

B. Sc. Medical Biotechnology Syllabus

Semester I

BU 101: BASIC CHEMISTRY

- Introduction to the Study of Chemistry
- Measurements in Chemistry
- Matter, Changes, and Energy
- Elements, Compounds, and Their Composition
- The Periodic Table and Chemical Nomenclature
- Modern Atomic Theory
- The Chemical Bond
- Chemical Reactions
- Quantitative Relationships in Chemistry
- The Gaseous State
- The Solid and Liquid States
- Aqueous Solutions
- Acids, Bases, and Salts
- Oxidation-Reduction Reactions
- Reaction Rates and Equilibrium
- Nuclear Chemistry
- Organic Chemistry

Books:

Basic concepts of chemistry – by Leo J. Malone

BU 102: MATHEMATICS FOR LIFE SCIENCES

- Real Numbers
- Sets and symbolic logic
- Relations and Functions
- The Power function and related functions
- Periodic functions
- Exponential and Logarithmic functions I
- Graphical Methods
- Limits
- Differential and Integral calculus
- Exponential and Logarithmic functions II
- Ordinary differential equations
- Functions of two or more independent variables
- Probability
- Matrices and vectors
- Complex numbers

Books:

Introduction to Mathematics for life scientist – by Edward Batschelet

BU 103: INTRODUCTION TO EVOLUTIONARY BIOLOGY

- Before Darwin
- Darwin
- The Arguments and the Evidence
- The Darwinian Impact: Evolution and Religion
- The Beginning
- The Earth
- Molecules and the Origin of Life

- Proteins and the Genetic Code
- From Metabolism to Cells
- Genetic Constancy and Variability
- Systematics and Classification
- Molecular Phylogenies and Evolution
- Evolution in Plants and Fungi
- From Protozoa to Metazoa
- Evolution Among Invertebrates
- The Origin of Vertebrates
- From Water to Air: Amphibians Reptiles, and Birds
- Evolution of Mammals
- Primate Evolution and Human Origins
- Populations, Gene Frequencies, and Equilibrium
- Changes in Gene Frequencies
- Structure and Interaction of Populations
- From Races to Species
- Culture and the Control of Human Evolution

Books:

Evolution – by Monroe W. Strickberger

BU 104: INTRODUCTION TO BIOTECHNOLOGY

- Modern Biotechnology
 - What is biotechnology?
 - Ancient Biotechnology
 - Classical Biotechnology
 - The Foundation of Modern Biotechnology
- The DNA Revolution: Promise and Controversy
 - The Early years of Molecular Biology
 - The First Recombinant DNA Experiments
 - Concerns about Safety
 - Drafting the NIH Guidelines
 - Current and Future Concerns
- Microbial Biotechnology
 - Commercial Production of Microorganisms
 - Bioconversion
 - Microorganisms and Agriculture
 - Products from Microorganisms
 - Bioremediation
 - Oil and Mineral Recovery
 - Future
- Animal Biotechnology
 - Gene Transfer Methods in Animals
 - Transgenic Animals
 - Animal Diseases
 - Animal Propagation
 - Conservation Biology
 - Regulation of Transgenic Animals
 - Patenting Genetically Engineered Animals
- Marine Biotechnology
 - Aquaculture
 - Marine Animal Health
 - Algal Products
 - Fuels from Algae
 - Algal Cell culture
 - Medical Application
 - Probing the marine Environment
 - Transgenic Fish
- The Human Genome Project
 - Goals of the human genome
 - Genetic Linkage Maps
 - Polymorphic DNA Markers

- Physical Maps
- DNA sequencing
- Ethical, Legal and Social Implications
- Medical Biotechnology
 - Gene Therapy
 - Gene Delivery Methods
 - Viral Delivery
 - Models
 - Commercialization
 - Vaccines
 - Synthetic DNAs
 - Tissue Engineering
 - Xenotransplantation
 - Antibody Engineering
 - Cell Adhesion Based Therapy
 - Drug Delivery
- Forensic and DNA Profiling
 - Satellite DNA
 - Population Genetics and Allele
 - Single and Multi-locus VNTRs, RFLPs
 - DNA Profiling, PCR, Digital DNA typing, Frye test, DNA Database

Books:

Biotechnology: An Introduction - by Susan R. Barum

SEMESTER II

BU 105: BIOPHYSICS

- Nature and Subject of Biophysics
- Molecular Structure of Biological Systems: Intramolecular Bonds
- Molecular Excitation and Energy Transfer
- Thermal Molecular Movement, Order and Probability
- Molecular and Ional Interactions as the Basis for the Formation of Biological Structures
- Interfacial Phenomena
- Energetics and Dynamics of Biological Systems: Some Fundamental Concepts of Thermodynamics
- The Aqueous and Ionic Equilibrium of the Living Cell
- The Thermodynamic Analysis of Fluxes
- Non-equilibrium States of Ions in Cells and Organelles
- The Mechanical Properties of Biological Materials
- The Biomechanical Consequences of Fluid Behavior
- Physical Factors in the Environment: Temperature; Pressure
- Mechanical Oscillations; Electromagnetic Fields; Ionizing Radiation
- The Kinetics of Biological Systems: The General Foundation of System Theory
- Metabolism and Exchange Systems
- Propagation, Growth and Evolution

Books:

Biophysics – by Roland Glaser

BU 106: CELL BIOLOGY

- Cells and Genomes
 - Universal features of cells
 - Genome diversity and tree of life
 - Genetic information in eukaryotes
- Visualizing Cells
 - Looking at the structures of cell in the microscope
 - Visualizing molecules and structures in living cells
- Intracellular compartments and Protein Sorting
 - The compartmentalization of cells
- The Transport of molecules between the nucleus and the cytosol

- The Transport of Proteins into
 - Mitochondria and Chloroplasts
 - Peroxisomes
 - The Endoplasmic Reticulum
- Intracellular Vesicular Traffic
 - The Molecular Mechanisms of Membrane Transport and the Maintenance of Compartmental Diversity
 - Transport from the ER through the Golgi Apparatus
 - Transport from the *trans* Golgi Network to Lysosomes
 - Transport into the Cell from the Plasma Membrane: Endocytosis
 - Transport from the trans Golgi Network to the Cell Exterior: Exocytosis

Books:

Bruce Albert

Lodish

Cooper

Sheeler and Bianchi

Walker and Rapley

BU 107: BASIC LABORATORY METHODS FOR BIOTECHNOLOGY

- Introduction to the biotechnology workplace
- Product quality and biotechnology
Math in the biotechnology laboratory: An overview
- Data in the laboratory
Laboratory measurements
- Laboratory solutions
- Basic Laboratory Techniques
 - Spectrophotometry.
 - Quantification of Protein and Nucleic acid Concentration.
 - Chromatography.
 - Gel Electrophoresis of Proteins and Nucleic acids.
 - Overview of Protein Purification.
 - Isolation and Characterization of the Enzyme Alkaline Phosphatase From *Escherichia Coli*.
 - Enzyme Kinetics.
 - Enzymatic Methods of Analysis.
 - Ligand Binding.
 - Polymerase Chain Reaction (PCR).
 - Using the Personal Computer and the Internet for Biochemical Research.

Books:

Basic Laboratory Methods for Biotechnology – by Lisa Seidman

BU 108: BASIC CONCEPTS OF INFORMATION TECHNOLOGY

- Getting Started: Hardware/Software and Information Technology
- Types of Computer
- Main Parts of a Personal Computer
 - Hardware: Central Processing Unit. Input Devices. Output Devices.- Storage: Measuring - Memory. Types of Memory. Computer Performance.
 - Software: Types of Software. Operating System Software. Applications Software
- Systems Development.- Information Networks: LAN and WAN
- The Telephone Network in Computing
- Electronic Mail
- The Internet
- Computers in Everyday Life: Computers in the Home
- Computers at Work in Education
- Computers in Daily Life. I.T. and Society: A Changing World
- A Good Workspace
- Health and Safety

- Security, Copyright and the Law: Security. Computer Viruses. Copyright. Data Protection Act.

Books:

Basic Concepts of Information Technology – by John Lancaster, D. Stott, D. Moran, D. Penfold

SEMESTER III

BU 201: GENETICS –A

- Mendelian Genetics.
- Cell Mechanics.
- Sex Determination and Sex Linkage.
- Genetic Material: Properties and Replication.
- Structure and Replication of Eukaryotic Chromosomes.
- Linkage, Crossing-Over, and Chromosome Mapping.
- Recombination in Bacteria.
- Transposable Genetic Elements.
- Gene Expression.
- Mutation.

Books:

Principles of Genetics – by Eldon J. Gardner, D. Peter Snustad, Michael J. Simmons

BU 202: MEDICAL MICROBIOLOGY – A

- Microbes and parasites
- The host-parasite relationship
- The organisms
- Entry, exit and transmission
- Natural defence in action
- Spread and replication
- Parasite survival strategies and persistent infections
- Pathological consequences of infection
- General principles and specimen quality
- Microbiological techniques for the diagnosis of infection

Books:

Medical Microbiology – Mims et. al.

Medical Microbiology – David Greenwood

Diagnostic Microbiology – Bailey and Scott

Practical Microbiology – Mackie and McCartney

BU 203: HUMAN BIOCHEMISTRY – A

- Biochemistry & Medicine
- Water & pH
- Amino Acids & Peptides
- Proteins: Myoglobin & Hemoglobin
- Bioenergetics: The Role of ATP
- Biologic Oxidation
- The Respiratory Chain & Oxidative Phosphorylation
- Carbohydrates of Physiologic Significance
- Lipids of Physiologic Significance
- Overview of Metabolism
- The Citric Acid Cycle: The Catabolism of Acetyl-CoA
- Glycolysis & the Oxidation of Pyruvate
- Metabolism of Glycogen
- Gluconeogenesis & Control of the Blood Glucose
- The Pentose Phosphate Pathway & Other Pathways of Hexose Metabolism

- Biosynthesis of Fatty Acids
- Oxidation of Fatty Acids: Ketogenesis
- Metabolism of Unsaturated Fatty Acids & Eicosanoids
- Metabolism of Acylglycerols & Sphingolipids
- Lipid Transport & Storage
- Cholesterol Synthesis, Transport, & Excretion

Books:

Harper's Illustrated Biochemistry – Robert Murray, Peter A., Mayes, Victor W. Rodwell, Daryl K. Granner
 Leninger: Principles of Biochemistry

BU 204: BIOSTATISTICS

Introduction to Data Analysis
 Introduction to Probability
 Probability Distributions
 Sampling Distributions
 Introduction to Hypothesis Testing
 One-Sample Tests of Hypothesis
 Tests of Hypothesis Involving Two Samples
 k-Sample Tests of Hypothesis: The Analysis of Variance
 Two-Factor Analysis
 Linear Regression and Correlation
 Goodness of Fit Tests for Categorical Data

Books:

Introduction to Biostatistics – by Thomas Glover, Kevin Mitchell

SEMESTER IV

BU 205: GENETICS –B

Genetic Fine Structure: Classical Genetics.
 Genetic Fine Structure: Gene Cloning and Sequencing.
 Regulation of Gene Expression in Prokaryotes.
 Regulation of Gene Expression and Development in Eukaryotes.
 Genetic Control of the Immune Response.
 Genetic Control of Cell Division: Oncogenes and Protooncogenes.
 Variations in Chromosome Structure.
 Variations in Chromosome Number.
 Extrachromosomal Inheritance.
 Quantitative Genetics.
 Population and Evolutionary Genetics.
 Genetics of Behavior.
 Genetic Engineering and the Future.

Books:

Principles of Genetics – by Eldon J. Gardner, D. Peter Snustad, Michael J. Simmons

BU 206: MEDICAL MICROBIOLOGY – B

- The clinical manifestations of infection: An introduction
- Upper respiratory tract infections
- Infections of the eye
- Lower respiratory tract infections
- Urinary tract infections
- Sexually transmitted diseases
- Gastrointestinal tract infections
- Obstetric and perinatal infections
- Central nervous system infections
- Infections of the skin, muscle, joints, bone and haemopoietic system

World-wide virus infections
Vector-borne infections
Multisystem zoonoses
Pyrexia of unknown origin
Infection in the compromised host
Strategies for control: An introduction
Antimicrobial agents and chemotherapy
Vaccination
Passive and non-specific immunotherapy
Epidemiological aspects of the control of infection and disease
Hospital infection, sterilization and disinfection

Medical Microbiology – Mims et. al.
Medical Microbiology – David Greenwood
Diagnostic Microbiology – Bailey and Scott
Practical Microbiology – Mackie and McCartney

BU 207: HUMAN BIOCHEMISTRY – B

Integration of Metabolism - the Provision of Metabolic Fuels
Biosynthesis of the Nutritionally Nonessential Amino Acids
Catabolism of Proteins & of Amino Acid Nitrogen
Catabolism of the Carbon Skeletons of Amino Acids
Conversion of Amino Acids to Specialized Products
Porphyrins & Bile Pigments
Nucleotides
Metabolism of Purine & Pyrimidine Nucleotides
The Diversity of the Endocrine System

- Hormone Action

Books:

Harper's Illustrated Biochemistry – Robert Murray, Peter A., Mayes, Victor W. Rodwell, Daryl K. Granner
Leninger: Principles of Biochemistry

BU 208: ENZYME TECHNOLOGY

- Introduction:
Enzymes are mainly proteins, enzymes are classified by the reactions they catalyze.
- Enzyme function:
Enzymes affect reaction rates not equilibria, Reaction rates and equilibria have precise thermodynamic definition, Principles behind catalytic power and specificity of enzymes, Weak interaction between enzyme and substrate are optimized in transition state, Enzyme use binding energy to provide reaction specificity and catalysis, Specific catalytic groups contribute to catalysis.
- Enzyme Kinetics:
Kinetics and mechanism, Substrate concentration and rate of reaction, Quantitative expression of relationship between substrate concentration and rate of reaction, The meaning of V_{max} and K_m , Enzymes catalyzing reactions involving two or more substrate Pre-steady state kinetics can provide evidence for specific reaction.
- Enzyme Inhibition:
Reversible and irreversible, Effect of pH, Examples of enzymatic reactions.
- Regulatory enzymes:
Allosteric enzymes are regulated by non-covalent binding of modulators, Allosteric organs are exceptions to many general rules, two models explain the kinetic behavior of allosteric enzymes, Other mechanisms of enzyme regulation.
- Production of enzymes:

Enzymes from animal and plant sources, Enzymes from microbial sources, Large scale production, Biochemical fundamentals, Genetic engineering, Recovery of enzymes, Isolation of soluble enzymes, Enzyme purification, Immobilised enzymes, Legislative and safety aspects.

- Synthesis of chemicals using enzymes:
Hydrolytic enzymes, Chiral building blocks for synthesis, Reduction and oxidation, Use of enzymes, in sugar chemistry, Use of enzymes to make amino acids and peptides.

Reference Books:

1. A text of biochemistry, - A.V.S.S. Rama Rao 9th ed. (UBS Publisher's and Distributors Pvt. Ltd.)
2. Leninger: Principles of Biochemistry, 3rd Ed. – Nelson D. et al (Worth Publishers)
3. Basic Biotechnology, 2nd Ed. – Rattledge, C and Kristiansen B. (Cambridge)
4. Biochemistry, 5th, - Ed. Breg, J.M. Tymoczko J.L. and Stryer L. (W.H. Freeman & Co.)
5. Molecular Biology of the Cell, 2nd Ed. – Alberts B. et al (Garland Publishing)
6. Molecular Cell Biology, 2nd Ed. – Lodish et.al

SEMESTER V

BU 301: MOLECULAR BIOLOGY

- Introduction to Molecular Biology
- The Structure of Proteins, Nucleic Acids, and Macromolecular Complexes
- Macromolecules
- Nucleic Acids
- The Physical Structure of Protein Molecules
- Macromolecular Interactions and the Structure of Complex Aggregates
- Function of Macromolecules
- The Genetic Material
- DNA Replication
- Transcription
- Translation
- Mutations, Mutagenesis, and DNA Repair
- Coordination of Macromolecular Function in Cells
- Regulation of Gene Activity in Prokaryotes
- Regulation of Gene Activity in Eukaryotes
- Genomics and Proteomics Drive Information-Age Biology
- Experimental Manipulation of Macromolecules
- Transposons, Plasmids, and Bacteriophage
- Recombinant DNA and Genetic Engineering: Molecular Tailoring of Genes
- Molecular Biology Is Expanding Its Reach
- Postscript to Your Review of Molecular Biology
- Chemical Principles Important for Understanding Molecular Biology

Books:

Genes and Genomes

Genes VIII

Sambrook

From Genes to Clones by Winnacker

Freifelder

Gardner

Walker and Rapley

BU 302: FERMENTATION TECHNOLOGY

- Introduction to fermentation processes
- Microbial Growth Kinetics
- The isolation, preservation and improvement of industrial microorganisms
- Media for industrial fermentations
- Sterilization
- The development of inocula for industrial fermentations

- Design of a fermentor
- Instrumentation and control
- Aeration and agitation
- The recovery and purification of fermentation products
- Effluent treatment
- Fermentation economics

Books

Industrial Microbiology: An Introduction

Mike J. Waites, Neil Morgan, John Rockey, Gary Higton, John S. Rockey

Bioreactor Operation, BIOTOL series

Product Recovery in Bioprocess Technology, BIOTOL Series

Principles of fermentation technology – P.F. Stanbury et.al.

BU 303: BIOMEMBRANES

- The lipid bilayer:
Membrane lipids are amphiphathic molecules that spontaneously form bilayers, The lipid bilayer is a two-dimensional fluid, The fluidity of a lipid bilayer depends on its composition, The lipid bilayer serves as a solvent for membrane proteins, The lipid bilayer of the plasma membrane is asymmetrical, Glycolipids are found on the surface of all plasma membranes, but their function is unknown.
- Membrane proteins:
Membrane proteins held in bilayer and their hydrophobic interaction with lipid molecules, SDS-PAGE and study of membrane proteins, The cytoplasmic side of membrane proteins can be studied in red blood cell ghosts, Association of spectrin with the cytoplasmic side of the red blood cell membrane, Glycophorin extends through the red cell lipid bilayer as single α - helix, Band III of the human red blood cell membrane is a transport protein, Bacteriorhodopsin is a proton pump that traverses the bilayer as seven α - helices, Membrane transport proteins can be visualized by freeze-fracture electron microscopy, vectorial labeling reagents can be used to study some plasma membrane proteins of nucleated cells, Fusion of two cells and the status of their plasma membrane proteins, Membrane proteins cluster into patches when they are cross-linked by antibodies, Cross-linked membrane proteins are actively swept to one pole of the cell in the process of “capping”, Hypothesis on cap, Association of two polypeptides in plasma membrane, Lateral diffusion rates of membrane proteins can be quantified, regulation of lateral mobility.
- Membrane carbohydrate:
The carbohydrate in biological membranes is confined to the noncytoplasmic surface, cell-surface carbohydrate is suspected to be important in cell-cell interactions.
- Membrane transport of small molecules:
Protein free lipid bilayer are permeable to water but impermeable to ions, Role of membrane proteins in transport across cell membrane, Transport form a continuous protein pathway across the lipid bilayer, Carrier proteins behave like membrane-bound enzymes, Role of $\text{Na}^+ -\text{K}^+$ pump, Role of Ca^+ pump, Membrane bound enzymes that synthesize ATP are transport ATPases working in reverse, Active transport can be driven by ion gradients, Active transport in bacteria can occur by group translocation and can involve water-soluble binding proteins, Some transmembrane proteins channels are gated and open only transiently, Aysmmetrically distributed ion channels can generate ion currents that polarize cells, Ionophores increase the ion permeability of synthetic and biological membranes.
- Membrane transport of macromolecules and particles – exocytosis and endocytosis:
Exocytosis occurs by the fusion of intracellular vesicles with the plasma membrane, Triggerred exocytosis is a localized response of the plasma membrane and its underlying cytoplasm, Membrane fusion involves bilayer adherence followed by bilayer joining, Endocytosis occurs continually in most cells, Most endocytotic vesicles ultimately fuse with lysosomes, Many endocytotic vesicles are coated, Coated pits and vesicles provide a specialized pathway for receptor-mediated endocytosis of specific macromolecules, Many cell surface receptors associate with coated pits only after ligand binding, Some macromolecules can penetrate cell membranes directly, Specialized phagocytic cells ingest particles that bind to specific receptors on their surface, Phagocytosis is a localized response that proceeds by a “membrane-zipping” mechanism, Membrane vesicular traffic how it is powered, guided and regulated?
- Membrane Receptors:
Structure and functions. Methods to study membrane receptors. Purification and characterization of adrenergic and cholinergic receptors.

Reference Books:

1. Leninger: Principles of Biochemistry, 3rd Ed. – Nelson D. et al (Worth Publishers)
2. Cell Biology – Roy S.C. and De Kalyan Kumar (New Central Book Agency)
3. Cell Biology – Fundamental and Application, - Gupta M.L. and Jangir M.L. (Agrobios)
4. Cell and Molecular biology, 8th Ed. – De Robertis E.D.P. and De Robertis, Jr. E.M.F. (Lippincott Williams & Wilkins).
5. Molecular Biology of the Cell, 2nd Ed. – Alberts B. et al (Garland Publishing)
6. Molecular Cell Biology, 2nd Ed. – Lodish et.al

SEMESTER VI

BU 304: ETHICAL ISSUES IN BIOTECHNOLOGY

- Fundamental Issues of Ethics and Biotechnology
- How to Assess the Consequences of Genetic Engineering
- Redesigning the World: Ethical Questions about Genetic Engineering
- "Playing God" and Invoking a Perspective
- The Scientific and Health Aspects of Genetically Modified Foods: Rapporteurs'
- The Safety of Foods Developed by Biotechnology
- Hazards of Genetically Engineered Foods and Crops: Why We Need a Global Moratorium
- Why We Need Labeling of Genetically Engineered Food
- Ethical Issues in Food Biotechnology
- Animal Biotechnology
- A Critical View of the Genetic Engineering of Farm Animals
- The "Frankenstein Thing": The Moral Impact of Genetic Engineering of Agricultural Animals on Society and Future Science
- On the Ethics of Using Animals for Human Benefit
- The Case for the Use of Animals in Biomedical Research
- Artificial Lives: Philosophical Dimensions of Farm Animal Biotechnology
- Genetic Engineering as Animal Slavery
- Uncertainty in Xenotransplantation: Individual Benefit versus Collective Risk
- Critical Ethical Issues in Clinical Trials with Xenotransplants
- Human Genetic Testing and Therapy
- Social, Legal, and Ethical Implications of Genetic Testing
- Genetic Links, Family Ties, and Social Bonds: Rights and Responsibilities in the Face of Genetic Knowledge
- Privacy and the Control of Genetic Information
- The Ethics of Somatic Cell Gene Therapy
- Human Inheritable Genetic Modifications: Assessing Scientific, Ethical, Religious, and Policy Issues
- Germ-Line Genetic Engineering and Moral Diversity
- Human Cloning and Stem Cell Research
- Human Cloning: Report and Recommendations of the National Bioethics Advisory Commission
- The Wisdom of Repugnance
- Genetic Encores: The Ethics of Human Cloning
- Stem Cell Research and Applications: Findings and Recommendations
- On Human Embryos and Stem Cell Research: An Appeal for Legally and Ethically Responsible Science and Public Policy

Books:

Ethical Issues in biotechnology – Wm H. Thorton, John Morrey

BU 305: PHARMACEUTICS

- Drug Products: Their Role in the Treatment of Disease, Their Quality, and Their Status and Future as Drug-Delivery Systems
- Principles of Drug Absorption
- Pharmacokinetics
- Factors Influencing Drug Absorption and Drug Availability
- The Effect of Route of Administration and Distribution on Drug Action
- Chemical Kinetics and Drug Stability
- Preformulation
- Cutaneous and Transdermal Delivery - Processes and Systems of Delivery
- Disperse Systems
- Tablet Dosage Forms
- Hard and Soft Shell Capsules
- Parenteral Products

- Design and Evaluation of Ophthalmic Pharmaceutical Products
- Delivery of Drugs by the Pulmonary Route
- Sustained- and Controlled-Release Drug Delivery Systems
- Target-Oriented Drug-Delivery Systems
- Packaging of Pharmaceutical Dosage Forms
- Optimization Techniques in Pharmaceutical Formulation and Processing
- Food and Drug Laws that Affect Drug Product Design, Manufacture, and Distribution
- European Aspects of the Regulation of Drug Products with Particular Reference to Development Pharmaceuticals
- Pediatric and Geriatric Aspects of Pharmaceuticals
- Biotechnology-Based Pharmaceuticals
- The Pharmacist and Veterinary Pharmaceutical Dosage Forms
- Dietary Supplements
- Bioequivalency
- Drug Information
- Managed Care and Pharmacotherapy Management

Books:

Modern Pharmaceutics – Gibert, S. Banker, C. Rhodes

Pharmaceutics – M.E. Aulton

BU 306: BASIC IMMUNOLOGY

- Introduction to the Immune System: The Nomenclature, General Properties, and Components of the Immune System
- Innate Immunity: The Early Defense Against Infections
- Antigen Capture and Presentation to Lymphocytes: What Lymphocytes See
- Antigen Recognition in the Adaptive Immune System: Structure of Lymphocyte Antigen Receptors and the Development of Immune Repertoires
- Cell-Mediated Immune Responses: Activation of T Lymphocytes by Cell-Associated Microbes
- Effector Mechanisms of Cell-Mediated Immunity: Eradication of Intracellular Microbes
- Humoral Immune Responses: Activation of B Lymphocytes and Production of Antibodies
- Effector Mechanisms of Humoral Immunity: The Elimination of Extracellular Microbes and Toxins
- Immunologic Tolerance and Autoimmunity: Self-Nonself Discrimination in the Immune System and Its Failure
- Immune Responses Against Tumors and Transplants: Immunity to Noninfectious Transformed and Foreign Cells
- Hypersensitivity Diseases: Disorders Caused by Immune Responses
- Congenital and Acquired Immunodeficiencies: Diseases Caused by Defective Immune Responses

Books:

Immunobiology by Janeway

Roitt

Kuby

Cellular Immunology - Biotol

Fudenberg

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SEMESTER I

BP 101: ADVANCE CELL BIOLOGY

- The Cytoskeleton
 - Muscle contraction
 - Ciliary Movements
 - General features of microtubules and actin filaments as dynamic assemblies
 - Microtubules organizing centers and microtubule associated proteins
 - Actin filaments and actin binding proteins in non-muscle cells
 - Intermediate filaments
 - Organization of the cytoskeleton
- Cell Differentiation and the maintenance of the tissues
 - Maintenance of the differentiated state
 - Tissues with permanent cells
 - Renewal by simple duplication
 - Renewal by stem cells – epidermis
 - Renewal by pluripotent stem cells – blood cell formation
 - Quiescent stem cells – Skeletal muscle
 - Soft cells and tough matrix – growth turn over and repair in skeletal connective tissue
 - Territorial stability in adult body
 - Cell growth and division
 - Control of cell division
 - Tumor viruses as tools for studying the control of cell cycle
 - Events in the S-Phase
 - The logic of the cycle
 - Cell division
- Cell adhesion and extra-cellular matrix
 - Intercellular recognition and cell adhesion
 - Cell junctions
 - The extra-cellular matrix
- Chemical signaling between cells
 - Three different strategies of chemical signaling – local chemical mediators, hormones and Neurotransmitters
 - Signaling mediated by intracellular receptors – mechanisms of steroid hormone action
 - Signaling mediated by cell surface receptors – cAMP and Ca⁺ ions as second messengers
 - Target cell adaptation
- Cancer
 - Tumor cells and the onset of cancer
 - Protooncogenes and tumor suppressor genes
 - Oncogenic mutation affecting cell proliferation
 - Mutations causing loss of cell cycle control
 - Mutations affecting genome stability
- Programmed cell death

Books: Bruce Alberts

Lodish

Cooper

Medical Cell Biology by Goodman

Cell and Molecular Biology by Sheeler and Bianchi

BP 102: ADVANCE MOLECULAR BIOLOGY AND TECHNIQUES

- **The Structure and Regulated Expression of Eukaryotic Genes**
 - Comparative features of prokaryotic and eukaryotic genes
 - Structure and expression of class I genes
 - Structure and function of class II genes
 - Structure and expression of class III genes
 - Dealing with introns
 - Novel structural motifs in transcription factors
 - Global influences on gene expression
- **The Molecular Anatomy of Eukaryotic genomes**
 - Architectural elements
 - Genes encoding RNA
 - Genes encoding polypeptides
 - Tandem repetition of DNA sequence: A common characteristic of eukaryotic genomes
 - Repeated sequences dispersed in genomes
 - Sequences at centromeres and telomeres
 - Genomes of eukaryotic organelles
 - Human genome project
 - DNA microarrays and functional genomics
- Techniques in molecular biology
 - Plasmid isolation
 - Preparation and analysis of eukaryotic genomic DNA
 - DNA sequencing
 - Isolation and purification of mRNA from cell
 - Blotting methods
 - PCR
 - Gene isolation
 - Site directed mutagenesis
 - Labeling of nucleic acids
 - Protein interaction technology
 - Molecular pharming
- Transgenic animals
 - Methods of gene transfer
 - Analysis of expressed gene
- Molecular markers
 - RFLP
 - RAPD
 - KFLP
 - Microsatellites

Books:

Genes and Genomes

Genes VIII

Sambrook

From Genes to Clones by Winnacker

Freifelder

Gardner

Walker and Rapley

BP 103: . BIOINFORMATICS

- Biology in the computer age
- Computational approaches to biological questions
- Biological research on the web
- Sequence analysis, pairwise alignment, and database searching
- Multiple sequence alignments, trees and profiles
- Visualizing protein structures and computing structural properties
- Predicting protein structure and function from sequence
- Tools for genomics and proteomics
- Building biological databases
- Visualizing and data mining

Books:

Parry Smith and Attwood
David Mount
Gibas and Jambeck

SEMESTER II

BP 104: GENETIC ENGINEERING

- **Recombinant DNA technology**
Principles of cloning
 - The recombinant DNA concept
 - Important Discoveries
 - Bacterial endonucleases
- **The Tools: Enzymes**
 - Nucleases
 - The Restriction Endonucleases
 - Phosphodiesterase
 - Polynucleotide kinase
 - DNA ligase
 - DNA polymerase I
 - Reverse transcriptase
 - Terminal deoxynucleotidyl transferase
 - Poly A polymerase
- **The Tools: Vector Systems**
 - *E. coli* systems – the host cells
 - *E. coli* – Plasmid Vectors
 - *E. coli* – Bacteriophage vectors
 - *E. coli* systems – Plasmid-Phage combination vectors
 - Other Prokaryotic Host-Vector systems
 - Eukaryotic Host-Vector Systems: Yeast
 - Eukaryotic Host-Vector Systems: Animals
- **The Means: Constructing, Cloning, and Selecting**
 - Inserts
 - Ligating vectors to insert
 - Infection, Transfection, and Cloning
 - Screening Cloned Populations of Recombinants
 - Libraries
 - Examples of Strategies used for cloning genes and cDNAs
- **The Products: Characterizing and Manipulating Recombinants**
 - The Gross Anatomy of a cloned insert
 - The fine anatomy of a DNA segment – Primary Nucleotide Sequence
 - Computer Analysis of DNA Sequences
 - Locating Cloned Segments in Genomes
 - Determining the number of copies of a DNA sequence in a genome
 - Alternating Cloned Segments: Constructing Mutants
 - Analyzing the function of Cloned DNA Segments
 - Synthesizing Polypeptides Encoded by Cloned Eukaryotic DNA Segments
 - Enzymatic Amplification of DNA and RNA Segments
- **Manipulation of gene expression in prokaryotes**
 - Prokaryotic gene expression
 - Gene expression from strong and regulatable promoters
 - Fusion proteins
 - Translation expression vectors
- **Heterologous Protein Production in Eukaryotic cells**
 - *Saccharomyces cerevisiae* expression systems
 - Other yeast expression system
 - Insect cell expression system
 - Mammalian cell expression system

Books:

Genes and Genome

BP 105: HUMAN PHYSIOLOGY

- Cell organisation
- The nervous system
- The endocrine system
- Digestion and absorption
- The circulation
- Respiration
- The kidney and its role in water and electrolyte balance
- Nutrient supply
- Muscular activity
- Muscular activity

Books:

Functional Physiology – Biotol

Human Physiology - Guyton

BP 106: DRUG DELIVERY

- Drug delivery: Basic concepts
- Drug delivery: Market perspective
- Advance drug delivery and targeting
- Rate control in drug delivery and targeting: Fundamentals and application to implantable systems
- Drug targeting systems: Fundamental and applications to parental drug delivery
- Routes of drug delivery
- Oral drug delivery
- Oral Trans-Mucosal drug delivery
- Transdermal drug delivery
- Nasal drug delivery
- Pulmonary drug delivery
- Vaginal drug delivery
- Ophthalmic drug delivery
- CNS drug delivery
- Future direction of drug delivery and targeting
- Plasmid based gene therapy
- Integrating drug discovery and delivery
- New generation technologies

Books:

Drug Delivery and Targeting by Anya Hilary, Andrew Lloyd

SEMESTER III

BP 201: ADVANCE IMMUNOLOGY

- **Antibody structure and function**
 - Discovery of antibodies
 - Interaction of antibodies with antigen
 - Biological functions of antibodies
 - Antibodies as cell membrane antigen receptors
 - Antibodies as biotechnological tools
- **Molecular genetics of antibodies**
 - Discovery of antibody gene rearrangement
 - Antibody gene organization
 - The basic DNA rearrangement mechanism
 - Diversity based on germline genes
 - Non-germline generation of diversity
 - VH gene usage and CD5 B cells
 - A novel VH to VHDj joining mechanism in pre-B cells and mature B cells
 - Class (isotype) switching

- The production of membrane and secreted forms of antibodies
- Regulation of immunoglobulin gene transcription
- Molecular genetic approaches to the humanizing of antibodies for therapy
- **Cell interaction in antibody production**
 - Landmark experiment on cell interactions in the humoral response
 - The major histocompatibility complex
 - MHC and mouse strains
 - T and B cell interactions
 - Antigen processing and presentation
- **Biology of T and B cells**
 - The T cell receptor
 - T cell receptor genes
 - Cell surface molecules on lymphoid cells
 - The CD3 complex
 - Other accessory molecules involved in cell interactions and T cell activation
 - Maturation of T cells in the thymus
 - T cell and B cell markers
 - T helper and B cell activation
 - Regulation of the immune response by suppressor T cells
 - B cell tolerance
 - A comparison of T and B cells
- **Cytokines – the intercellular messengers**
 - Antigen specific factors
 - General properties of cytokines
 - IL-2
 - Cytokines involved in T / B activation
 - Cytokines and T cell activation
 - Cytokines and B cell activation
 - Ig class switching and production of isotypes
 - Helper T cell subsets
 - Antibody synthesis
- **The lymphatic system and the immune response**
 - The lymphatic system
 - Cells of the immune system
 - Cell migration and adhesion molecules
 - Antibody production in vivo
 - Disease caused by antibodies – the hypersensitivity reactions
- **Cell mediated immunity**
 - Activation of T cells
 - Antigen specific T cells
 - Cloning of T cells
 - The roles of T cells in antibacterial immunity
 - Cell mediated immunity to viruses
 - Cytotoxic T cells in viral infections
 - Natural killer cells
 - CTL and other cells in tumor immunity
 - Disease caused by T cells

Immunobiology by Janeway
 Roitt
 Kuby
 Cellular Immunology - Biotol
 Fudenberg

BP 202: BIOPHARMACEUTICAL BIOTECHNOLOGY

- **Production and downstream processing of biotech products**
 - Expression system
 - Cultivation systems
 - Cultivation medium
 - Contaminants
 - Downstream processing
 - Issues to consider in production and purification of proteins
- **Formulation of biotech products, including biopharmaceutical Considerations**

- Microbiological consideration
- Excipients used in Parental formulations of Biotech products
- Shelf life of protein based pharmaceuticals
- Delivery of proteins: Routes of administration and adsorption enhancement
- Approaches for rate controlled and target site specific
- Delivery by the parental route
- **Pharmacokinetics and Pharmacodynamics of peptide and protein drugs**
 - Elimination of protein therapeutics
 - Distribution of protein therapeutics
 - Pharmacodynamics of protein therapeutics
 - Interspecies scaling
 - Heterogeneity of protein therapeutics
 - Chemical modification of protein therapeutics
 - Immunogenicity
- **Genomics, Proteomics and additional biotechnology-related techniques**
 - Genomics, proteomics and pharmacogenetics/genomics
 - Genetically engineered animals
 - Protein engineering
 - Peptide chemistry and peptidomimetics
 - Nucleic acid technologies
 - Catalytic antibodies
 - Tissue engineering
 - Glycobiology
 - Biotechnology and drug discovery
- **Gene therapy**
 - *Ex vivo* versus *in vivo* gene therapy
 - Potential target diseases for gene therapy
 - Gene transfer methods
 - Non-viral gene transfer
 - Gene transfer using recombinant viruses
 - Clinical studies
 - Pharmaceutical Production and regulation
- **Hematopoietic Growth Factors**
 - Hematopoiesis
 - Chemical description of hematopoietic growth factors
 - Pharmacology
 - Cellular sources and stimuli for release
 - Physiologic role of G-CSF, GM-CSF, EPO, SCF, Thrombopoietins
 - Pharmaceutical issues
 - Clinical and practical aspects
 - Toxicities
 - Other uses and new formulation
- **Interferons and Interleukins**
 - Cytokines
 - Interleukins
 - Commercially available interleukins
 - Interferons
- **Vaccines**
 - Conventional vaccines
 - Modern vaccine technologies
 - Pharmaceutical considerations
 - Regulatory and clinical aspects
- **Monoclonal Antibody-Based Pharmaceuticals**
 - Development of monoclonal antibodies as therapeutics

Books:

Crommelin

Gary Walsh

BP 203: ANIMAL TISSUE CULTURE

- **Introduction to animal tissue culture**
 - Historical background
 - The application of tissue culture
 - Terminology
 - Stages in cell culture

- **Outline of the key techniques of animal cell culture**
 - Setting up the laboratory
 - Culturing cells
 - Maintaining the culture
 - Quantification of cells in cell culture
 - Cloning and selecting cell lines
 - Physical methods of cell separation
 - Hazards and safety in the cell culture laboratory
- **Animal cell culture media**
 - General cell culture media design
 - Natural media
 - Synthetic media
 - Further considerations in media formulation
 - Nutritional components of media
 - The role of serum in cell culture
 - Choosing a medium for different cell types
- **Characterization of cell lines**
 - Species verification
 - Intra-species contamination
 - Characterization of cell type and stage of differentiation
 - Microbial contamination
- **Preservation of animal cell lines**
 - Variation and instability in cell lines
 - Preservation of cell lines
 - Freezing of cells
 - Thawing of cells
 - Quantification of cell viability
 - Cell banks
- **Hybridomas**
 - The limitation of traditional antibody preparation
 - The basis of hybridoma technology
 - The details of hybridoma technology
 - Long term storage of hybridoma cell lines
 - Contamination
 - Hybridomas from different species
 - Human hybridomas
 - Commercial scale production of monoclonal antibodies
- **Large scale animal cell culture**
 - Culture parameters
 - Scale up of anchorage-dependant cells
 - Culture vessels
 - Suspension culture

Books:

Cell and Tissue Culture: Lab Procedures in Biotechnology

Alan Doyle (ed) J. Bryan Griffith (ed)

Freshney

John Paul

SEMESTER IV

M.Sc. Dissertation Project: Each candidate needs to complete a short dissertation project. Prior to proposing a project, the students must have identified a research topic and a mentor who is familiar with their prospective inquiry and who is willing to provide guidance and oversee the project.

Course Structure: B. Sc + M.Sc Medical Biotechnology

SEMESTER I			
Subject Code	Subject	Practical hours/wk	Lecture hours/wk
BU 101	Basic Chemistry	3	3
BU 102	Mathematics for Life Sciences	3	3
BU 103	Evolutionary Biology	3	3
BU 104	Introduction to Biotechnology	3	3
SEMESTER II			
BU 105	Biophysics	2	5
BU 106	Cell Biology	3	6
BU 107	Basic Laboratory Methods	1	3
BU 108	Computational Methods in Biotechnology	1	3
SEMESTER III			
BU 201	Genetics – A	2	4
BU 202	Medical Microbiology – A	2	4
BU 203	Human Biochemistry – A	2	4
BU 204	Biostatistics	2	4
SEMESTER IV			
BU 205	Genetics – B	2	4
BU 206	Medical Microbiology – B	2	4
BU 207	Human Biochemistry – B	2	4
BU 208	Enzyme Technology	2	4
SEMESTER V			
BU 301	Molecular Biology	3	6
BU 302	Fermentation Technology	3	6
BU 303	Biomembrane	3	4
SEMESTER VI			
BU 304	Ethical issues in biotechnology	2	4
BU 305	Pharmaceutics	3	6
BU 306	Basic Immunology	3	6

SEMESTER I			
Subject Code	Subject	Practical hours/wk	Lecture hours/wk
BP 101	Advance Cell Biology	5	3
BP 102	Advance Molecular Biology	5	3
BP 103	Bioinformatics	5	3

SEMESTER II			
BP 104	Genetic Engineering	5	3
BP 105	Human Physiology	5	3
BP 106	Drug Delivery	5	3

SEMESTER III			
BP 201	Advance Immunology	5	3
BP 202	Biopharmaceutical Biotechnology	5	3
BP 203	Animal Tissue Culture	5	3

SEMESTER IV			
M.Sc. Dissertation Project: Each candidate needs to complete a short dissertation project. Prior to proposing a project, the students must have identified a research topic and a mentor who is familiar with their prospective inquiry and who is willing to provide guidance and oversee the project.			