B.Sc. in Integrative Biology is an undergraduate Biology course. The study of biology encompasses the study of life and living organisms, including their origin, evolution, distribution, structure, function, growth, and a comprehensive and complete knowledge of all the processes that define life. The degree course includes the study of the fundamental principles of ‘Biology’ namely cell theory, evolution, genetics, molecular biology, immunology, and energy harvesting processes. The B.Sc. (Hons.) degree course provides complete training in the studies of organisms and their relationship to their environment. The duration of the course is three years and the graduates will stand poised to pursue a broad range of careers in biological and medical research, public and global health, science policy, law and intellectual property, business, education, and science writing.

Integrative Biology

B. Sc. (Hons.)

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| **BIO110** | **MICROBIOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | MICROBIOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting 2019 | | | | | | |

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| **PURPOSE** | | A fundamental understanding of how a cell works has come through the study of microorganisms. Microbiology also is an applied science, helping agriculture, health and medicine and maintenance of the environment, as well as the biotechnology industry. Microbiologists study microbes at the level of the community (ecology and epidemiology), at the level of the cell (cell biology and physiology) and at the level of proteins and genes (molecular biology). | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | define/explain within multiple microbiology disciplines the core theories and practices; | |  |  |  |  |  |  |  |
|  | describe/explain the processes used by microorganisms for their replication, survival, and interaction with their environment, hosts, and host populations; | |  |  |  |  |  |  |  |
|  | explain the theoretical basis of the tools, technologies and methods common to microbiology; | |  |  |  |  |  |  |  |
|  | demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments. | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **Unit I - Introduction to microbiology** | **9** |  |  |  |
|  | History of microbiology | 1 | C | 1 | 1 |
|  | Essential methods to study microbes: sterilisation and disinfection: Methods of sterilization- physical methods (heat, filtration), radiation and chemical methods | 2 | C,D,I | 1 | 1 |
|  | Principles of microscopy, Spontaneous generation vs. biogenesis | 1 | C,D,I | 1 | 1 |
|  | Contributions of Anton von Leeuwenhoek, Louis Pasteur-germ theory of disease, Robert Koch- Koch's postulates, Joseph Lister, Alexander Fleming | 2 | C | 1 | 1 |
|  | Microbial growth, Growth media types - selective and differential media | 1 | C | 1 | 1,2,3 |
|  | Influence of environmental factors for microbial growth. Growth phases and kinetics | 1 | C | 1 | 1,2,3 |
|  | Maintenance and preservation of bacterial cultures | 1 | C,D,I | 1 | 1.2 |
|  | **UNIT II** – **Bacterial Cells - Structure and function** | **9** |  |  |  |
|  | Different groups of microorganisms and their general characteristics | 1 | C | 1,2 | 1 |
|  | Ultrastructure of Gram positive and Gram negative bacterial cell wall | 2 | C,D | 1,2 | 1,3 |
|  | Size, shape and arrangement of bacterial cells | 2 | C | 1,2 | 1 |
|  | cell membrane, cytoplasmic matrix, pili, capsule, flagella | 1 | C | 1,2 | 1,2,3 |
|  | Classification & molecular taxonomy-Phylogenetic tree | 1 | C,D | 2,3 | 2,3 |
|  | Measuring diversity by 16S/18S rRNA, RAPD, T-RFLP | 2 | C | 2,3 | 2,3 |
|  | **UNIT III** – **Molecular pathogens** | **9** |  |  |  |
|  | Viral structure and classification | 1 | C | 1 | 1,2 |
|  | Bacteriophage and its life cycle | 2 | C | 1 | 2,3 |
|  | Viral pathogenesis; Immune response to viral infections | 2 | C | 1 | 2,3 |
|  | Acute, chronic and latent viral infections | 1 | C | 1 | 2,3 |
|  | Viral vaccines | 1 | C | 1 | 1 |
|  | Viroid, Prions, Plasmid and transposable elements | 2 | C | 1 | 1,2,3 |
|  | **UNIT IV: Microbial disease and antimicrobial agents** | **9** |  |  |  |
|  | Microbial disease: - Tuberculosis, Typhoid, Infection caused by *E. coli*, *Staphylococcus*, *Sterptochoccus* | 3 | C | 2 | 1,2,3 |
|  | Role of quorum sensing and biofilm in microbial disease | 1 | C | 2 | 2,3 |
|  | Action of antimicrobial drugs | 1 | C | 2 | 1 |
|  | Inhibitors of cell wall synthesis, inhibitors of protein synthesis | 1 | C | 1 | 1 |
|  | Inhibitors of nucleic acid synthesis, competitive inhibitors, antifungal, antiviral, anti-protozoan drugs | 2 | C | 1 | 1 |
|  | Mechanism of antibiotic resistance | 1 | C | 2 | 1 |
|  | **UNIT V: Applied microbiology** | **9** |  |  |  |
|  | Microorganism of Industrial use | 1 | C | 1 | 2,3 |
|  | Basics of fermenter design | 1 | C | 1 | 2,3 |
|  | Primary and secondary metabolites | 1 | C | 1 | 2,3 |
|  | Strains-screening, adaptation and strain improvement | 1 | C | 1 | 2,3 |
|  | Industrial production of antibiotics – penicillin; alcohol- ethanol | 2 | C | 1 | 2,3 |
|  | Food microbiology – Microorganisms in food, Introduction to probiotics and prebiotics, Food preservation | 1 | C | 1 | 2,3 |
|  | Environmental microbiology – Bioremediation, Bioleaching, Microbial degradation of textile waste | 2 | C | 1 | 2,3 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Microbiology, 6th edition (1993), Pelczar, Chan and Krieg; McGraw Hill International |
| 2 | Prescott, Harley, and Klein's Microbiology, 8th edition, (2011), Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton, McGraw Hill International |
| 3 | Stainer R. Y., Ingraham. J. L., Wheelis M. J., Painter P. R. (1999). General microbiology. MacMillan Educational Ltd. London |

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| **BIO111** | **EVOLUTION AND ORGANISMAL BIOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | EVOLUTION AND ORGANISMAL BIOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | The course aims to provide concept of evolution and organismal biology. The course is for the student seeking a foundation for advanced training in genomics, systems biology, ecology, evolutionary biology, conservation and environmental biology, or related sub disciplines. Course will address biological diversity, primarily in plants and animals. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand and describe the processes through which current knowledge about the areas of ecology and evolutionary biology was developed | |  |  |  |  |  |  |  |
|  | To gain an understanding of the general concepts of evolution, natural selection, and speciation. | |  |  |  |  |  |  |  |
|  | Explain the evolutionary processes and the major evolutionary innovations that have led to the diversity of extant plant and animal life | |  |  |  |  |  |  |  |
|  | Appreciate the multidisciplinary nature of ecology and evolutionary biology and the relationships with other courses | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: BIOLOGICAL DIVERSITY AND ORIGIN OF LIFE** | **9** |  |  |  |
|  | Origin of life; Tree of life | 1 | C | 1-4 | 2,3,4 |
|  | Prokaryotic and eukaryotic organisms  Archaea- a group distinct from bacteria and eukarya | 1 | C,D | 1 | 3,4 |
|  | Endosymbiotic theory of organelle biogenesis | 1 | C,D | 1 | 3,4 |
|  | Protozoa- the unicellular eukaryotes  Slime molds; Cyanobacteria and algal life forms | 1 | C,D | 1 | 1,2,3 |
|  | Diversity of plant life- bryophyta, pterediophyta, gymnosperms and angiosperms (dicots and monocots)- a perspective from alternation of generation and anatomy | 2 | C | 1 | 1,2,3 |
|  | Animal life- porifera, ctenophora, chidaria, rotifers, platyhelminths, annelida, mollusca, nematoda, arthropoda, echinodermata and chordata -a perspective from body plan, embryology and anatomy | 2 | C | 1 | 1,2,3 |
|  | Fungi- a group distinct from pants and animals. | 1 | C,D | 1 | 1,2,3 |
|  | **UNIT II** – **HISTORY OF LIFE ON EARTH** | **9** |  |  |  |
|  | History of life on a geological time scale | 1 | C | 2,3 | 1,2,3 |
|  | Great oxygenation event | 1 | C | 2,3 | 1,2,3 |
|  | Paleontology and paleobotany | 1 | C | 2,3 | 1,2,3 |
|  | Evolutionary radiation-Cambrian explosion as an example | 1 | C | 1,2 | 1,2,3 |
|  | Mass extinction events in history | 1 | C | 2 | 1,2,3 |
|  | Taxonomy and biological classification | 2 | C | 2 | 1,2,3 |
|  | Specimen preparation and preservation | 1 | C,D,I | 2 | 1,2,3 |
|  | Brief introduction to biorepositories and their purpose | 1 | C,D |  |  |
|  | **UNIT III** – **EVOLUTION** | **9** |  |  |  |
|  | Theory of evolution by natural selection; A short discussion on Darwin’s “Origin of Species” | 1 | C | 3 | 2,4,5 |
|  | The genetic and developmental basis of evolutionary change | 2 | C | 3 | 2,4,5 |
|  | Brief introduction to molecular evolution; Species, speciation, migration, adaptation and inbreeding | 2 | C,D | 3 | 2,4,5 |
|  | Life history evolution; Macroevolutionary trends; Experimental evolution | 2 | C | 3 | 2,4,5 |
|  | Modes of selection; Evolutionary developmental biology; Evolutionary psychology | 1 | C,D | 3 | 2,4,5 |
|  | Extinction and human evolution; Evolutionary medicine. | 1 | C,D | 2-3 | 2,4,5 |
|  | **UNIT IV: MOLECULAR SYSTEMATICS AND PHYLOGENY** | **9** |  |  |  |
|  | Methods and practices of molecular phylogenetics | 2 | C,D,I | 2-3 | 2,3,4,5 |
|  | Multiple sequence alignment; Clustering and construction of phylogenetic tree, Rooted and un-rooted trees | 3 | C,D,I | 2-3 | 2,3,4,5 |
|  | Bootsrapping method, Cladistics | 2 | C,D, | 3 | 2,3,4,5 |
|  | The concept of phyla-monphylatic, polyphyletic and paraphylatic groups | 2 | C,D | 3 | 2,3,4,5 |
|  | **UNIT V: BRIEF INTRODUCTION TO ECOLOGY** | **9** |  |  |  |
|  | Ecology of individual organisms - physiological ecology | 1 | C | 4 | 2,6,7 |
|  | Population ecology - population growth and regulation | 2 | C,D | 4 | 2,6,7 |
|  | Species interactions, trophic interactions | 1 | C | 4 | 2,6,7 |
|  | Community ecology - community structure and properties | 2 | C | 4 | 2,6,7 |
|  | Succession and disturbance | 1 | C,D | 4 | 2,6,7 |
|  | Ecosystem ecology | 1 | C | 4 | 2,6,7 |
|  | Symbiosis, mutualism, parasitism and predation | 1 | C | 4 | 2,6,7 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Principles of Biology: Interactive textbook from Nature Education |
| 2 | Biology: N. Campbell and J. Reece (2005) 7 edition, Pearson, Benjamin, Cummings |
| 3 | Biology: P.H. Raven, G.B. Johnson, J.B. Losos and S.R. Singer (2005) 7 edition, McGraw Hill |
| 4 | Evolutionary Analysis: S. Freeman and J.C. Herron (2007) Prentice Hall |
| 5 | Evolution: D.J. Futuyma (1997) Sinauer Associates |
| 6 | Ecology: from individuals to ecosystems: M. Begon, C.R. Townsend, thand J.L. Harper (2006) 4 edition, Blackwell Publishing |
| 7 | Ecology: R.E. Ricklefs and G.L. Miller (2000) 4 edition, W.H. Freeman |

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| **BIO210** | **BIOCHEMISTRY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | BIOCHEMISTRY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | Biochemistry involves the study of the molecular composition of living cells, the organization of biological molecules within the cell, and the structure and function of these biological molecules. The biological macromolecules which this course focuses on are proteins, polysaccharides, and polynucleic acids (DNA and RNA), including the monomeric units of these macromolecules. A special emphasis is given on the structure-function relationship of complex protein architectures. The overall goal of this course is for the student to gain a basic working knowledge of biochemical concepts which is necessary for future scientific endeavors. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | the special properties of water and how the aqueous environment influences the behaviour of biological macromolecules | |  |  |  |  |  |  |  |
|  | the structures of amino acids, their chemical properties and their organization into polypeptides and proteins. | |  |  |  |  |  |  |  |
|  | structure of fundamental monosaccharides and polysaccharides structure and basic function of nucleotides | |  |  |  |  |  |  |  |
|  | structure of different classes of lipids and their roles in biological systems | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **Unit I: Biomolecules and Thermodynamics** | **9** |  |  |  |
|  | Biomolecules: water- structure and properties | 2 | C | 1 | 1-2 |
|  | Buffers and its biological importance’s | 1 | C | 1 | 1-2 |
|  | Principles of bioenergetics- Laws of thermodynamics – entropy and enthalpy | 2 | C | 1 | 1-2 |
|  | standard free energy changes- standard reduction potentials | 2 | C | 1 | 1-2 |
|  | thermodynamics of coupled reaction. | 2 | C | 1 | 1-2 |
|  | **Unit II: Carbohydrates** | **8** |  |  |  |
|  | Carbohydrates: definition and functions, | 2 | C,D | 1-2 | 1-3 |
|  | Carbohydrates: classification, properties | 1 | C | 1-2 | 1-3 |
|  | Monosaccharides, disaccharides, oligosaccharides | 1 | C | 1-2 | 1-3 |
|  | Polysaccharides- homo- and hetero- polysaccharides | 2 | C,D | 1-2 | 1-3 |
|  | Quantitative and qualitative methods of carbohydrate estimation | 2 |  | 1-2 | 1-3 |
|  | **Unit III: Lipids** | **10** |  |  |  |
|  | Lipids- Classification- structure and properties | 2 | C | 1 | 1-2 |
|  | Phospholipids- glycolipids- sphingolipids- cholesterol | 2 | C | 1 | 1-4 |
|  | Fatty acids- saturated and unsaturated fatty acids | 3 | C | 1 | 1-4 |
|  | biosynthesis and essential fatty acids | 3 | C | 1 | 1-4 |
|  | **Unit IV: Aminoacid** | **10** |  |  |  |
|  | Amino Acids-Classification and properties | 2 | C | 1-2 | 1-4 |
|  | structure and properties of amino acids | 2 | C | 1-2 | 1-4 |
|  | Essential and nonessential amino acids | 1 | C | 1-2 | 1-4 |
|  | Proteins-classification and functions | 2 | C | 1-2 | 1-4 |
|  | Levels of protein structure | 1 | C | 1-2 | 1-4 |
|  | Haemoglobin and myoglobin | 2 | C | 1-2 | 1-4 |
|  | **Unit V: Nucleic acid** | 8 |  |  |  |
|  | Nucleic acids- Structure | 2 | C | 2 | 1-4 |
|  | Purine and Pyrimidine bases structure | 2 | C | 2 | 1-4 |
|  | Properties and functions of nucleic acids (DNA, RNA) | 2 | C | 2 | 1-4 |
|  | Different forms of DNA and RNA | 2 | C | 2 | 1-4 |
|  |  | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Nelson.D.L, Cox. M. M. Lehninger’s Principle of Biochemistry |
| 2 | Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. Harper’s Biochemistry |
| 3 | Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry |
| 4 | Adams. R.L, Knowler.J.Leader. D.P. Biochemistry of Nucleic Acids. Cambridge Univ. Press, 1998 |

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| **BIO211** | **CELL BIOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | CELL BIOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | Academic Council Meeting, 2019 | | | | | | |

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| **PURPOSE** | | Cells are the building blocks of life. Understanding how cells work is fundamental to our understanding of life. This course will provide detailed insight into cellular structure and function and touch upon complex regulatory mechanisms that control cellular function | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand the fundamental organization of cells in simple systems like prokaryotes and complex systems like eukaryotes | |  |  |  |  |  |  |  |
|  | Understand general concepts cell division and cell death | |  |  |  |  |  |  |  |
|  | Appreciate how cells can over-ride specific pathways to become death-less cancer cells | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: Introduction to Cell biology** | **11** |  |  |  |
|  | History of Cell biology | 2 | C | 1 | 1,2 |
|  | Cell theory, Origin and Evolution of cells | 2 | C,D | 1 | 1,2 |
|  | Basic properties of cells, Prokaryotic cells and types (bacteria and archea) | 2 | C,D | 1 | 1,2 |
|  | Eukaryotic cells and types (unicellular and multi-cellular eukaryotes) | 2 | C,D | 1 | 1,2 |
|  | Cellular organization of prokaryotes vs eukaryotes, | 2 | C | 1 | 1,2 |
|  | Viruses | 1 | C | 1 | 1,2 |
|  | **UNIT II: Cell structure and function** | **8** |  |  |  |
|  | Cell Membrane and their models | 2 | C | 2,3 | 1,2,3 |
|  | Membrane proteins, carbohydrates and their role | 2 | C | 2,3 | 1,2,3 |
|  | Molecular mechanisms of interactions during development | 2 | C | 2,3 | 1,2,3 |
|  | Transport across membranes –Diffusion - active and passive diffusion | 2 | C | 1,2 | 1,2,3 |
|  | **UNIT III** – **Cellular Organelles** | **8** |  |  |  |
|  | Nucleus: Structure and function | 2 | C | 2,3 | 1,2,3 |
|  | Endoplasmic reticulum – Types, structure and function | 2 | C | 2,3 | 1,2,3 |
|  | Golgi apparatus – Structure and function | 1 | C,D | 2,3 | 1,2,3 |
|  | Lysosome– Structure and functions | 1 | C | 2,3 | 1,2,3 |
|  | Morphology and functions of peroxisomes and glyoxisomes | 1 | C | 2,3 | 1,2,3 |
|  | Ribosomes – Types structure and function | 1 | C,D | 2,3 | 1,2,3 |
|  | **UNIT IV: Cell division and Cytoskeleton** | **10** |  |  |  |
|  | Cell division in bacteria – Binary fission | 2 | C,D,I | 3 | 1 |
|  | Eukaryotic cell division processes - Cell cycle, Mitosis, Cytokinesis, Meiosis | 4 | C,D,I | 3 | 1 |
|  | Cytoskeleton and their functions - Actin, Myosin, Microtubules, Intermediate filaments | 4 | C,D, | 3 | 1 |
|  | **UNIT V: Cell death pathways and Cancer** | **8** |  |  |  |
|  | Introduction to Necrosis, Senescence, Apoptosis | 2 | C | 3 | 1, 2, 3 |
|  | Programmed cell death | 2 | C,D | 3 | 1, 2, 3 |
|  | Mechanism of Apoptosis | 1 | C | 3 | 1, 2, 3 |
|  | Oncogenes | 1 | C | 3 | 1, 2, 3 |
|  | Types of cancer | 2 | C,D | 3 | 1, 2, 3 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Bruce Alberts, Molecular Biology of the Cell, Garland Science, 5th edition, 2008 |
| 2 | Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, Molecular Cell Biology, W. H. Freeman; 6th edition, 2007. 2. |
| 3 | Cooper, G. M., & Hausman, R. E. (2004). The cell: Molecular approach. Medicinska naklada |

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| **BIO310** | **GENETICS** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | GENETICS | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | The course enables students to understand fundamentals of inheritance. Also, the fundamental concepts of alleles, mutations and genetic diseases will be covered in this course. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand basic principles of inheritance | | 1 |  |  |  |  |  |  |
|  | Familiarize with the fundamental concepts of population genetics | |  | 2 |  |  |  |  |  |
|  | To understand model systems and their use in studying biology | |  |  | 3 |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: Introduction to genetics** | **10** |  |  |  |
|  | Scope of genetics, Pre-mendelian genetics | 1 | C | 1 | 1,2 |
|  | Mendel’s work on genetics | 2 | C,D | 1 | 1,2 |
|  | Barbara McClintock’s work, Non- Mendelian genetics | 1 | C,D | 1 | 1,2 |
|  | Genetic Variation, Principles of Inheritance | 2 | C,D | 1 | 1,2 |
|  | Concept and basics of alleles, Multiple alleles, Lethal alleles | 2 | C,D | 1 | 1,2 |
|  | Linkage and Crossing over, Recombination | 2 | C,D | 1 | 1,2 |
|  | **UNIT II: Mutations** | **8** |  |  |  |
|  | Chromosomal mutations, Translocation, | 2 | C | 2 | 1,2 |
|  | Deletion, Duplication, Inversion | 1 | C | 2 | 1,2 |
|  | Aneuploidy and Polyploidy; | 2 | C | 1,2 | 1,2 |
|  | Gene mutations: Induced v/s Spontaneous, Back v/s Suppressor mutations. | 2 | C | 1,2 | 1,2 |
|  | Molecular basis of mutations in relation to UV light and chemical mutagens | 1 | C | 1,2 | 1,2 |
|  | **UNIT III: Bacterial and phage genetics** | **10** |  |  |  |
|  | Phage genetics and its applications | 2 | C,D,I | 2-3 | 1,2,3 |
|  | Benzer’s fine structure of gene in bacteriophage T4, Plaque Formation, mapping of phage chromosome by phage crosses | 3 | C,D,I | 2-3 | 1,2,3 |
|  | The genetics of Bacteria; Bacterial transposons; | 2 | C,D, | 3 | 1,2,3 |
|  | Concept of vertical and horizontal gene transfer; Bacterial transformation, transduction and bacterial conjugation | 3 | C,D | 2,3 | 1,2,3 |
|  | **UNIT IV: Chromosomal Basis of Inheritance** | **9** |  |  |  |
|  | Chromosome and chromosomal basis of inheritance; | 2 | C,D | 2,3 | 1,2,3 |
|  | Chromosome structure and Cytogenetics | 3 | C,D | 2,3 | 1,2,3 |
|  | Chromosomal staining and banding patterns, | 1 | C,D | 2,3 | 1,2,3 |
|  | Fluorescent in-situ hybridizations (FISH) | 1 | C,D | 2,3 | 1,2,3 |
|  | Advanced Chromosome biology – karyotyping & Spectral Karyotyping (SKY); Chromosome Painting | 2 | C,D | 2,3 | 2,3,4 |
|  | **UNIT V: Population Genetics and model organism** | **8** |  |  |  |
|  | Allele frequencies, Genotype frequencies, | 1 | C | 1,2 | 1,2 |
|  | Hardy-Weinberg Law | 2 | C,D | 1,2 | 1,2 |
|  | Role of natural selection, Genetic drift. Speciation, Pedigree analysis | 2 | C,D | 1,2 | 1,2 |
|  | A brief Introduction to genetic model organisms: Yeast, Zebrafish, Arabidopsis thaliana, Caenorhabditis elegans and Drosophila melanogaster | 3 | C,D,O | 1,2,3 | 2,3,4 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Introduction to Genetic Analysis: A.J. Griffiths et al. (2008) 9 edition, W.H. Freeman |
| 2 | Genetics: A Molecular Approach by Peter J Russell, 3rd edition, Pearson International Edition |
| 3 | Molecular Biology of the Gene: J.D. Watson, T.A. Baker, S.P. Bell, A.A.F . Gann, M. Levine and R.M. Losick (2007) 7th edition, Benjamin Cummings |
| 4 | Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2007) 5 edition, Garland Science |

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| **BIO311** | **IMMUNOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | IMMUNOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | The purpose of this course is to provide thorough grounding in immunology. This course will acquaint students with the molecules, cells and organs of the invertebrate and vertebrate immune system. Students will learn about the mechanisms involved in immune system development and responsiveness. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand the core principles and learn about different elements of the immune system | |  |  |  |  |  |  |  |
|  | Understand the fundamental mechanisms of innate and adaptive immunity | |  |  |  |  |  |  |  |
|  | Appreciate the importance of immune system in health and disease | |  |  |  |  |  |  |  |
|  | Understand the concepts of vaccine design and its importance in immune development | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: Overview of the Immune System** | **16** |  |  |  |
|  | A historical perspective of immunology. | 2 | C | 1-4 | 1,2,3 |
|  | Cells and organs of the immune system: Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues. | 2 | C,D | 1 | 1,2,3 |
|  | Antigens, Antibodies, Haptens. Types of Immunity: Innate and Acquired. | 2 | C,D | 1 | 1,2,3 |
|  | Innate immunity: Anatomical barriers, cell types of innate immunity. | 3 | C,D | 1 | 1,2,3 |
|  | Adaptive immunity: humoral immunity and cell-mediated immunity. | 3 |  | 1 | 1,2,3 |
|  | Connections between innate and adaptive immunity, cell adhesion molecules, chemokines, cytokines, leukocyte extravasation, localized and systemic response. | 4 |  | 1 | 1,2,3 |
|  | **UNIT II** – **Antibody** | **10** |  |  |  |
|  | Antibody structure and function: Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold. | 3 | C | 1 | 1,2,3 |
|  | effector functions of antibody, antigenic determinants on Ig and Ig super family. | 3 | C | 1 | 1,2,3 |
|  | Antigen-antibody reactions. Hemagglutination and immunological basis of ABO blood grouping. | 2 | C | 1 | 1,2,3 |
|  | Generation of antibody diversity. | 2 | C | 1 | 1,2,3 |
|  | **UNIT III** – **Complement System and The Major Histocompatibility Complex** | **5** |  |  |  |
|  | Complement system: components of complement system. | 1 | C | 2 | 1,2,3 |
|  | Complement activation by classical, alternate and MB lectin pathway. | 1 | C | 2 | 1,2,3 |
|  | MHC complex and antigen presentation: General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins. | 2 | C,D | 2 | 1,2,3 |
|  | Pathways of antigen processing and presentation. | 1 | C | 2 | 1,2,3 |
|  | **UNIT IV: Basic Techniques in Immunology** | **5** |  |  |  |
|  | Radioimmunoassay (RIA), Enzyme-linked immunosorbent assay (ELISA), Coombs tests and detection of Rhesus incompatibility. | 1 | C,D | 2-3 | 1,2,3 |
|  | Monoclonal antibodies. | 1 | C,D | 2-3 | 1,2,3 |
|  | Phage display libraries for antibody V-region production. | 1 | C,D, | 3 | 1,2,3 |
|  | Immunoelectron microscopy, Immunohistochemistry, Immunoprecipitation and co-immunoprecipitation, Immunoblotting. | 1 | C,D | 3 | 1,2,3 |
|  | ELISPOT assay, Transfer of protective immunity, Hematopoietic stem-cell transfers. | 1 | C,D | 3 | 1,2,3 |
|  | **UNIT V: Tolerance, autoimmunity and hypersensitivity** | **9** |  |  |  |
|  | Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity. | 2 | C | 1 | 1,2,3 |
|  | Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity. | 2 | C,D | 1 | 1,2,3 |
|  | Transplantation immunology and vaccines: Immunological basis of graft rejection, clinical manifestations. | 2 | C | 1 | 1,2,3 |
|  | Immunosuppressive therapy and privileged sites. | 1 | C | 1 | 1,2,3 |
|  | Vaccines - active and passive immunization, types of vaccines. | 2 | C,D | 1 | 1,2,3 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Kuby Immunology. T. Kindt, R. Goldsby, B. A. Osborne. W. H. Freeman, 6th edition. |
| 2 | Basic Immunology: Functions and Disorders of the Immune System. Abul K. Abbas, Andrew H. Lichtman. Saunders Elsevier, 3rd edition. |
| 3 | Janeway’s Immunobiology. Kenneth Murphy, Casey Weaver. Garland Science, 9th edition. |

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| **BIO410** | **INTERMEDIARY METABOLISM** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | INTERMEDIARYMETABOLISM | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | The course aims to provide core concept and principles of biochemistry. The course will provide idea about bioenergetics and metabolism. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand the structural and functional properties of carbohydrates,  proteins, lipids and nucleic acids | |  |  |  |  |  |  |  |
|  | To gain an understanding bioenergetics | |  |  |  |  |  |  |  |
|  | an awareness of the ethical aspects of molecular science | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: Foundations of metabolism: Bioenergetics** | **6** |  |  |  |
|  | Laws of Thermodynamics - first and second law | 1 | C | 1 | 2,3,6 |
|  | Concept of enthalpy, entropy and free energy. Standard free energy. Endergonic and exergonic reactions | 2 | C,D | 2 | 2,3,6 |
|  | Coupled reactions. High energy compounds – structural features of ATP and its free energy change during hydrolysis, other high energy compounds | 2 |  |  |  |
|  | Metabolism : Anabolism and catabolism | 1 | C,D | 1 | 2,3,6 |
|  | **UNIT II** – **Metabolism of carbohydrates** | **11** |  |  |  |
|  | Photosynthetic carbohydrate biosynthesis | 1 | C | 2 | 1,2 |
|  | Photorespiration and C4 and CAM pathways | 1 | C | 2 | 1,2 |
|  | Biosynthesis of starch and sucrose. Glycolysis, energetics of glycolysis. Entry of other carbohydrates into glycolytic pathway | 1 | C,D | 2 | 1-4 |
|  | Fates of pyruvate – conversion of pyruvate to lactate, alcohol and acetyl Co-A. | 1 | C | 2 | 1,2 |
|  | Glycogen metabolism – glycogenolysis, glycogen synthesis | 1 | C,D | 2 | 1-4 |
|  | Citric acid cycle and its energetics. Amphibolic integrating roles of TCA cycle | 1 | C,D | 2 | 1-4 |
|  | Glyoxylate cycle. Anaplerotic reactions | 1 | C | 2 | 1,2 |
|  | Pentose phosphate pathway and its significance | 1 | C,D | 2 | 1-4 |
|  | Cori cycle. Gluconeogenesis | 1 | C | 2 | 1-4 |
|  | Disorders of carbohydrate metabolism: Fructose metabolism disorder, Galactosemia, Glycogen storage diseases, Pyruvate metabolism disorders, Wernicke-Korsakoff syndrome. | 1 | C | 2 | 1-4 |
|  | **UNIT III** – **lipid metabolism** | **10** |  |  |  |
|  | Biosynthesis of fatty acids, triacylglycerols (TAGs), phospholipids, cholesterol and steroids | 2 | C | 2 | 1-4 |
|  | Digestion and transport of lipids. Oxidation of fatty acids – α, β and ω oxidation | 2 | C,D | 2 | 1-4 |
|  | Energetics of β-oxidation. Biosynthesis of even number saturated fatty acids | 2 | C,D | 2 | 1-4 |
|  | Pathophysiology of lipid metabolism- Ketone bodies formation | 1 | C | 2 | 1-4 |
|  | Disorders of lipid metabolism: Gaucher disease, Niemann-Pick disease, Tay-Sachs disease, Sandhoff disease | 1 | C | 2 | 1-4 |
|  | Metachromatic leukodystrophy, Wolman’s disease, Cholesteryl ester storage disease | 1 | C | 2 | 1-4 |
|  | **UNIT IV: Metabolism of amino acids and nucleic acids** | **10** |  |  |  |
|  | Biosynthesis of amino acids. Metabolic fates of amino groups | 2 | C | 2 | 1-4 |
|  | General reaction of amino acid degradation – Transamination, deamination and decarboxylation | 2 | C | 2 | 1-4 |
|  | Ketogenic and glucogenic amino acids. Urea cycle and its significance | 2 | C | 2 | 1-4 |
|  | Disorders of amino acid metabolism: Argininosuccinic acidemia (also called ASA), Citrullinemia (CIT), Homocystinuria (HCY | 1 | C | 2 | 1-4 |
|  | Disorders of amino acid metabolism: Maple syrup urine disease (MSUD), Phenylketonuria (PKU), Tyrosinemia type I (TYR I) | 1 | C | 2 | 1-4 |
|  | Disorders of nucleic acid metabolism: Orotic aciduria, Dihydropyrimidine dehydrogenase deficiency, Gout, adenosine deaminase deficiency. | 2 | C | 2 | 1-4 |
|  | **UNIT V: Oxidative phosphorylation and photophosphorylation** | **8** |  |  |  |
|  | Types of phosphorylation- Substrate level phosphorylation and oxidative phosphorylation | 1 | C | 2 | 1,2 |
|  | Electron transport chain (ETC) | 1 | C | 2 | 1,2 |
|  | Electron transport complexes- Complex I, II, III and IV | 2 | C | 2 | 1,2 |
|  | Uncouplers and inhibitors of ETC (Rotenone, antimycin. cyanide and 2,4 DNP) | 1 | C | 2 | 1,2 |
|  | Photosynthesis: General features of photophosphorylation | 1 | C | 2 | 1,2 |
|  | Light absorption, Light-driven electron flow | 1 | C | 2 | 1,2 |
|  | ATP synthesis by photophosphorylation |  | C | 2 | 1,2 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Lehninger Principles of Biochemistry. David L. Nelson, Michael M. Cox. 6th Edition. W.H. Freeman and Company-Newyork |
| 2 | Fundamentals of Biochemistry: Life at the Molecular Level. Donald Voet, Judith G. Voet, Charlotte W. Pratt. 5th Edition. Wiley. |
| 3 | Biochemistry. Jeremy M. Berg, Lubert Stryer, John Tymoczko, Gregory Gatto. 9th Edition. WH Freeman |
| 4 | Harper’s Illustrated Biochemistry. Victor W. Rodwell, David A. Bender, Kathleen M. Botham, P. Anthony Weil. 30th Edition. McGraw-Hill |

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| **BIO411** | **MOLECULAR BIOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | MOLECULAR BIOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | The course aims at providing the students with an introduction to the molecular mechanisms which are the foundations of biological processes in cells and organisms. An introduction to necessary biological background knowledge will be given. Fundamental principles within molecular biology and genetics will also be covered. Ethical considerations connected with the use of gene technology will be discussed. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | explain the structure and function of cells and cell organelles for eukaryote and prokaryote cells | |  |  |  |  |  |  |  |
|  | explain the structure and function of DNA, RNA, proteinin a cell biological relation | |  |  |  |  |  |  |  |
|  | explain central cell biological processes and how they are regulated and quality assured (for instance: replication and cell division, gene expression) | |  |  |  |  |  |  |  |
|  | explain genetic variation and inheritance and understand how molecular cell biology forms the foundation of biotechnology in different social structures | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **Unit I - DNA Replication and Repair** | **9** |  |  |  |
|  | Central dogma of life, DNA as genetic material | 1 | C | 1-4 | 1-4 |
|  | Structure and types of DNA | 1 | C | 1 | 1-4 |
|  | Semi-conservative nature of DNA replication | 1 | C,D | 1 | 1-4 |
|  | The replication machinery: the enzymes and proteins involved in the DNA replication, the replisome | 1 | C,D | 1 | 1-4 |
|  | The mechanism of DNA replication: Replication fork and its dynamics, concept of leading and lagging strand, semi-discontinuous mode of DNA replication | 1 | C | 1 | 1-4 |
|  | The replication process: Initiation, elongation and termination | 1 | C | 1 | 1-4 |
|  | Proofreading | 1 | C,D | 1 | 1-4 |
|  | Replication in prokaryotes | 1 | C | 1 | 1-4 |
|  | Regulation of DNA replication | 1 | C | 1,3 | 1-4 |
|  | **UNIT II** – **DNA damage and Repair** | **9** |  |  |  |
|  | Homologous recombination; Holliday Junctions | 2 | C | 2,3 | 1-4 |
|  | RecA, RecBCD function | 2 | C,D | 2,3 | 1-4 |
|  | RuvAB function | 2 | C | 2,3 | 1-4 |
|  | Site-specific recombination | 1 | C | 1,2 | 1-4 |
|  | Illegitimate recombination | 2 | C,D | 2 | 1-4 |
|  | **UNIT III** – **Gene Expression: Transcription and RNA Processing** | **9** |  |  |  |
|  | Structure of a gene and the coding sequence; concept of antisense and coding DNA strand | 2 | C | 3 | 1-4 |
|  | mRNA: Types and Structure | 1 | C,D | 3 | 1-4 |
|  | Steps in transcription: initiation, elongation and termination | 2 | C,D | 3 | 1-4 |
|  | RNA processing: polyadenylation, capping and splicing | 2 | C,D | 3 | 1-4 |
|  | Transcription factories or euchromatins | 1 | C,D | 3 | 1-4 |
|  | Transcription in prokaryotes | 1 | C,D | 3 | 1-4 |
|  | **UNIT IV: Gene Expression: Translation and Post-Translational Modification of Proteins** | **9** |  |  |  |
|  | Genetic code, degeneracy and codon bias | 1 | C | 2 | 1-4 |
|  | Ribosomes; Ribozymes and RNA world hypothesis | 1 | C,D | 2 | 1-4 |
|  | Enzymes involved in translation; Steps in translation: initiation, elongation and termination | 2 | C | 3 | 1-4 |
|  | Regulators of translation and protein synthesis blockers | 2 | C,D | 3 | 1-4 |
|  | Post-translational modification of proteins | 1 | C,D | 3 | 1-4 |
|  | Prokaryotic translation: coupled transcription and translation | 1 | C, D |  | 1-4 |
|  | Protein sorting and degradation | 1 |  |  | 1-4 |
|  | **UNIT V: Gene Regulation** | **9** |  |  |  |
|  | Basic concepts of regulation of gene expression | 1 | C,D | 4 | 1-4 |
|  | Gene regulations at various stages: DNA accessibility and chromatin changes | 1 | C | 4 | 1-4 |
|  | Gene regulations at various stages: transcriptional regulators- activators and repressors | 1 | C | 4 | 1-4 |
|  | Post-transcriptional regulation and the role of microRNAs | 1 | C,D | 4 | 1-4 |
|  | mRNA degradation | 1 | C,D | 4 | 1-4 |
|  | Regulation of translation | 1 | C | 4 | 1-4 |
|  | Post-translational regulation of functional proteins | 1 | C,D | 4 | 1-4 |
|  | Gene regulation in prokaryotes | 2 | C |  | 1-4 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Molecular Biology of the Cell: B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter (2007). 5thedition, Garland Science. |
| 2 | Genes VIII. Benjamin Lewin. 8th edition, Pearson. |
| 3 | Molecular Biology of the Gene: J.D. Watson, T.A. Baker, S.P. Bell, A.A.F. Gann, M. Levine and R.M. Losick (2007). 7thedition. Benjamin Cummings. |
| 4 | Molecular Cell Biology: H. Lodish, A. Berk, C.A. Kaiser et al (2007) 6thedition. W.H. Freeman. |

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| **BIO510** | **BIOPHYSICAL AND BIOCHEMICAL TECHNIQUE** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | BIOPHYSICAL AND BIOCHEMICAL TECHNIQUE | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | The course aims to provide students with a foundation in the basic concepts of Biophysics. Basicideas of diffusion, thermodynamics and kinetics will be discussed in the context of biological processes. Fundamental concepts that govern biomolecular interactions will be discussed and biophysical methodsthat are used for the structural analysis of the complex biological systems will be introduced. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | demonstrate knowledge of the fundamental concepts in physics and chemistry that underliebiological processes; | |  |  |  |  |  |  |  |
|  | define the structural characteristics of nucleic acids and proteins and examine parameters thatvariously determine their stability and function(s); | |  |  |  |  |  |  |  |
|  | describe the principles that dictate biomolecular interactions and understand how establishedmethods of research and enquiry are employed to analyze the different aspects of these interactions. | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **Unit I - Thermodynamics of Living System** | **2** |  |  |  |
|  | Conservation of energy in living systems, Entropy and Life. | 1 | C | 1-4 | 1,2 |
|  | Gibbs and Standard free energy, Equilibrium constant, Coupled reactions; Molecular forces and Bioenergetics. | 1 | C | 1 | 1,2 |
|  | **UNIT II** – **Dynamics of Biomolecules** | **9** |  |  |  |
|  | Diffusion- Laws of diffusion, Brownian motion, | 1 | C | 2,3 | 1-3 |
|  | Active transport, Facilitated diffusion; | 2 | C,D | 2,3 | 1,2 |
|  | Osmosis- Osmotic pressure, Osmoregulation; | 1 | C | 2,3 | 1,2 |
|  | Viscosity and its biological importance; | 1 | C | 1,2 | 1,3 |
|  | Surface tension- Factors influencing surface tension and its biological importance; | 1 | C,D | 2 | 1,3 |
|  | Sedimentation; | 1 | C | 2 | 2-4 |
|  | Macromolecular crowding and pattern formation. | 2 | C,D,I | 2 | 5,6 |
|  | **UNIT III** – **Cellular and Molecular Biophysics** | **12** |  |  |  |
|  | Neuro-biophysics- action potentials and ion channels. | 2 | C | 3 | 4 |
|  | Biomembranes- self assembly and micelle formation. | 1 | C,D | 3 | 2,4 |
|  | Membrane pumps and electro-osmotic effects. | 1 | C,D | 3 | 2 |
|  | Physics of Biomolecules, Biophysics of vision and audition. | 2 | C,D | 3 | 4 |
|  | Physics of muscle function. | 1 | C,D | 3 | 4 |
|  | Introductory bio-mechanics- key concepts. | 1 | C,D | 3 | 4 |
|  | Protein structure and function: Structure of heme, Structure of Myoglobin and hemoglobin. | 2 | C | 3 | 2,5 |
|  | Oxygen binding mechanism, Oxygen binding co-cooperativity, Hill equation, Hill coefficient, Allostery in hemoglobin, Bohr effect. | 2 | C | 3 | 2,3,5 |
|  | **UNIT IV: Physical Methods in Biology and Medicine** | **10** |  |  |  |
|  | Principles of chromatography and electrophoresis-1D and 2D; | 1 | C | 2 | 3 |
|  | Centrifugation, Sub-cellular fractionation; | 1 | C,D | 2 | 3 |
|  | X-ray diffraction; | 1 | C | 3 | 6 |
|  | Isotope labelling; Dynamic light scattering, Circular Dichroism (CD); | 1 | C,D | 3 | 6 |
|  | Nuclear Magnetic Resonance (NMR), Fluorescent and UV-vis Spectroscopy; | 2 | C,D | 3 | 6 |
|  | Florescent resonance energy transfer (FRET); | 1 | C, D | 2,3 | 3,6 |
|  | Magnetic Resonance Imaging, Surface Plasmon resonance (SPR); | 2 | C,D | 2 | 3,6 |
|  | Mass Spectrometry (MS). | 1 | C,D | 3 | 5,6 |
|  | **UNIT V: Structural Biology** | **12** |  |  |  |
|  | Principles of protein purification, crystallization, structure determination; | 2 | C,D | 4 | 6 |
|  | Structure validation, Use of available protein structures from protein data bank; | 2 | C | 4 | 5,6 |
|  | RNA secondary structure prediction and covariation analysis; | 2 | C | 4 | 4-6 |
|  | RNA structure determination and dynamics by X-ray. | 2 | C,D | 4 | 6 |
|  | Dynamics of Protein-RNA complexes; | 2 | C,D | 4 | 5 |
|  | Protein functional dynamics. | 2 | C | 4 | 6 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Biological Thermodynamics by Donald T. Haynie |
| 2 | Biochemistry: D. Voet and J.G. Voet (2010/2004), 4th/3rd edition, Wiley. |
| 3 | Introductory Biophysics by J. R. Claycomb and J.Q.P. Tran. |
| 4 | Molecular and Cellular Biophysics by Meyer B. Jackson. |
| 5 | Cantor CR, Schimmel PR (1980) Biophysical Chemistry: Part 2 - The Study of Biological Structure and Function. 1st Edition, WH Freeman. |
| 6 | Biomolecular crystallography: principles, practice, and application to structural biology. Rupp, Bernhard. New York: Garland Science, c2010. |

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| **BIO511** | **BIOTECHNOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | BIOTECHNOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | Academic Council Meeting, 2019 | | | | | | |

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| **PURPOSE** | | Biotechnology is the science of manufacturing or processing useful biological products. The course help students to understand basic concepts of genetic engineering and provide insights in various areas of biotechnology including plant, animal and medical biotechnology with illustrated examples. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand about the cloning strategies, expression vectors, and various techniques involved and their applications in the advancement of Biotechnology | |  |  |  |  |  |  |  |
|  | Appreciate how microbes are used for industrial applications | |  |  |  |  |  |  |  |
|  | Learn how plants and animals are genetically engineered to produce useful biotechnological products | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: Introduction to Biotechnology** | **8** |  |  |  |
|  | Biotechnology – Scope and Importance; History of biotechnology | 1 | C | 1-4 | 1,2 |
|  | Tools of Genetic Engineering – vectors, restriction enzymes, DNA ligases, DNA polymerase and polymerase chain reaction | 3 | C,D | 1 | 1,2 |
|  | Types of vectors - Plasmid vectors, Bacteriophage lambda and M13 based vectors, | 2 | C,D | 1 | 1,2 |
|  | Cosmids, Shuttle vectors, Expression vectors, Baculovirus-based vectors, Ti based vectors (Binary and Cointegrated vectors). | 2 | C,D | 1 | 1,2 |
|  | **UNIT II: Genome editing and Gene delivery methods** | **10** |  |  |  |
|  | The process of Genetic Engineering; Protoplast and cell fusion technologies | 2 | C | 2,3 | 1,2,3 |
|  | Genome engineering tools – Conventional methods (Mutagenesis, Knock-in, Knock-out, conditional knock-outs) | 3 | C | 2,3 | 1,2,3 |
|  | Modern methods using engineered Nucleases (Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALENs), Clustered regularly interspaced short palindromic repeats (CRISPR)) | 3 | C | 2,3 | 1,2,3 |
|  | Gene delivery techniques: Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery. | 2 | C | 1,2 | 1,2,3 |
|  | **UNIT III** – **Microbial biotechnology** | **8** |  |  |  |
|  | Methods of fermentation | 1 | C | 3 | 1,2,3 |
|  | Industrial Bioprocesses: ethanol, lactic acid production - Citric acid, acetic acid | 2 | C | 3 | 1,2,3 |
|  | Production of Penicillin- Streptomycin - beer, Amylase and protease, vitamin B12, PHA | 2 | C,D | 3 | 1,2,3 |
|  | Bofertilizers - vermicompost, biopesticides – Bacillus thuringiensis | 1 | C | 3 | 1,2,3 |
|  | Recombinant insulin and hepatitis B production | 1 |  | 3 | 1,2,3 |
|  | Waste water management by microbes | 1 |  | 3 | 1,2,3 |
|  | **UNIT IV: Plant and Algal Biotechnology** | **10** |  |  |  |
|  | Engineering of insect-resistant plants and disease resistant crops | 2 | C,D,I | 2-3 | 4,5 |
|  | Genetically modified food products; Bt transgenics-rice, cotton, brinjal. | 2 | C,D,I | 2-3 | 4,5 |
|  | Biofuels from algae – Biodiesel, biohydrogen, methanol and electricity generation | 2 | C,D, | 3 | 4,5 |
|  | Nanoscience and technology for the production of bioproducts from algae | 2 | C | 2-3 | 4,5 |
|  | Phycoremediation by algae | 2 | C | 2-3 | 4,5 |
|  | **UNIT V: Animal and Medical Biotechnology** | **9** |  |  |  |
|  | Basic principal of organismal cloning and the challenges | 2 | C | 4 | 2,4,5 |
|  | Cloned animals – Carp the fish, Dolly the sheep, Dehorning of calves | 2 | C,D | 4 | 4,5 |
|  | Sickle cell therapy, CRISPR babies | 2 | C | 4 | 4,5 |
|  | Ethical debate on organismal cloning | 3 | C | 4 | 1,2 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Gene Cloning and DNA Analysis: An Introduction. 6th Edition. T. A. Brown and Wiley-Blackwel |
| 2 | Principles of Gene Manipulation. 5th Edition. R. W. Old and S. B. Primrose. |
| 3 | Herren, Ray V. Introduction to biotechnology. Cengage Learning, 2012 |
| 4 | Crueger, Wulf, et al. "Biotechnology: a textbook of industrial microbiology." (2005). |
| 5 | Textbook of Biotechnology (2005),R.C.Dubey,S.Chand and Co |

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| **BIO512** | **BIOSTATISTICS** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | BIOSTATISTICS | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | The course aims to provideknowledge of statistical methods used for biological data analysis | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Choose and apply appropriate statistical methods for analyzing data | |  |  |  |  |  |  |  |
|  | Interpret statistical results correctly, effectively, and in context | |  |  |  |  |  |  |  |
|  | Learn to participate in a research team setting in study design, data coordination and management, and statistical analysis and reporting of study results | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: BIOSTATISTICS I** | 10 |  |  |  |
|  | Introduction to Biostatistics: Data, Sampling and study design | 2 | C,D | 1 |  |
|  | Data- Frequency distribution and graphical representation | 2 | C,D | 1 |  |
|  | Measures of central tendency- Mean, Median and Mode | 2 | C,D | 1 |  |
|  | Measures of dispersion- Range, Variance, Standard deviation | 2 | C,D | 1 |  |
|  | Coefficient of variance, Standard error, Confidence limits | 2 | C,D | 1 |  |
|  | **UNIT II** – **BIOSTATISTICS II** | **10** |  |  |  |
|  | Probability. Binomial, Poisson and normal distribution | 2 | C,D | 1 |  |
|  | Linear Regression and correlation analysis | 2 | C,D | 1 |  |
|  | Analysis of variance, Multiple regression | 2 | C,D | 1 |  |
|  | Tests of Significance-normal, X2 (chi square) and t-tests | 2 | C,D | 1 |  |
|  | ANOVA and Two way analysis of variance | 2 | C,D | 1 |  |

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| **BIO513** | **PLANT PHYSIOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | PLANT PHYSIOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- | | | | | | |

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| **PURPOSE** | | The course is tailored to provide an understanding of the basic concepts and state of art techniques and methods underlying plant physiology. The students will gain an understanding of theoretical principles enabling them to employ the knowledge to solve problems related to plant physiology | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand the structural and functional properties of plants | |  |  |  |  |  |  |  |
|  | Understand principles underlying intermediary metabolism in plants | |  |  |  |  |  |  |  |
|  | Learn plants stress response and tissue culture | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: Basic Plant Physiology** | **8** |  |  |  |
|  | Structural organization and function of plant cell | 2 | C | 1 | 1 |
|  | Cellular basis of growth and development | 2 | C | 1 | 1 |
|  | Solute transport, Movement of water towards xylem by apoplast and symplast pathway | 2 | C | 1 | 1 |
|  | A brief account on Micro and macro nutrients for plants | 2 | C | 1 | 1 |
|  | **UNIT II Photosynthesis and Photomorphogenesis** | **9** |  |  |  |
|  | Photosynthesis, Factors affecting photosynthesis | 2 | C | 2 | 1 |
|  | Respiration and photorespiration | 1 | C | 2 | 1 |
|  | CAM pathway | 1 | C | 2 | 1 |
|  | Nitrogen metabolism | 2 | C | 2 | 1 |
|  | Photomorphogenesis: responding to light | 2 | C | 2 | 1 |  |
|  | Photoperiodism | 1 | C | 2 | 1 |
|  | **UNIT III** – **Plant growth regulators** | **9** |  |  |  |
|  | Plant growth regulators – auxins, gibberellins and their physiological role | 3 | C | 2 | 1,2 |
|  | Plant growth regulators – cytokinins, abscissic acid, ethylene and their physiological role | 3 | C | 2 | 1,2 |
|  | Synthetic growth regulators and their uses in crop productivity | 2 | C | 2 | 1,2 |
|  | Practical application of Plant Growth Regulators in crop productivity | 1 | C | 2 | 1,2 |
|  | **UNIT IV: Plant stress response** | **9** |  |  |  |
|  | Environmental stresses to plants | 2 | C | 3 | 1,2 |
|  | Water stress - physiological changes - adaptation to drought and amelioration | 2 | C | 3 | 1,2 |
|  | Temperature stress - Physiological changes - low and high temperature | 2 | C | 3 | 1,2 |
|  | Chilling injury - tolerance – alleviation | 1 | C | 3 | 1,2 |
|  | Programmed cell death, aging and senescence | 2 | C | 3 | 1,2 |
|  | **UNIT V: Plant Biotechnology** | **10** |  |  |  |
|  | Conventional methods of crop improvement, selection, mutation, polyploidy and clonal selection | 2 | C | 4,5 | 1,3 |
|  | Plant tissue culture | 1 | C | 4,5 | 1,3 |
|  | Agrobacterium and crown gall tumors: - Ti plasmid & Ri Plasmid vectors | 2 | C | 4,5 | 1,3 |
|  | Mechanism of T-DNA transfer to plants, Agro infection | 2 | C | 4,5 | 1,3 |
|  | Plant viral vectors | 1 | C | 4,5 | 1,3 |
|  | Direct transformation of plants by physical methods | 1 | C | 4,5 | 1,3 |
|  | Genetic engineering in plants: -Selectable markers, Reporter genes | 1 | C | 4,5 | 1,3 |
|  | Genetic engineering in plants:- Promoters used in plant vectors | 1 | C | 4,5 | 1,3 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Taiz. L and Zeigler.E, “Plant Physiology,” Panima Publishing Corporation, New Delhi, Third edition.  2003 |
| 2 | Buchnan, B. B., Gruissem, W. and Jones, R. L., Biochemistry and molecular biology of plants |
| 3 | R.H.Smith, Plant Tissue Culture: Techniques and Experiments |

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| **BIO610** | **ENDOCRINOLOGY** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | ENDOCRINOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | This is a comprehensive study of the endocrine system which will allow the student to integrate and better understand the physiological functions of the body. The relationship of the nervous system to the endocrine system is explored in the context of signaling within a multicellular organism. Also, the pathological conditions and diagnostic procedures associated with endocrine imbalance are investigated. The student will develop an understanding of the role of the endocrine system in maintaining homeostasis and health. The student will be better able to understand the integrative workings of the human body by studying this signaling system. The student will be introduced to the significant endocrine pathologies which appear as comorbid conditions in the field and will be better equipped to educate others on disease prevention where applicable and to undertake research projects directly pertaining to human health and diseases. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | The student will demonstrate an understanding of the anatomy of the endocrine system; | |  |  |  |  |  |  |  |
|  | the student will demonstrate an understanding of the basic properties of hormones; | |  |  |  |  |  |  |  |
|  | the student will demonstrate the role of hormones in maintaining body function; | |  |  |  |  |  |  |  |
|  | the students will demonstrate those endocrine details helpful in the clinical realm; | |  |  |  |  |  |  |  |
|  | the student will demonstrate knowledge of the major endocrine disorders. | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **Unit I – Principles of endocrinology** | **9** |  |  |  |
|  | Functions of hormones and their regulation | 1 | C | 1-4 | 1 |
|  | Chemical signalling - endocrine, paracrine, autocrine and intracrine mechanisms, Chemical classification of hormones | 1 | C | 1 | 1 |
|  | Hormone synthesis | 1 | C,D | 1 | 1 |
|  | Transport of hormones in the circulation and their half-lives | 1 | C,D | 1 | 1 |
|  | Hormone receptors - cell surface, Hormone receptors – intracellular, Hormones and gene transcription, Hormone receptor regulation | 1 | C | 1 | 6 |
|  | Neuroendocrine interactions | 1 | C | 1 | 1 |
|  | Hormones- growth promotion and malignancy | 1 | C,D | 1 | 1 |
|  | Genes, mutations and endocrine function | 1 | C | 1 | 1 |
|  | Clinical evaluation of endocrine disorders | 1 | C | 1,3 | 1 |
|  | **UNIT II** – **The endocrine pancreas** | **9** |  |  |  |
|  | Pancreas, Glucose turnover, Anabolic and catabolic phases of glucose metabolism | 1 | C | 2,3 | 1 |
|  | Actions of insulin and glucagon | 1 | C,D | 2,3 | 1 |
|  | Lipid metabolism - insulinopenia and diabetic ketosis | 1 | C | 2,3 | 1 |
|  | Protein metabolism and the anabolic actions of insulin | 1 | C | 1,2 | 1 |
|  | Etiology of type 1 diabetes mellitus (DM) Prevention of type 1 DM | 1 | C,D | 2 | 1 |
|  | Structure, synthesis and metabolism of insulin and glucagon | 1 | C | 2 | 7 |
|  | Control of insulin and glucagon secretion, Type 2 DM, Causes of DM, Counter-regulatory hormones and DM | 1 | C,D,I | 2 | 7 |
|  | Development of the pancreas: effects of DM on organogenesis, Treatment of DM - rationale and practical considerations | 1 | C,D | 2 | 8 |
|  | Hypoglycemia, Physiological responses to hypoglycemia and its treatment, Hypoglycemia and insulinoma | 1 | C,D | 2 | 9 |
|  | **UNIT III** – **The thyroid gland** | **9** |  |  |  |
|  | The thyroid gland, Iodine intake, Synthesis of thyroid hormones | 1 | C | 3 | 6 |
|  | Actions of thyroid hormones, Control of thyroid hormone synthesis and secretion, Hyperthyroidism — Graves' disease | 2 | C,D | 3 | 6 |
|  | Primary hypothyroidism — Hashimoto's disease and myxedema, Transport and metabolism of thyroid hormones | 1 | C,D | 3 | 6 |
|  | The parathyroid glands and vitamin D, Calcium and phosphate in serum and its measurement | 2 | C,D | 3 | 6 |
|  | Intracellular calcium concentration, Calcium and phosphate balance | 1 | C,D | 3 | 6 |
|  | Hormonal control of serum Ca2+ and Pi concentrations | 2 | C,D | 3 | 6 |
|  | **UNIT IV: The adrenal gland** | **9** |  |  |  |
|  | The adrenal gland, Specificity of the biological effects of adrenal steroid hormones, Cholesterol and steroid synthesis in the adrenal cortex | 2 | C | 2 | 5 |
|  | Glucocorticoid receptors, Actions of glucocorticoids and clinical features of Cushing's syndrome | 1 | C,D | 2 | 5 |
|  | The gonad Genetic determination of sexual differentiation, GnRH and the control of gonadotrophin synthesis and secretion | 1 | C | 3 | 5,8 |
|  | The gonadotrophins - LH and FSH - and their actions, Spermatogenesis, Ovarian control and the menstrual cycle | 2 | C,D | 3 | 5,8 |
|  | Transport, metabolism and actions of ovarian steroids, The ovary - folliculogenesis and oogenesis, Ovarian failure, the menopause and andropause | 2 | C,D | 3 | 8 |
|  | Hormonal replacement therapy (HRT) and selective estrogen receptor modulators (SERMS) | 1 | C, D |  | 1,8 |
|  | **UNIT V: The pituitary gland** | **9** |  |  |  |
|  | The pituitary gland, Anatomical and functional connections of the hypothalamo-pituitary axis | 1 | C,D | 4 | 2 |
|  | Sheehan's syndrome, Growth and somatotrophin deficiency | 1 | C | 4 | 2 |
|  | Growth hormone - secretory patterns and control | 1 | C | 4 | 2 |
|  | Actions of growth hormone and insulin-like growth factors | 1 | C,D | 4 | 2 |
|  | GH replacement therapy, GH excess - gigantism and acromegaly, Pituitary adenomas - incidence and treatment | 1 | C,D | 4 | 2 |
|  | Circadian rhythms and the suprachiasmatic nucleus, The pineal gland and melatonin | 1 | C | 4 | 3 |
|  | Cardiovascular and renal endocrinology, Endocrinology of heart failure | 1 | C,D | 4 | 3 |
|  | Paracrine and autocrine regulation of blood pressure: the endocrinology of sepsis | 1 | C |  | 3 |
|  | Hormones and blood cell production – erythropoietin | 1 | C |  | 4 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Integrated Endocrinology, 1st Edition, by John Laycock and Karim Meeram. |
| 2 | Hormones by A.W. Norman and H.L. Henry, Academic Press, 3rd Edition. |
| 3 | Vertebrate Endocrinology, 5th Edition by Norris & Carr. |
| 4 | Marieb EN. Human Anatomy and Physiology. (9th ed. 2013). |
| 5 | Goodman HM. Basic Medical Endocrinology. ( 4th ed. 2009). |
| 6 | Guyton AC. Textbook of Medical Physiology. (12th ed. 2011). |
| 7 | Endocrinology& Metabolism : Felig, Baxter and Broadus. |
| 8 | Reproductive Endocrinology: Speroff and Kase. |
| 9 | Metabolic basis of inherited disease: Stanbury. |

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| **611** | **Applied Microbiology** | | | **L** | **T** | **P** | **C** |
| **3** | **0** | **0** | **3** |
| *Co-requisite:* | NIL | | | | | | |
| *Prerequisite:* | NIL | | | | | | |
| *Data Book / Codes/Standards* | NIL | | | | | | |
| *Course Category* | P | PROFESSIONAL CORE | APPLIED MICROBIOLOGY | | | | |
| *Course designed by* | Department of Biology | | | | | | |
| *Approval* | -- Academic Council Meeting -- , 2019 | | | | | | |

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| **PURPOSE** | | Microbiology is the study of microscopic organisms, such as bacteria, viruses, archaea, fungi and protozoa. Microbiology is an applied science, helping agriculture, health and medicine and maintenance of the environment, as well as the biotechnology industry. This course will provide detailed insight into screening and isolation of microorganisms, microbial growth processes through fermentors and bioreactors, for large scale application in food and industry. | | | | | | | |
| **LEARNING OBJECTIVES** | | | **STUDENT OUTCOMES** | | | | | | |
| At the end of the course, student will be able to | | |  |  |  |  |  |  |  |
|  | Understand the Definition and scope of Industrial Microbiology, Industrially important microorganisms | |  |  |  |  |  |  |  |
|  | Understand Isolation, selection and Strain improvement, Growth of cultures in the fermentors | |  |  |  |  |  |  |  |
|  | Bioreactors, Reactors for specialized applications, Microbial fermentations. | |  |  |  |  |  |  |  |

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| **Session** | **Description of Topic** | **Contact hours** | **C-D-I-O** | **IOs** | **Reference** |
|  | **UNIT I: Definition and scope of Industrial Microbiology** | **11** |  |  |  |
|  | Historical development | 2 | C | 1-4 | 1,2 |
|  | Chronological order of outstanding scientific achievements | 2 | C,D | 1 | 1,2 |
|  | Concepts and practices of microbiology proceeded to Industrial Microbiology. | 2 | C,D | 1 | 1,2 |
|  | Industrially important microorganisms | 2 | C,D | 1 | 1,2 |
|  | Introduction to industrially important microorganisms – Bacteria, fungi, actinomycetes, microalgae and viruses. | 2 | C | 1 | 1,2 |
|  | Culture collection centers. | 1 | C | 1 | 1,2 |
|  | **UNIT II: Isolation, selection and Strain improvement** | **8** |  |  |  |
|  | Screening and isolation of microorganisms | 2 | C | 2,3 | 1,2,3 |
|  | Primary and secondary metabolites, enrichment, specific screening for the desired product | 2 | C | 2,3 | 1,2,3 |
|  | Mutation and screening of improved cultures, protoplast fusion techniques for strain improvement of primary and secondary metabolites | 2 | C | 2,3 | 1,2,3 |
|  | Improvement of characters other than products and its application in the industry. | 2 | C | 1,2 | 1,2,3 |
|  | **UNIT III : Growth of cultures in the fermentors** | **8** |  |  |  |
|  | Design of a basic fermentor | 2 | C | 3 | 1,2,3 |
|  | Importance of media in fermentation, media formulation and modification | 2 | C | 3 | 1,2,3 |
|  | Kinetics of growth in batch culture, continuous culture with respect to substrate utilization | 1 | C,D | 3 | 1,2,3 |
|  | Specific growth rate, steady state in a chemostat, fedbatch fermentation | 1 | C | 3 | 1,2,3 |
|  | Yield of biomass, product, calculation of productivity | 1 |  |  | 1,2,3 |
|  | Substrate utilization kinetics | 1 |  |  | 1,2,3 |
|  | **UNIT IV: Bioreactors** | **10** |  |  |  |
|  | Bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, | 4 | C,D,I | 2-3 | 5,7 |
|  | Measurement and control of fermentation process, Reactors for specialized applications | 2 | C,D,I | 2-3 | 5,7 |
|  | Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases. | 4 | C,D, | 3 | 5,7 |
|  | **UNIT V: Microbial fermentations** | **8** |  |  |  |
|  | Metabolic pathways and metabolic control mechanisms | 2 | C | 4 | 6,7 |
|  | Food fermentations and food produced by microbes | 2 | C,D | 4 | 6,7 |
|  | Bread, cheese, malt beverages, vinegar | 1 | C | 4 | 6,7 |
|  | Fermented dairy products and oriental fermented foods | 1 | C | 4 | 6,7 |
|  | Microbial cells as food – single cell proteins. | 2 | C,D | 4 | 6,7 |
|  | Total contact hours | 45 | | | |

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| **LEARNING RESOURCES** | |
|  | **TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL** |
| 1 | Crueger W and Crueger A (2000) Biotechnology : A test Book of Industrial Microbiology |
| 2 | Prescott and Dunn’s Industrial Microbiology |
| 3 | Industrial Microbiology by CASIDA. |
| 4 | Industrial Microbiology by A.H. Patel |

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| **Course nature** | | | | | **Theory and Lab** | | | | |
| **Assessment Method (Weightage 100%)** | | | | | | | | | |
| **In-semester** | **Assessment tool** | Cycle test I | Cycle test II | Assignments | | Lab Performance | Quiz | | **Total** |
| **Weightage**  **Theory** | **15%** | **15%** | **5%** | | **10%** | **5%** | | **50%** |
| **End semester examination Weightage :** | | | | | | | | **50%** | |