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					

*** Four Years structure if approved by 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).

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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.

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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
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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.