BIOLOGICAL SCIENCES

I Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits (AL/3)
BIO 101	Biology I: Biomolecules	2	1	5	0	0	8	3	O to F	3
BIO 103	General Biology Laboratory	0	0	1	3	0	4	3	O to F	1

II Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits (AL/3)
BIO 102	Biology II: Fundamentals of Cell Biology	2	1	5	0	0	8	3	O to F	3

III Semester

	Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits (AL/3)
DC	BIO201	Biology III: Fundamentals of Molecular Biology	3	1	4.5	0	0	8.5	4	O to F	3
	BIO203	Biology V: Diversity of Life I	3	1	4.5	0	0	8.5	4	O to F	3
	BIO205	Biology Laboratory I	0	0	1	3	0	4	3	O to F	1
MD	CHM211	Basic organic Chemistry-II	3	1	4.5	0	0	8.5	4	O to F	3

IV Semester

	Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits (AL/3)
DC	BIO202	Biology IV: Basic Genetics	3	1	4.5	0	0	8.5	4	O to F	3
	BIO204	Biology VI: Diversity of Life II	3	1	4.5	0	0	8.5	4	O to F	3
	BIO206	Biology Laboratory II	0	0	1	3	0	4	3	O to F	1
MD	CHM222	Classical Thermodynamics	3	1	4.5	0	0	8.5	4	O to F	3

DC: Departmental Compulsory Course; **MD:** Mandatory Course from Other Department;

V Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits
BIO 301/601	Cell Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 303/603	Biochemistry I	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 305/605	Plant Biology I	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 307	Biology Laboratory III	0	0	2	6	0	8	6	O to F	3
BIO***/***	Departmental Elective I	3	0	7.5	0	0.5	11	3.5	O to F	4
*** ***	Open Elective I	3	0	4.5/7.5	0	0	7.5/10.5	3	O to F	3/4
Total Credits		**15**	**0**	**36.5/39.5**	**6**	**2**	**59.5/62.5**	**23**		**22/23**

VI Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits
BIO 302/602	Biochemistry II	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 304/604	Molecular Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 306/606	Immunology I	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 308	Biology Laboratory IV	0	0	2	6	0	8	6	O to F	3
BIO***/***	Departmental Elective II	3	0	7.5	0	0.5	11	3.5	O to F	4
*** ***	Open Elective II	3	0	4.5/7.5	0	0	7.5/10.5	3	O to F	3/4
Total Credits		**15**	**0**	**36.5/39.5**	**6**	**2**	**59.5/62.5**	**23**		**22/23**

VII Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits
BIO 401/621	Immunology II	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 403/623	Structural Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 405/625	Developmental Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO***/***	Departmental Elective III	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO***/***	Departmental Elective IV	3	0	7.5	0	0.5	11	3.5	O to F	4
*** ***	Open Elective III	3	0	4.5/7.5	0	0	7.5/10.5	3	O to F	3/4
Total Credits		**8**	**0**	**42/45**	**0**	**2.5**	**62.5/65.5**	**20.5**		**23/24**

VIII Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits
BIO 402/622	Bioinformatics	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 404/624	Neurobiology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 406/626	Evolutionary Ecology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO***/***	Departmental Elective V	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO***/***	Departmental Elective VI	3	0	7.5	0	0.5	11	3.5	O to F	4
*** ***	Open Elective VII	3	0	4.5/7.5	0	0	7.5/10.5	3	O to F	3/4
Total Credits		**18**	**0**	**42/45**	**0**	**2.5**	**62.5/65.5**	**20.5**		**23/24**

IX Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits
BIO 501	MS Thesis	-	-	-	-	-	45	-	O to F	18
HSS 503*	Law Relating to Intellectual Property and Patents*	1	0	2.5	0	0	3.5	1	S/X	1
Total Credits		**1**	**0**	**2.5**	**0**	**0**	**48.5**	**1**	**-**	**19**

X Semester

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits
BIO 501	MS Thesis	-	-	-	-	-	45	-	O to F	18
Total Credits		**-**	**-**	**-**	**-**	**-**	**45**	**-**	**-**	**18**

***** Students can credit this course anytime during their BS-MS study, as and when offered.

Elective courses

Course No.	Course Title	Lec Hr	Tut Hr	SS Hr	Lab Hr	DS Hr	AL	TC Hr	Grading System	Credits
BIO 309/609	Microbiology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 310/610	Animal Physiology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 311/611	Cell Signaling and Stress Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 312/612	Recombinant DNA Technology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 313/613	Virology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 314/614	Plant Biology II	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO407/627	Biostatistics	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 408/628	Bioinstrumentation	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 409/629	Biophysics	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 410/630	Epigenetics	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 411/631	Advances in Microbiology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 412/632	Cancer Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 413/633	Stem Cell Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 414/634	Behavioral Biology	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 415/635	Advances in Genetics	3	0	7.5	0	0.5	11	3.5	O to F	4
BIO 416/636	Protein Folding and Function	3	0	7.5	0	0.5	11	3.5	O to F	4

DEPARTMENT OF BIOLOGICAL SCIENCES

BIO 101: Biology I: Biomolecules (3)

Course Contents

Elemental Composition of Biomolecules; Properties of Water, hydrogen bonding and its biochemical properties; Concept of pH, pKa and buffers; Basic structure and function of Biological Macromolecules: Amino acids, Nucleotides and Monosaccharides, fatty acids (building blocks) Proteins, enzymes Nucleic Acids, Carbohydrates and Lipids (polymers); Origin of Life- Spontaneous generation; Pasteur and Miller experiments; An Introduction to cell and cell organelles.

Suggested Readings

1. Principles of Biochemistry: Lehninger, Nelson and Cox; W.H. Freeman; 5th edition; 2008.
2. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; New York: Garland Science; 5^{th} edition; 2008
3. NCERT basic Biology books

BIO 102: Biology II: Fundamentals of Cell Biology (3)

Course Contents

Cell Theory, Cell- the building blocks of life, structural components of cells and their function, Prokaryotic cell and Eukaryotic cell - Structure and function (Overview, Cell Wall, Cell membrane, Cytoplasm and components therein, Cytoskeleton and cell motility). Structure and functions of cell organelles: Mitochondria, Chloroplasts, Golgi, ER and lysosomes; Cell division; Approaches to study cellular processes-microscopy, biochemical and biophysical assays with specific examples, Cell Division.

Suggested Readings

1. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; New York: Garland Science; 5th edition ;2008
2. Essential Microbiology: Stuart Hogg; John Wiley & Sons; 2005
3. NCERT basic biology books

BIO 103: General Biology Laboratory (1)

Course Contents

- Introduction to lab instruments and general lab practices
- Buffer preparation - amino acid titration (Glycine)
- Carbohydrate estimation (Molisch test, Iodine test, Barfoed test, Benedict and Osazone test)
- Quantitative Carbohydrate estimation by DNSA.
- Quantitative amino acid estimation by Ninhydrin method.
- Protein estimation – Bradford's method
- Saponification and use of detergents
- Cholesterol estimation by Salkowsky test.
- Osmosis

BIO 201: Biology III: Fundamentals of Molecular Biology (3)

Course Contents

Concept of central dogma of life and variations; Macromolecules and their organizations- DNA, RNA, Protein- Structure, conformation and organization; ploidy, Chromatin structure and nucleosomes; Genes and genome organization; c value paradox, repeats and polymorphism, Plasmids and extra-chromosomal DNA, Transposons; Gene regulation; DNA replication in prokaryotes and eukaryotes; Mechanism of transcription in prokaryotes and eukaryotes; Translation: Genetic code, and its degeneracy, regulation of translation process; Concept of RNA world; RNA replication and processing: capping, polyadenylation; Introduction to gene silencing, epigenetics.

Suggested Readings

1. Genes – Benjamin Lewin; Jones & Bartlett Learning; 10th edition; 2009.
2. Molecular biology of the gene: James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick; Benjamin Cummings; 6th edition; 2007.
3. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; New York: Garland Science; 5th edition; 2008.

BIO 202: Biology IV: Basic Genetics (3)

Course Contents

Principles of inheritance; Concept of gene- allele, multiple alleles, pseudoallele; Mendelian principles - Dominance; Segregation; Independent assortment; Codominance, Incomplete dominance; Non Mendelian inheritance- cytoplasmic inheritance, Maternal effect, Epistasis, Pleiotropy. Introduction to linkage and crossing over. Overview of different mutations: Lethal, conditional, biochemical, loss of function, gain of function, germinal and somatic mutants, insertional mutagenesis; Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation and ploidy; Chromosomal theory of inheritance, Sex linked inheritance, pedigree analysis, Microbial genetics: Methods of genetic transfers- transformation, conjugation and transduction; Cell division-Mitosis and meiosis, Behavioral and population genetics, and environmental effects. Human genetics (blood group, genetic diseases), probability.

Suggested Readings

1. Genetic Analysis and Principles: Robert Brooker; McGraw-Hill Science/Engineering/Math; 4th edition; 2011.Genetics- From genes to genomes: Leland Hartwell, Leroy Hood, Michael Goldberg, and Ann Reynolds; McGraw-Hill Science/Engineering/Math; 4th edition; 2010

BIO203: Biology V: Diversity of Life I (3)

Course Contents

Why study diversity- application in medicine, agriculture, conservation, etc.; What causes diversity?; Living vs non-living, status of viruses; Origin of life on earth; Spontaneous generation of life- concept and criticism, Evolutionary theories (Natural Selection, neutral theory), Introduction to the Five kingdom classification, Building up organisms- Unicellular, colonies and multicellular organizations, origin of multicellularity, Structural organization and life cycles of different groups of organisms, Eubacteria, archaebacteria, protista (using representative organisms-amoeba, paramecium, plasmodium, euglena, diatoms, etc). Diversity in morphology, cellular organization, ecological adaptations and metabolism; pathogenic and non-pathogenic protists; Introduction to fungi and

processes unique to fungi. Introduction to various phyla within fungi, Introduction to Lichens, algae.

Suggested Readings

1. NCERT, XI and XII
2. Biology, Campbell et al, 8 th edition, Pearson Benjamin Cummings, 2009.
3. Biology, Raven et al, 6 th edition, Mc-Graw Hill, 2011.
4. Biology, Concepts and applications, Starr et al, 9 th edition, Cengage learning, 2015.

BIO 204: Biology VI: Diversity of Life II (3)

Course Contents

Diversity of life forms in higher plants and animals- levels of structural organization, habitat, nutrition, survival strategies, reproduction, behavior etc; plants tissues, anatomy of flowers, (bryophytes, gymnosperms, angiosperms etc); animals- symmetry, body cavities, tissues. Diversity in life processes (comparison between different groups of organisms)-reproduction, nutrition, vision, movement and locomotion, communication/signaling/response to stimuli, relationship between organisms (parasitism, mutualism, symbiosis etc); Homeostasis-temperature regulation, hibernation, aestivation. How to study diverse life forms-need and approach to group/classify organisms; Taxonomic categories- kingdom to species; Introduction to Systems of classification. Major characteristics used in taxonomy- classical (morphological, ecological, physiological, biochemical, genetics), molecular (comparison of proteins, RNA, DNA), Phylogenetic trees, systems of classification, Species concept, Molecular basis of diversity, effect of genes, gene expression and environment.

Suggested Readings

1. NCERT, XI and XII
2. Biology, Campbell et al, 8th edition, Pearson Benjamin Cummings, 2009.
3. Biology, Raven et al, 6th edition, Mc-Graw Hill, 2011.4. Biology, Concepts and applications, Starr et al, 9th edition, Cengage learning, 2015.

BIO 205: Biology Laboratory I (1)

Course Contents

- Slides and specimens (bacterial, protozoans and higher organisms)
- Media Preparation and sterilization/Bacterial pure culture isolation
- Bacterial growth curve and Gram staining
- Bacterial motility/Cancer cells motility
- Agarose Gel Electrophoresis
- DNA isolation from bacteria and plant
- RNA isolation
- Plasmid isolation
- Competent cell preparation and transformation
- SDS page Demo

BIO 206: Biology Laboratory II (1)

Course Contents

- Slides of Anatomical features of Plants and Animals
- Nutrition diversity (growth of Auxotroph, Prototroph) in yeast..
- Onion root tip – mitosis, Meiosis slides observation
- Understand the concept of dominant/recessive using Yeast strains
- Beta-galactosidase based mutation analysis assay
- RFLP analysis for genetic disease
- Conjugation
- Transduction
- Chromosome preparation

BIO 301/601: Cell Biology (4)

Course Contents

Approaches to study cell structure and functions. Microscopy; (Bright field and dark field microscopy; Fluorescence microscopy; Confocal microscopy; Electron microscopy) Membrane and vesicular transport; Membrane based ion channels, lipid rafts; Regulation of cell cycle, cell division and consequences; Study of cell nucleus and chromosomal DNA; nucleocytoplasmic transport, Cellular

cytoskeleton: Microtubules, Intermediate filaments, actin filaments and microtubule associated proteins (MAPs); Molecular motors and cytoskeletal proteins; Movement of proteins into membranes and organelles; Vesicular trafficking; Secretion, endocytosis and exocytosis; Integrating cells into tissues (animals and plants); Cell-Cell junctions; Cell-ECM junctions, Plasmodesmata;

Suggested Readings

1. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walte; 5th edition New York: Garland Science; 2008.
2. Essential Cell biology: Bruce Alberts; Garland Science; 3rd edition; 2009.
3. Cell and Molecular Biology-Concepts and Experiments; Gerald Karp. John Wiley; 6th edition; 2008.
4. Cell biology by Pollard and Earnshaw

BIO 302/602: Biochemistry-II (4)

Course Contents

Mechanism of energy production: Fatty acid biosynthesis and degradation: Digestion, Mobilization, and Transport of Fats, Oxidation of Fatty Acids, Ketone Bodies; Amino acid biosynthesis and degradation; gluconeogenesis, nitrogen excretion and the Urea Cycle; Nucleotide metabolism: Pathways and their regulations, Cholesterol biosynthesis.

Suggested Readings

1. Principles of Biochemistry: Lehninger, Nelson and Cox; 5th edition, W.H. Freeman; 2008.
2. Biochemistry: Lubert Stryer; W. H. Freeman; 7th Edition; 2010.
3. Biochemistry by Donald Voet, Judith G. Voet; Wiley; 4th edition; 2010.
4. The Biophysical Chemistry of Nucleic Acids and Proteins: Thomas E. Creighton; Helvetian Press; 2010.

BIO 303/603: Biochemistry I (4)

Course Contents

Bioenergetics, Biological oxidation reduction reactions, ATP and its role in various metabolic processes; An introduction to enzymes: Mechanism of enzyme action, introduction to enzyme kinetics, Km, Vmax and Kcat calculation, Biological interaction (protein-ligand interaction) Enzyme inhibition (Competitive and non-competitive), co-enzymes and cofactors-NAD, FAD, Vitamins, IC50, Allostery, cooperativity, Hill's coefficient; Metabolic pathways; Glycolysis, Fermentation, pentose phosphate pathway and their regulations; TCA/Kreb's cycle and its regulation: anaerobic respiration, Production of Acetyl-CoA, reactions of the Citric Acid Cycle Glyoxylate pathway, mitochondrial electron transport chain and Chemo-osmotic theory,

Suggested Readings

1. Principles of Biochemistry: Lehninger, Nelson and Cox; W.H. Freeman; 5th edition; 2008.
2. Biochemistry: Lubert Stryer; W. H. Freeman; 7th Edition; 2010.
3. Biochemistry by Donald Voet, Judith G. Voet; Wiley; 4th edition; 2010.
4. The Biophysical Chemistry of Nucleic Acids and Proteins: Thomas E. Creighton; Helvetian Press; 2010.

BIO 304/604: Molecular Biology (4)

Course Contents

DNA replication: Unit of replication, Enzymes involved, origin of replication and replication fork, Fidelity of replication, extrachromosomal replicons; DNA damage and repair- mechanisms, homologous and site-specific recombination; RNA Synthesis: transcription factors and machinery; initiation complex formation, activators and repressors of transcription, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, different types RNA: structure and functions, RNA transport; Protein synthesis: Ribosome, formation of initiation complex and regulation of initiation factors, elongation and elongation factors, termination, concept of genetic code, translation: aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and proof-reading, inhibitors of translation, post- translational

modification of proteins; Regulation of gene expression: Gene expression control at transcription and translational level; Chromatin and gene expression; Gene silencing. siRNA and microRNA

Suggested Readings

1. Genes – Benjamin Lewin; Jones & Bartlett Learning, 10th edition; 2009.
2. Molecular biology of the gene: James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick; Benjamin Cummings; 6th edition; 2007
3. Molecular Biology of the Cell: Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter; New York: Garland Science; 5th edition; 2008.
4. The Biophysical Chemistry of Nucleic Acids and Proteins: Thomas E. Creighton; Helvetian Press; 2010.
5. Introduction to Protein Structure: Carl Branden and John Tooze; Garland Science; 2nd edition; 1999.
6. Latest/classic research articles and reviews relevant to various topics.

BIO 305/605: Plant Biology I (4)

Course Contents

Introduction to plants. Origin and evolution of plants. Genome organization of plants. Plant cells (structure, function, growth), Plant Water Relations. Mineral Nutrition (emphasis on nitrogen and phosphate nutrition. Transport in plants, Photosynthesis (Photorespiration, Light and Dark Reaction, C3, C4 and CAM pathways), Plant growth and development (embryonic, root, shoot, leaf and flower development), Light regulated development (Photoreceptors- Phytochromes, Cryptochromes, Phototropins, UVR8, light signaling- COP1, HY5, PIFs and other major regulators), Phytohormones (Auxin, GA, Cytokinin, ABA, Ethylene, Brassinosteroids, Strigolactones) (Synthesis, transport, signaling, developmental regulation and commercial uses of hormones). Flowering (Regulation of flowering in plants, vernalization).

Suggested Readings

1. Plant Physiology by Lincoln Taiz and Eduardo Zeiger; Sinauer Associates Inc. 5th edition. 2010

2. Plant Biology by Alison M. Smith *et al.*
3. Mechanisms in Plant Development by Leyser and Day.
4. The Molecular Life of Plants by Russell L. Jones *et al*.
5. Raven Biology of Plants, 8th Edition

BIO 306/606: Immunology I (4)

Course Contents

Introduction to Immune System: organs, cells and molecules; Mechanisms of barrier to entry of microbes into human body. Natural and adaptive immune responses; Differentiation of stem cells to different cellular elements in blood, role of cytokines; Introduction to inflammatory reaction, Chemokines, migration of neutrophils to the site of infection, phagocytosis and microbicidal mechanisms. Interferons and viral infections, Parasitic infections and role of Eosinophils Asthma. Basophils, IgE receptor, immediate hypersensitivity; Innate receptors (TLR, RLRs and NLRs) and sensing of PAMPs. Signal transduction. Opsonization, Fc Receptors, classification. Prostaglandins and leukotrienes. Complements structure and function. Classical and alternative pathways; Antibody structure and function. Concept of Histocompatibility. Genetic organization of H2 and HLA complexes. Class I and class II MHC molecules, structure and function; T cell receptors, APC-T cell interaction T cell activation, Super antigens; Natural Killer Cells, ADCC, Hybrid resistance, NK cell receptors and NK gene complex, inverse correlation with target MHC expression, missing self-hypothesis; Classification of immunoglobulins, immunoglobulin domains, concept of variability, crosses reactivity. Isotypes, allotypes and Idiotypic markers.

Suggested Readings

1. Essential Immunology: Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt; Wiley-Blackwell; 12th edition; 2011.
2. Immunobiology: The immune system in health and disease by Charles Janeway, Paul Travers, Mark Walport, Mark Shlomchik; Garland Science; 5th edition; 2001.
3. Kuby Immunology; W. H. Freeman & Company; 6th edition; 2006.

BIO 307: Biology Laboratory III (3)

Course Contents

- Hypocotyl growth and bending experiment,
- Fractionation of cell organelles
- Protoplast preparation/ visualization of stomata
- TLC analysis of Plant pigments
- Enzyme kinetics (with or without inhibition) for alkaline phosphatase.
- Detection of proteins by CBBR and silver staining
- Size exclusion chromatography for analysis of proteins
- Pure culture isolation, Growth curve
- Antibiotic sensitivity

BIO 308: Biology Laboratory IV (3)

Course Contents

- Immunodiffusion
- Estimation of Antibody by ELISA.
- Analyzing the components of blood.
- Introduction to animal cell culture
- Visualization Histology Slides, tissue specimen
- PCR, Restriction digestion, cloning, Blue white selection, screening
- Protein expression screening in BL21 strains and one-step purification from whole cell lysates.

BIO 309/609: Microbiology (4)

Course Contents

The Scope of microbiology, History of microbiology, Different types of microbes- Algae, Protozoa, Fungi, Viruses, Bacteria, Characterization, classification and identification, Pathogenic and non-pathogenic microbes, Morphology and fine structure of bacteria, Gram (+)ve and Gram (–)ve bacteria, Cultivation of bacteria and the unculturable ones, Microbes with unusual properties, reproduction and growth, energy production and utilization, microbial motility, pathogenesis and defense mechanisms, control of microbes, antibiotics,

environmental microbiology- soil, ocean, skin, gut, food etc., Industrial microbiology, Introduction to microbial genomics and sequencing

Suggested Readings

1. Microbiology 5E by Michael PelCzar, et al.
2. General Microbiology by Roger Yate Stanier, et al.

BIO 310/610: Animal Physiology (4)

Course Contents

Principles of physiology: relationship between structure and function, Adaptation, Homeostasis, Feed-back control systems and regulation; Tissue system and their functions: Epithelial tissue, Connective tissue, muscular tissue and nervous tissue; Muscular and skeletal system, Integumentary system, thermoregulation; Cardiovascular system: blood and circulation; anatomy of heart, , cardiac cycle, regulation of cardiac output and blood pressure; Respiratory system: transport of gases in blood, regulation of body pH; Excretory system: Osmoregulation, obligatory exchanges of ions and water. Endocrine system: Hormones and their physiological effects; Nervous system: Neurons, gross anatomy of the brain and spinal cord; sense organs; Digestive system. Reproductive System

Suggested Readings

1. Introduction to Animal Physiology: Ian Kay; Bios Scientific Publishers; 1999
2. Animal Physiology: Hill, Wyse and Anderson; Sinauer Associates, Inc; 3rd 2012.
3. Animal Physiology by Randall Burggren & French; W. H. Freeman; 5th edition; 2001.
4. Principles of Anatomy and Physiology: Tortora and Derrickson; John Wiley and Sons; 13th edition, 2012.
5. Text book of Medical physiology: Guyton and Hall; Saunders; 12th edition; 2011.

BIO 311/611: Cell Signaling and Stress Biology (4)

Course Contents

Basic introduction to signaling, components of signaling, ligand and receptor concept. Types of ligand (soluble/insoluble, abiotic/biotic etc), Signal amplifiers, second messengers and molecular pathways for signal transduction. post translational modification and signal regulation. Types of receptors (Soluble and membrane bound) Ion channels, receptors with associated enzymatic activities. Various cellular processes involving signaling and its consequences. Signaling in bacteria and plant, Two component system (Histidine kinase receptor). G-protein coupled receptors, heterotrimeric G-proteins and associated signaling pathways. Receptor tyrosine kinase, JAK-STAT and MAP kinase pathway. Receptor serine/threonine kinase Receptor like kinases (RLK's) in plants. Stress signaling and regulation of stress induced gene expression, different types of stress (Temperature extremes, high salt, bright light, pH, oxidative stress, desiccation stress, heavy metal, xenobiotic stress as well as biotic stress such as herbivory, insect attack, bacterial and viral infection), stress proteins and their functions, molecular chaperones, mechanism of stress perception, tolerance and avoidance. Basal and acquired stress tolerance. Regulation of protein homeostasis during stress, ER stress and unfolded protein response, examples of high level of stress tolerance in different organisms and understanding the genetic and molecular basis of stress tolerance. Manipulation of specific stress associated proteins for production of stress tolerant organisms. Mental stress and its consequences in mammals with special emphasis on humans.

Suggested Readings

1. Molecular Biology of the Cell by Bruce Alberts; 5^{th} edition
2. Signal transduction: Pathways, Mechanisms and diseases by Ari Sitaramayya
3. Recent and Classical research and review articles

BIO 312/612: Recombinant DNA Technology (4)

Course Contents

Basic principles of gene cloning, Polymerase chain reaction – Theory and applications: Nested, Inverse, Asymmetric, Hot start, touchdown etc.

Troubleshooting. RT-PCR, Site-directed mutagenesis and random mutagenesis. Vectors for gene cloning – features, applications. Methods of molecular cloning: strategy design and screening. Usage of restriction enzymes; ligation independent cloning. Construction of DNA libraries and library screening; Reporter gene technology. Gene knockout in bacteria – methods and applications. Bacterial and yeast two hybrid systems – theory and applications. Preparation of biomolecules – isolation and purification. DNA sequencing – capillary based and next gen sequencing. 2-dimensional gel electrophoresis and MALDI based protein identification.

Suggested Readings

1. Sambrook and Russell: Molecular Cloning.
2. T. A. Brown: Gene cloning and DNA analysis
3. Glick, Pasternak and Patten: Molecular Biotechnology

BIO 313/613: Virology (4)

Course Contents

Overview and history; Classification of viruses; Virion components and structure; Viral entry: Viral proteins and host cell surface receptors involved; Mechanisms of viral entry; Viral replication; Viral maturation and release; Pathogenic viruses : Respiratory viruses; Gastroenteritis causing viruses; Hepatitis viruses; Herpesviruses; Haemorrhagic fever causing viruses; Enteroviruses; Congenital viral infections; Retroviruses; Arboviruses and Viral zoonoses; Oncogenic viruses; Viruses implicated in exanthematous diseases.; Agents of viral encephalitis; Emerging and re-emerging viral infections (In each of the above groups, to discuss briefly on the following: (i) viruses included (ii) epidemiology (iii) viral pathogenicity); Immunology of viral infections; Strategies for control of viral infections: Antiviral agents; Active and passive immunoprophylaxis; General laboratory methods for diagnosis of viral infections; Case studies from literature, evolving and emerging areas of interest; Viruses as gene delivery vehicles.

Suggested Readings

1. Field's Virology: David M. Knipe, Peter M. Howley, Diane E. Griffin, Robert A. Lamb, Malcolm A. Martin, Bernard Roizman, Stephen E. Straus; Lippincott Williams & Wilkins; 5th edition; 2007.
2. Jawetz, Melnick, & Adelberg's Medical Microbiology: Geo. F. Brooks, Karen C. Carroll, Janet S. Butel, Stephen A. Morse, Timothy A. Mietzner; McGraw-Hill Medical; 25th edition; 2010.
3. Virus: Biology-Applications-Control- David R. Harper

BIO 314/614: Plant Biology II (4)

Course Contents

The move of plants to land from water, evolution of plants. Land plants as monophyletic group. Plant cell structure, growth and function. Characteristics of plant development. Embryonic development in plants. Early post embryonic development in plants. Formation of axes in plants: longitudinal, radial, abaxial-adaxial. Pattrn formation in plants: importance of position. Light regulated development and signal transduction mechanisms. Hormone signaling. Biotic interactions. Plant Epigenetics. Applications in the field of plant biotechnology.

Suggested Readings

1. Mechanis-ms in Plant Development by Leyser and Day'
2. plant physiotogy by Lincoln taiz and'Eduaroo Zeigeri SinauerAssociates lnc. 5th edition' 2010
3. Plant Biology by Alison M. Smith ef a/'
4. The Molecuiar Lite of Plants by Russell L' Jones et al'
5. Life by Sadava, 8th Edition

BIO 401/621: Immunology II (4)

Course Contents

Idiotypic network Immunoglobulin genes, Immunological techniques, Hybridoma and monoclonal antibodies. VJ/VDJ rearrangements and genetic mechanisms responsible for antibody diversity, affinity maturation, allelic exclusion; Class switching, receptor and soluble forms of immunoglobulin; Th1 Th2 cells and

cytokines. Intercellular antigen presentation pathways, antigen presentation and MHC restriction; T cell differentiation in thymus, aβ and gd T cells. Thymic selection and tolerance to self. Cytotoxic T-cells.

Overview of Viral diseases: Generalized overview of viral infections with emphasis on viral infections with global epidemiological burden including Influenza, AIDS, congenital and arboviral infections. Brief discussion on immunology of viral infections including role of innate, cell mediated and humoral immunity in evasion and clearance of viral infections.

Bacterial infections: Generalized overview of viral infections with emphasis on viral infections with global epidemiological burden including tuberculosis, systemic and hospital acquired infections. Brief discussion on immunology of bacterial infections including immune responses to intracellular and extracellular bacteria and evasion on antagonistic mechanisms devised by bacteria to evade such responses. Special note on the contribution of immune responses on bacterial pathogenesis.

Parasitic diseases: Parasitic organisms come in many shapes and sizes, Protozoan parasites account for huge worldwide disease burden with emphasis on Malaria,

Fungal Diseases: Generalized overview of fungal infections with emphasis on mycoses. Brief discussion on the role of innate immunity in control of fungal infections.

Emerging and Re-emerging infectious diseases: diseases may re-emerge for various reasons, Overview of some recently appearing fatal diseases. The SARS and Ebola outbreak triggered a rapid international response.

Suggested Readings

1. Jawetx, Melnick & Adelberg's Medical Microbiology, 25e
2. Infectious Diseases: pathogenesis, prevention and case studies. Authors: Nandini Shetty, Julian W Tang, Julie Andrews (2009)
3. Kuby Immunology 7ed, 7th revised international edition; Authors Sharon Stanford, judy Owen and Jenny Punt
4. Immunobiology, 6E: The immune system in health & disease 6th Editionp Janeway C. A.

BIO 402/622: Bioinformatics (4)

Course Contents

Introduction to bioinformatics, overview, concepts, utility, scope, applications, skills needed, sequences, biological data; Databases, web resources: NCBI-Entrez, PubMed, GenBank, data organization and retrieval using FTP from NCBI, DDBJ, UCSC, PDB, SwissProt, KEGG, and web resources; Sequence formats: FASTA, GenBank, EMBL, PDB, XML, Medline, GCG, etc. Conversion from one format to another, tools available for format interconversion; Sequence alignment algorithm and tools: Introduction to sequence alignment, homology, similarity, identity. Local and global alignments, multiple sequence alignments, insertions, deletions, gaps, Needleman-Wunsch algorithm, Dot matrix method, dynamic programming algorithm, scoring matrices- PAM and BLOSUM, Blast, Blat, Clustalw, MAFFT, BLOCKS, etc.; Prediction of genes and annotation methods: Concept of genes, challenges in gene prediction, ORFs, reading frames, codons and codon bias, genetic code, commonly used gene prediction methods- ORF finder, Glimmer, GeneMark, Metagene, etc. Annotation using homology-based alignment using Blast or Blat, COGs and Gene ontology based functional annotation; Phylogenetic analysis: concepts and terminologies, commonly used phylogenetic methods such as PHYLIP, MEGA. Introduction to rRNA, taxonomy and taxonomic classification. Maximum parsimony method, Distance methods, Neighbor-joining methods; Protein classification and structure prediction: Introduction to domains, motifs, fold, family, Helices, beta-sheets, loops, coils. Primary, secondary and tertiary structure. Structure visualization tools such as RasMol; Genome analysis: Introduction to genomes and packages for genomic analysis such as EMBOSS; Introduction to Linux and Perl.

Suggested Readings

1. Bioinformatics- Sequence and Genome Analysis by David W. Mount; Cold Spring Harbor Laboratory Press,U.S.; 2nd Revised edition edition; 2004.
2. Introduction to Computational Genomics by Nello Cristianini and Matthew W. Hahn; Cambridge University Press; 2007.

BIO 403/623: Structural Biology (4)

Course Contents

Proteins from primary to quaternary structures: Amino acids, primary sequence, peptide bond, dihedral angle, Geometry and chemistry of di-peptide, Ramachandran map, Secondary structural elements and their geometric description. Collagen triple helix, Super secondary structure, Structural domains, Quaternary association of globular proteins; Basics of nucleic acid structure: The building blocks, DNA secondary structure: the Double Helix, Deviation from the ideal geometry, higher-order structure and nucleosomes, tertiary structure of RNA

Suggested Readings

1. Biochemistry: Lubert Stryer; W. H. Freeman; 7th Edition; 2010.
2. Introduction to Protein Structure: Carl Branden and John Tooze; Garland Science; 2nd edition; 1999
3. Research Articles as per requirements.

BIO 404/624: Neurobiology (4)

Course Contents

Organization of the nervous system; Cytology of neurons- structural and functional blue print of neurons, sensory and motor neurons; Ion-channels- importance of ion channel in nerve physiology, characteristics of ion channels, structure of ion channels, techniques used to study ion channels; Bioelectricity, measurement of bioelectricity; Electrical properties of neurons; Membrane potentials- resting membrane potential, Ionic basis of membrane potential; Generation and propagation of action potential; Synaptic transmission- membrane trafficking at nerve terminals, local machinery at nerve terminals for vesicle recycling, genetics and cell biology of synaptic vesicle trafficking; modulation of synaptic transmission; Neurotransmitters- properties, types and classification of neurotransmitters and their synthesis neuromodulators; Synaptic plasticity and its implication in learning and memory; Introduction to perception (with emphasis on Pain, Visual and Odor perception).

Suggested Readings

1. Principle of neural science: Eric R. Kandel, James Schwartz, Thomas Jessell, Steven Siegelbaum, A.J. Hudspeth; McGraw-Hill, 5th edition; 2012
2. From Neuron to Brain: Nicholls, Martin, Wallace and Fuchs; Sinauer Associates; 4th edition; 2001.

BIO 405/625: Developmental Biology (4)

Course Contents

Meiosis, gametogenesis, fertilization and embryogenesis, morphogen gradients, differentiation, asymmetric cell division, cell fate and lineage determination; Developmental embryonic stages, zygotic division, incomplete division and consequences; Ecto, meso and endodermal development, neural plate and neural tube formation; Early asymmetric division and generation of symmetry in developing embryo; organogenesis and morphogenesis, metamorphosis, animal life cycle, role of apoptosis in organ development; Role of morphogens and their gradient in axis patterning and determination. Concept of anterio-posterior, dorso-ventral and medio-lateral axis formation; Model organisms like Drosophila, C. elegans, Xenopus. Cellular differentiation and senescence; Stem cells and pluripotency. iPS cells; Introduction to plant development; embryonic, meristems and flower development.

Suggested Readings

1. Developmental Biology: Scott F. Gilbert; Sinauer Associates Inc.
2. Principles of Development – L. Wolpert (Oxford Univ. Pr.)
3. Essential Developmental Biology: J. Slack; Wiley Blackwell Scientific. 2nd edition; 2005.
4. Mechanisms in Plant Development by Leyser and Day

BIO 406/626: Evolutionary Ecology (4)

Course Contents

History of the theory of evolution, introduction to evolutionary biology; experimental design; ecology of individual organisms; population ecology;

ecological communities; ecosystem ecology (food chain, food web, producers, consumers, decomposers, energy flow, ecological efficiency, detritus vs. grazing food chains, transport of production); community change and succession: phenology, seasonal pattern; adaptive evolution, neutral evolution, types of selection, evolution of genotype, phenotype, concepts of population genetics: Hardy-Weinberg principle, selection, drift, migration, evolution of sex, life history traits, r and K selection, group selection, extinction; trophic interactions: plant-pollinator, plant-disperser, herbivory, predation, optimal foraging, parasitism, competition, mutualism; conservation ecology. Phylogenetics and molecular ecology.

Suggested Readings

1. *Ecology*,Second Edition by Michael L. Cain, William D. Bowman, and Sally D. Hacker, published by Sinauer Associates. 3rd edition. 2014
2. The Economy of Nature, Robert Ricklefs, Sixth Edition, 2008. Freeman, W. H. & Company
3. Cotgreave, Peter and Irwin Forseth. *Introductory Ecology*. Oxford: Blackwell Science Ltd, 2002.
4. Krebs, John R. and Nicholas B. Davies. *An Introduction to Behavioral Ecology*, 3rd ed. Oxford: Blackwell Science Ltd, 1993.
5. Krebs, C. J. 2008. Ecology: The Experimental Analysis of Distribution and Abundance (6th edition). Benjamin Cummings, Boston, MA.

BIO407/627: Biostatistics (4)

Course Contents

Role of statistical analysis in biology, an introduction, Introduction to R programming language, using R to perform statistical analysis, Descriptive statistics and data visualization (through graphs), Distributions (normal, binomial, Poisson, Gaussian), Hypothesis and tests (null hypothesis, statistical significance, type 1 and type 2 errors)

T tests, Goodness of fit (Chi-squared, Shapiro-Wilk test), Multiple testing, Anova, Correlation and regression, Non-parametric statistics & models (Kolmogorov-Smirnov test, Wilcoxon rank sum test, KNN's, support vector machines), Resampling methods for estimation (Bootstrap and Jacknife), Introduction to

multivariate analysis, Principal component analysis, multidimensional scaling and cluster analysis, Design and power analysis, Mini-project (material provided early in the course)

Suggested Readings

1. Gerald Peter Quinn and Michael J. Keough (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press

BIO 408/628: Bioinstrumentation (4)

Course Contents

Principles of UV/Vis spectroscopy, fluorescence spectroscopy, CD spectroscopy, with applications in understanding proteins; principle and application of analytical ultracentrifugation; surface plasmon resonance; mass spectrometry (MALDI, ESI, native mass spectrometry), XRD instrumentation; principles and application of NMR; atomic force microscopy (AFM); optical tweezers; next generation sequencing; realtime QPCR.

Prerequisites: Must have studied structural biology, biophysics, biochemistry, cell biology and molecular biology.

Suggested Readings

1. Analytical ultracentrifugation for the study of protein association and assembly, Geoffrey J Howlett, Allen P Minton, Germán RivasCurrent Opinion in Chemical Biology Volume 10, Issue 5, October 2006, Pages 430–436
2. Analytical Ultracentrifugation: Sedimentation Velocity and Sedimentation Equilibrium. James L. Cole, Jeffrey W. Lary, Thomas Moody, and Thomas M. Laue
3. How to study proteins by circular dichroism Biochim. Biophys. Acta (2005) 1751: 119
4. Principles of Fluorescence Spectroscopy by Lakowicz
5. Recent research articles for specific bioinstrumentation methods

BIO 409/629: Biophysics (4)

Course Contents

Biomolecules and their properties; basic principles of modern biophysical methods to study macromolecules from the atomic to cellular levels; introduction to molecular spectroscopy; introduction to thermodynamics and kinetics; biophysical chemistry; introduction to molecular dynamics simulations. The problem of protein folding; theoretical and experimental approaches to study protein folding. Introduction to membrane biophysics; structure and function of membranes; experimental and theoretical tools for studying biological membranes.

Prerequisites

Must have studied biochemistry, cell biology and molecular biology.

Suggested Readings

1. Biophysical Chemistry: Parts I, II and III by Charles R. Cantor and Paul Reinhart Schimmel. W H Freeman and Co, Oxford.
2. Recent research articles for specific topics.

BIO 410/630: Epigenetics (4)

Course Contents

Introduction to theme; Chromatin, Epigenetics and Transcription, DNA methylation and demethylation, Histone modifications; Acetylation, Methylation, Phosphorylation, Ubiquitinylation, Sumoylation, Poly-ADP Ribosylation:, Heterochromatin; Histone variants; Nucleosome; Long non-coding RNA and chromatin; Epigenetics and alternative splicing; Epigenetics and mammalian development; Polycomb and Trithorax group proteins; Dosage compensation and Genomic imprinting; Epigenetics and Human Diseases, Cancer

Suggested Readings

1. Lyle Armstrong, Epigenetics, Garland Science, ISBN:9780815365112
2. Thomas Jenuwein, Danny Reinberg, Marie-laure Caparros, C. David Allis, Epigenetics 1st Edition Cold Spring Harbor Laboratory Press, Usa 2008, ISBN-13 9780879698751

3. Bryan M Turner, Chromatin and gene regulation, John Wiley & Sons (asia) Pte Ltd 2001, ISBN-13 9780865427433
4. Krishnarao Appasani, Epigenomics From Chromatin Biology to Therapeutics, Cambridge University Press 2012, ISBN-13: 978-1107003828
5. Robert A. Meyers, Epigenetic Regulation and Epigenomics, John Wiley & Sons 2012, ISBN-13:978-3527326822

BIO 411/631: Advances in Microbiology (4)

Course Contents

Microbial genetics; Modes of DNA transfer in bacteria; Bacteriophage biology; Phage display and lambda DNA library. Lytic and temperate phage; Bacteriophage genetics and gene regulation; Microbial Adaptive Physiology - Mechanism of drug resistance; Signal Transduction in bacteria; Quorum sensing and Two component system; Stringent response in bacteria;

Suggested Readings

1. Microbiology by Prescott, Harley and Klein; McGraw-Hill Science/Engineering/Math; 7th edition; 2007.
2. Modern Microbial Genetics by Streips and Yasbin; Wiley-Liss; 2nd edition; 2002.
3. Bacterial and Bacteriophage Genetics: Edward Birge; Springer; 5th edition (December 8, 2005).
4. E. coli and Salmonella Typhimurium- Vol 1-2: Cellular and Molecular Biology by Neidhardt and Curtiss; American Society for Microbiology; 2 Volume Set edition. 1987.

BIO 412/632: Cancer Biology (4)

Course Contents

Aneuploidy, polyploidy and chromosomal translocations, consequential uncontrolled growth and cancer; Nature of cancer; carcinogens, DNA damage and mutagenesis; Inherited susceptibility to cancer; Genomic integrity and development of cancer; Cancer cell cycle and tumor suppressor proteins, Cellular

Oncogenes, dysregulation of pathways in cancer; Growth factors and associated signaling pathways in cancer; Tumor viruses and mechanisms of oncogenesis; Tumor metastasis; Angiogenesis; Cellular immortalization and activation of telomerase in cancer; Apoptosis; Stem cells; Tumor immunology; Role of cytokines and hormones in cancer; Immunotherapy and cancer therapy, Cancer as metabolic disorder

Suggested Readings

1. The biology of Cancer: Weinberg RA; Garland Science; 2007.
2. The Molecular Basis of Cancer: Mendelsohn J, Howley PM, Israel MA, Gray JW, Thompson CB (eds); Saunders Elsevier, Philadelphia; 3rd edition; 2008

BIO 413/633: Stem Cell Biology (4)

Course Contents

Introduction to concepts in stem cell biology- stemness, potency, lineage, renewal,clonality, etc; Stages of early development (zygote to gastrula) in mouse and human; Classification of stem cells- based on potency, tissue of origin, stage of origin; Embryonic stem cell (ESC)- molecular mechanism of cell renewal and maintenance of pluripotency, epigenetic modifications, spontaneous and directed differentiation, Embryonic carcinoma cells (ECC) and embryonic germ cells (EGC); Fetal stem cell in extra-embryonic tissues; Adult stem cell- stem cell niche, localization and identification of stem cells from various tissues and organs (skin, intestine, blood, brain, retina, muscle); Induced pluripotent stem cell (iPSC)- methods of reprogramming differentiated cells, comparison with ESC; Personalized pluripotent stem cells; Stem cells and cancer; Potential therapies using stem cells- modeling diseases using stem cells, stem cell and tissue engineering for skin graft, stem cell in corneal and retinal regeneration; stem cell therapy for sickle cell anemia, neural stem cells for central nervous system repair, stem cells to repair damaged heart, insulin producing cells for treatment of diabetes, stem cell gene therapy; Ethical issues and guidelines for stem cell research.

Suggested Readings

1. Essentials of Stem Cell Biology: Robert Lanza et al, 2nd Edition, Academic Press, 2009.
2. Stem Cells: A very short introduction, Jonathan Slack, Oxford University Press, 2012.
3. Developmental Biology, Scott F. Gilbert, Eighth Edn, Sinauer Associates, Inc., 2006.
4. Classical/recent research papers and reviews relevant to the topics.

BIO 414/634: Behavioral Biology (4)

Course Contents

Behavioral biology course: The importance of studying behavior. Historical perspective, Tinbergen's four questions for studying behavior; development of behavior; evolution of behavior. Learning and memory: innate and learned behavior. Important behaviors such as general communication, foraging, mate search, predator avoidance. Social behaviors such as leks, migration, altruism, reciprocity, kin selection, and eusociality. Introduction to plant behavior. Sensory systems - auditory and visual systems, basic organization and adaptations. Neural mechanisms of selected behavior such as echolocation in bat, counter sonics and predator avoidance in moths and directional locations in owls. The above topics will be complemented with discussions of classic and recent research papers in the field of behavioral biology.

Suggested Readings

1. Alcock J. 2013. Animal Behavior: an evolutionary approach. 10^{th} Ed. Sinauer publications, USA
2. Zupanc, G. K. 2010. Behavioral Neurobiology: an integrative approach. 2^{nd} Ed. Oxford Univ. Press
3. Davies, NB, Krebs JR and SA West. 2012. An introduction to behavioral ecology. 4^{th} Ed. Wiley Blackwell.

BIO 415/635: Advances in Genetics (4)

Course Contents

History of genetics; Mendelian Genetics; Extension of Mendelian genetics; Chromosomal theory of inheritance; Patterns of Inheritance; relationship between genotype and phenotype; Mutations and Repair; Linkage and recombination; Gene mapping; Genetic Fate mapping, Tetrad analysis; Functional genomics; Phage genetics; Genetic Analysis of populations and their evolution; Evolution at the molecular level. Making transgenic animals, Use of FLIP-FRT and Cre-lox system

Suggested Readings

1. Genetic Analysis and Principles: Robert Brooker; McGraw-Hill Science/Engineering/Math; 4th edition; 2011.
2. Genetics- From genes to genomes: Leland Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds and Lee Silver, 4th edition; 2010

BIO 416/636: Protein Folding and Function (4)

Course Contents

Thermodynamics of protein folding. Kinetics of protein folding. Molecular regulators of protein folding. Assisted versus unassisted folding and the molecular mechanism of chaperones. Folding and regulation in soluble proteins. Folding and regulation in membrane proteins. Protein folding versus protein aggregation: cause and consequence in function and disease states. Modern biophysical tools and how to study protein folding with them: Fluorescence and circular dichroism, FRET, stopped flow kinetics, conventional and native mass spectrometry, NMR spectroscopy, atomic force microscopy, optical tweezers, analytical ultracentrifugation; cryo-EM; molecular dynamics simulations.

Suggested Readings

1. Structure and mechanism in protein science. Alan Fersht. W H Freeman and Co, New York.
2. Biophysical Chemistry: Parts I, II and III by Charles R. Cantor and Paul Reinhart Schimmel. W H Freeman and Co, Oxford.Protein

3. Folding, Misfolding and Aggregation. Victor Munoz, Stephen Neidle, David Lilley, Maurius Clore, Simon Campbell et al.. RSC Biomolecular Sciences (Book 13)

BIO 637: Advances in Omics (4)

Course Contents

Introduction to various –omics, **Genomics:** Introduction to genomics; metagenomics and metatranscriptomics; current sequencing technologies. **Transcriptomics:** Introduction to transcriptomics; microarray; EST; SAGE; applications and case studies. **Proteomics:** Introduction to proteomics; identification and analysis of proteins; protein/peptide separation techniques; methodology (electrophoresis, chromatography, mass spectrometry, protein database analysis etc.); quantitative proteomics; protein modification proteomics; interaction proteomics; protein biomarker development; structural mass spectrometry; structural biology; case studies from current scientific literature. **Bioinformatics:** Bioinformatics tools for protein identification and computational modeling. **Metabolomics:** Metabolic pathways resources; KEGG; nutrigeomics; metabolite separation and detection methods; problems and challenges. Systems Biology and other -omics

Selected Readings:

Latest papers and review articles in each topic (from journals including, but not limited to, Nature, Curr. Opin. Chem. Biol., Cell, Nature Biotech., Science, Trends series). This will be provided in the class.