Department of Life Sciences

BS in Biotechnology Program

The Department of Life Sciences in the School of Natural Sciences, SNU, believes in laying a strong foundation in Biology and at the same time not being orthodox, apprises the students of advanced technology that will help them to become excellent teachers and/or world-class researchers or experts to successfully compete for jobs in industry, academia and hospitals. For this, they will be exposed to hands-on training in the state-of-the-art laboratories and the custom designed research projects to help them achieve their goals.

Welcome Note

If your ambitions fly high and you are willing to shape them by putting up hard work with sincerity, we assure to fulfill them. We do not compromise on the quality of teaching, research and steer that to fulfill your career of interest by tailoring the curriculum to job oriented programs or creating the map for you to get trained in the best universities or institutes in the world. We will help you realize your dreams and that is our promise.

The Teaching Experience

The Bachelor of Science in Biotechnology degree program at the Department of Life Sciences combines the strengths of four departments of Natural Sciences i.e. Life Sciences, Chemistry, Mathematical Sciences, and Physics. The Department provides modern teaching by highly skillful globally trained biological researchers and educators from esteemed universities throughout the world. The degree is designed for students who have interest and exceptional ability to get trained in this interdisciplinary area for their overall and scientific development. The course of study is structured to be completed in four years that will lead the students trained to pursue their career for a Ph.D. in SNU or other similarly-structured universities in the USA and Europe (without having to obtain an additional MS degree) while others can find placements in Hospitals, Biopharmaceutical companies in India and abroad.

The Lab Journey

The Department has advanced infrastructure and state-of-the-art research laboratories that can match any well renowned lab of Molecular Biology in the world. We have exclusive instruments to provide expertise in 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.
Research and Training

Shiv Nadar University being a teaching cum Research University we lay equal emphasis on Teaching and Research through our researchers and the teachers. The mandatory undergraduate research projects 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 get associated with the faculty who will assign the projects, guide their execution, help students write the 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, or 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
- Malarial Vaccinology
- 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, Biologic companies, Hospitals, Research institutes and Universities. On completion of the program, students will be coached by the scientists to help them find jobs in the areas of their interest which will be further supplemented by counseling and guiding to get grants, fellowship and projects from independent agencies like intramural grants, BCIL India support and others.
### BS in Biotechnology -- Course Catalogue

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the Course</th>
<th>Periods/Week</th>
<th>No. of Credits</th>
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<tr>
<td>TBA</td>
<td>English-I</td>
<td>4</td>
<td>4</td>
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<tr>
<td>BIO 102</td>
<td>Fundamentals of computers</td>
<td>5</td>
<td>4</td>
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<tr>
<td>TBA</td>
<td>Chemistry I</td>
<td>5</td>
<td>4</td>
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<tr>
<td>TBA</td>
<td>Mathematics for Biologists</td>
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<td>4</td>
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<tr>
<td>TBA</td>
<td>Concepts of Physics</td>
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<td><strong>Total Credits for I semester</strong></td>
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<tr>
<td>TBA</td>
<td>English II</td>
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<tr>
<td>BIO 103</td>
<td>Plant Sciences I</td>
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<tr>
<td>TBA</td>
<td>Chemistry II</td>
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<tr>
<td>TBA</td>
<td>Biostatistics</td>
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<tr>
<td>BIO 104</td>
<td>Animal Sciences I</td>
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<tr>
<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 204</td>
<td>Developmental Biology</td>
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<td>BIO 205</td>
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<td>IV Semester</td>
<td>BIO 206</td>
<td>Bio analytical techniques</td>
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<td></td>
<td>BIO 207</td>
<td>Fundamentals of Molecular biology</td>
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<td>BIO 208</td>
<td>Microbiology I</td>
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<td>BIO 209</td>
<td>Biophysics</td>
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<tr>
<td></td>
<td>BIO 210</td>
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<td>V Semester</td>
<td>BIO 301</td>
<td>Recombinant DNA Technology</td>
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<td>BIO 302</td>
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<td>BIO 303</td>
<td>Virology</td>
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<td>BIO 304</td>
<td>Bioinformatics</td>
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<td>BIO 305</td>
<td>Immunology</td>
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<td>VI Semester</td>
<td>BIO 306</td>
<td>Animal Biotechnology</td>
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<td>BIO 307</td>
<td>Plant Biotechnology</td>
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<td>BIO 308</td>
<td>Biomedical engineering</td>
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<td>BIO 309</td>
<td>Industrial Biotechnology</td>
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<td>Elective 1 BIO 310</td>
<td>Biology of infectious diseases*</td>
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<td>Elective 2 BIO 311</td>
<td>Drug design and Drug development *</td>
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<td>Total Credits for VI semester</td>
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* Elective course depending upon specialization area.
VII Semester

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<td>BIO 401</td>
<td>IPR and Patent law</td>
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<tr>
<td>BIO 402</td>
<td>Internal Project Dissertation</td>
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<tr>
<td>Elective 3 Bio 403</td>
<td>Bio-imaging and nano medicine **</td>
<td>5</td>
</tr>
<tr>
<td>Elective 4 Bio 404</td>
<td>Genomics ,Proteomics &amp; System Biology **</td>
<td>5</td>
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<tr>
<td>Elective 5 BIO 405</td>
<td>QC and Regulatory affairs **</td>
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** Two elective course to be chosen depending upon specialization area

Total Credits for VII semester 20

VIII Semester

<table>
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<th>Title</th>
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<tbody>
<tr>
<td>BIO 406</td>
<td>6 months Dissertation Project with Thesis presentation and Viva Voce</td>
<td>20</td>
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</tbody>
</table>

Total Credits for VIII semester 20

**BIO 102: Fundamentals of Computers**

**Introduction to computers:** Overview and functions of a computer system, History: Evolution, Generation of computers (I, II, III, IV, V), Classification of computers (mainframes, mini computers, microcomputers, special purpose), Input and output devices. Storage devices: Hard disk, Magnetic tape, RAID, Digital tape, CD-ROM, DVD. Memory: Register, buffer, RAM, ROM, PROM, EPROM, EEPROM. Types of Processing: Batch, Real-Time, Online, Offline

**Introduction to operating systems:** Operating System concept, Windows 98/XP, Windows server NT/2000, Unix/Linux & servers

**Computer Networking:** Introduction to networking: Associated hardware devices, gadgets (Router, Switch etc.), Network Topologies and Protocols LAN, WAN and MAN, World Wide Web (WWW) Network security: fire walls.

Internet searches: Search engines: Google, Yahoo etc. Concepts in text-based searching Medline, bibliographic databases.

Databases: Introduction & need of databases, Types of databases, Basic concepts in: Data Abstraction, Data Models, Instances & Scheme, E-R Model (Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables) Network Data Model: Basic concepts, Hierarchical Data Model: Basic concepts, Multimedia Databases: Basic concepts and Applications Indexing and Hashing

Introduction to Bioinformatics: Nature of Biological data, Overview of Bioinformatics, Major Bioinformatics Resources: NCBI, EBI & ExPASY

Recommended Books:
1. Introduction to Computers Data processing & Networking
3. Introduction to Bioinformatics- Attwood
4. Instant Notes in Bioinformatics

BIO 103: Plant Sciences I

Taxonomy: General principles of taxonomy, Hierarchy Systematics: Carolus Linnaeus
Systematics. Outlines and relative studies on classification of angiosperms, Bentham & Hooker, Engler and Prantel and Hutchinson system.


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

BIO 104: Animal Sciences I

Introduction to Invertebrates: General characters 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, Tenia solium and Ascaris lumbricoides. Introduction to model systems: C.elegans, Drosophila and zebra fish.
BIO 201: Cell Biology and Genetics

Cell as a basic unit of living systems: The cell theory, precellular evolution; broad classification of cell types: archaeabacteria, 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 organisation 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 ciliar; cell senescence and death : apoptosis, necrosis and autophagy, Cell differentiation, Mechanism of cell differentiation (e.g., RBC), difference between normal and cancer cells.


Recommended Books:


Cell and Molecular Biology, DeRobertis, B.I. Publication Pvt. Ltd.

Cell and Molecular Biology - Sheelar & Bianchi, John Wiley
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 Phytogeography, 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

**LSPP 615- ECOLOGY AND ENVIRONMENTAL MANAGEMENT**

### 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.


**Recommended books:**

1. HopkinsWG & Huner PA introduction to plant physiology
2. Dickinson WC integrative plant anatomy

### BIO 204: Developmental Biology

Introduction to Developmental Biology: History and Basic Concepts, Vertebrate Model Systems Invertebrate and Plant Model Systems, 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.

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:**

Developmental Biology, By Scott F Gilbert.

Human Developmental Biology by Danton O'Day

Developmental Biology: A Very Short Introduction by Lewis Wolpert

Principles of Development by Lewis Wolpert and Cheryll Tickle

Principles of Developmental Biology by Sarah Hake and Fred Wilt

**BIO 205: Animal Sciences II**


**Recommended books:**
2. Medical Physiology, Shambulingam
3. Human Physiology Roase & Wilson

**BIO 206: 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 Son 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 207: Fundamentals of Molecular Biology**


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)
3. Cell and Molecular Biology by E,D.P.De Roberties (International edition)

**BIO 208: Introduction to Microbiology**

The study of microbial structure by use of light, 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
4. Microbiology- Principles and Application by J.G. Black, John Wiley and Sons, New york
6. General Microbiology volume I and II - Power

**BIO 209: 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 radiations 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-MJP Publishers (Unit III)
4. Bio Physics- Rodney Cotterill John Wiley & Sons, Ltd. (Unit V)

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.

Nucleic acids: Structure and properties of nucleic acids. Different forms of DNA- A, B, Z. Circular DNA and DNA supercoiling. Different types of RNA- mRNA, and non coding RNA – tRNA, rRNA, scRNA, snRNA and siRNA.

Lipids: Classification, structure, properties and functions of fatty acids, triglycerides, phospholipids, sphingolipids, cholesterol and eicosanoids-prostaglandins. Source, structure, biological role and deficiency disorders of fat soluble vitamins (A,D,E and K) and water soluble vitamins (riboflavin, niacin, thiamine, pyridoxine, biotin, folicacid, pantothenic acid, cobalmine, and ascorbic acid).

**Recommended Books:**

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

**BIO 301: Recombinant DNA Technology**

Isolation of DNA, cDNA synthesis, chemical synthesis of DNA by
Phosphoramidite method. Introduction of DNA into living cells. Introduction to 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 nucleotide transferase, alkaline phosphatase, polynucleotide 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 to 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 r-DNA 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 Biotechnology: Principles and Applications of Recombinant DNA, B.R. Grick and J.J.

Pasternak, ASM Press

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 302: Advanced Biochemistry**

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 303: 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, life cycle and pathogenicity of important viruses, genome organization and replication of DNA viruses, RNA viruses, Adeno virus, Pox virus, SV40, Vaccinia, Lentivirus. Clinical diagnosis and
treatment of HIV, Influenza and Hepatitis. Plant Viruses: Classification 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 immuno chemistry. 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 REF Matthews

BIO 304: Bioinformatics

Introduction to Bioinformatics ,Introduction to Internet, Search Engines (Google, Yahoo, Entrez etc). Biological Databases: Biological database concept, Primary, secondary and composite 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 origins 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, ESTs – 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 305: 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 disease susceptibility, 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 immuno diffusion and Mancini’s radial immuno diffusion, 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 306: Animal Biotechnology**


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.


**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., (University press)  
6. Principles and practices of aquaculture by TVR Pillay.  
7. Coastal aquaculture by Santhanam.  
8. Fisheries of India by CBL Srivatsava.

**BIO 307: Plant Biotechnology**

Plant tissue culture media, phytohormones, in vitro cultures- initiation and maintenance of callus, suspension cultures and single cell clones- organogenesis, somatic embryogenesis, cite differentiation and morphogenesis. Embryo culture, embryo rescue after wide hybridization, and its applications. Endosperm culture and production of triploids. Introduction to the processes of embryogenesis and organogenesis and their practical applications.


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:**
3. Biotechnology and its applications to Agriculture, by Copping LG and P. Rodgers
(British Crop Projection).
5. Agricultural biotechnology by Purohit.

**BIO 308: 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, cylindro conical, airlift fermentor, deep jet fermentor, photo bioreactor, membrane bioreactor and Micro carrier reactors.

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

**BIO 309: 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.

Primary and secondary metabolites and their applications; preservation of food. Biogas; bio-fertilizers and bio-pesticides. Use of microbes in mining: leaching of ores by microorganisms; microorganisms and pollution control-bioremediation; biosensors. Biological waste treatment and in-plant sanitation - principle and use of biosensor - production of vitamins, amino acids, organic acids, enzymes and antibiotics, alcohols. Enzyme technology - production and recovery of enzymes,
enzyme immobilization - application of enzyme in industries. Biosensor.
**Recommended Books:**

Industrial Microbiology – Cassida

Principles of fermentation Technology, Salisbury, Whitaker and Hall

Industrial microbiology – Prescot & Duhn.


**BIO 310: Biology of Infectious diseases**


**BIO 311: 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 base 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.
BIO 401: IPR and Patent Law

Intellectual property rights - TRIP International conventions patents and methods of application of patents - legal implications biodiversity and farmer rights - beneficial applications and development of research focus of the need of the poor - Identification of directions for yield effect in agriculture - aquaculture and bioremediation. major changes in Indian patent system as post TRIPS effects (i) obtaining patent (ii) geographical indication

Objectives of the patent system - basic principles and general requirements of patent law-biotechnological inventions and patent law - legal development - patentable subjects and protection in biotechnology - The patentability of microorganisms - IPR and WTO regime - consumer protection and plant genetic resources-GATT and TRIP. Distinction among various forms of IPR, requirement of a patentable novelty, invention step and prior art and state of art, procedure. Rights/protection, infringement or violation, remedies against infringement – civil and criminal. Detailed information on patenting biological products, Biodiversity, Budapest treaty, Appropriate case studies. Biosafety and Bioethical issues in Biotechnology

Recommended Books:

www.patentoffice.nic.in/ipr/patent/patents.htm

BIO 402: Internal Project

BIO 403: Bio-Imaging and Nanomedicine (Elective)

Basic concept of microscopy: geometrical and physical optics of microscope image formation including Abbe’s theory of the microscope and Fourier optics, interaction of light and matter, phase contrast polarization and interference microscopy for the nondestructive analysis of molecular and fine-structural organization in living cells. Fluorescence microscopy, quantification of fluorescence, and GFP, principles and application of digital video imaging, recording, analysis, and display Digital image processing and quantitative digital image deconvolution, ratiometric measurement of
intracellular ion concentrations. Confocal microscopy; and such as FRET, FLIM, TIRF, Spining Disk and patterned illumination.

Introduction to super resolution microscopy, STORM, SIM, STED. The focus of this course is on the application of nano materials in health care technologies. Knowledge and understanding of the nano scale design, synthesis, engineering and application of materials for the delivery of challenging drug molecules such as oligonucleotides and anti-tumour agents and for fabrication of the next generation of medical implants. Use of both inorganic support materials and biological molecule for nanomedicine, development of novel biomaterials, therapeutic delivery systems, Imaging agents and biosensors. Knowledge and understanding of the relationships between structure, stability and folding of biological molecules (e.g. proteins, antibodies) as the basis of biomolecular engineering. De novo design of biomolecules with desired properties for nanotechnology applications.

An understanding of the principles underlying the construction, and operation of biological sensor systems and their application in biomedical nanotechnology. Drug Delivery and Imaging Background to the delivery of drugs and therapeutics in healthcare applications. Nanoparticles and dendrimers in drug targeting, delivery and activation – the interface with imaging. The basic principles underlying sensor technology, including bio recognition and signal transduction.

**BIO 404: Genomics, Proteomics and Systems Biology (Elective)**

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. MAP Kinase cascade in yeast), Metabolic (E coli), Neural network. Topology of genetic and metabolic networks.

**Recommended Books:**

**BIO 405: QC and Regulatory Affairs (Elective)**


**Non Clinical Study Reports** Non- Clinical Study Objectives & Timings Pharmacological Studies. Bioavailability and Bioequivalence Toxicology Studies **Clinical Trials** Clinical Trials Clinical Trial Design Good Clinical Practice The Sponsor. The Investigator The Trial Protocol Competent Authority Clinical Trial Application Amendments to Clinical Trials Monitoring of Trials Trial Master File.

**BIO 406: 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.