Prospectus B.S. Biotechnology 2014

Department of Life Sciences
School of Natural Sciences
Shiv Nadar University
Post office Shiv Nadar University
Gautam Buddha Nagar
UP-201314
B.S. Biotechnology Program

Biotechnology is the use of microorganisms such as bacteria, yeast or viruses which are genetically engineered to produce Bio-therapeutics, Cancer drugs, Malarial and Viral vaccines, Synthetic hormones, Drugs against Biological and Genetic disorders like Diabetes and Hemophilia, or even cleanup of oil spills using genetically modified bacteria. The Department of life sciences believes in laying the strong foundation in Biotechnology and at the same time not being orthodox, apprises the students to advanced and applied technology that will help them being good teachers, world class researchers or experts to successfully compete for the jobs in Pharma and Biotechnology companies, Academia at par with international standards or Medical industry in the fields of Bioimaging, Cellbiology, and Diagnostics. For this they will be trained by exposing them to hands on training in our state of art laboratories, the custom designed research projects to be performed in the companies.

The Teaching Experience

Besides the core courses of Biosciences, Department of Life sciences has also designed interdisciplinary courses whereby expertise of other departments from Chemistry, Mathematics, and Physics will be availed. The Department provides a teaching using modern tools by highly skillful globally trained biological researchers and educators from esteemed universities around the world. The degree is designed for students who have interest and exceptional ability to get trained and develop an aptitude in the interdisciplinary program for their overall scientific development. The course is structured to be completed in four years that will train the students to pursue their career in premiere scientific institutes like Indian Institute of Science, TIFR, CCMB, IIT, John Hopkins school of Medicine, NIH and many more institutes/universities throughout the world. The course will also be helpful for the
students to do Integrated Ph.D. saving them a year or two for the completion of the doctorate degree. The degree also qualifies them to enroll for direct Ph.D. in USA or Europe without obtaining the additional MS degree.

The Lab Journey

The department boasts the best infrastructure and state-of-the-art research laboratories that can match any progressive and modern lab of Molecular Biology. We have exclusive instruments for Live Cell Imaging, Analytical methodologies, Medical microbiology, Molecular Biology etc. supported by FACS, Confocal microscopy, Fluorescent microscope, RT PCR, HPLC, Akta Prime and many more. We have a central facility that hosts the instruments like NMR, CD, X-Ray Diffractors, LC- MS, MS-MS Next gen sequencer to name a few.

Research and Training

Shiv Nadar University being a teaching cum Research University, we lay equal emphasis on the Training and Research through our globally experienced faculty. The research project followed with thesis writing and colloquium will be conducted in the department in the fields of immunomodulation, vascular Biology, drug development and cancer genetics to name a few. For research projects, the students will be associated with the faculty who will assign the projects, guide their execution, help student write a thesis and prepare them for viva voce and the interviews. Besides, students will be required to spend their last semester in one of the premier Bio pharmaceutical companies, National research institutes or Hospitals depending upon which they will be awarded specialization in BS Biotechnology. The specialized projects may be opted from one of these:

- Industrial Biotechnology
- Medical Biotechnology
- Nanotechnology and Molecular medicine
- Cancer Biology
- Infectious and non-infectious diseases
- In silico and in vivo drug designing
- Virology
- Vascular Biology
- Biophysical Structural Analysis
- Malaria
- Neurodegenerative diseases Biomarkers
Career Building

Eligible students may use their independent research and teaching for their future career leading to integrated MS-PhD degree or finding the jobs in Pharmaceutical and Biopharmaceutical companies, Biotechnology companies, Health industry, Research institutes and Universities. On completion of the program, students will be mentored by the faculty to help them further choose their career and find the jobs in the areas of their interest. Guidance will be accorded for obtaining the admission, fellowships and research grants for pursuing higher studies in national and international institutes/universities.

Life Sciences Course Catalog

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>No. of Credits</th>
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<tr>
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<tr>
<td><strong>I Semester</strong></td>
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<tr>
<td>BIO 101</td>
<td>Fundamentals of computers</td>
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<tr>
<td>CHY111</td>
<td>Chemical Principles</td>
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<td>III</td>
<td>BIO 201</td>
<td>Cell biology and Genetics</td>
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<td>BIO 202</td>
<td>Ecology and Environmental Sciences</td>
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<td>BIO 203</td>
<td>Plant Sciences II</td>
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<td>BIO 206</td>
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<td>BIO 207</td>
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<td>BIO 302</td>
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<td>Drug design and Drugdevelopment *</td>
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<td>Elective 3BIO 405</td>
<td>Genomics ,Proteomics&amp; System Biology *</td>
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<td>BIO 406</td>
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<td>BIO 407</td>
<td>One semester Dissertation Project with Thesis presentation and VivaVoce</td>
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**Total Credits for VI semester**: 12

**Total Credits for VII semester**: 15

**Total Credits for VIII semester**: 15

**BIO 101: Fundamentals of Computers**


**Algorithms, Flowcharts & Programming concepts**: Algorithms: Concepts & definitions, Converting algorithms to flowcharts, Comparing algorithms, flowcharts
**Recommended Books:**
1. Fundamentals of Computers, V Rajaraman, PHI.
2. Introduction to computers, Peter Norton
3. Computer Fundamentals, P.K. Sinha
4. Introduction to Bioinformatics, Attwood
5. Instant Notes in Bioinformatics

**BIO 102: Plant Sciences I**


**Recommended Books:**
1. Unified series for Botany
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by PS Verma and VK Agarwal
3. 

**BIO 103: Animal Sciences I**

Introduction to Invertebrates: General characteristics of invertebrates, classification of invertebrates up to different phyla from protozoa to echinoderms with special reference to protozoa and arthropod. Type study of human pathogens: Plasmodium vivax, Trypanosoma gambiense, Entamoeba histolytica, Faciola hepatica, Teniasolium and Ascaris lumbricoides. Introduction to model systems: C. elegans, Drosophila and zebrafish.

**Recommended Books:**
1. Unified series for Zoology
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by PS Verma and VK Agarwal
BIO 101: Fundamentals of Computers


Computers in Biology: Nature of Biological data, Biological Databases, pubmed, Overview of Bioinformatics, Major Bioinformatics Resources: NCBI, EBI & ExPASY

Recommended Books:
6. Fundamentals of Computers, -V Rajaraman, PHI.
7. Introduction to computers- Peter Norton
9. Introduction to Bioinformatics- Attwood
10. Instant Notes in Bioinformatics

BIO 201: Cell Biology and Genetics

Cell as a basic unit of living systems: The cell theory, pre-cellular revolution; broad classification of cell types: archaea bacteria, PPLOs, bacteria, eukaryotic microbes, plant- and animal cells; cell, tissue, organ and organisms, different levels of organization.

Cell organelles: Ultrastructure of cell membrane and function, Structure of cell organelles; Chromosomes: Structural organization of chromosomes, chromatids, centromere, telomere, chromatin, nucleosome organization, euchromatin and heterochromatin. Cell division and cell cycle: Cell cycle, interphase, mitosis and meiosis, Cell–Cell interaction: Cell locomotion: amoeboid, flagellar and ciliary; cell senescence and death: apoptosis, necrosis and autophagy, Cell differentiation, Mechanism of cell differentiation (e.g., RBC), difference between normal and cancer cells.

position effect, intragenic crossing over and complementation test, Benzer’s work on rII locus in T4 Bacteriophage.


Recommended Books:


Cell and Molecular Biology, DeRobertis, B.I. Publication Pvt. Ltd. Cell and Molecular Biology-Sheelar&Bianchi, John Wiley


Principles of Genetics, E. J. Gardner, John Wiley & Sons Inc.

Concepts of Genetics (Sixth Edition), William S. Klug and Michael R. Cummings, Pearson Education.

BIO 202: Ecology and Environmental Sciences


Population and Community Ecology Population attributes, density, natality, mortality, age ratio, sex ratio, dispersal and dispersion of population, exponential and logistic growth, life history strategies, population interactions, predation types, predator-prey system, functional and numerical response, host-parasite interactions, social parasitism, symbiosis

Biogeography Phyto geography, Phytogeographic realms, major plant communities of the world, Vegetation of India, Zoogeography: Zoogeographic realms, Threatened species of animals

Bioresource management Biodiversity and regional conservation strategies success stories with reference to India and sustainable utilization. Principles of wildlife
management, wildlife sanctuaries, parks and biosphere reserves in India, endangered and threatened species of plants and animals in India, germplasm banks.

Environmental Issues, Policies and Regulation Impact of urbanization and industrialization, EIA - Environmental Impact Assessment (Global, National and Local), restoration of degraded ecosystems, bioremediation, environmental pollution, global climatic change.

**Recommended Books:**

1. Mishra, A. Environmental Studies Selective and Scientific Books, New Delhi
2. Allaby, M. Basics of Environmental Science Routledge

**BIO 203: Plant Sciences II**

Structural organization of flower, initiation and differentiation of floral organs, structure and development of anther, microsporogenesis, structure and type of ovule, megasporogenesis, types of embryo sac.


Plant development: structure of plant body; fundamental differences between animal and plant development; embryogenesis - classical and modern views using Fucus and Arabidopsis as models; axis specification and pattern formation in angiosperm embryos; organization and homeostasis in the shoot and root meristems; patterning in vegetative and flower meristems; growth and tissue differentiation in plants; evolution of developmental mechanisms in plants.

**Recommended books:**

1. Hopkins W.G & Huner P.A. Introduction to Plant Physiology
2. Dickinson W.C. Integrative Plant Anatomy
BIO 204: Animal Sciences II


Animal development: Introduction, history and concepts of developmental biology; the current understanding on the mechanisms of development of organisms using vertebrate (mouse, chick, frog, fish) and invertebrate (fly, worm) models; how does a complex, multicellular organism arise from a single cell; the beginning of a new organism (fertilization), the creation of multicellularity (cellularization, cleavage), reorganization into germ layers (gastrulation), cell type determination; creation of specific organs (organogenesis); molecular mechanisms underlying morphogenesis and differentiation during development; stem cells and regeneration; evolution of developmental mechanisms.


Recommended books:
2. Medical Physiology, Shambulingam
3. Human Physiology Roase & Wilson
BIO 205: Bio-analytical Techniques

Instruments, basic principles and usage: pH meter, absorption and emission spectroscopy, principle and law of absorption, fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red), polarography, centrifugation, atomic absorption, NMR, X-ray crystallography.

Chromatography techniques: Paper chromatography, thin layer chromatography, column chromatography, HPLC, gas chromatography, gel filtration and ion exchange chromatography.

Electrophoresis: Agarose gel electrophoresis, SDS polyacrylamide gel electrophoresis, immunoelectrophoresis, isoelectric focussing. Radioisotope tracer techniques and autoradiography.

Recommended Books:

Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
Bioinstrumentation, Webster
Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press
Modern Spectroscopy, J.M. Hollas, John Wiley and Sons Ltd.
NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.
Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall. Principles and Practice of Bioanalysis, Richard F. Venn
Microscopic Techniques in Biotechnology, Michael Hoppert
Principles of Fermentation Technology, P.F. Stanbury, A. Whitaker, S.J. Hall

BIO 206: Microbiology


The study of microbial structure by use of flight, phase, fluorescent and electron microscopy. Preparation and staining of specimens. Microbial nutrition, nutritional types, requirements, design and types of nutrient media, microbial growth principles, kinetics and methods. The influence of environmental factors on growth.
Microbial control- definition, methods of sterilization, physical methods and chemical agents. Isolation of pure cultures- spread plate, streak plate and pour plate.

Classification of general features of cyanobacteria and importance of Spirulina, Rickettsia, Chlamydia, Mycoplasma, Archaebacteria, Methanogenic and Halophilic bacteria. General account and economic importance of algae and fungi. Clinically important bacteria and protozoans. Distribution of microbes in nature.


Recommended Books:
1. Microbiology- Pelczar, Chan and Krieg
2. Brock Biology of microorganisms (9th edition) by Madigan, Martinko and Parker.
3. Introduction to microbiology by Ross
6. General Microbiology volume I and II- Power

BIO 207: Biophysics

Thermodynamics: Laws of thermodynamics, concept of free energy, unavailable energy and entropy, heat content of food, bomb calorimetry, chemical kinetics—rate, order, molecularity of reactions and energy of activation. Redox potential: Oxidation and reduction, redox potential and its calculation by Nernst equation, examples of redox potential in biological system. Bioenergetics: Energy requirements in cell metabolism, role and structure of mitochondria, high energy phosphate bond, electron transfer phenomenon and biological transfer.

Biophysical properties: Surface tension, adsorption, diffusion, osmosis, dialysis and
colloids. Kinetics of Biophysics: absorption and emission of light by molecules. Wave properties of particles, absorption of light (UV and IR) by molecules, fluorescence and phosphorescence and biological effects of UV and visible radiation.


Radiation Biophysics: Introduction, particles and radiation of significance, physical and biological half-lives, macroscopic absorption of radiation, activity and measurements, units of dose, relative biological effectiveness and action of radiation at molecular level.

**Recommended Books:**
1. Introductory Bio Physics F. R. Hallet, P. A. Speight, R. H. Stinson Chapman & Hall (Unit I and II)
2. Bio Physics Principles and Applications M. A. Subrahmaniam - MJPPublishers (Unit III)
4. Bio Physics - Rodney Cotterill John Wiley & Sons, Ltd. (Unit V)

**BIO 208: Biochemistry I**


Carbohydrates: Different carbohydrates and with examples of glucose, galactose, sucrose, starch and glycogen. Carbohydrates metabolism - Glycolysis, Kreb's Cycle and oxidative phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Glyoxylate cycle
Proteins: Classification and properties of amino acids, Classification based on structure and functions, structural organization of proteins (primary, secondary, tertiary and quaternary structures), biosynthesis of protein. Enzymes and enzyme kinetics.


Lipids: Classification, structure, properties and functions of fatty acids, triglycerides, phospholipids, sphingolipids, cholesterol, eicosanoids, prostaglandins. Source, structure, biological role, and deficiency disorders of fatsoluble vitamins (A, D, E and K) and watersoluble vitamins (riboflavin, niacin, thiamine, pyridoxine, biotin, folic acid, pantothenic acid, cobalamin, and ascorbic acid).

Recommended Books:

2. Biochemistry by L. Stryer 6ed (Freeman-Tappan).
7. Biochemistry by Mathews et. al., (Pearson)

BIO 301: Biochemistry II

Principles of bioenergetics – free energy concept, enthalpy, entropy, redox potential, phosphate group transfer potential. Coupled reactions, high energy compounds in biological systems. Substrate level phosphorylation, electron transport - oxidative phosphorylation and photophosphorylation.

Enzymes Nomenclature and classification of enzymes, effect of pH, temperature, metal ions, substrate concentration and enzyme concentration on enzyme activity. Enzyme assay and units of enzyme activity. Michaelis-Menten equation, significance of Km, Vmax and Kcat. Lineweaver–Burk plot.


**Recommended Books:**


2. Biochemistry by L. Stryer 6 ed (Freeman-Tappan).


5. Biochemistry by Mathews et. al., (Pearson)

**BIO 302: Virology**

General aspects: Classification and nomenclature of viruses in general, their properties, morphology and ultrastructure typical bacteriophage, animal virus and plant virus, types of envelope, their composition, Viroids and Prions. Animal Viruses: Classification of animal viruses, lifecycle and pathogenicity of important viruses, genome organization and replication of DNA viruses, RNA viruses, Adeno virus, Poxvirus, SV40, Vaccinia, Lentivirus. Clinical diagnosis and treatment of HIV, Influenza and Hepatitis. Plant Viruses: Classification of plant viruses, life cycle and pathogenicity of important viruses. Genome organization and replication of common plant viruses, such as TMV, CaMV, Potato X Virus, Gemini Virus. Transmission of plant viruses by vectors and other means. Diagnostic techniques in seed, seed stocks and diseased plants.

Diagnostic Methods: Immunodiagnostic, haemagglutination and haemagglutination inhibition tests, Complement Fixation, Neutralisation, Western Blot, RIPA, flow cytometry and immunochemistry.

a) Nucleic acid based diagnosis: Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing.
b) Microscopic techniques—Fluorescence, confocal and electron microscopic techniques—principles and applications.
c) Analytical techniques: Electrophoresis, chromatography, membrane filtration, NMR, X-ray Crystallography.

Recommended Books:
General Virology by S.E. Luria
Molecular Virology, pathogenesis and control, ASM Press, Washington DC
Plant Virology by Matthews

BIO 303: Fundamentals of Molecular Biology

Nature of genetic material, organization of genetic material in prokaryotes and eukaryotes.
C-value paradox, mitochondrial & plastid genomes.


Transcription in prokaryotes and eukaryotes. Mechanism of transcription, Types of RNA polymerases and promoter-polymerase interactions. Transcriptional factors. Processing of mRNA, tRNA and rRNA. RNA editing and transport.

Translation in prokaryotes and eukaryotes: Genetic code, translational machinery, mechanism of initiation, elongation, and termination. Regulation of translation, co and post translational modifications. Leader sequences & protein targeting.


Recommended Books:
1. Biochemistry by L. Stryer 5 Ed. (freeman-Toppan)
2. Genes VIII by B. Lewin (Oxford)
BIO 304: Immunology


Cytokines—classes and their biological activities. Therapeutic uses of cytokines and their receptors. Complement system—mode of activation, classical, alternate and mannose binding pathway, biological functions and regulation. Major histocompatibility complex (MHC). Human leukocyte antigens (HLA), MHC restriction. MHC and diseasesusceptibility, regulation of MHC expression. APC’s and antigen processing and presentation.

Immunological techniques: Principle concepts of antigen–antibody interactions: Agglutination, precipitation, gel diffusion, Ouchterlony double immunodiffusion and Mancini’s radial immunodiffusion, immunoelectrophoresis and complement fixation test. ELISA, RIA, Western Blot and FACS.

Recommended Books:
3. Janeway’s Immunobiology by Kenneth Murphy 8th edition (Garland Science)
4. Fundamental Immunology by William E. Paul, Paul, 6th Edition (Lippincott Williams & Wilkins publishers)

BIO 305: Animal Biotechnology

Basic techniques of cell, tissue and organ culture. Primary culture and subculture of cells. Kinetics of cell growth. Properties of normal and transformed cells. Role of

Organ culture and tissue engineering: Organ cultures, histolytic cultures, three dimensional cultures, organotypic cultures. Production of bio-artificial skin, liver and pancreas. Tissue engineering—cell source and culture, culture of cells, design engineering of tissues, tissue modeling. Embryonic stem cell engineering.

Production of monoclonal antibodies, Production of Transgenic Animals—Mouse, sheep, cattled and fish by microinjection, retroviral vector method and embryonic stem cell method. Animal cloning—Somatic cell nuclear transfer and embryonic stem cell nuclear transfer methods. Bio phar ming and gene knockout.

Recommended books:

2. Molecular Biotechnology by Bernard R. Glick and Jack. J. Pasternak
3. Elements of Biotechnology by PK Gupta (Rastogi & Co).
4. Biotechnology by U. Satyanarayana
5. Concepts of Biotechnology by Balasubrahmanian et al., (Universitypress)
6. Principles and practices of aquaculture by TVR Pillay.
7. Coastal aquaculture by Santhanam.
8. Fisheries of India by CBLSrivatsava.

BIO 306: Plant Biotechnology

Plant tissue culture media, phytohormones, invitrocultures—initiation and maintenance of callus, suspension cultures and single cell clones—organogenesis, somatic embryogenesis, cutedifferentiation and morphogenesis. Embryoculture, embryorescuederferwidehybridization, and its applications. Endosperm culture and production of triploids. Introduction to the processes of embryogenesis and organogenesis and their practical applications.

tissue culture for genetic manipulation of plants, Introduction to A. tumefaciens.

Tumor formation on plants using A. tumefaciens (Monocots vs Dicots). Practical application of genetic transformation.


Plant secondary metabolites - types and applications, Biofertilizers - organization of nif genes and their regulation, Rhizobium, Azotobacter, Azolla, cyanobacteria and their associations, Mycorrhizal biofertilizers and biopesticide production strategies.

**Recommended Books:**
5. *Agricultural biotechnology* by Purohit.

**BIO 307: Recombinant DNA Technology**

Isolation of DNA, cDNA synthesis, chemical synthesis of DNA by phosphoramidite method. Introduction of DNA into living cells, Introduction of gene cloning and its uses, tools and techniques: plasmids and other vectors, DNA, RNA, cDNA. Enzymes used in genetic engineering. Restriction endonucleases and restriction mapping, DNA ligase, DNA polymerase-I, reverse transcriptase, SI nuclease, terminal nucleotidetransferase, alkaline phosphatase, polynucleotid kinase, polynucleotide phosphorylase. Production of proteins from cloned genes: gene cloning in medicine (Pharmaceutical agents such as insulin, growth hormones, recombinant vaccines), gene therapy for genetic diseases. Cloning vectors - salient features, plasmid vectors, phage vectors, cosmids, phagemids (Lambda and M13 phages), viral vectors (SV40, Baculo and CMV), artificial chromosomes BAC, YAC and MAC.

Ligation of DNA vectors - cohesive end, blunt end, homopolymer tailing, linkers and adaptors. Gene transfer techniques - transformation, transfection, microinjection, electroporation,
lipofection and biolistics. Reporter gene assay, selection and expression of rDNA clones. Polymerase Chain Reaction, PCR variations and their applications. DNA sequencing—chemical, enzymatic and NGS methods. Salient features of human genome project. Applications of genetic engineering in agriculture, animal husbandry, medicine and industry.

**Recommended Books:**

Recombinant DNA, J.D. Watson et al, W.H. Freeman and Company

Gene cloning and DNA analysis by T.A. Brown


Molecular Biology of gene by Watson, Baker, Bell, Gann, Levine, Losick

DNA Science by Micklos Freyer

Principles of Gene manipulation and Genomics by Primrose and Twyman

**BIO 308: Bioinformatics**

Introduction to Bioinformatics, Introduction to Internet, Search Engines (Google, Yahoo, Entrez etc). Biological Databases: Biological database concept, Primary, secondary and composited databases, Nucleotide Sequence databases (EMBL, GenBank, DDBJ), Protein Databases ~(UNIPROT, PIR, TREMBL), Protein family/domain databases (PROSITE, PRINTS, Pfam), Metabolic & Pathway databases (KEGG, etc.), Structural databases (PDB).

Genomics: The origin of genomes, Acquisition of new Genes, DNA sequencing—chemical and enzymatic methods, The origin of introns, Restriction mapping, DNA & RNA fingerprinting, The Human Genome, SAGE, ESTs, AFLP & RFLP analysis.

Annotation, Functional & Comparative Genomics, Basic concepts of Multi-omics methods, Genome analysis, genome anatomy, genome rearrangements with inversions, signed inversions, gene identification, gene expression, expression analysis, gene identification and functional classification.

Primary Sequence Analysis: Sequence alignment, Homology concept, pairwise sequence alignment, multiple sequence alignment, Annotation, comparison of different methods, Phylogenetic Analysis, tree building methods, snip identification, EST databases, clustering.
Recommended Books:

Bioinformatics – Sequence, Structure and Databanks, Des Higgins & Willie Taylor
Bioinformatics: Sequence and Genome Analysis, D.W. Mount, Cold Spring Harbor Laboratory Press
A Primer of Genome Science, Greg Gibson and Spencer V. Muse
Database Annotation in Molecular Biology: Principles and Practice, Arthur M. Lesk
DNA: Structure and Function, Richard R. Sinden
Recombinant DNA (Second Edition), James D. Watson and Mark Zoller
Gene Cloning and DNA Analysis – An introduction (Fourth Edition), T.A. Brown
Structural Bioinformatics, Philip E. Bourne, Helge Weissig 2003
Introduction to Bioinformation – T. Attawoo

BIO 401: Biology of Infectious Diseases


BIO 402: Industrial Biotechnology

Introduction to fermentation, the fermentation industry, production process batch and continuous system of cultivation, solid-state fermentation. Selection of industrial microorganisms, media for fermentation, aeration, pH, temperature and other requirements during fermentation, downstream processing and product recovery, food industry waste as fermentation substrate.

Production of compounds like antibiotics, enzymes, organic acids, solvents, beverages, SCP. Production of fermented dairy products, immobilized enzymes systems, production and applications. Industrial application of microbes - Wine, Beer, Cheese, Yogurt.

by microorganisms; microorganisms and pollution control-bioremediation; biosensors.

**Recommended Books:**

Industrial Microbiology– Cassida

Principles of fermentation Technology, Salisbury, Whitaker and Hall

Industrial microbiology– Prescot & Duhn.

**Elective 1 BIO 403: Biomedical Engineering**

Introduction to fermentation: rate of microbial growth and death. Fermentation: types, classification, basic requirements, design of a fermentor, factors involved in fermentor design - basic functions - containment body construction - temperature control - stirring and mixing - viscosity - Newtonian and Non-Newtonian fluids. Isolation and preservation of industrially important microorganisms - strain development - mutation and recombination - upstream processing. Fermentation kinetics of batch, continuous and fed batch fermentation - cell recycle - scale up window - principle types of fermentor: tower fermentor, cylindrical, airlift fermentor, deep jet fermentor, photobioreactor, membrane bioreactor and Micro carrier reactors.

Biomechanics, bio fluidics, biomedical signal processing, embedded systems in medicine, principles of diagnostic and therapeutic instruments. Biomaterials.

**Elective 2 BIO 404: Drug designing and Drug Development**

Concepts of Drug and Drug Targets, important databases, Methods for target identification, lead identification, optimization and validation concepts, Pharmacodynamics and Pharmacokinetics, Natural substances as drugs, Stages and cost of modern drug design, Terminologies in Drug designing and CADD, Bioactivity of a compound, HTS and Virtual screening, docking methodologies, Molecular Modeling concepts, Drug designing methods: structure based drug designing and ligand based drug designing, Molecular Descriptors, Drug Receptor interaction and SAR/QSAR methods. Biomolecular Screening methods, HTS, parameters required
for testing the compounds, LADME approaches, Toxicity criteria, pharmacogenomics and Pharmacogenetics.

**Recommended Books:**

Molecular Modeling: Principles and Applications, Andrew R. Leach. Structural Bioinformatics, Philip E. Bourne.

**Elective 3 BIO 405: Genomics, Proteomics and Systems Biology**

Introduction and scope of proteomics; Protein separation techniques: ion exchange, size-exclusion and affinity chromatography techniques; Polyacrylamide gel electrophoresis; Isoelectric focusing (IEF); Two-dimensional PAGE for proteome analysis; Image analysis of 2D gels; Introduction to mass spectrometry; Strategies for protein identification; Protein sequencing; Protein modifications and proteomics; Applications of proteome analysis to drug; Protein-protein interaction (Two hybrid interaction screening); Protein engineering; Protein chips and functional proteomics; Clinical and biomedical application of proteomics; Proteome database; Proteomics industry.

Methods of preparing genomic DNA; DNA sequence analysis methods: Sanger Dideoxy method and Fluorescence method; Gene variation and Single Nucleotide Polymorphisms (SNPs); Expressed sequenced tags (ESTs); Gene disease association; Recombinant DNA technology: DNA cloning basics, Polymerase chain reaction, DNA fingerprinting, Human genome project and the genetic map.

Introduction to systems biology. Terms and definitions. Dynamical systems, linear stability and bifurcation analysis. Limit cycles, attractors. Genetic and biochemical networks, chemical kinetics, deterministic and stochastic descriptions. Other network types: Regulatory (e.g. fly), Signal transduction (e.g. MAPKinase cascade in yeast), Metabolic (E.coli), Neural network. Topology of genetic and metabolic networks.


**Recommended Books:**

**BIO 406: Internal Project**

The students are advised to work under the supervision of anyone of the faculty members in the department.

**BIO 407: Research Project**

Under this course the students are directed to work in solving a research project in their field of interest related to biotechnology external or internal depending upon choice and interest of the student.

**Minor courses**

The department of life sciences is offering a minor degree to students pursuing various major degrees across the university. The department has 10 seats reserved for students opting for a minor degree. The criteria for selection of students for a minor will be based on the overall CGPA followed by an interview by the departmental committee.

For getting a minor degree, the students have to complete a minimum of 24-30 credits in life science department, which includes four compulsory and two optional* courses.

**Compulsory courses**

<table>
<thead>
<tr>
<th>CODE</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 201</td>
<td>Cell Biology and Genetics</td>
<td>4</td>
</tr>
<tr>
<td>BIO 207</td>
<td>Fundamentals of Molecular Biology</td>
<td>4</td>
</tr>
<tr>
<td>BIO 208</td>
<td>Microbiology I</td>
<td>4</td>
</tr>
<tr>
<td>BIO 210</td>
<td>Biochemistry I</td>
<td>4</td>
</tr>
</tbody>
</table>

*All courses offered to BS Biotechnology major students in the IV, V and VI semesters will be offered as optional courses for the minor degree.