

COURSE STRUCTURE & SYLLABUS

(w.e.f. 2020)

B.Sc. Biosciences (CBCS Pattern)

Department of Biosciences
Jamia Millia Islamia

SEMESTER – I		Credits
BSB-101 Animal Diversity -I	4 periods/wk Marks : 60*+40**=100	4
BSB-102 Plant Diversity -I	4 periods/wk Marks : 60*+40**=100	4
BSB-103 Essential Mathematics (CBCS)	4 periods/wk Marks : 60*+40**=100	4
BSB-104 Lab Course -I	8 periods/wk Marks : 50*+50**=100	4
BLE-011 General English -I	4 periods/wk Marks : 60*+40**=100	4

Qualifying Papers – 1. General Urdu
2. Islamiat/ IRC/ HRS

SEMESTER – II		Credits
BSB-201 Animal Diversity -II	4 periods/wk Marks : 60*+40**=100	4
BSB-202 Plant Diversity -II	4 periods/wk Marks : 60*+40**=100	4
BSB-203 Chemistry -I	4 periods/wk Marks : 60*+40**=100	4
BSB-204 Biomathematics & Biostatistics (CBCS)	4 periods/wk Marks : 60*+40**=100	4
BSB-205 Lab Course -II	12 periods/wk Marks : 50*+50**=100	4
BLE-021 General English -II	4 periods/wk Marks : 60*+40**=100	4

Qualifying Papers – 1. General Urdu
2. Islamiat/ IRC/ HRS

SEMESTER – III		Credits
BSB-301 Cell Biology	4 periods/wk Marks : 60*+40**=100	4
BSB-302 Molecular Biology	4 periods/wk Marks : 60*+40**=100	4
BSB-303 Chemistry -II	4 periods/wk Marks : 60*+40**=100	4
BSB-304 Environmental Sciences (AECC)	4 periods/wk Marks : 60*+40**=100	4
BSB-305 Lab Course -III	12 periods/wk Marks : 50*+50**=100	4

SEMESTER – IV		Credits
BSB-401 Developmental Biology	4 periods/wk Marks : 60*+40**=100	4
BSB-402 Animal Physiology	4 periods/wk Marks : 60*+40**=100	4
BSB-403 Plant Physiology	4 periods/wk Marks : 60*+40**=100	4
BSB-404 Biophysics (CBCS)	4 periods/wk Marks : 60*+40**=100	4
BSB-405 Lab Course -IV	12 periods/wk Marks : 50*+50**=100	4

SEMESTER – V		Credits
BSB-501 Microbiology	4 periods/wk Marks : 60*+40**=100	4
BSB-502 Immunology	4 periods/wk Marks : 60*+40**=100	4
BSB-503 Genetics	4 periods/wk Marks : 60*+40**=100	4
BSB-504 Bioinformatics & Information Technology (CBCS)	4 periods/wk Marks : 60*+40**=100	4
BSB-505 Lab Course -V	12 periods/wk Marks : 50*+50**=100	4

SEMESTER – VI		Credits
BSB-601 Biochemistry	4 periods/wk Marks : 60*+40**=100	4
BSB-602 Ecology	4 periods/wk Marks : 60*+40**=100	4
BSB-603 Organic Evolution	4 periods/wk Marks : 60*+40**=100	4
BSB-604 Techniques in Biology (SEC)	4 periods/wk Marks : 60*+40**=100	4
BSB-605 Lab Course -VI	12 periods/wk Marks : 50*+50**=100	4

Total Credits = 124

***Semester End Examination**

****Internal Assessment**

BSB -101
ANIMAL DIVERSITY-I

Lectures: 60

Unit I

Principles of taxonomy and relationship with systematic. General characters and criteria for classification of invertebrates. An outline classification of non-chordates.

Classification of Protozoans. Type study of *Paramecium caudatum* and *Plasmodium vivax*. Locomotion and reproduction in Protozoa. Leishmaniasis, Trypanosomiasis, toxoplasmosis, Giardiasis and Amoebiasis.

Unit II

Organization of metazoa including symmetry, metamerism and body cavity or coelom. Theories of origin of metazoa. General characters and classification of phylum Porifera. Canal system and skeleton in Sponges. General characters and classification of Coelenterates. Type study of *Aurelia*. Polymorphism, corals and coral reefs. General characters and classification of phylum Platyhelminthes

Unit III

General characters and classification of nematodes. Type study of *Ascaris lumbricoides*. Nematodes and human diseases. *Coenorhabditis elegans* and its application in research. General characteristics and classification of Arthropods. Mouth parts of insects. Vision in arthropods. Metamorphosis in insects. Larval forms of Crustaceans. Social insects and their life cycle. Economic importance of insects. Lac culture, Sericulture, Apiculture and Prawn culture.

Unit IV

General characters and classification of phylum Mollusca. Type study of *Pila globosa*. Torsion and detorsion in gastropods. General characters and classification of phylum Echinodermata. Water vascular system in star fish, Larval form in Echinoderm, Structure and affinities of *Balanoglossus*.

Recommended Books:

1. Ruppert, E. E. and Barnes, R. D., Invertebrate Zoology, Saunders College Publishing.
2. Parker, T. J. and Haswell, W. A., Textbook of Zoology, Vol. 1 (Invertebrates), Low Price Publications.
3. Kotpal, R. L., Modern Textbook of Zoology: Invertebrates, Rastogi Publications.
4. Jordan, E. L. and Verma, P. S., Invertebrate Zoology, S. Chand & Co.
5. Anderson, D. T., Invertebrate Zoology, Oxford University Press, India.

BSB -102
PLANT DIVERSITY-I

Lectures: 60

Unit I

Cyanobacteria and Algae: General features, Classification, Distribution, Range of thallus organization, Reproduction, Life Cycle and Economic importance with special reference to *Nostoc*, *Volvox*, *Oedogonium*, *Chara*, *Ectocarpus*, and *Polysiphonia*.

Unit II

Fungi: General features, Reproduction and economic importance with special reference to Slime molds, *Albugo*, *Phytophthora*, *Aspergillus* and *Puccinia*. Fungal Diseases: White rust of crucifers, Late blight of potato, Black stem rust of wheat
Lichens: Thallus organization, Reproduction and their ecological significance.

Unit III

Bryophytes: General features, Habitat, Range of thallus organization and reproduction, Affinities with Algae and Pteridophytes. Type study of *Marchantia*, *Anthoceros* and *Funaria*.

Unit IV

Pteridophytes: General features, Habitat, Stellar system, Heterospory and seed habit, Adaptive features: Spores, cuticle, stomata and tracheids. Morphology anatomy and reproduction of *Psilotum*, *Selaginella* and *Pteris*.

Recommended Books:

1. Hait, Bhattacharya & Ghosh, A Text Book of Botany ,Volume I (NCBA).
2. Sporne. Morphology of Bryophytes (Oxford Publishing House).
3. Alexopoulos C.J , Mims C.W. and Blackwell M.I . Introductory Mycology. (John Wiley and Sons Inc).
4. George N. Agrios, Plant Pathology (Elsevier).
5. Tortora, G.J., Funke, B.R., Case, C.L. Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A.
6. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.

BSB-103
ESSENTIAL MATHEMATICS (CBCS)

Lectures: 60

Unit I

The factorial introduction, fundamental principle of counting, permutation as arrangement, practical problems on permutations, permutation under certain conditions, Combinations, practical problems on combinations, combinational identities, Binomial theorem for any positive integral exponent (without proof), general and middle term, Binomial theorem for any index. Set and their representations, finite and infinite sets, subsets, type of sets, operations on sets and their algebraic properties, Venn diagram, ordered pair, Cartesian product & relation.

Unit II

Concept of functions and Relation in biological terminology, its domain and range, Types and classification of function, graphs of some well known functions, even and odd functions, periodic functions, algebra of functions, composite functions, inverse of a function. Limits, left hand and right hand limits, algebra of limits, continuity of a function at a point, over an open/closed interval, differentiability of a function at a point, left hand and right hand differentiability, relation between continuity and differentiability, Derivative of a function, its geometrical and physical significance, Applications.

Unit III

Introduction of indefinite integral, anti-derivative or primitive function, standard formulae, and fundamental laws of integrations, methods of integration: by substitution, by parts, by long division, by partial fractions, by successive reduction, Integration of some well known forms. Definition of definite integral as the limit of sum, The fundamental theorem of calculus (without proof), evaluation of definite integral, transformation of definite integral by substitution, by parts. Properties of definite integral and problems based on these properties, Applications.

Unit IV

Definition and examples of matrices, types of matrices, basic operations, equality of matrices, addition and scalar multiplication of matrices, properties of addition and scalar multiplication, transpose of a matrix, symmetric and skew symmetric matrices and their properties, matrix multiplication in general and its properties. Definition of Determinant, minors and cofactors of an element of a determinant, singular and non-singular matrices, multiplicative inverse of a matrix and its properties, Applications.

Recommended Books

1. Seymour Lipschutz, 1981, Set Theory, (Schaum's Outline Series) McGraw-Hill Book Co.
2. Frank Ayres, J.R., 1974, Matrices, (Schaum's Outline Series) McGraw-Hill Inc.
3. Shanti Narayan, 1999, Differential and Integral Calculus, S.Chand & Company Ltd.
4. Frank Ayres, Jr. and Elliott Mendelson, 1992, Differential and Integral Calculus, Schasun's Outline series, McGraw Hill Book Company.
5. N. Piskunov, Differential and Integral Calculus, 1981, CBS Publishers & Distributors.

BSB- 201
ANIMAL DIVERSITY-II

Lectures: 60

Unit I- Introduction and classification of Chordates

General Characters, origin and ancestry of Chordates. A brief classification of phylum Chordata. Diversity of chordates and comparison with non-chordates. General characters and classification of subphylum Urochordata. Characteristics and affinities of *Herdmania*. General characters and classification of subphylum Cephalochordata. Characters and structure of *Branchiostoma*.

Unit II- Superclass Pisces

General characters and classification of superclass Pisces. Type study of Class Cyclostomata: *Petromyzon*. Scales of fishes. Air or swim bladder and accessory respiratory organs. Migration and parental care in fishes. Pisciculture. Dipnoi Freshwater and Brackish water fisheries in India.

Unit III- Class Amphibia and Reptilia

General characters, origin and classification of Amphibians. Parental care in class Amphibia. Origin, general characters and classification of Reptiles. Identification of snakes. Poisonous and non-poisonous snakes biting mechanism in snakes. Venom and anti-venom. Extinct reptiles (Dinosaurs), Evolution and adaptive radiation of reptiles.

Unit IV- Class Aves and Mammalia

General characteristics and classification of class Aves. Affinities, origin and ancestry of birds. Mechanism and modes of flight adaptations. Type of beaks in birds. Flight adaptation in birds. Migration in birds. Economic importance of birds. General characters and classification of class Mammalia. Origin and ancestry of mammals. Dentition in mammals, Prototheria and Metatheria.

Recommended Books

1. Young J Z (2004) The life of vertebrates III edition, Oxford university press.
2. Kent GC & Karr RK (2000) Comparative anatomy of Vertebrates, 9th Edition, The Mcgraw – hill companies.
3. Kardong KV (2005) Vertebrates comparative anatomy, function and evolution 4th edition. The Mcgraw – hill higher Education.
4. RL Kotpal (2016) Modern textbook of zoology-vertebrates

BSB-202
PLANT DIVERSITY -II

Lectures: 60

Unit I

Gymnosperms: Introduction, Diversity, Economic importance, Classification, origin and Evolutionary significance. Affinities of Gymnosperms with Angiosperms and Pteridophytes.

Unit II

General features, Habitat and distribution, External features, Anatomy of vegetative and reproductive structures, Development and reproduction of *Cycas*, *Pinus*, and *Gnetum*

Unit III

Inflorescence, Flower and floral parts of Angiosperms. Taxonomy of Angiosperms: Introduction and outlines of systems of classification of Angiosperms; Bentham and Hooker's system, Hutchinson's system, Engler & Prantel's System.

Unit IV

Systematic study, Affinities, Distinguishing features and economic importance of dicot families viz. *Ranunculaceae*, *Solanaceae*, *Moraceae*, *Malvaceae*, *Fabaceae*, *Umbelliferae*, *Asteraceae*, and monocot families *Liliaceae* and *Poaceae*. Economic botany: Food, drug, fiber, spices, beverages, timber and rubber yielding plants.

Recommended Books

1. Swingle, D.B. A Text book of Systematic Botany. (Mc Graw Hill)
2. Harrison, H.J., New Concepts of Flowering Plant Taxonomy, (Hieman Educational Books Ltd., London.)
3. Simpson, M.G. Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Hait, Bhattacharya & Ghosh, A Text Book of Botany ,Volume II (NCBA)
5. Bhatnagar, S.P. and Moitra, A., Gymnosperms (New Age International).
6. Biswas C and Johari B.M, The Gymnosperms (Narosa Publishing House)
7. Stewart W.N. and Rathwell G.W. Paleobotany and the Evolution of plants (Cambridge University Press).
8. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. Biology. Tata McGraw Hill, Delhi, India.

Unit I- Fundamentals of Organic Chemistry

Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Polarity of Bonds and molecules, Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit II- Stereochemistry

Fischer Projection, Newman and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules upto two chiral-centres, Distereoisomers, meso structures, racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

Unit III- Hydrocarbons

Alkanes: Structure of methane, ethane, propane and butane, Nomenclature, Physical Properties. *Reactions:* Free radical Substitution: Halogenation of alkanes, selectivity of bromine towards substitution reactions.

Alkenes: Structure of ethylene, propylene and butylenes, Isomerism in alkenes, Nomenclature, Physical Properties. *Reactions:* cis-addition (alk. KMnO₄) and trans-addition (bromine). Addition of HX (Markownikoff's and anti-Markownikoff's addition). Hydration, Ozonolysis, oxymercuration-demercuration, hydroboration-oxidation.

Aromatic Hydrocarbons

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism.

Unit IV- Alkyl and aryl halides

Preparation: from alkenes and alcohols. Structure, classification, nomenclature and physical properties, Reactions: Williamson ether synthesis, Nucleophilic substitution reactions (Nucleophiles & leaving groups, Thermodynamics & kinetics, SN¹ & SN² reactions: mechanism, kinetics, stereochemistry and reactivity, Carbocations: structures, relative stabilities & rearrangement, Factors affecting rates of SN¹ & SN² reactions), Elimination reactions of Alkyl halides: Dehydrohalogenation, E¹ & E² reactions. Elimination vs substitution.

Aryl halides: Preparation: from phenol, Sandmeyer and Gattermann reactions and important reactions. Reactivity and relative strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Recommended Books

1. I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.

2. R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
3. Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand
4. Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.

BSB-204
BIOMATHEMATICS AND BIOSTATISTICS (CBCS)

Lectures: 60

Unit I

Differential equation, order and degree of a differential equation, solution of a (first order and first degree) differential equation by the method of variable separable, Homogeneous differential equation and their solution, solution of the linear differential equation of the first order of type: $dy/dx+P(x).y=Q(x)$.

Unit II

Mathematical Modeling, Steps in building Mathematical Models, Relation of Models to data, Evolution, Choosing Mathematics for the models. Linear and Non linear First order Discrete Time Model; Differential Equation Models, Population dynamics, Discrete Dynamical Models, Continuous Models, Epidemic Models, Models, Growth Models.

Unit III

Methods of sampling, measure of central tendency (mean, median and mode), measures of variation (mean deviation and standard deviation). Correlation, covariance, Karl Pearson's coefficient of correlation, degree of correlation, Regression, coefficient of regression, Method of Least Square.

Unit IV

Random experiment and associated sample space, events, definition of probability of event, algebra of events, and addition and multiplication theorem on probability (without proof), Conditional probability, Independent event, Baye's theorem (without proof), Binomial, Poisson and Normal distributions.

Recommended Books

1. Frank Ayres, J.R., 1992, Theory and Problems of Differential Equations. Schaum's Outline Series, McGraw-Hill Book Co
2. Arora, P.N. and P.K. Malhan, 2002, Biostatistics, Himalaya Publishing House.
3. Murray R. Spiegel, 1980, Probability and Statistics, Schaum's Outline Series) McGraw-Hill Book Co.

**BSB-301
CELL BIOLOGY**

Lectures: 60

Unit I- Cell Organelles

Structure and functions of Endoplasmic reticulum, SRP based targeting of proteins to ER, folding and disulfide bond formation, mechanism of vesicle transport, Mitochondria (DNA & pathways), lysosomes and their role in degradation, Golgi apparatus (post translational modifications of proteins and lipid synthesis).

Unit II- Cytoskeleton network

Structure and organization of actin, myosin, muscle contraction system and intermediate filaments, microtubules and their role. Cell Shape, Mitotic Spindle, 9+2 Array, Filipodia Structure.

Unit III- Nucleus organization and cell cycle

Structure and Function of Nucleus. Nuclear Membrane and Transport, Nuclear Pore complex, chromosomal structure and positioning. Potentiated genes, Cell cycle: controls and checkpoints.

Unit IV- Membrane Transport and Cell signaling

Lipid bilayer and membrane proteins, Ionic channels, Ion pumps, membrane transport (Simple, Facilitated, Active and Voltage gated). Signaling molecules and their receptors (GPCR, Tyrosine, Kinase based) , Role of protein kinase , functions, intracellular signal transduction pathways (selected pathways), signaling networks and cross talk.

Recommended Books

1. Cell and Molecular Biology by Robertis De, E.D.P. and E.M.F. De Robertis
2. Molecular Biology of the Cell by Bruce Albert, Dannis Bray, Julian Lewis, Martin Raff
3. Molecular Cell Biology by Harvey Lodish
4. Molecular Cell Biology by Darnell, J.E.

BSB - 302
MOLECULAR BIOLOGY

Lectures: 60

Unit I

Replication of DNA: Types of DNA polymerase and enzymes involved, replication origin, replication fork, semi conservative replication of double stranded DNA, mechanism of replication, proof reading. Replication in Eukaryotes. RNA Synthesis: Types of RNA polymerases, mechanism of transcription, RNA processing, capping, polyadenylation, splicing; small interfering RNA, micro RNA. Transcription in Eukaryotes.

Unit II

Protein Synthesis: Genetic Code, Wobble Hypothesis, tRNA, Ribosome, formation of initiation complex, initiation, elongation and termination, folding and processing of proteins. Comparison of Prokaryotic and Eukaryotic translation. Expression and Regulation of genes: Negative and positive regulation, operons, gene expression in prokaryotes, chromatin remodeling, eukaryotes; gene silencing: transcriptional, post transcriptional, antisense RNA.

Unit III

Restriction enzymes, DNA polymerases, ligase, kinase, phosphatase, nuclease; molecular cloning: Cloning Vectors: Lamda phage, plasmid, M13 phage, cosmid, shuttle vectors, yeast and viral vectors, construction of genomic and cDNA library.

Unit IV

Nucleotide sequencing methods and amplification of DNA; types of PCR: RT-PCR, inverse PCR, asymmetric PCR, DNA fingerprinting, molecular markers, RAPD, RFLP, AFLP, SNPs analysis of gene expression, micro array, production of genetically modified crops, transgenic animals

Recommended Books

1. Principles of Gene Manipulations & Genomics, S.B. Primrose, M. Twyman, John & Willey Publishers
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Bernard R.Glick and Jack J.Pasternack, 2010, Panima Publishing Corporation.
3. Molecular Biology: Genes to Proteins, 2010, Burton E.Tropp, Jones and Bartlett Publishers.
4. Molecular Biology, David Clark, 2010, Publisher A P Cell.

BSB-303
CHEMISTRY-II

Lectures: 60

Unit I

Carbonyl Compounds: Structure, Nomenclature and Physical properties, Nucleophilic addition to carbon-oxygen double bond, Reaction of Aldehydes and Ketones: Oxidation, Baeyer Villager oxidation, Reduction to alcohols & hydrocarbons: Clemmensen & Wolff Kishner reduction, Reductive amination, Addition of water & alcohols, Additions of derivatives of ammonia, Addition of hydrogen cyanide & sodium bisulphite, Addition of Halides : Wittig reaction, Aldol reactions: enolate ions, keto-enol tautomerism, reactions via enol and enolate ions.

Carboxylic acids and their Derivatives: Structure, Nomenclature, Physical properties and Acidity of carboxylic acids, Reactions of carboxylic acids: Nucleophilic substitutions at acyl carbon, Conversion into acyl chloride, anhydrides, lactones, nitriles esters, amides and lactams, Reduction of carboxylic acids, substitution in alkyl or aryl group, Decarboxylation of carboxylic acids, Reactions of acyl chloride and acid anhydrides, Reaction of Esters: Conversion into acids and acids and acid derivatives, Reduction to alcohols, Reactions with carbanion.

Unit II

Definition and type of solution; expressing the concentration of solution; colligative properties (definition); Raoult's law, Raoult's law and molecular weight of the solute; elevation of boiling point; depression of freezing point, osmotic pressure; definition, laws of osmotic pressure, van't Hoff theory of dilution; determination of molecular weight, theoretical explanation of osmosis. Osmotic behaviour of living cells: tonicity, turgor pressure.

Unit III

Electrolytes (True and Potential), Ionization of electrolytes, Colligative properties of true electrolytes (The van't Hoff factor, the nonideality of solution, ionic strength of the solution and its effect on Debye-Huckel limiting law) Colligative properties of potential electrolytes; (Ionization and degree of ionization. Solubility of Salts: Thermodynamic and apparent solubility products, salt or electrolyte effect, the common ion effect.

Introduction (Biological relevance of pH); Concepts of acids and bases. The exact treatment of the ionization of monoprotic acid in water; Relation between initial acid concentration, pK_a and pH, Henderson-Hasselbalch equation, dependence of ionization on pH of solution, uses of the H-H equation, titration of strong and weak acids with strong base. Exact treatment of the ionization of diprotic acid. Exact treatment of Bronsted lowery type monobase. Salt hydrolysis. Buffer mixtures. pH indicators, Biological relevance of pH: buffering in living organism, effect of pH on protoplasmic components.

Unit IV

Definition of terms: reaction rate, order and molecularity. Rate measurements and rate laws, Factors influencing rates of reactions. Zero, I and II order reaction with examples. Mathematical treatments of rate constants of I and II order reactions. Calculation of activation energy, Collision and absolute theory of reaction rates.

Recommended Books

1. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
2. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
3. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand
4. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
5. Atkins, P.W. 2001, Physical Chemistry, W.H. Freeman & Co. 7th Edition.
6. Clydel., R., Metz, 1988, Schaum's Series Outline of Physical Chemistry, McGrawHill.
7. Puri & Sharma, 2002, Physical Chemistry, S. Chand & Sons Co.
8. Bahl & Tuli, 2002, Essential of Physical Chemistry, S. Chand & Sons. Co.
9. Gordon, G., Hammes, 2000, Thermodynamics and Kinetics for the Biological Sciences, John Wiley & Sons.

BSB-304
ENVIRONMENTAL SCIENCE (AECC)

Lectures: 60

Unit I

Multidisciplinary nature of environmental studies, Scope and importance, Sustainable development, Forest conservation act. International agreements: Montreal protocol, Kyoto protocol. Conservation of biological diversity. Soil formation (weathering of rocks, mineralization and humification), soil nutrient, soil cation exchange capacity, nutrient availability, soil moisture, soil type, soil texture, soil aeration, soil mixing.

Unit II

Threat to biodiversity : Deforestation, Overgrazing, Agriculture, Shifting cultivation, Mining, Urbanization; Threat to wild life : Hunting and export, Habitat loss, Selective destruction, Domestication Man –wild life conflicts, Biological invasions; Extinct and threatened species; Red data book; Conservation of biodiversity : Habitat conservation, Providing critical resources, Captive breeding, Development of reserves; UNESCO Biosphere Reserve Programme, Man –wild life conflicts, Biological invasions, Controlling introduction of alien species, Reducing pollution, Research and documentation, Legal actions, Environmental movements - Chipko, Appiko, Silent valley, Bishnoi community of Rajasthan, In -situ and Ex-situ conservation, Project Tiger, Environmental ethics : Role of religious and cultural activities.

Unit III

Pollution: Types, causes, effects and control (Air , water, soil, Noise, Thermal, Radiation, Pesticide , Heavy metal , Particulate, Solid waste pollution); Climate Change; Global warming; Ozone depletion; Acid rain; Minamata disease; Itai-Itai disease; Skeletal fluorosis; Occupational hazards; Pollution Monitoring (Physical, Chemical and Biological). Forest Conservation Act; International Agreements : Montreal Protocols, Kyoto Protocols and Convention on Biological Diversity.

Unit IV

Renewable energy sources: Flowing water, Wind, Tides, Oceanic waves, Biofuel (Biodiesel, Biogas, Bioethanol, Hydrogen), Nuclear, Geothermal, Antimatter ; Non-renewable energy sources : Fossil Fuel (Coal, Petroleum, Natural Gas); Rain water harvesting, Conflicts over water (International and interstate).

Recommended Books

1. Groom Martha J, Gary K Meffe and Carl Ronald Carroll. 2006. Principles of Conservation Biology. Sunderland: Sinauer Associates.
2. Peeper IL, Gerba,CP, Brusseau ML. 2011.Environmental and Pollution Science. Academic Press.
3. Raven PH, Hassenzahl DM and Berg LR. 2012. Environment. 8th Edition. John Wiley & Sons.

4. Singh JS, Singh SP and Gupta SR. 2014. Ecology, Environmental Science and Conservation. S Chand Publishing , New Delhi .
5. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.
6. Julian E Andrews, Peter Brimblecombe, Tim D Jickells, Peter S Liss, and Brian J. Reid. 2004. An Introduction to Environmental Chemistry. Blackwell Publishing.
7. Pandey SN, Misra SP. 2011. Environment and Ecology, Ane Books Pvt. Ltd.
8. LSE-02 Ecology Blocks (1,2,3,4). IGNOU.

BSB- 401
DEVELOPMENTAL BIOLOGY

Lectures: 60

Unit I

Gametogenesis: Spermatogenesis and Oogenesis, Ovulation and hormonal Control, Menstruation Cycle, Fertilization: Molecular basis of Fertilization, Block of Polyspermy, Cortical Reaction, Role of Zona Pellucida.

Unit II

Post Fertilization Events: Zygote formation, Morula, Cleavage, Compaction, Cavitation, Differentiation, ICM, Trophoblast and importance of Blastula. Implantation. Formation of Gastrula, Germ Layers, Primitive Streak, Types of morphogenetic Movements: Bilaminar Disk, Epiblast and Hypoblast. Neuralation: Neuronal Tube, Neuronal Plate, Axon Guidance, Somite and Notochord.

Unit III

Fundamental Process in Development: Gene activation, determination, induction, differentiation, morphogenesis, intracellular communications, Cell movements, Cell death: Apoptosis and Apoptotic regulatory genes

Unit IV

Organogenesis: Myogenesis: Myofibril, Satellite Cells, importance of myoblast and gene activation. Ossification: Intramembranous and Endochondral, Formation of Limb, Sex determination factors and reproductive organs, Development of Heart and Kidney.

Recommended Books

1. Gilbert. S. F. (2006). Developmental Biology, VIII edition, Sinauer Associates Inc, Publishers, Sunderland, Massachusetts, USA
2. Balinsky. B. I. (2008). 'An introduction to Embryology', International Thomson Computer Press.
3. Carison. Bruce M (1996). 'Patten's Foundation of Embryology', McGraw Hill Inc.
4. C.C. Chatterjee's, 'Human Physiology', CBS Publishers and Distributors pvt ltd.

BSB-402
ANIMAL PHYSIOLOGY

Lectures: 60

Unit I- Endocrinology

Hormones, Mechanism of Action, Types and Classes. Endocrine glands (Hypothalamus, Pituitary, Thyroid, Adrenal, Parathyroid, Pancreas, Gonads). Neuroendocrine System, Enteric hormones

Unit II- Digestion and Respiration

Histology of digestive tract, Digestive enzymes of mouth, stomach & intestine and associated gland, Enzymes, Absorption of food, Energy balance. Pulmonary ventilation, Respiratory volumes and capacities, Transport and exchange of gases, Neuronal and chemical regulation of respiration, Breathing and respiration, Cellular respiration, Hemoglobin, Binding and release of O₂ its regulation.

Unit III- Excretion and Cardiovascular system

Kidney, structure of nephron, mechanism of Urine formation, Renin Angiotensin System, Blood: Composition, Hemostasis, Heart structure, Origin and conduction of the cardiac impulse, Cardiac cycle, Neuronal regulation.

Unit IV- Nerve and muscle systems

Anatomy of Brain, CNS & PNS. Structure of a neuron, resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, vision and hearing, Types of muscle fibre, Ultrastructure of cardiac muscle, Molecular and chemical basis of muscle contraction

Recommended Books

1. Tortora, G.J. & Derrickson, B.H. (2009). Principles of Anatomy and Physiology, 12th edn., John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. & Strang, K.T. (2008) Vander's Human Physiology, 11th ed, McGraw Hill.
3. Guyton, A.C. & Hall, J.E. (2011) Textbook of Medical Physiology, 12th ed, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
4. Human Physiology, CC Chatterjee.

BSB-403
PLANT PHYSIOLOGY

Lectures: 60

Unit I

Water Transport: Movement of water in plants in relation to water potential, osmotic potential, pressure potential and metric potential. Ascent of sap: mechanism of water absorption, Guttation Physiology of stomatal opening and closing.

Nitrogen Assimilation: Uptake and assimilation of nitrogen by plants. Nitrogen fixation: Nonsymbiotic and symbiotic nitrogen fixation, Assimilation of ammonia. Role of glutamine synthase and glutamine dehydrogenase.

Unit II

Photosynthesis: Role of photosynthetic pigments. PS II and PS I complex and their inter-relationship. Mechanism of photosynthetic electron transport, Photophosphorylation. Mechanism of carbon dioxide fixation in C₃, C₄ and CAM Plants, Photorespiration. Dormancy: Significance, Seed dormancy, bud dormancy.

Unit III

Translocation: Translocation of photo-assimilates in plants. Phloem loading and unloading. Plant growth regulators: Auxin, Ethylene, Cytokinins, Gibberellins and abscisic acid. Distribution and mechanism of action of plant growth regulators. Phototropism: Phototropic signal perception & Signal transduction. Gravitropism: Gravisperception & Signal Transduction. Vernalization.

Unit IV

Tissue Culture & Techniques: Introduction to *in vitro* methods, General techniques, Factors involved in totipotency, embryogenesis, organogenesis and their applications. Auxillary bud, shoot tip and meristem culture. Haploids and their applications, Somaclonal variations and applications, Single cell suspension culture and their applications in selection of variants. Introduction to protoplast isolation, principles and applications. Somatic hybridization and practical applications.

Recommended Books

1. Taiz, L., Zeiger, E. Plant Physiology. Sinauer Associates Inc., U.S.A.
2. Hopkins, W.G., Huner, N.P. Introduction to Plant Physiology. John Wiley & Sons, U.S.A.
3. Bajracharya, D. Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Plant Biotechnology, 2011, 3rd Ed, BD Singh.

BSB-404
BIOPHYSICS (CBCS)

Lectures: 60

Unit I

Thermodynamics of living systems: Laws of Thermodynamics, Conservation of energy in living systems, Entropy and Life, Gibbs and Standard free energy, Equilibrium constant, Coupled reactions. Osmosis, Osmotic pressure, Osmoregulation, Viscosity and biological importance, Surface tension, Factors influencing surface tension. Dialysis. Colloids, colloidal systems of life. Buffer, buffer capacity, Buffers in life systems

Unit II

Energy requirements in cell metabolism, role and structure of mitochondria, high energy phosphate bond, electron transfer phenomenon and biological transfer. Oxidation and reduction, redox potential and its calculation by Nernst equation, examples of redox potential in biological system.

Unit III

Micelles, reverse micelles, bilayers, liposomes, phase transitions of lipids, active, passive and facilitated transport of solutes and ions, Diffusion, Laws of diffusion, Active transport, Facilitated diffusion, Fick's Laws, Nernst Planck Equations, Donnan effect, permeability coefficient. Ionophores, transport equation. Application of biological membranes in drug delivery

Unit IV

Basic principles of electromagnetic radiations, spectroscopic techniques, energy, wavelength, wave numbers and frequency. Absorption laws, Basic principles of microscopy, light and electron microscopy. Uses and applications.

Recommended Books

1. A text book of Biophysics by Dr. R. N. Roy
2. Biophysics: An introduction by Rodney Cotterill
3. Biophysics by K. Sarn

BSB-501 MICROBIOLOGY

Lectures: 60

Unit I

History of Microbiology: The microscope, Cell theory, spontaneous generation, theory of biogenesis, Koch's postulates, fermentation, pasteurization. Vaccination, germ theory of diseases, Microbial Diversity: Algae, fungi, protozoa, bacteria, viruses and prions.

Microscopy: Bright Field Microscope, Dark Field Microscope, Phase contrast Microscope.

Electron microscope: Transmission electron microscope & scanning electron microscope.

Unit II

Bacterial Morphology: Bacterial size, shapes and pattern of arrangement; the cell wall structure: Gram positive and gram negative bacteria, Structures external to cell wall, Structures internal to cell wall, Gram staining technique

Reproduction and growth of bacteria: modes of cell division, generation time, Growth curve.

Bacteriological media: Selective media, maintenance media, differential media. Isolation of pure cultures and maintenance of culture.

Unit III

Control of microorganisms, Definitions and fundamentals of control, Physical agents/processes for control: high temperature, low temperature, filtration, desiccation, osmotic pressure, high pressure, radiation. Chemical agents and their mode of action: Phenol & Phenolic compounds, Halogens, Aldehydes, Heavy metals, Antibiotics.

Unit IV

Architecture of viruses: Capsid morphology, Nucleic acid and envelop. Transmission & replication of viruses, Transmission of plant viruses, Animal viruses & bacteriophages, Replication of Animal viruses & Lambda phage, Replication of RNA virus and DNA virus.

Recommended Books

1. Microbiology by Pelczar M J
2. Principles of Microbiology Ronald M. Atlas
3. Prescott's Microbiology by Christopher J. Woolverton, Joanne Willey, and Linda Sherwood
4. A text book of Microbiology by R. C Dubey

BSB-502
IMMUNOLOGY

Lectures: 60

Unit I

The immune system and immunity historical perspective. Types of immunity Humoral & Cell Mediated. The cells and organs of the immune system. Innate immunity. Anatomical barriers, cell types of innate immunity, connection between innate and adaptive immunity

Unit II

Adaptive immunity. Antigens and haptens Factors that dictate immunogenicity. Structure and distribution of classes and substances of immunoglobulins(Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Generation of antibody diversity. Complement and its activation by classical, alternate and lectin pathway; biological consequences of complement activation; regulation of complement activity.

Unit III

Immunological methods-Antigen-antibody interactions. Agglutination, hemagglutination. Precipitin reactions in solution and in gels; immunoassays. Selection, Antigen presentation, Activation of T and B cells. Cytokines.

Unit IV

Immunological tolerance-Primary and secondary. Hypersensitivity and its types. Immune response against major classes of pathogens. Vaccines: Live attenuated, Inactivated, Toxoid, subunit/conjugate vaccine. Monoclonal Antibody.

Recommended Books:

1. Immunology by Kuby.
2. Fundamentals of Immunology by William E. Paul.
3. Text book of Immunology by Seemi Farhat Basir, Abbas, Published PHI 2012.
4. Cellular and molecular Immunology by Abdul Abbas, Andrew H Lichtman & Shiv Pillai

BSB- 503 GENETICS

Lectures: 60

Unit I

Mendelism and law of inheritance, Law of segregation, Law of Independent assortment, Phenotypes and genotypes, Chromosomal theory of inheritance, Linkage, Recombination, Linkage maps, Crossing over, Double cross over, Coincidence & interference, Sex-linkage, X-linked inheritance.

Unit II

Multiple Alleles, Incomplete dominance, Over- dominance and co- dominance, Sex-link trait and their inheritance, Non-allelic or inter allelic gene interaction: example of modified dihybrid ratio 9:3:4, 9:7, 12:3:1, 15:1, 13:3, 9:6:1, 7:6:1, 7:6:3, 6:3:3:4, and 7:4:3:2. Recombination in bacteria, Transformation, Transduction and Conjugation.

Unit III

Population genetics: Mendelian population, Hardy – Weinberg equilibrium, Gene and genotype frequencies, Factors affecting the frequencies of gene in population, Pleiotropism, lethal gene, Penetrance and Expressivity.

Extra-chromosomal Inheritance, Mitochondrial genome, Cytoplasmic inheritance, maternal effects, Extra nuclear genome, Variegation in leaves of higher plants, Shell coiling in snail.

Unit IV

Structural organization of Chromosome, Nucleosome model, Euchromatin and Heterochromatin, Structure of Chromosome, special chromosome(Polytene and lampbrush chromosome), Banding pattern in human chromosome, Structural and numerical aberrations involving chromosome, Hereditary defects, Klinefelters, Turner, Cri-du-Chat and Down Syndrome, Abnormal Euploidy, Polyploidy, Autotetraploid. Mutations, spontaneous and induced mutagenesis.

Recommended Books:

1. Principles of Genetics by Gardner, Simmons and Snustad.
2. Genetics: A Conceptual Approach by Benjamin A. Pierce.
3. Genetics by Monroe E. Strickberger.

BSB-504
BIOINFORMATICS & INFORMATION TECHNOLOGY (CBCS)

Lectures: 60

Unit I

Computer and its components, Characteristics of Computer, Types of Digital Computer, Hardware basics: Processors, motherboard, slots / cards, bus, parallel and serial ports.

Various storage devices, Input/Output, Memory unit, Software basics: Data vs. information, Software: types of software, Operating systems, Languages, Compilers, Interpreters, Ideas of portability and platform dependence. Basic word processing in Microsoft word. Power Point and Excel, Preparing and processing text documents.

Internet: Introduction and back ground, functioning, governing bodies, uses.

Unit II

What is Bioinformatics, Use of information technology for studying Biosciences, Emerging areas in Bioinformatics, Future prospects of Bioinformatic, Introduction to Genomics, Introduction to Proteomics, Human Genome Project, Biological Software, Public Database, Gen Bank.

Unit III

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.

EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.

DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ.

Unit IV

Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR, Swiss-Prot: Introduction and Salient Features. Phylogenetic analysis, Protein sequence analysis, Protein structure prediction. Basics of database management system, SQL, Artificial Neural Network Technology, Genetic algorithm, Decision trees.

Recommended Books:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley- Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

**BSB-601
BIOCHEMISTRY**

Lecture: 60

Unit I- Enzymology

Enzymes as biological catalysts: characteristics, nomenclature and classification, coenzymes: structure and function, Enzyme kinetics: Michaelis-Menten equation, significance of K_m and V_{max} , Analysis of kinetics data, Enzyme inhibition: competitive, uncompetitive and mixed inhibition, Enzyme catalytic mechanisms: Acid-base, covalent, metal ion, proximity and orientation effects. Mechanism of action of lysozyme and chymotrypsin.

Unit II- Carbohydrate

Occurrence, classification, characteristics, structure and function of monosaccharides, disaccharides and polysaccharides, Mucopolysaccharides, glycosaminoglycans, proteoglycans, glycoproteins, Glycolysis: reactions and regulation, Gluconeogenesis, HMP pathway, Citic acid cycle, Glycogen degradation and synthesis.

Unit III- Lipid

Classification and type of lipids, structure and function of phospholipids, sphingolipids and glycolipids, Lipid linked proteins and lipoproteins, Mobilization of lipids for oxidation, beta-oxidation of saturated, unsaturated and odd chain fatty acids, synthesis of palmitic acid by fatty acid synthase system.

Unit IV- Amino Acids and Protein

Structure, nomenclature, classification and acid-base behaviour of amino acids, primary structure of proteins and its determination, Secondary structure of proteins: peptide group, helical and beta structures, Bonds and forces which stabilize native protein structure, protein denaturation. Oxidation of amino acids: transamination reactions and urea biosynthesis. Flow sheet diagram of amino acid catabolism and synthesis (without structures).

Recommended Books

1. Principles of Biochemistry by Albert L. Lehninger, David L. Nelson, Michael M. Cox.
2. Biochemistry by Stryer.

Unit I

General ecology : Atmosphere, Weather, Climate, Weather Assessment, Fine weather; Cloudy weather; Biosphere, Biomes and Ecosystems, (Tundra, Taiga, Grassland, Desert and aquatic), Concept, components and types of ecosystem (Tundra, Taiga, Grassland, Desert and aquatic- Fresh water, Marine and Brackish water), ecological range (Eury, Steno), Ecological factors (abiotic and biotic), Ecological pyramids, Food chains; Food web, Productivity, Biogeochemical cycles : Gaseous and sedimentary.

Unit II

Community ecology: Community gradients and boundaries- Ecotone and species diversity, Edge effect. Qualitative characters of community (Floristic composition, Stratification of vegetation, periodicity, vitality and vigour, life forms), Quantitative characters of community (Population density, Cover, Height, weight of plants). Community dynamics (Succession)- Processes in succession, Primary and secondary succession, Kind of succession-Hydrach and Xerarch succession, Autogenic and Allogenic succession, Autotrophic and heterotrophic succession, Models of Succession, Trends in succession, Climax Concept : Monoclimax and polyclimax , Preclimax, Postclimax, Disclimax etc).

Unit III

Community organization: Habitat and Niche, Keystone species; Dominant species, Indicator species, Umbrella species, Flagship species, Views of community organization, Species interaction-Neutralism, Competition, Predation including herbivory, Parasitism, Commensalism, Mutualism, Amensalism, Competition - Lotka and Volterra equation for competition and predation, Competition in laboratory population- Gause principle, competition in natural populations, Competitive exclusion, Resource partitioning, Evolution of competitive ability- territorial behavior, Predation- Parasitoidism, herbivory, Cannibalism, Predation in laboratory, predation in field, Co- evolution of predator and prey system; Herbivory, - defence mechanism in plants, Herbivore counter measures, Herbivore interactions, Phenotypic and genotypic plasticity, Canalization.

Unit IV

Population dynamics: Density; Natality, Mortality, Immigration; Emigration, Survivorship curves, Population dispersal, Age distribution, Factors affecting biotic potential, Population growth- exponential and logistic growth equations, r and K selection, Carrying capacity, Population regulation-density dependent factors, density independent factors, Gene diversity of population.

Recommended Books

1. Wilkenson DM. Fundamental Processes in Ecology.
2. Odum EP . 2008. Fundamentals of Ecology.
3. Singh JS, Singh SP and Gupta SR. 2014. Ecology, Environmental Science and Conservation. S Chand Publishing , New Delhi .
4. LSE-02 Ecology Blocks (1,2,3,4), IGNOU.
5. Pandey SN, Misra SP. 2011. Environment and Ecology, Ane Books Pvt. Ltd.

BSB- 603
ORGANIC EVOLUTION

Lectures: 60

Unit I

Origin of life, theories of the origin of life, cosmozoic, chemogeny, biogeny, experimental evidences in support of biochemical origin of life. Evidence in favour of evolution, evidence from embryology, paleontology, taxonomy connecting links. Evidence from biology, physiology and genetics.

Unit II

Lamarck and Lamarckism, Darwinism and theory of natural selection, Neo Lamarckism, Neo Darwinism, modern synthetic theory of evolution. Patterns of evolution, polymorphism types of polymorphism, monophyletic, polyphyletic and paraphyletic evolution, divergent evolution, convergent evolution, co-evolution, microevolution, megaevolutions, adaptive radiations.

Unit III

Fossils. Geological distributions of animals, Era, Period Epoch and their features. Origin and evolution of Horse, phylogeny of human.

Unit IV

Biogeography, various theories of zoogeography regions and sub regions in spatial distributions with special reference to the Indian sub regions.

Recommended Books

1. Organic evolution by Veer Bala Rastogi, Kedarnaath Ramnaath Publishers, Meerut
2. Organic Evolution, a text book by Lull, Richard Swann, 1867
3. Strickberger's Evolution by Brian K. Hall and Benedikt Hallgrimsson
4. A text book of Organic Evolution by Mohan P. Arora and Himanshu Arora

BSB- 604
TECHNIQUES IN BIOLOGY (SEC)

Lectures: 60

Unit I

Spectroscopic techniques: Principle and applications of UV-visible, FTIR, Fluorescence and CD spectroscopy. Principle and applications of Colorimeter, Spectrophotometer, Flame photometer. Beer and Lambert's law.

Unit II

Separation techniques: Principle and applications of paper chromatography, thin layer chromatography, ion exchange chromatography, affinity chromatography and HPLC. Electrophoresis – principle and applications of PAGE, agarose gel electrophoresis. Ultra centrifuge and organelle separation.

Unit III

Immunological techniques: Immunodiffusion (Single & Double) - Immuno electrophoresis Techniques immuno detection - Immunocyto / histochemistry - Immunoblotting, immunodetection, immunofluorescence. ELISA, RIA, Hybridoma technology, Histological techniques - Principles of tissue fixation - Microtomy - Staining - Mounting – Histochemistry, Cell culture techniques. Design and functioning of tissue culture laboratory - Culture media, essential components and Preparation - Cell viability testing.

Unit IV

Cytological techniques: Mitotic and meiotic chromosome preparations. Chromosome banding techniques (G.C.Q. R. banding) – Flowcytometry, Molecular cytological techniques - In site hybridization (radio labelled and non-radio labelled methods) - FISH - Restriction banding. Molecular biology techniques - Southern hybridization, Northern hybridization, Polymerase chain reaction (PCR) & its types.

Recommended Books

1. Introduction to instrumental analysis-Robert Braun-McGraw Hill.
2. A biologist Guide to principles and Techniques of Practical Biochemistry- K. Wilson and K.H. Goulding EIBS Edn.
3. Clark & Swizer. Experimental Biochemistry. Freeman, 2000.
4. Locquin and Langeron. Handbook of Microscopy. Butterwaths, 1983
5. Boyer. Modern Experimental Biochemistry. Benjamin, 1993
6. Freifelder. Physical Biochemistry. Freeman, 1982.
7. Wilson and Walker. Practical Biochemistry. Cambridge, 2000.