: MUSHROOM CULTIVATION

COURSE TITLE: MUSHROOM CULTIVATION
COURSE CODE: UG-BIO-SEC1
CREDITS: 3
MARKS: 100
TOTAL HOURS: 60

Course Objective

This paper provides an insight to create awareness among students on the different types of mushrooms and its nutritional contents and mushroom cultivation technology.

Course Outcome

On completion of this module, students will be able to understand the importance of mushroom cultivation, understand the mushroom cultivation technology and types of storage methods.

MUSHROOM CULTIVATION

Module 1: Introduction & History ***(20 hrs)***

Introduction to types of edible mushrooms available in India- *Calocybe indica , Pleurotus florida, Agaricus bisporus*; chracteristics features of edible mushrooms; differentiating features between edible and poisonous mushrooms; 4S of mushroom cultivation- spawn, substrate, sanitization and sterilization; recent trends in diversification of edible mushrooms.

Module 2: Cultivation Technology ***(20 hrs)***

Infrastructure: substrates (locally available) Polypropylene bag, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit, water sprayer, tray, culture media preparation; Selection of mushrooms to be cultivated; Production of the starter – Preparation of spawn; Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves Factors affecting the mushroom bed preparation; Preparation of the compost – Spawning, harvesting, post harvesting technology

Module 3: Storage, nutrition and Value added products ***(20 hrs)***

Short-term storage (Refrigeration - up to 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions; Nutrition - Proteins - amino acids, minerals, Carbohydrates, Crude fibre content, Vitamins Types of foods prepared from mushroom;

Research Centres - National level and Regional level; Major pests: Insect Pests, Mite Pests, Viral, Bacterial, fungal Mushroom insect diseases – Prevention and Control measures.
Preparation of value added products viz. Mushroom Soup Powder; Mushroom Biscuit; Mushroom Nuggets; Mushroom Candy; Mushroom Preserve (Murabba); Pickle; Mushroom Chips; Ready-to-Serve Mushroom Curry

REFERENCES

1. Casida L.E. (2009). Industrial Microbiology, New Age International (P) Ltd. New Delhi.
2. Prescott & Dunn. (1982). Industrial Microbiology, 4th edition, AVI Publishinhg Co.
3. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms. Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
4. Swaminathan, M. (1990) Food and Nutrition. The Bangalore Printing and Publishing Co. Ltd., Bangalore.
5. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation. Mittal Publications, Delhi.
6. V.N.Pathak, Nagendra Yadav & Maneesha Gaur, Mushroom Production and Processing Technology. Agrobios (India) Jodhpur.
7. https://nios.ac.in/media/documents/vocational/mushroom_production_(revised)(618)/Lesson-10.pdf

SEMESTER II

DISCIPLINE SPECIFIC CORE COURSE

UG-BIO-103: BASIC MICROBIOLOGY (MAJOR CORE)

COURSE TITLE: BASIC MICROBIOLOGY (THEORY)
COURSE CODE: UG-BIO-103
CREDITS: 3
MARKS: 75
TOTAL HOURS: 45

Course Objective

The main aim of this course is to introduce the students to the vast world of Microbiology. This course covers a range of topics in Basic Microbiology from the historical perspective to the structure and composition of microorganisms, their interactions with the environment and their impact on humans.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Understand the scope and importance of Microbiology, classification schemes, cultivation, preservation and maintenance of microbial cultures.
CO2: Discriminate between various groups of microorganisms and also comprehend the beneficial and harmful effects of each group of microorganisms.
CO3: Compare, analyse, apply the concepts of principle, working of microscopes types.
CO4: Adhere to strict laboratory safety measures to be followed in a microbiology laboratory.
CO5: Master skills in aseptic techniques as well comprehend the importance of cleaning and decontamination.

UG-BIO-103: BASIC MICROBIOLOGY (THEORY)

Module I **(15 hrs)**

History and Scope of Microbiology - 2 hrs

Historical account from 16th – 19th century

Basics of Microscopy - 3 hrs

Principle of working of light microscope (Bright-field, Dark-field, Phase-contrast, Fluorescence).

Bacterial Taxonomy - 8 hrs

Introduction to Archaea; taxonomic ranks; classification systems (Phenetic, Numerical, Phylogenetic); Bergey's Manual of Systematic/ Determinative Bacteriology and rdNA sequencing.

Reproduction in bacteria - 1 2 hrs

Binary fission; definitions: cell growth, growth rate, generation time

Module II **(15 hrs)**

Cultivation of microorganisms - 8 hrs

Sterilisation; disinfection; decontamination: principle and methods; types of culture media: synthetic/defined, complex solid, liquid, enrichment, selective, differential; cultivation of microorganisms: broth culture, agar plate, pour plate; determination of viable count: serial dilution; spread plating; determination of colony forming units (CFU) and calculation of viable count; isolation of pure cultures: streak plate; colony morphology.

Maintenance and preservation of microbial cultures - 4 hrs

Slant and stab cultures; periodic transfer; storage in sterile soil; overlaying with mineral oil; glycerol stocks; preservation in liquid nitrogen; lyophilisation.

Bacteria in Extreme Environments - 3 hrs
Thermophiles, barophiles, halophiles, acidophiles and alkaliphiles.

Module III **(15 hrs)**
Organization and Ultrastructure of a Bacterial cell 8 hrs
Cell wall: structure and chemical composition in Gram positive and Gram-negative bacteria; introduction to cell membrane, pili, fimbriae and capsule; flagella structure and function; nucleoid and plasmids: nature and function; endospore: structure, sporulation and germination; reserve materials.
Reproduction in bacteria - 2 hrs
Bacterial growth curve; characteristics of growth phases; diauxic growth curve, continuous and synchronous growth
Viruses - 5 hrs
Basic classification and structure of viruses (prokaryotic and eukaryotic); characteristic features of phage; viral replication (lytic and lysogenic).

UG-BIO-103: BASIC MICROBIOLOGY (PRACTICAL)
COURSE TITLE: BASIC MICROBIOLOGY (PRACTICAL)
COURSE CODE: UG-BIO-103
CREDITS: 1
MARKS: 25
TOTAL HOURS: 30

1. Introduction to laminar air flow unit, autoclave, pH meter, incubator, microwave & microscope
2. Preparation and sterilization of glassware
3. Preparation of media and autoclaving
4. Preparation of agar plates and open-air cultures
5. Serial dilution technique and spread plating
6. Bacterial isolation techniques: streaking methods such as, simple continuous, T-streak, quadrant, radiant.
7. Preparation and staining of specimen- simple staining, Gram staining, endospore staining
8. Biochemical tests for bacterial identification: sugar fermentation and IMViC tests
9. Isolation and staining of Fungi by lactophenol cotton blue
10. Cleaning and decontamination.

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

WEB REFERENCES

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5524440/ (History of Microbiology)
2. https://microbeonline.com/streak-plate-method-principle-purpose-procedure-results/ (Streaking)
3. https://www.khanacademy.org/science/biology/bacteria-archaea (Bacteria and Archaea)
4. https://www.khanacademy.org/science/biology/bacteria-archaea/prokaryotemetabolismecology/a/prokaryote-classification-and-diversity (Prokaryotic Taxonomy)

UG-BIO-104: FUNDAMENTAL GENETICS (MINOR CORE)

COURSE TITLE: FUNDAMENTAL GENETICS (THEORY)
COURSE CODE: UG-BIO-104
CREDITS: 3
MARKS: 75
TOTAL HOURS: 45

Course Objective

Genetics allows for the understanding of the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders.

Course Outcomes

On the successful completion of the course, students will be able to:
CO1: Outline the basic principles of Mendelian genetics and compare and analyse different inheritance patterns as well as solve problems based on genetic principles.
CO2: Compare and contrast different mutations, their effects on cells and the application of the same to research.
CO3: Differentiate between the structure and working of a compound and dissection microscope.
CO4: Construct and interpret a karyotype prepared from a spread of metaphase chromosomes.
CO5: Understand and identify Barr bodies and Giant chromosomes.

UG-BIO-104: FUNDAMENTAL GENETICS (THEORY)

Module I **(15 hrs)**

Introduction to Genetics - 2 hrs

Scope and importance of Genetics; terminology.

Mendelian Genetics - 9 hrs

Mendel's experiments; principle of segregation; monohybrid crosses (dominance, recessive, co-dominance, incomplete dominance); principle of independent assortment; multiple alleles ABO blood type, Rh factor alleles in humans; genotypic interaction, epistasis, pleiotropy, extra-nuclear inheritance.

Chromosomes - 4 hrs

Chromosome number; morphology; chromosome material and chemical composition; giant chromosomes.

Module II **(15 hrs)**

Introduction to the concepts - 2 hrs

Inbreeding, heterosis, hybrid vigour.

Cell Cycle and cell division - 4 hrs

Cell cycle - G1, S and G2 phase; Mitosis and Meiosis, Cell cycle checkpoints.

Linkage and Crossing Over - 4 hrs
Concept of linkage and crossing over, Sutton-Boveri Chromosome theory of inheritance; coupling and repulsion hypothesis; types of linkage (complete and incomplete); types of crossing over; mechanism of meiotic crossing over & significance.
Population Genetics - 5 hrs
Gene pool; theory of allele frequencies (gene and genotypic frequencies); the Hardy-Weinberg principle and its application; exceptions to the Hardy-Weinberg principle -natural selection; random genetic drift; problems on Hardy-Weinberg principle; speciation-definition of species and mode of speciation (allopatric, sympatric).

Module III **(15 hrs)**
Sex Determination, Sex Linkage and Pedigree Analysis - 8 hrs
Sex determination (pattern and sex chromosomes); sex determination in human beings and flowering plants; dosage compensation; sex-linked inheritance – Haemophilia, Duchenne Muscular Dystrophy, Fragile X Syndrome, Colour blindness; pedigree Analysis – penetrance and expressivity; family tree; dominant inheritance; recessive inheritance.
Structural and Numerical Chromosomal Mutations - 4 hrs
Types of structural changes (deletion, duplication, inversion, translocation, variation in chromosome morphology); types of numerical changes (euploidy and aneuploidy).
Human Genetics - 3 hrs
Gene action and related diseases (Alkaptonuria, Phenylketonuria, Sickle Cell Anaemia); autosomal and sex chromosomal anomalies involving numerical and structural aberrations. (Down's, Cri-du-chat, Klinefelter's and Turner's syndromes).

UG-BIO-104: FUNDAMENTAL GENETICS (PRACTICAL)
COURSE TITLE: FUNDAMENTAL GENETICS (PRACTICAL)
COURSE CODE: UG-BIO-104
CREDITS: 1
MARKS: 25
TOTAL HOURS: 30

1. Study of a dissection microscope.
2. Study of Barr bodies in sex determination.
3. Study of Polytene chromosomes.
4. Study of Mendelian traits in human population
5. Problem solving on Mendel's Laws & Hardy-Weinberg's Law
6. Karyotype analysis of chromosomal abnormalities
7. Pedigree analysis and problem solving.

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

WEB REFERENCES

1. https://journals.sagepub.com/doi/full/10.1177/0962280215597579 (mendelian genetics)
2. https://link.springer.com/article/10.1007/s10577-017-9562-z (Giant chromosomes)
3. https://www.sciencedirect.com/science/article/abs/pii/S0962892416301271 (cell cycle, division)
4. https://onlinelibrary.wiley.com/doi/abs/10.1111/mec.13736 (linkage and crossing over)
5.https://onlinelibrary.wiley.com/doi/abs/10.1002/em.21945 (Structural, numerical chromosomal mutations)
6. https://www.genetics.org/content/203/2/699.short (pedigree analysis)

MULTDISCIPLINARY COURSES (MDC)

UG-BIO-MDC2: BASICS OF BIODIVERSITY

COURSE TITLE: BASICS OF BIODIVERSITY
COURSE CODE: UG-BIO-MDC2
CREDITS: 3
MARKS: 100
TOTAL HOURS: 60

Course Objective

The objective of the paper is to introduce the fundamental concepts of biodiversity to students and improve their understanding on various aspects of the same.

Course Outcome

On successful completion of the course, students will gain awareness on basic knowledge of local biodiversity. It will also involve basic concepts of biodiversity identification and generate a sense of belonging and ownership to the biodiversity and its conservation.

BASICS OF BIODIVERSITY

Module I ***(20 hrs)***

Identification of Biodiversity

Introduction to biodiversity**;** Type of biodiversity (genetic , species, ecosystem); Distribution of Biodiversity; Biodiversity values; Threats to Biodiversity; IUCN status (India); Conservation measures, Hotspots of biodiversity (world & India). Activities based on the above concepts.

Module II ***(20 hrs)***

Identification of Common species.

Plants: Non flowering plants- Ferns, Mosses, gymnosperms; Flowering plants- Monocots and Dicots; Animals: fish, amphibians, reptiles, mammals and birds; Microbes & Archaea.

Activities based on identification of common local Birds, local fish, Amphibians and Observation of microbes such as bacteria and fungus/yeast under a microscope (Bacteria).

Module III ***(20 hrs)***

Case studies related to biodiversity and conservation efforts.

Case studies around the world: 10 Landmark Cases for Biodiversity

Indian context: Chipko andolan, The Project Tiger, Project elephant, Orissa – Olive Ridley Turtles, Beej Bachao Andolan (Save the Seeds Movement), Kokkare Bellure – Karnataka: Co-existence (Man and Wildlife); Kailadevi Wildlife Sanctuary – Sawai Madhopur, Rajashtan.

Activities: Visit to Bondla Wildlife Sanctuary; Preparation of Synthetic seeds and planting of a tree (lab to field).

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
2. https://www.journals.elsevier.com/algal-research
3. https://academic.oup.com/mbe/article/23/3/541/1110188
4. https://www.sciencedirect.com/science/article/pii/S0960982211008311
5. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/echinodermata

SKILL ENHANCEMENT COURSE (SEC)

UG-BIO-SEC2: ELEMENTARY TOOLS FOR VISUALISATION OF BIOLOGICAL DATA

COURSE TITLE: ELEMENTARY TOOLS FOR VISUALISATION OF BIOLOGICAL DATA
COURSE CODE: UG-BIO-SEC2
CREDITS: 3
MARKS: 100
TOTAL HOURS: 60

Course Objective

To provide basic information about the field of Bioinformatics, its applications. The students will be able to understand Basics of Bioinformatics and its applications in the field of Biotechnological research and related field.

Course Outcomes

On successful completion of this course, students will be able to understand basics of computer and bioinformatics and its application in biological sciences. They will get acquainted with biological databases and its types, Data retrieval systems;tools and algorithms for analysis of biological data.

ELEMENTARY TOOLS FOR VISUALISATION OF BIOLOGICAL DATA

Module I: Basics of computer sciences and concepts in bioinformatics (20 hrs)

Basics of computer structure, input and output devices, memory devices, Internet – IP address, TCP/IP, DNS, & URL; Bioinformatics-definition, history, aims, scope and applications; Literature Databases – PubMed.

Biological databases: DNA Databases – GenBank, EMBL, DDBJ, understanding structure of DNA databases; Protein Databases – UniprotKB, Swiss Prot, TrEMBL, understanding structure of these databases; Structural Databases – PDB and Understanding its structure.

Module II: Sequence Alignment (20 hrs)

Pairwise and Multiple sequence alignment, Global and Local Alignment, Dot-Plot method, BLAST and FASTA tools for sequence similarity search, Basics of phylogenetics, online tools for sequence alignment.

Module III: Visualisation of Amino Acids and Protein structure (20 hrs)

Amino acids and Protein structure - primary, secondary, tertiary and quaternary, basics of secondary and tertiary structure prediction methods, Ramachandran Plot, Homology Modelling, Companies & Research Institutes in Bioinformatics – India & International.

References:

1. Bioinformatics. Baxevanis, A.D. and Quelette, B.F.F.
2. Bio informatics. Des Higgins & Willie Taylor
3. Bioinformatics. Methods and protocols. Macsewer, S.
4. Bioinformatics. Sequence and genome analysis. Mount, D.W.
5. Computer fundamentals. Nagpal, D.P.

SEMESTER III

DISCIPLINE SPECIFIC CORE COURSE

UG-BIO-201: MOLECULAR BIOLOGY (MAJOR CORE)

COURSE TITLE: MOLECULAR BIOLOGY (THEORY)
COURSE CODE: UG-BIO-201
CREDITS: 3
MARKS: 75
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: Understand basic concepts in molecular biology
CO2: Explain the structure of DNA and its properties
CO3: Distinguish between DNA, RNA and Proteins
CO4: Compare differences between replication, transcription and translation processes in prokaryotes and eukaryotes.
CO5: Describe the mechanism of gene transfer and regulation

UG-BIO-201: 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

UG-BIO-201: MOLECULAR BIOLOGY (PRACTICAL)

COURSE TITLE: MOLECULAR BIOLOGY (PRACTICAL)
COURSE CODE: UG-BIO-201
CREDITS: 1
MARKS: 25
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

UG-BIO-202: ENZYMOLOGY (MAJOR CORE)

COURSE TITLE: ENZYMOLOGY (THEORY)
COURSE CODE: UG-BIO-202
CREDITS: 3
MARKS: 75
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: Understand the structure of an enzyme and kinetics of enzyme catalysed reactions
CO2: Comprehend factors that affect enzymatic activity
CO3: Analyse and compare different types of enzyme inhibitions
CO4: Value the wide applications of enzymes and future potential
CO5: Isolate and purify crude forms of enzyme extract and apply appropriate method for determination of activity of enzyme

UG-BIO-202: 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

UG-BIO-202: ENZYMOLOGY (PRACTICAL)
COURSE TITLE: ENZYMOLOGY (PRACTICAL)
COURSE CODE: UG-BIO-202
CREDITS: 1
MARKS: 25
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)

UG-BIO-203: METABOLISM OF BIOMOLECULES (MINOR CORE)

COURSE TITLE: METABOLISM OF BIOMOLECULES (THEORY)
COURSE CODE: UG-BIO-203
CREDITS: 3
MARKS: 75
TOTAL HOURS: 45
PRE-REQUISITES: Completion of UG-BIO-101-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: Elucidate the interconnections of metabolic pathway.
CO3: Analyse the effect of diet on metabolism and defects caused due to improper metabolism.
CO4: Evaluate the causes and treatment of various metabolic disorders through case studies.
CO5: Estimate and isolate various biomolecules using spectrophotometry, Thin layer chromatography & centrifugation techniques.

UG-BIO-203: 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

UG-BIO-203: METABOLISM OF BIOMOLECULES (PRACTICAL)
COURSE TITLE: METABOLISM OF BIOMOLECULES (PRACTICAL)
COURSE CODE: UG-BIO-203
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)

MULTDISCIPLINARY COURSES (MDC)

UG-BIO-MDC3: COMPOSTING TECHNOLOGY

COURSE TITLE: COMPOSTING TECHNOLOGY
COURSE CODE: UG-BIO-MDC3
CREDITS: 3
MARKS: 100
TOTAL HOURS: 60

Course Objective
This paper provides an insight to create awareness among students on organic compost production from biodegradable wastes using earthworms, fly larvae and microbes.

Course Outcome
On completion of this module, students will be able to understand the importance and application of compost production for sustainable environment management.

COMPOSTING TECHNOLOGY

Module I: ***(20 hrs)***

Introduction to composting
Meaning, history, economic importance, value in maintenance of soil structure, role in recycling of organic wastes, Composting for sustainable agriculture and prospects of second green revolution using earthworms. Alternative methods of composting-Bokashi, Black Soldier Fly Larvae.

Selection of the organism (earthworm, black soldier fly, microbes)
Earthworm anatomy, black soldier fly anatomy and microbe classification including those based on their feeding habits, ecological strategies, Choosing the right organism; Useful species of organisms; Local species; Exotic species; working with organisms: bedding; food source; moisture, aeration; protection against predators.

Composting technology
Requirements for compost production- site selection, selection of suitable organism, selection of food, selection of bedding material. Methods of vermicomposting-Pit or pot method- Heap method, Bin or tray method, Windrow method, Wedge system, Vermi reactor system.
Harvesting - Manual methods, Self-Harvesting (migration) methods, Mechanical methods, Nutritive value of vermicompost, Overview of Potential Benefits and Constraints, Vermiwash collection, composition & use. Bokashi composting, black soldier fly larvae based composting-methods, application, limitations.

Module II: ***(20 hrs)***

Composting Technology prospects
Field trip to composting technology center, General problems in vermicomposting, Bokashi composting, composting with black soldier fly larvae. Prospects of composting as self-employment venture, Challenges in Scale-up. Advantages and Disadvantages of vermicomposting, Bokashi and black solider fly larvae based composting.

Module III: ***(20 hrs)***

Application of Composting Technology
Designing composting technology unit (earthworms, black soldier fly larvae, bokashi composting), value added products from composting technology, outreach programmes.

References

1. Sathe, T. V. (2004). Vermiculture and Organic farming. Daya publishing House, New Delhi.
2. Dortmans, Bram & Diener, Stefan & Verstappen, Bart & Zurbrügg, Christian. (2017). Black Soldier Fly Biowaste Processing - A Step-by-Step Guide.
3. Sinha, Rajiv & Valani, Dalsukh & Chauhan, Krunal & Agarwal, Sunita. (2010). Embarking on a second green revolution for sustainable agriculture by vermiculture biotechnology using earthworms: Reviving the dreams of Sir Charles Darwin. Journal of Agricultural Bi-otechnology and Sustainable Development. 2. 113-128.
4. Bokashi Composting: The Definitive Guide That Contains The Basics Of Bokashi Compost And How It Can Help Your Garden Paperback – April 5, 2021
5. R.K. Bhatnagar & R.K. Palta, Earthworm Vermiculture and Vermicomposting. Kalyani Publishers, Chennai.
6. P.K. Gupta, Vermi Composting for Sustainable Agriculture. Agrobios (India), Jodhpur.

SKILL ENHANCEMENT COURSE (SEC)

UG-BIO-SEC3: BIOSTATISTICS

COURSE TITLE: BIOSTATISTICS
COURSE CODE: UG-BIO-SEC3
CREDITS: 3
MARKS: 100
TOTAL HOURS: 60

Course Objective

To introduce students to statistical methods and to understand the underlying principles (summarizing data and drawing valid inferences based on the limited information). The purpose of the course is to give students an introduction to the discipline, an appreciation of a statistical perspective on information from biology and basic critical skills to assess the quality of research evidence.

Course Outcome

On successful completion of this course, students will be able to appreciate the application of statistics in biology. They would also understand the concepts of sampling, representation and interpretation of the data using graphical methods and MS Excel. Additionally they would learn how to solve problems on measures of central tendency, dispersion and hypothesis testing. Also they would be able to apply appropriate statistical tools and softwares in their final year project work.

BIOSTATISTICS

Module 1: Introduction to Biostatistics & different measures of analysis (20 hrs)

Concepts of Biostatistics:

Statistical population, sample, types of data; collection of data, frequency distibution, types of sampling methods

Measures of central tendency:

Mean, Median, and Mode (for grouped and ungrouped data).

Measures of dispersion and Correlation analysis

Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance.

Module 2: Regression analysis, Hypothesis testing and Basic statistical softwares (20 hrs)

Regression analysis and Hypothesis testing

Regression equation, regression coefficient, Parameter and statistics; sampling theory; sampling and non-sampling error; confidence limits testing of -test: unpaired & paired; F test; Chi-square test and ANOVA

Software in statistics

MS Excel, XLSTAT, PAST, IBM SPSS. Solving different statistical problems using the software.

Module 3: Graphical/Diagrammatic representation of data & experimental study (20 hrs)

Tabulation of data; graphical and diagrammatic representation of data; construction of graphs using computer programs; Experimental study and report preparation.

REFERENCES

1. Banerjee, P.K. (2011). Introduction to Biostatistics, A textbook of biometry, New Delhi, India: S. Chand & Company Ltd.
2. Khan IA & Khanum A. (2009). Fundamentals of Biostatistics, Delhi: Ukaaz publications Hyderabad
3. Rajan, K. (2007). Biostatistics Theory and Problems, New Delhi: India, Himalaya Publishing House.
4. Rastogi, V.B. (2009). Fundamentals of Biostatistics, Ane Books Pvt. Ltd, New Delhi.
5. Ross, S. M. (2010). Introductory Statistics. Third edition, Academic press.
6. Arora P.N. and Malhan P.K., (2006), Biostatistics, 2nd Edition, Himalaya Publishing House

WEB REFERENCES

1. http://www.economicsdiscussion.net/statistics/8-functions-of-statistics-scope-and-importance/2325 (Scope & importance of Biostatistics)
2. https://www.toppr.com/guides/business-economics-cs/descriptive-statistics/diagrammatic-presentation-of-data/ (Graphical & Diagrammatic representation of data)
3. http://www.economicsdiscussion.net/statistics/data/graphical-representation-of-statistical-data/12010 (Measures of central tendency)
4. https://statisticsbyjim.com/basics/measures-central-tendency-mean-median-mode/ (Measures of central tendency)
5. http://onlinestatbook.com/2/summarizing_distributions/measures.html (Measures of central tendency)
6. https://www.toppr.com/guides/business-mathematics-and-statistics/measures-of-central-tendency-and-dispersion/measure-of-dispersion/ (Measures of dispersion)
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3198538/ (Measures of dispersion)
8. http://sphweb.bumc.bu.edu/otlt/MPHModules/BS/BS704_Multivariable/BS704_Multivariable5.html (Correlation & regression analysis)

SEMESTER IV

DISCIPLINE SPECIFIC CORE COURSE

UG-BIO-204: IMMUNOLOGY (MAJOR CORE)

COURSE TITLE: IMMUNOLOGY (THEORY)
COURSE CODE: UG-BIO-204
CREDITS: 3
MARKS: 75
TOTAL HOURS: 45

Course Objectives

This paper aims at introducing the basic concepts of the immune system and its defence 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 gain knowledge of the structure and function of the cells and organs of immune systems

CO2: Understand the mechanisms of Ag-Ab reaction, hypersensitivity reactions and importance of Complement system

CO3: Compare and contrast primary and secondary immune response.

CO4: Evaluate the importance of Monoclonal Ab and their role in various immunodeficiency diseases

CO5: Get acquainted with various techniques involved in immunology

UG-BIO-204: 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

UG-BIO-204: IMMUNOLOGY (PRACTICAL)

COURSE TITLE: IMMUNOLOGY (PRACTICAL)
COURSE CODE: UG-BIO-204
CREDITS: 1
MARKS: 25
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
5. Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. (2013). Kuby immunology. New York: WH Freeman.

WEB REFERENCES

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

UG-BIO-205: MOLECULAR GENETICS (MAJOR CORE)

COURSE TITLE: MOLECULAR GENETICS (THEORY)
COURSE CODE: UG-BIO-205
CREDITS: 3
MARKS: 75
TOTAL HOURS: 45
PRE-REQUISITES: Completion of Biomolecules and Molecular biology

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: Understand the various molecular aspects of human genetics including DNA variation and mutations.
CO2: Differentiate between the various methods of chromosome analysis and cell division
CO3: Compare and contrast the various techniques associated with forensics genetics
CO4: Investigate the risk factors in genetic counselling for individuals with a family history of genetic disorders
CO5: Apply their knowledge of various molecular techniques in order to diagnose specific genetic disorders.

UG-BIO-205: 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

UG-BIO-205: MOLECULAR GENETICS (PRACTICAL)
COURSE TITLE: MOLECULAR GENETICS (PRACTICAL)
COURSE CODE: UG-BIO-205
CREDITS: 1
MARKS: 25
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)

UG-BIO-206: BASICS OF PLANT AND ANIMAL SCIENCES (MAJOR CORE)

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (THEORY)
COURSE CODE: UG-BIO-206
CREDITS: 3
MARKS: 75
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: Understand classification of plant and animal kingdom
CO2: Compare and contrast the differences in morphology and anatomy in Angiosperms
CO3: Examine features of the non-chordates and chordates
CO4: Critique various phyla of the plant and animal kingdoms based on characteristics
CO5: Sketch the morphology and anatomy of selected plant and animal specimens.

UG-BIO-206: 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

UG-BIO-206: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)

COURSE TITLE: BASICS OF PLANT AND ANIMAL SCIENCES (PRACTICAL)
COURSE CODE: UG-BIO-206
CREDITS: 1
MARKS: 25
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, testes, ovary and uterus
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)

UG-BIO-207: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (MAJOR CORE)

COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (THEORY)
COURSE CODE: UG-BIO-207
CREDITS: 3
MARKS: 75
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: Comprehend the principle and application of various centrifugation techniques in biological sciences
CO2: Understand the principle and apply various spectroscopic and chromatographic techniques for industrial analysis
CO3: Compare and contrast various electrophoretic techniques used in molecular biology research
CO4: Evaluate the various radioactivity techniques used in biomedical research
CO5: Perform purification and separation of proteins.

UG-BIO-207: 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

UG-BIO-207: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)
COURSE TITLE: TOOLS AND TECHNIQUES IN BIOTECHNOLOGY (PRACTICAL)
COURSE CODE: UG-BIO-207
CREDITS: 1
MARKS: 25
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

VOCATIONAL COURSE (VOC)

UG-BIO-VOC1: EVOLUTION AND ANTHROPOLOGY (VOCATIONAL)

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (THEORY)
COURSE CODE: UG-BIO-VOC1
CREDITS: 3
MARKS: 75
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: Compare and contrast past and present cultures including ecological adaptations with scientific approach
CO4: Examine the 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.

UG-BIO-VOC1: 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

UG-BIO-VOC1: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)

COURSE TITLE: EVOLUTION AND ANTHROPOLOGY (PRACTICAL)
COURSE CODE: UG-BIO-VOC1
CREDITS: 1
MARKS: 25
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)*

List of external examiners for the T.Y.B.Sc Project viva of the Department of Biotechnology (AY: 2023-24)

1. Dr. Sunita Borkar
Associate Professor, Department of Microbiology,
PES College of Arts and Science, Farmagudi, Ponda,
Goa 403404
Email id: sunib456@gmail.com

2. Dr. Flory Pereira
Associate Professor, Department of Microbiology,
PES College of Arts and Science, Farmagudi, Ponda,
Goa 403404
Email id: florycliffy@gmail.com

3. Dr. Shanti N. Dessai
Assistant Professor, Department of Zoology,
Goa University, Taleigao Plateau, Goa
Email id: shantidessai@unigoa.ac.in

4. Mrs. Mrunal Phadke
Assistant Professor, Department of Biotechnology
Dhempe College of Arts & Science, Miramar, Panjim, Goa
Email id: mrunal@dhempecollege.edu.in