B.Sc. Biosciences - Four Year Programme
Curriculum and Credit Framework
Department of Biosciences
Faculty of Life Sciences
Jamia Millia Islamia, New Delhi-110025

I YEAR

Semester I					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-101	Plant Diversity-I	Major	4	100
2.	24-BOS-C-102	Animal Diversity-I	Major	4	100
3.	24-BOS-M-103	ChemistryforLife Sciences-I	Minor	4	100
4.	24-BOS-T-104	SWAYAM/ Microbes in Health & Disease	MD	3	75
5.	24-BOS-A-105	General English	AEC	2	50
6.	24-BOS-S-106	Lab Course-I	SEC	3	75
7.	24-BOS-V-107	Environmental Sciences	VAC	2	50
8.	-	General Urdu	Compulsory qualifying	2*	
9.	-	IRC/Islamiat/HRS	Compulsory qualifying	2*	
Total				**22**	**550**

Semester II					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-151	Plant Diversity-II	Major	4	100
2.	24-BOS-C-152	Animal Diversity-II	Major	4	100
3.	24-BOS-M-153	Physics for Life Sciences	Minor	4	100
4.	24-BOS-T-154	Bioethics & Biosafety	MD	3	75
5.	24-BOS-A-155	General English	AEC	2	50
6.	24-BOS-S-156	Lab Course-II	SEC	3	75
7.	24-BOS-V-157	SWAYAM/IKS	VAC	2	50
8.	-	General Urdu	Compulsory qualifying	2*	
9.	-	IRC/Islamiat/HRS	Compulsory qualifying	2*	
Total				**22**	**550**

Students exiting the programme after securing **48 credits** will be awarded **Certificate in Biosciences** provided they secure 4 credits in work based vocational courses during summer term or internship / apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

II YEAR

Semester III					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-201	Plant Physiology	Major	4	100
2.	24-BOS-C-202	Animal Physiology	Major	4	100
3.	24-BOS-M-203	Genetics	Minor	4	100
4.	24-BOS-T-204	Mathematics for Life Sciences	MD	3	75
5.	24-BOS-A-205	Organic Evolution	AEC	2	50
6.	24-BOS-V-206	SWAYAM/Recombinant DNA Technology	VAC	2	50
7.	24-BOS-C-207	Lab Course-III	Major	4	100
Total				**23**	**575**

Semester IV					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-251	Cell Biology	Major	4	100
2.	24-BOS-C-252	Chemistry for Life Sciences-II	Major	4	100
3.	24-BOS-M-253	Enzymology	Minor	4	100
4.	24-BOS-A-254	Ecology	AEC	2	50
5.	24-BOS-V-255	SWAYAM/AI in Health and Disease	VAC	2	50
6.	24-BOS-C-256	Lab Course-IV	Major	4	100
Total				**20**	**500**

Students exiting the programme after securing **91 credits** will be awarded **Diploma in Biosciences** provided they secure 4 credits in skill based vocational courses during first year or second year summer term.

III YEAR

Semester V					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-301	Immunology	Major	4	100
2.	24-BOS-C-302	Microbiology	Major	4	100
3.	24-BOS-C-303	Techniques in Biology	Major	4	100
4.	24-BOS-M-304	Biophysics	Minor	4	100
5.	24-BOS-C-305	SWAYAM/Developmental Biology	Major	4	100
6.	24-BOS-S-306	Lab course-V	SEC	3	75
Total				**23**	**575**

Semester VI					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-351	Biochemistry	Major	4	100
2.	24-BOS-C-352	Molecular Biology	Major	4	100
3.	24-BOS-C-353	Bioinformatics	Major	4	100
4.	24-BOS-M-354	Biomaths& Biostats	Minor	4	100
5.	24-BOS-C-355	Lab Course-VI	Major	4	100
Total				**20**	**500**

Students who want to undertake 3-year UG programme will be awarded **Degree in B. Sc. Biosciences** upon securing **132-134 credits** provided they secure 2-4 credits in skill based vocational courses during third year summer term.

IV YEAR

Semester VII					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-401	Advance Biochemistry	Major	4	100
2.	24-BOS-C-402	Advance Cell Biology	Major	4	100
3.	24-BOS-C-403	Advance Genetics	Major	4	100
4.	24-BOS-M-404	PCMM	Minor	4	100
5.	24-BOS-C-405	SWAYAM/Plant Biochemistry	Major	4	100
6.	24-BOS-C-406	Lab Course-VII	Major	4	100
Total				**24**	**600**

Semester VIII A					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-451	Toxicology	Major	4	100
2.	24-BOS-C-452	SWAYAM/Proteomics	Major	4	100
3.	24-BOS-C-453	Genome Biology	Major	4	100
4.	24-BOS-M-454	Advance Biophysics	Minor	4	100
5.	24-BOS-C-455	Lab Course-VIII	Major	4	100
Total				**20**	**500**

OR

Semester VIIIB					
S.No.	**Paper Code**	**Course**	**Type**	**Credit**	**Maximum Marks**
1.	24-BOS-C-456	Scientific Writing	Major	4	100
2.	24-BOS-M-457	SWAYAM/Proteomics	Minor	4	100
3.	24-BOS-P-458	Research Project	Project	12	300
Total				**20**	**500**

Student will be awarded **Degree in B.Sc. Biosciences (Honours)** if they do not undertake research project and secure an overall **176-178 credits.**
Student will be awarded **Degree in B.Sc. Biosciences (Honours) with research** if they undertake research project of 12 credits and secure an overall **176-178 credits.**

B.Sc. Biosciences - Four Year Programme
Credit Distribution Structure
Department of Biosciences
Faculty of Life Sciences
Jamia Millia Islamia, New Delhi-110025

Semester	Major	Minor	Multidisciplinary	AEC	SEC	VAC	Vocational course/Summer internship	Research Project	Total Credits	Award (Minimum Credits)	Exit	Compulsory qualifying-I	Compulsory qualifying-II
I	8	4	3	2	3	2			22			2*	2*
II	8	4	3	2	3	2			22			2*	2*
Summer Vacation							4**	I Yr Credits	**44**	**UG Certificate (48)**	**Exit-I**		
III	12	4	3	2		2			23			2*	2*
IV	12	4		2		2			20			2*	2*
Summer Vacation							4***	II Yr Credits	**43**	**UG Diploma (91)**	**Exit-II**		
V	16	4			3				23				
VI	16	4					02-04#		22-24				
Summer Vacation								III Yr Credits	**45-47**	**UG Degree (132-134)**	**Exit-III**		
VII	20	4							24				
VIII (A)	16	4							20				
IV Yr. Credits (A) = VII Sem. Credits + VIII (A) Credits									**44**				
Total Credits	**108**	**32**	**9**	**8**	**9**	**8**	**02-04**	**Total Credits**	**176-178**	**UG Degree (Honours) (176-178)**	**Exit-IV (A)**		
OR													
VIII (B)	4	4						12	20				
IV Yr. Credits (B) = VII Sem. Credits + VIII (B) Credits									**44**				
Total Credits	**96**	**32**	**9**	**8**	**9**	**8**	**02-04**	**12**	**176-178**	**UG Degree (Honours with research) (176-178)**	**Exit-IV (B)**		

Notes: Majors and Minors shall be treated as Honors-Subsidiary in the erstwhile system

***Two courses of 2 credits each viz. Compulsory Qualifying - I & II are to be taken during I-IV Semesters. Compulsory Qualifying - I shall be General Urdu and Compulsory Qualifying - II shall be any one of Islamiyat/Hindu Religion Studies/Indian Religions & Culture.**

AEC: In I & II Semester students will study General English; In Semester III & IV students may choose from a pool of AEC courses offered by Faculties of Humanities & Languages/Social Sciences/Sciences/Life Sciences/Management/Fine Arts subject to the prescribed prerequisites and other specific requirements.

VAC: Students will choose from a pool of VAC coursesoffered by Faculties of Humanities & Languages/Social Sciences/Sciences/Life Sciences/Management/Fine Arts subject to the prescribed prerequisites and other specific requirements.

Multidisciplinary (MD): Students of Faculty of Life Sciences will choose Multidisciplinary courses from a pool of Multidisciplinary courses offered by Faculty of Life Sciences. Students of Faculty of Humanities & Languages, Social Sciences, Sciences, Management & Fine Arts may choose Multidisciplinary courses from a pool of such courses offered by these five faculties.

****Compulsory for those who seek exit after 1st Year (Exit-I). ***Compulsory for those who seek exit after 2nd Year (Exit-II). #For those who have not taken exit either in I or II Year.**

If required, a department may add additional courses/credits to the Major or Minor components in consultation with the Dean of Faculty, Timetable In charge & in coordination with COE's office to accommodate requirement of their specific disciplines while not overburdening the students.

B.Sc. Biosciences - Four Year Programme
Syllabus
Department of Biosciences
Faculty of Life Sciences
Jamia Millia Islamia, New Delhi-110025

SEMESTER-I

PLANT DIVERSITY-I (MAJOR)
24-BOS-C-101

Credits:4 **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, Stelar 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. Alexopoulus C.J , Mims C.W. and Blackwel 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.

ANIMAL DIVERSITY-I (MAJOR)
24-BOS-C-102

Credits:4 **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. *Caenorhabditis 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.

CHEMISTRY FOR LIFE SCIENCES-I (MINOR)
24-BOS-M-103

Credits:4 **Lectures: 60**

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, oxymecuration-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, Nuleophilic substitution reactions (Nucleophiles & leaving groups, Thermodynamics & kinetics, SN^1 & SN^2 reactions: mechanism, kinetics, stereochemistry and reactivity, Carbocations: structures, relative stabilities & rearrangement, Factors affecting rates of SN^1 & SN^2 reactions), Elimination reactions of Alkyl halides: Dehydrohalogenation, E^1 & E^2 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.

MICROBES IN HEALTH & DISEASE (MULTIDISCIPLINARY)
24-BOS-T-104

Credits: 3 **Lectures: 45**

Unit I
Introduction to Microbes and Human Health
Overview of microbiology and it's importance in health and disease,
Types of microorganisms: Bacteria, viruses, fungi, protozoa, Brief historical perspective of microbial diseases and microbiological discoveries.

Unit II
Human Microbiota and Microbial Interactions
Composition and roles of normal microbiota at different body sites (skin, gut, respiratory tract, genitourinary tract); Human microbiome in health and disease; concept of dysbiosis; probiotic and prebiotic microbes; host-microbe interactions.

Unit III
Microbial Pathogenesis
Mechanisms of microbial infection and virulence, Bacterial pathogenesis: toxins, adhesins, and invasion strategies, Viral pathogenesis: replication strategies and immune evasion.

Unit IV
Microbes and Human Diseases
Bacterial diseases: tuberculosis and gastrointestinal infections, Viral diseases: influenza, HIV, and COVID-19, Fungal and parasitic diseases: candidiasis, and amoebiasis.

Recommended Books

1. Prescott, Harley & Klein. Microbiology.
2. Jawetz, Melnick & Adelberg's Medical Microbiology.
3. Murray, Rosenthal & Pfaller. Medical Microbiology.
4. Tortora, Funke & Case. Microbiology: An Introduction.
5. Schaechter's Mechanisms of Microbial Disease.

ENVIRONMENTAL SCIENCES (VALUE ADDED COURSE)
24-BOS-V-107

Credits:2 **Lecture: 30**

Unit I

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 II

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.

Recommended Books

1. Groom Martha J, Gary K Meffe and Carl Ronald Carroll. 2006. Principles of Conservationn 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.

SEMESTER-II

PLANT DIVERSITY-II (MAJOR)
24-BOS-C-151

Credits: 4 **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 C*ycas*, *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 Toxonomy, (Hieman Educational BooksLtd., 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.

ANIMAL DIVERSITY-II (MAJOR)
24-BOS-C-152

Credits: 4 **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

PHYSICS FOR LIFE SCIENCES (MINOR)
24-BOS-M-153

Credits: 4 **Lecture: 60**

Unit I

Vector and scalar quantities. Addition, subtraction, multiplication of vector quantities. Partial derivatives and elementary ideas of gradient, divergence and curl. Description of motion in two and three dimensions. Newton's laws of motion. Invariance of Newton's laws in Galilean transformations. Pseudo forces. Limitations of Newtonian mechanics. Need for relativistic and quantum mechanics (only elementary idea). Conservation of momentum. Centre of mass. Finding center of mass for discrete and continuous distributions of mass. Examples in biological systems.

Unit II

Work-Energy theorem. Work done by a variable force. Numerical method. Potential energy. Electrical potential energy in a capacitor and inductor. Conservative forces. Scattering and collisions. Elastic and inelastic collisions. Reactions and decay processes. Rutherford's scattering. Examples in biological systems.

Unit III

Angular momentum. Torque. Moment of inertia. The cases of ring, disc axis and sphere. Parallel and perpendicular theorems. Rotational kinetic energy and conservation of angular momentum. Combination of angular and translational motion. Examples in biological systems.

Unit IV

Simple Harmonic motion. Damped and forced oscillations. Resonance. Waves in an elastic medium. Power and intensity of a wave. Wave particle duality. De Broglie waves. Group and phase velocity. Davisson and Germer experiment. Compton effects. Examples in biological systems.

Suggested Readings

1. An introduction to mechanics: Kleppner & Kolenkow.
2. Feynman Lectures-Volume I,
3. Newtonian Mechanics: A.P.French
4. Mechanics: Berkeley Physics Course.
5. Vibrations and Waves: A. P. French.
6. The Physics of Waves and Oscillations: N.K. Bajaj

BIOETHICS & BIOSAFETY (MULTIDISCIPLINARY)
24-BOS-T-154

Credits: 3 **Lecture: 45**

Unit I:

Bioethics and misconduct in science

Ethics, Definition, moral philosophy, nature of moral judgements and reactions, Ethics and misconduct in science, Ethical issues during and after the study, Ethics in Research, publication ethics, Best practices / standards setting initiatives and guidelines, conflict of interests, Intellectual honesty and research integrity, violation of publication ethics, Scientific misconduct: Falsification, fabrication and Plagiarism.

Unit II:

Biosafety and guidelines

Introduction to biosafety issues, Biological Safety cabinets and their types, Containment for biohazards (Primary and secondar); Biosafety levels of specific microorganisms. Biosafety guidelines and regulations (National and international); International dimensions in bioterrorism and biosafety, convention on biological weapons, social and ethical implications of biological weapons. GMOs- concerns and challenges, Guidelines for research in transgenics, ICMR guidelines for research in human participants. Role of Institutional Biosafety Committees.

Recommended Books

1. Biotechnology and Safety Assessment Thomas J.A., Fuch R.L Academic Press 3rd Edition 2002
2. Bioethics & Biosafety R Rallapalli &Geetha Bali APH Publication 2007

SEMESTER-III

PLANT PHYSIOLOGY (MAJOR)
24-BOS-C-201

Credits: 4 **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, Gibbrelins and abscicis acid. Distribution and mechanism of action of plant growth regulators. Photropism: Phototropic signal perception & Signal transduction. Gravitropism: Graviperception & 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.

ANIMAL PHYSIOLOGY (MAJOR)
24-BOS-C-202

Credits: 4 **Lectures: 60**

Unit I- Endocrinology
Hormones, Mechanism of Action, Types and Classes. Endocrine glands (Hypothalamus, Pitutary, Thyroid, Adernal, 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 nalance. 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.

GENETICS (MINOR)
24-BOS-M-203

Credits: 4 **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, Klinefelter's, 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.

MATHEMATICS FOR LIFE SCIENCES (MULTIDISCIPLINARY)
24-BOS-T-204

Credits: 3 **Lecture: 45**

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.

ORGANIC EVOLUTION (ABILITY ENHANCEMENT COURSE)
24-BOS-A-205

Credits: 2 **Lectures: 30**

Unit I

Theories of origin of life - cosmozoic, chemogeny, biogeny, experimental evidences in support of origin of life. Evidences in favour of evolution - evidence from embryology, paleontology, taxonomy, connecting links, biology, physiology and genetics. Lamarckism, Darwinism and theory of natural selection, Neo Lamarckism, Neo Darwinism, modern synthetic theory. Polymorphism and its types.

Unit II

Patterns of evolution - monophyletic, polyphyletic and paraphyletic evolution, divergent and convergent evolution, co-evolution, microevolution, megaevolutions, adaptive radiations. Fossils. Geological time scale and distribution of organisms. Origin and evolution of horse and phylogeny of human. Biogeography, various theories of zoogeographic regions and in spatial distributions with special reference to the Indian sub regions.

Recommended Books

1. Organic evolution by Veer Bala Rastogi, Medtech Publications, Delhi
2. Evolution by Mark Ridley, Blackwell Publishing
3. Strickberger's Evolution by Brian & Benedikt, Jones and Bartlett Publishers
4. Evolution by Douglas & Mark, Mark Ridley, Sinauer Associates Inc.
5. A text book of Organic Evolution by Mohan & Himanshu, Himalaya Publishing House

RECOMBINANT DNA TECHNOLOGY (VALUE ADDED COURSE)
24-BOS-V-206

Credits: 2 **Lecture: 30**

Unit I

History of recombinant technology, restriction modification system in bacteria, DNA modifying enzymes and their mechanisms of action, PCR Technology and its applications, molecular cloning, purification of DNA from living cells, construction of genomic and cDNA libraries, screening of libraries, substrative hybridization for tissue specific DNA libraries

Unit II

Expression of foreign genes in E. coli, production of recombinant protein by prokaryotic expression vectors, eukaryotic expression vectors, mammalian expression vectors; fusion tags, role in purification of recombinant proteins, detection of expressed proteins. Chemical synthesis of DNA, changing gene: Random and site-directed mutagenesis.

Recommended Books

1. Singh BD (2010) Biotechnology 4 th Edition, Kalyani Publications
2. Nair AJ (2008) Introduction to Genetic Engineering and Biotechnology. Infinity Science Press
3. Brown T (2010) Gene cloning and DNA analysis: an introduction. John Willey & amp; Sons

SEMESTER-IV

CELL BIOLOGY (MAJOR)
24-BOS-C-251

Credits: 4 **Lecture: 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.

CHEMISTRY FOR LIFE SCIENCES-II (MAJOR)
24-BOS-C-252

Credits:4 **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); Roults' law, Roults' law and molecular weight of the solute; elevation of boiling point; depression of freezing point, osmotic pressure; definition, laws of osmotic pressure, vant 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 vant 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 in 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, pKa 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.

ENZYMOLOGY (MINOR)
24-BOS-M-253

Credits: 4 **Lecture: 60**

Unit I: General characteristics of enzymes; nature of enzymes - Ribozymes. apoenzyme, holoenzyme, Cofactor and prosthetic group. Classification and nomenclature of the enzymes. Enzyme activity. Features of enzyme catalysis, Catalytic power, Factors affecting the rate of enzymatic reactions (pH, Temperature), Activation energy and transition state theory. Lock and key hypothesis, Induced fit hypothesis. Vitamins and their significance.

Unit II: Enzyme kinetics and inhibition: Relationship between initial velocity and substrate concentration, equilibrium constant, steady state kinetics. Derivation of Michaelis-Menten equation; other enzyme plots like Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. Determination of Km Vmax and Kcat, specificity constant. Cooperativity, Symmetric and Sequential mode of action. Scatchard plots. Types of bisubstrate reactions (sequential-ordered and random, ping pong reactions), Reversible inhibition (competitive, uncompetitive, non-competitive) and irreversible inhibition**.**

Unit III: Mechanism of action of enzymes and Regulation of enzyme activity: General features - proximity and orientation, acid-base and covalent catalysis (chymotrypsin and Triose phosphate isomerase), Coenzymes (TPP, NAD, pyridoxal phosphate) in enzyme catalyzed reactions. Mechanism of action and regulation of multienzyme system of pyruvate dehydrogenase and fatty acid synthetase. Feedback inhibition, Allosteric modulation (aspartate transcarbamoylase), regulation by covalent modification (glycogen phosphorylase), Zymogen (chymotrypsinogen). Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit IV: Applications of enzymes: Enzymes as reagents (glucose oxidase, cholesterol oxidase); Marker enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases); Enzyme therapy (streptokinase); Immobilized enzymes.

Recommended Books

1. ENZYMES: Biochemistry, Biotechnology, Clinical Chemistry, by Trevor Palmer (Author), Philip Bonner (Author)
2. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of Biochemistry, John Wiley & Sons, 2002.
3. Structure And Mechanism In Protein Science: A Guide To Enzyme Catalysis And Protein Folding (Fersht Alan R)
4. Enzymology and Enzyme Technology by Bhatt S.M. 5. Enzymology, by T. Devasena

ECOLOGY (ABILITY ENHANCEMENT COURSE)
24-BOS-A-254

Credits: 2 **Lecture: 30**

Unit I

Biomes and Ecosystems, (Tundra, Taiga, Grassland, Desert and aquatic) ecological range (Eury, Steno), Ecological factors (abiotic and biotic), Ecological pyramids, Food chains; Food web, Productivity, Biogeochemical cycles. Community ecology: Community gradients and boundaries- Ecotone and species diversity, Edge effect, 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).

Unit III

Community organization: Habitat and Niche, Species interaction-Neutralism, Competition, Predation (herbivory, parasitism), Commensalism, Mutualism, Amensalism, Lotka and Voltera equations, 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.

AI IN HEALTH & DISEASE (VALUE ADDED COURSE)
24-BOS-V-255

Credits: 2 **Lecture: 30**

Unit I

Bioinformatics Resources and databases, To explore NCBI, EMBL and its resources, Global and Local alignment of two sequences to perform pairwise and multiple sequence alignment using CLUSTALW and BLAST, retrieve gene expression data from genomics data repository such as GEO, retrieving structural data of a protein using PDB database.

Unit II

AI and Machine Learning

An introduction to Artificial Intelligence (AI) and Machine Learning (ML), Overview of ML (supervised, unsupervised), AI application in data analysis and healthcare solutions.

Recommended Books

1. Baxevanis, Andreas D., and BF Francis Ouellette. Bioinformatics: a practical guide to the analysis of genes and proteins. Vol. 43. John Wiley & Sons, 2004.
2. J. Dudley and A. Butte, "A Quick Guide for Developing Effective Bioinformatics Programming Skills", PLoS Computational Biology, vol. 5, no. 12, p. e1000589, 2009.
3. http://vlab.amrita.edu/index.php?sub=3&brch=273

SEMESTER-V

IMMUNOLOGY (MAJOR)
24-BOS-C-301

Credits:4 **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

MICROBIOLOGY (MAJOR)
24-BOS-C-302

Credits: 4 **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 by 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

TECHNIQUES IN BIOLOGY (MAJOR)
24-BOS-C-303

Credits: 4 **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) - Immunoelectrophoresis Techniques immunodetection – 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 ElBS 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.

BIOPHYSICS (MINOR)
24-BOS-M-304

Credits: 4 **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, permeabilily 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

DEVELOPMENTAL BIOLOGY (MAJOR)
24-BOS-C-305

Credits: 4 **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.

SEMESTER-VI

BIOCHEMISTRY (MAJOR)
24-BOS-C-351

Credits: 4 **Lectures: 60**

Unit I

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

Unit II

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 III

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).

Unit IV

Nucleic Acid-Structure of purines, pyrimidines, nucleosides and nucleotides, physicochemical properties of nucleic acids - denaturation and renaturation kinetics, hyperchromic effect and Tm. conformation of nucleic acids (A, B, Z), mRNA, tRNA, De novo biosynthesis of purines and pyrimidines, Ribonucleotide reductase and its role in nucleic acid metabolism

Recommended Books

1. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th ed.). WH Freeman.
2. Stryer, L. (1995). Biochemistry. New York: W H Freeman.

MOLECULAR BIOLOGY (MAJOR)
24-BOS-C-352

Credits: 4 **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, microRNA. 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.

BIOINFORMATICS (MAJOR)
24-BOS-C-353

Credits: 4 **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 Neutral Network Technology, Gentic alogorithm, 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.

BIOMATHS & BIOSTATS (MINOR)
24-BOS-M-354

Credits: 4 **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.

SEMESTER-VII

ADVANCE BIOCHEMISTRY (MAJOR)
24-BOS-C-401

Credits: 4 **Lectures: 60**

Unit I
Carbohydrate and Lipid Metabolism Glycolysis, HMP pathway, Glycogenolysis, PDH reaction, Tricarboxylic Acid Cycle: Kreb's discovery, isotopic tests, amphibolic nature, energetics and regulation. Gluconeogenesis, Synthesis of Glycogen and important disaccharides, hormonal regulation of Carbohydrate metabolism. Oxidation of lipids: beta-oxidation, oxidation of unsaturated and odd chain fatty acids, regulation of Fatty acid oxidation, Formation and oxidation of Ketone bodies. Biosynthesis of saturated fatty acids: carbon sources, acetyl CoA carboxylase and reaction of Fatty acid synthase. Synthesis of odd chain and unsaturated fatty acids. Biosynthesis of Triacylglycerol and phosphoglycerides. Biosynthesis of cholesterol and its regulation.

Unit II
Amino Acid Metabolism Amino acid oxidation flow sheet, deamination and transamination reactions, alpha- ketoglutarate, succinate, fumarate and oxaloacetate pathways of amino acid oxidation. Metabolic fates of amino groups, role of glutamate and glutamine. Urea Cycle: reaction and regulation, Biosynthesis of standard essential and non-essential amino acids. Regulation of amino acid biosynthesis. Genetic defects in amino acid metabolism.

Unit III
Nucleotide and Heme Metabolism Degradation of purinc & pyrimidine ribonucleotides and its regulation. Biosynthesis of purine & pyrimidine 4 ribonucleotides: de-novo pathways and salvage. Reactions and regulation of ribonucleotide reductase and thymidylate synthase, purine nucleotide cycle. Genetic defects, in nucleotide metabolism. Enzymes of Nucleotide metabolism as chemotherapeutic targets. Heme biosynthesis and degradation

Unit IV
Enzymology Enzyme catalysis: Acid-Base, metal ion, covalent and electrostatic catalysis, Reaction coordinates. Transition state stabilization and entropy reduction by enzymes. Enzyme kinetics: Substrate velocity curve, Michaelis Menten mechanism for single substrate reactions, Meaning and significance of Km, Ks, Kcat and specificity constant. Lineweaver-Burk and Eadie-Hofstee plots, kinetics of bisubstrate reactions. Enzyme Inhibition: Mechanism and kinetics of competitive, uncompetitive, mixed and noncompetitive inhibitions.

Recommended Books

1. Nelson, David L., Albert L. Lehninger, and Michael M. Cox. Lehninger principles of biochemistry. Macmillan, 2008.
2. Berg, Jeremy M., John L. Tymoczko, and Lubert Stryer. "Biochemistry 5th ed." (2002).
3. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of Biochemistry 2002 Update. John Wiley & Sons, 2002.

ADVANCE CELL BIOLOGY (Major)
24-BOS-C-402

Credits: 4 **Lectures: 60**

Unit I

Cytoskeletal Network Intramembrane System Cytoskeletal network, alpha and beta tubulins, actin-myosin system intermediatary filaments and Dynein activator complex. Structure and Function of Endoplasmic Reticulum, Golgi body and Lysosome.

Unit II

Nucleus, Cell cycle and Molecular Structure of Gene The nuclear envelop and traffic between nucleus and cytoplasm, internal organization of the nucleus, the nucleolus, nucleus during mitosis. The eukaryotic cell cycle, regulation of cell cycle progression. Nuclear compartment chromosomal organization of genes, functional rearrangement in chromosomal DNA, Morphology and functional elements of eukaryotic chromosome, mitochondrial DNA.

Unit III

Cell to Cell Signaling Overview of extracellular signaling, Arachadanic acid Nitriconide based signaling, G-protein coupled receptors and their effectors, Receptor tyrosine kinase and RAS, MAP kinase pathways. Program cell death.

Unit IV

Molecular basis of Cancer Tumor cells and onset of cancer, Protooncogene and tumor suppressor gene, oncogenic mutations affecting cell proliferation, mutation causing loss of cell cycle control, mutation affecting genome stability.

Recommended Books

1. The Cell, A Molecular Approach – 6th Edition – Geoffrey M. Cooper/Robert E. Hausman- Sinauer Associates, Inc.
2. Molecular Biology of the Cell - 5th Edition - Bruce Alberts et al - Garland Science
3. Molecular Cell Biology - 7th Edition - Harvey Lodish, Arnold Berk & Chris A. Kaiser - W.H. Freeman
4. Lewin's Cells – 2nd Edition – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers
5. Cell Biology, A Short Course – 3rd Edition – Stephen R. Bolsover et al – John Wiley& Sons
6. Microbial Physiology: Moat, Foster and Spector
7. Cell and molecular biology: Gerald Karp.
8. Cell and molecular biology: DeRobertis and DeRobertis

ADVANCE GENETICS (MAJOR)
24-BOS-C-403

Credits: 4 **Lectures: 60**

Unit I

Chromatin structure, Nucleosome, Chromosome structure-centromere and telomere. Tandomly repeated non-coding DNA Interspersed repeated non-coding DNA Expression and processing of heterogeneous nuclear RNA, r RNA, t RNA. Alternate transcription and processing on individual genes. Mitochondrial genome and diseases.

Unit II

General homologous recombination. Non-homologous end joining. Site specific recombination, Transposable elements, Mechanism of Transposition. The Lac -operon positive, negative and repression. Arabinose operon. Tryptophan operon. The lambda phase: a complex of operon.

Unit III

Molecular basis of gene mutation. Gain of function mutation. Loss of function mutation and their consequences. Chemical mutagenesis in higher organism. Repair of DNA damage. Photoreactivation. SOS repair mechanism. Base excision repair. Nucleotide excision repair. Stability of the genome.

Unit IV

Population and gene pool. Calculating allele frequencies. The Hardy-Weinberg law. Extension of Hardy -Weinberg law, Natural selection, Mutation, Migration, Genetic drift, Non-random mating. Adaptive radiation and modification, Isolating mechanism, Speciation- Allopatric and Sympatric, Convergent evolution, Sexual selection, Co-evolution.

Recommended Books:

1. Introduction to Genetic Analysis. 9th Edition by Griffiths et al. 2008.
2. Concept of Genetics. 9th Edition, by Klug et al.2009.
3. Principles of Genetics by Snustad et al. 2004.
4. Genes IX Lewin 2008.
5. Molecular Biology of the Gene Watson et al. 6th Edition 2009.
6. Molecular Cell Biology by Lodish et al. 2008
7. Molecular Biology of the Cell Alberts et al. 5th Edition. 2007.

PHYSICAL CHEMISTRY OF MACROMOLECULES (MINOR)
24-BOS-M-404

Credits: 4 **Lectures: 60**

Unit I
Macromolecules Proteins Amino acids their physical & chemical properties, Peptides and polypeptides. Peptide group, charges on peptides (pH dependence), Hendersen-Haselbalch equation, buffers. Primary structure of proteins, separation of amino acids, end group analysis, reduction, modification and location of disulfide bonds, sequencing of polypeptide. Nucleic acids: Primary, secondary and tertiary structures of Nucleic acids, polymorphism of DNA (A, B, Z forms), denaturation and renaturation of DNA, supercoiled DNA, superhelix topology, measurements of supercoiling.

Unit II
Structure and function of Protein Different levels in protein structure, Ramachandran plot, Secondary structure (α-helix, β-strand, β-sheet, turns and loops), Super secondary structures, tertiary structure, quaternary structure, globular and fibrous proteins. Functions of different protein, Hemoglobin function, oxygen binding, hill equation, Bohr effect, binding of BPG.

Unit III
Protein folding Forces stabilizing the native state of proteins (electrostatic, hydrophobic and hydrogen bonding). The denatured state, modes of denaturation. Protein folding. Landmark experiments in protein renaturation, folding pathways, techniques to monitor protein folding, landscape theory of protein folding. Accessory proteins in folding: protein disulfide isomerase, Rotamases and molecular chaperones.

Unit IV
Biophysical Techniques Chromatography Paper, TLC, adsorption, partition, ion exchange, gel filtration, affinity, GLC, HPLC. Electrophoresis: paper electrophoresis, gel electrophoresis SDS-PAGE, isoelectric focussing, gel electrophoresis of nucleic acids. Viscosity and Sedimentation: Viscosity of macromolecules, measurement of viscosity, velocity and equilibrium sedimentation of macromolecules, diffusion of macromolecules, centrifugation techniques and their applications, ultracentrifugation (analytical and preparative), boundary and band sedimentation, estimation of molecular weight.

Recommended Books

1. Principles and Techniques of Biochemistry and Molecular Biology by Wilson and Walker 2005
2. Lehninger principles of biochemistry Nelson, David L., Albert L. Lehninger, and Michael M. Cox.
3. Macmillan, 2008. Berg, Jeremy M., John L. Tymoczko, and Lubert Stryer.
4. Biochemistry 5th ed. (2002). Voet, Donald, Judith G. Voet, and Charlotte W. Pratt.
5. Fundamentals of Biochemistry 2002 Update. John Wiley & Sons, 2002.

PLANT BIOCHEMISTRY (MAJOR)
24-BOS-C-405

Credits: 4 **Lectures: 60**

Unit I

Plant and animal cell, Photosynthesis: Significance of Photosynthesis, Ultrastructure of Chloroplast and photosynthetic pigments, Photosynthesis in C3 and C4 plants, Photosynthetic light and dark reactions, Photophosphorylation and Photorespiration, Plant genome organization, Molecular biology of biotic and abiotic stresses

Unit II

Plant growth and development, Biological nitrogen fixation, Nitrate and sulphate reduction and their incorporation into amino acids, Secondary metabolites, Secondary metabolites II, Plant hormones I: Introduction, biochemistry and mode of action of auxins, Plant hormones II: Gibberellins and Cytokinins, Plant hormones III: Ethylene and Abscisic Acid

Unit III

Embryo culture and plant organ culture, Callus culture and somatic embryogenesis, Single cell and cell suspension culture, Protoplast isolation, purification, culture and fusion, Factors Affecting in vitro Secondary Metabolite Production, Hairy Root Culture, Somaclonal Variation, Synthetic seed technology.

Unit IV

Germplasm Conservation, Direct and indirect methods of gene transfer, Transgenic plants and their applications, Morphological, Biochemical and DNA – based markers, Marker assisted selection (MAS) and crop improvement, Requirements for plant tissue culture laboratory, Micropropagation, To Study about Callus Induction and Plant Regeneration, Spectral analysis of DNA, Cell suspension culture, Determination of molecular size of DNA sample by agarose gel electrophoresis, DNA Profiling of Plants

Recommended Books

1. Taiz, L. and Zeiger, E. (2010) Plant Physiology. 5th Edition, Sinauer Associates, Inc., Sunderland.
2. Razdan, M. K. (2003). Introduction to plant tissue culture (2. ed. ed.). Enfield, NH [u.a.]: oxford Publishers. ISBN 1-57808-237-4.
3. Chawla, H.S. (2002). Introduction to plant biotechnology (2nd ed. ed.). Enfield, N.H.: Science. Publishers. ISBN 1-57808-228-5.
4. Bhojwani, S.S. and Rajdan, Plant Tissue Culture: Theory and Practice, Amsterdam, Elsevier.
5. Roberta Smith, (2012) Plant Tissue Culture: Techniques and Experiments, Academic Press
6. Agriculture: Role of Genetic Engineering. Kluwer Academic Publishers, The Netherlands.
7. Basra, A.S. (1994). Srtess-induced Gene Expression in Plants. Taylor and Francis, London.
8. Basra, A.S. and Basra, R.K. (eds) (1997). Mechanism of Environmental Stress Resistance in Plants. Harwood Academic Publishers. The Netherlands.

SEMSTER VIII A

TOXICOLOGY (MAJOR)
24-BOS-C-451

Credits: 4 **Lectures: 60**

Unit I
History, general principles and scope of toxicology. Dose response relationships. LD50, ED50, LC50, EC50. General mechanisms of toxicity. Disposition of toxicants – adsorption, distribution, and elimination of toxicants. Biotransformation of Xenobiotics – basic properties, categories and distribution of xenobiotic biotransforming enzymes.

Unit II
Toxic agents – Toxic effects of pesticides & metals with special reference to DDT, lindane, cyclodienes, lead, arsenic, mercury, cadmium, aluminum. Health effects of radiation and radioactive materials. Important radiation episodes.

Unit III
Environmental Toxicology – air pollution & health effects, pollutants of the outdoor ambient air with special reference to sulfur dioxide, sulfuric acid, particulate matter, smog, ozone, nitrogen dioxides and carbon monoxides.

Unit IV
Applications of Toxicology: Food Toxicology – Safety standards for foods, food ingredients & contaminants; Forensic Toxicology – analytic role, toxicological investigation of a poison death, criminal poisoning of the living; Clinical Toxicology – strategy for treatment of the poisoned patient; Cosmetic Toxicology, Occupational Toxicology – Occupational diseases, worker health surveillance, exposure monitoring

Recommended Books

1. A Textbook of Modern Toxicology by Ernest Hodgson & Patricia E Levi, III Ed. Appleton & Lange 1997
2. A Textbook of Modern Toxicology IV Edition, edited by Ernest Hodgson Wiley, 2010
3. Principles of Biochemical Toxicology by John Timbrell, IV Edition
4. Principles of Toxicology, III Edition 2015 by Karen E Sine & Thomas M Brown, CRC Press Teller & Francis Group
5. Environmental Toxicology; Current Developments Edition J. Rose 1998, CRC Press Teller & Francis Group

PROTEOMICS (MAJOR)
24-BOS-C-452

Credits: 4 **Lectures: 60**

Unit I

Basics of Proteins and Proteomics, Introduction to amino acids, Introduction to Proteins, Protein folding & misfolding, Introduction to Proteomics, Lab session – Protein-protein interaction using label-free biosensors, Gel-based proteomics, Sample preparation and pre-analytical factors, Protein extraction and quantification, One-dimensional electrophoresis Introduction to 2-DE.

Unit II

2-DE: Second dimension, staining & destaining, 2-DE: Gel analysis, 2-DE Applications, Lab session - Protein/peptide pre-fractionation using OFFGEL FRACTIONATOR & data analysis**,** Difference in gel electrophoresis (DIGE) & Systems Biology, 2D-DIGE: Basics, 2D-DIGE: Data analysis, 2D-DIGE: Applications, Systems biology and proteomics – I, Systems biology and proteomics - II

Unit III

Basics of mass spectrometry, Fundamentals of mass spectrometry, Chromatography technologies, Liquid chromatography, Mass spectrometry: Ionization sources, Mass spectrometry: Mass analyzers**,** Basics of mass spectrometry and sample preparation, MALDI sample preparation and analysis, Hybrid mass spectrometry configurations, Lab session - Demonstration of Q-TOF MS technology, In-gel & in-solution digestion, Lab session - Sample preparation: tissue sample preservation technology

Unit IV

Quantitative proteomics, Introduction to quantitative proteomics, SILAC: In vivo labelling, iTRAQ: In vitro labelling, TMT: In vitro labelling, Quantitative proteomics data analysis, Advancement in Proteomics, Proteomics applications, Challenges in proteomics, OMICS and translational research, Lab session – Targeted proteomics using triple quadrupole mass spectrometry, Lab session – Targeted proteomics: multiple reaction monitoring.

Recommended Books

1. Liebler, D. C. (2002). Introduction to proteomics: tools for the new biology. Humana Press.
2. Twyman, R. (2004). Principles of proteomics. Taylor & Francis.

GENOME BIOLOGY (MAJOR)
24-BOS-C-453

Credits: 4 **Lectures: 60**

Unit I
Genome Organization & Transgenesis Elements of eukaryotic genome organization; Human genome and organization of genes; Epigenome and regulation of genes through epigenetic mechanism, genomic imprinting; Uni Parental Disomy (UPD). Principle, methods and types of gene transfer in animal oocytes and embryonic stem cells. Production of transgenic/gene knock out animal (Mice), applications of transgenic animal; animal cloning and its broad spectrum applications, advantages, disadvantages and ethical concern.

Unit II
Molecular Pathology Understanding chromosomal and molecular basis of genetic diseases in man. Molecular pathology of single gene multifactorial and sex-linked diseases with special reference to Marfan Syndrome, Prader Willi Syndrome, Fragile 'X' Syndrome, sickle cell anemia, and DMD. Cancer and characteristics of cancer cells, involvement of tumor suppressor genes and oncogenes in cancer.

Unit III
Molecular Diagnosis Prenatal diagnosis, Chorionic Villi Sampling Amniocentesis, Cordocentesis. Application of molecular, Cytogenetic and immunohistochemical techniques in diagnosis of various chromosomal and molecular pathogenesis.

Unit IV
Molecular Therapeutics Types and models of gene therapy; gene delivery system, viruses in delivery system. Application of gene therapy in correction of different genetic diseases. Ethics associated with somatic and germ cell gene therapy. Interferon and other cytokines in therapeutics. Therapeutical application and ethical implication of cloned animals.

Recommended Books

1. Human Genetics: Proceedings of the 7th International Congress Berlin 1986Paperback – Import, 17 Nov 2011
2. Vogel and Motulsky's Human Genetics: Problems and Approaches Hardcover – Import, 1 Feb 1982
3. Genetics of Sex Determination (Advances in Genome Biology Book 4) Kindle Edition by R. S. Verma (Editor)
4. Genomes 4 Paperback – 21 Jun 2017 by T. A. Brown (Author)
5. Genome Refactoring (Synthesis Lectures on Synthetic Biology) Paperback – Import, 1 Jun 2009
6. Lewin's GENES XII Hardcover – 1 Feb 2017 by Jocelyn E. Krebs (Author), Elliott S. Goldstein (Author), Stephen T. Kilpatrick (Author)

ADVANCE BIOPHYSICS (MINOR)
24-BOS-M-454

Credits: 4 **Lectures:60**

Unit I
Bioenergetics Free energy changes, Gibbs energy, Flow of energy in the biological system, concepts of chemical energy, Redox Potential, Nernst Equation, Ion electrochemical potential, Proton electrochemical potential, Membrane potential, equilibrium across a semi-permeable membrane, Donnan potential, respiratory chains, mitochondrial respiratory chains, respiratory control and oxidative phosphorylation, photosynthetic generators of proton motive force.

Unit II
Membrane Biophysics Structure and organization of cell membrane, membrane models and drug delivery system. Energy transducing membranes, measurement of driving forces, metabolite and ion transport, active and passive transport, influx and efflux mechanisms, proton circuit and electrochemical gradient, Ionophores, Uniport, antiport and symport mechanisms, Shuttle systems. ATP synthase, Transport ATPases, Na+/K+ATPase and H+/K+ATPase, Molecular mechanisms of calcium transport, use of Na+ as an alternative to H+ in energy transduction.

Unit III
Radiation Biophysics Electromagnetic spectrum, properties of non-ionizing and ionizing radiation, radiation units, principles of detection and measurement, Interaction of radiation with matter, free radicals, ions pair and dosimetry, dose effect graphs and target theory, direct and indirect radiation action, radiation effects on proteins, nucleic acids, carbohydrates, cell and whole organism, genetic effects of radiation, repair of radiation induced damages, radiation in diagnosis and therapeutics.

Unit IV
Biophysical Techniques Spectroscopy: Principle instrumentation and applications of UV-visible Fluorescence, Infra-Red, Raman and CD spectroscopies. Basic concept of NMR and X-ray crystallography. Dynamic Light Scattering, Surface Plasmon Resonance, Differential scanning and Isothermal Calorimetry. Mass Spectrometry; MALDI-TOF, ESI/MS. Microscopy: Optical, Phase Contrast, Fluorescence Microscopy, Scanning Electron, Transmission Electron.

Recommended Books

1. Keith Wilson and John Walker. Practical Biochemistry Principles and Techniques. Cambridge University Press.,1997
2. Creighton TE. Proteins Structures and Molecular Properties. W.H. freeman & Company, New York.,2006
3. David Freifelder. Physical Biochemistry: applications to Biochemistry and Molecular Biology. W.H. freeman and Company.,2006
4. New Era of Bioenergetics, by Yasuo Mukohata, Publisher Academic Press, 2012, ISBN 0323140297, 9780323140294.\
5. Principles of Bioenergetics: Authors, Vladimir P. Skulachev, Alexander V. Bogachev, Felix.
6. Fundamentals of Molecular Spectroscopy, 5th Edn, McGraw Hill, ISBN-10 1259062597, ISBN-13 9781259062599, 2013 May.
7. Chadwick K.H. & Leenbouts H.P. Molecular Theory of Radiation Biology, Springer Verlag.
8. Atlik F.H. Introduction to Radiological Physics and Radiation Dosimetry, John Wiley

SEMESTER VIII B

PROTEOMICS (MINOR)
24-BOS-M-457

Credits: 4 **Course: 60**

Unit I
Basics of Proteins and Proteomics, Introduction to amino acids, Introduction to Proteins, Protein folding & misfolding, Introduction to Proteomics, Lab session – Protein-protein interaction using label-free biosensors, Gel-based proteomics, Sample preparation and pre-analytical factors, Protein extraction and quantification, One-dimensional electrophoresis Introduction to 2-DE.

Unit II
2-DE: Second dimension, staining & destaining, 2-DE: Gel analysis, 2-DE Applications, Lab session - Protein/peptide pre-fractionation using OFFGEL FRACTIONATOR & data analysis**,** Difference in gel electrophoresis (DIGE) & Systems Biology, 2D-DIGE: Basics, 2D-DIGE: Data analysis, 2D-DIGE: Applications, Systems biology and proteomics – I, Systems biology and proteomics - II

Unit III
Basics of mass spectrometry, Fundamentals of mass spectrometry, Chromatography technologies, Liquid chromatography, Mass spectrometry: Ionization sources, Mass spectrometry: Mass analyzers**,** Basics of mass spectrometry and sample preparation, MALDI sample preparation and analysis, Hybrid mass spectrometry configurations, Lab session - Demonstration of Q-TOF MS technology, In-gel & in-solution digestion, Lab session - Sample preparation: tissue sample preservation technology

Unit IV
Quantitative proteomics, Introduction to quantitative proteomics, SILAC: In vivo labelling, iTRAQ: In vitro labelling, TMT: In vitro labelling, Quantitative proteomics data analysis, Advancement in Proteomics, Proteomics applications, Challenges in proteomics, OMICS and translational research, Lab session – Targeted proteomics using triple quadrupole mass spectrometry, Lab session – Targeted proteomics: multiple reaction monitoring.

Recommended Books

1. Liebler, D. C. (2002). Introduction to proteomics: tools for the new biology. Humana Press.
2. Twyman, R. (2004). Principles of proteomics. Taylor & Francis.