

Department of Biotechnology, Parvatibai Chowgule College of Arts and Science (Autonomous),  
Goa



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 YEAR UNDERGRADUATE DEGREE PROGRAMME IN BIOTECHNOLOGY

(Implemented from the Academic Year 2023-2024  
onwards)

**APPROVED COURSE STRUCTURE AS PER NEP**

<b>SEMESTER</b>	<b>MAJOR CORE</b>	<b>MINOR/ VOCATIONAL</b>	<b>MULTIDISCIPLINARY COURSE (MDC)</b>	<b>VALUE ADDED COURSES (VAC)</b>	<b>ABILITY ENHANCEMENT COURSE (AEC)</b>	<b>SKILL ENHANCEMENT COURSE (SEC)</b>
<b>I</b>	<b>UG-BIO-101: Biomolecules</b>	<b>UG-BIO-102: Cell biology</b>	<b>UG-BIO-MDC1: Food and Fermentation technology</b>			<b>UG-BIO-SEC1: Mushroom cultivation</b>
<b>II</b>	<b>UG-BIO-103: Basic Microbiology</b>	<b>UG-BIO-104: Fundamental Genetics</b>	<b>UG-BIO-MDC2: Basics of Biodiversity</b>			<b>UG-BIO-SEC2: Elementary tools for visualisation of biological data</b>
<b>III</b>	<b>UG-BIO-201: Molecular Biology</b>	<b>UG-BIO-203: Metabolism of Biomolecules</b>	<b>UG-BIO-MDC3: Composting technology</b>			<b>UG-BIO-SEC3: Biostatistics:</b>
	<b>UG-BIO-202: Enzymology</b>					
<b>IV</b>	<b>UG-BIO-204: Immunology</b>	<b>UG-BIO-VOC4: Basics of Plant and Animal Sciences</b>				
	<b>UG-BIO-205: Molecular Genetics</b>					
	<b>UG-BIO-206: Plant and Animal Physiology</b>					
	<b>UG-BIO-207: Tools and Techniques in Biotechnology</b>					
<b>V</b>	<b>UG-BIO-301: Concepts in Genetic Engineering</b>	<b>UG-BIO-VOC2: Bioethics and Biosafety</b>				
	<b>UG-BIO-302: Environmental Biotechnology</b>					
	<b>UG-BIO-303: Plant Biotechnology</b>					

<b>VI</b>	<b>UG-BIO-304: Industrial Biotechnology</b>	<b>UG-BIO-VOC3: Food Biotechnology</b>				
	<b>UG-BIO-305: Bioinformatics</b>					
	<b>UG-BIO-306: Animal Cell culture</b>					
	<b>PROJECT (from Major discipline):04 credits</b>					

## 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 Learning Outcomes**

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

CLO1: Understand the landmarks of biochemistry and comprehend the structure cum functional significance of major biomolecules-carbohydrates and proteins.

CLO2: Elucidate the structure and functional importance of lipids and modified biomolecules such as vitamins and hormones

CLO3: Compare and contrast various types of nucleic acid, concepts of enzyme kinetics, and biomolecular interactions in a living system.

CLO4: Develop practical skills in preparation of different solutions such as buffers, reagents, stock solutions and operation of 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.

**Vitamins - 5 hrs**

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

**Hormones - 3 hrs**

Classification and functions

**Module III (15 hrs)**

**Nucleic acids -5 hrs**

DNA structures and their importance, different types of RNA, unusual DNA structures,

**Water and Molecular interactions - 5 hrs**

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

**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); Brief overview of MM equation, Lineweaver-Burk plot, 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. Determination of  $\lambda_{max}$  of a given compound
4. Determination of Molar extinction coefficient of a given compound
5. Estimation of reducing sugar - DNSA method
6. Estimation of protein – Folin Lowry's method
7. Titration curve of any one amino acid
8. Determination of peroxide value of oil
9. Qualitative tests for carbohydrates
10. Qualitative tests for lipids, proteins and nucleic acids
11. 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/](https://www.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 Learning Outcomes**

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

CLO1: Understand the structure and functional aspects of the cell wall and plasma membrane.

CLO2: Interpret the structure and functional importance of each cell organelle.

CLO3: Analyse the cell cycle and cell-cell communication.

CLO4: Develop practical knowledge in identification and analysis of cell organelle & ultrastructure via microscopy, cell cycle stages and perform cell viability studies.

### **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. 5th edition. 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)

## MULTIDISCIPLINARY COURSES (MDC)

### UG-BIO-MDC1: FOOD AND FERMENTATION TECHNOLOGY

COURSE TITLE: FOOD AND FERMENTATION TECHNOLOGY

COURSE CODE: UG-BIO-MDC1

CREDITS: 3

MARKS: 75

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 Learning 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 appreciate 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, 7<sup>th</sup> 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: 75

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 Learning 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*; characteristics 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, 4<sup>th</sup> 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](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 Learning Outcomes

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

CLO1: Discuss the scope of Microbiology, basics of microscopy and bacterial Taxonomy.

CLO2: Execute techniques of culturing, preservation and maintenance of microorganisms.

CLO3: Examine the structure and organisation of microorganisms, growth characteristics and reproduction patterns.

CLO4: Develop skills in microscopic observation, aseptic techniques and microbiological culture methods.

#### 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 Learning Outcomes**

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

CLO1: Understand the basic principles of Mendelian genetics and inheritance patterns

CLO2: Comprehend the importance of cell division, inbreeding, linkage, crossing over and its significance in population genetics

CLO3: Analyse the sex determination patterns, pedigree analysis and disorders associated with structural and numerical chromosomal aberrations.

CLO4: Develop skills in operation of dissection and compound microscope, and identify Barr bodies, Giant chromosomes, construct and interpret karyotypes.

### **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 - G<sub>1</sub>, S and G<sub>2</sub> 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, 8<sup>th</sup> 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<sup>th</sup> 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.

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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)

## **MULTIDISCIPLINARY COURSES (MDC)**

### **UG-BIO-MDC2: BASICS OF BIODIVERSITY**

COURSE TITLE: BASICS OF BIODIVERSITY

COURSE CODE: UG-BIO-MDC2

CREDITS: 3

MARKS: 75

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).

## **SEMESTER I**

### **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](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: 75

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 Learning 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.