Department of Biotechnology

Jamia Millia Islamia

New Delhi-25

B.Sc./B.Sc. Hons. (Biotechnology)

Syllabus

(NEP Compliance-CBCS Pattern)

Academic Year 2024-2025

Department of Biotechnology
Jamia Millia Islamia, New Delhi-110025

B.Sc. Biotechnology Course Structure and Credit Distribution as per NEP Guidelines

1ST YEAR

SEMESTER-I				
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Biochemistry &Metabolism (Major)	BBT-101(T)	4	100
2	Cell Biology (Major)	BBT-102(T)	4	100
3	Plant Diversity-I (Minor)	BBT-103(T)	4	100
4	Essential Mathematics (MLD)	BBT-104(T)	3	75
5	Biotechnology and Human Welfare (SEC)	BBT-105(T)	3	75
6	Introduction to Biodiversity (VAC)	BBT-106(V)	2	50
7	General English (AEC-1)	BBT-107(T)	2	50
8	Lab Course-I (AEC-2)	BBT-108(L)	2	50
	Total		**24**	**600**

SEMESTER-II				
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Mammalian Physiology (Major)	BBT-201(T)	4	100
2	Plant Anatomy& Physiology (Major)	BBT-202(T)	4	100
3	Animal Diversity-I (Minor)	BBT-203(T)	4	100
4	Chemistry-I (MLD)	BBT-204(T)	3	75
5	Bioinformatics and Biostatistics, (SEC)	BBT-205(T)	3	75
6	Entrepreneurship Development (VAC)	BBT-206(V)	2	50
7	General English (AEC-1)	BBT-207(T)	2	50
8	Lab Course-II (AEC-2)	BBT-208(L)	2	50
	Total		**24**	**600**

Students choosing to conclude their studies after the first year will receive a **Certificate in Biotechnology,** after achieving a **minimum of 52 credits.** Additionally, they must fulfill a work-based vocational course or internship, earning 4 credits, during the summer break of the first year as mentioned in the attached credit distribution table.

2ND YEAR

SEMESTER-III				
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Genetics (Major)	BBT-301(T)	4	100
2	General Microbiology (Major)	BBT-302(T)	4	100
3	Animal Biotechnology (Minor)	BBT-303(T)	4	100
4	Chemistry-II (MLD))	BBT-304(T)	3	75
5	Medical Biotechnology (VAC)	BBT-305(V)	2	50
6	Lab Course-III (AEC-1)	BBT-306(L)	2	50
7	Lab Course-IV (AEC-2)	BBT-307(L)	2	50
	Total		**21**	**525**

	SEMESTER-IV			
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Molecular Biology (Major)	BBT-401(T)	4	100
2	Immunology (Major)	BBT-402(T)	4	100
3	Enzymology (Major)	BBT-403(T)	4	100
3	Plant Diversity-II (Minor)	BBT-404(T)	4	100
4	Developmental Biology (VAC)	BBT-405(V)	2	50
5	Lab Course-V (AEC-1)*	BBT-406 (L)	2	50
6	Lab Course-VI (AEC-2)*	BBT-407(L)	2	50
	Total		**22**	**550**

AEC subjects could be changed according to the availability and requirement based on NEP guidelines

Students choosing to conclude their studies after second year will receive a **Diploma in Biotechnology,** after achieving a minimum of **93-95 credits.** Additionally, they must undertake a work-based vocational course or internship, earning 4 credits, during the summer break of the second year as mentioned in the attached credit distribution table.

3RD YEAR

SEMESTER-V				
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Bioprocess Technology (Major)	BBT-501(T)	4	100
2	Plant Biotechnology (Major)	BBT-502(T)	4	100
3	Recombinant DNA Technology (Major)	BBT-503(T)	4	100
4	Lab Course- VII (Minor)	BBT-504 (L)	4	100
5	Ecology and Environment Management (SEC)	BBT-505(T)	3	75
	Total		**19**	**475**

SEMESTER-VI				
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Bio Analytical Tools (Major)	BBT-601(T)	4	100
2	Environmental Biotechnology (Major)	BBT-602(T)	4	100
3	Lab Course- VIII (Major)	BBT-603 (L)	4	100
4	Animal Diversity-II (Minor)	BBT-604(T)	4	100
5	Vocational course/ Summer Internship	BBT-605(SI)	4	100
	Total		**20**	**500**

Students who choose to withdraw after completion of three years will receive a **Bachelor of Science (B.Sc.) degree in Biotechnology,** provided they have accumulated a minimum of **126-130** credits.

4TH YEAR

SEMESTER-VII				
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Research Ethics (Human Animal & Environment) (Major)	BBT-701(T)	4	100
2	Biosafety & Radiation Safety (Major)	BBT-702(T)	4	100
3	Genomics and Proteomics (Major)	BBT-703(T)	4	100
4	Scientific writing (Minor)	BBT-704(T)	4	100
5	Seminar (Minor)_	BBT-705(S)	4	100
	Total		**20**	**500**

SEMESTER-VIII				
S.No.	**Papers**	**Code**	**Credit**	**MM**
1	Research Project	BBT-801(R)	16	400
2	SWAYAM	BBT-802(O)	4	100
	Total		**20**	**500**

After completion of Four years students will receive a degree in **Bachelor of Science (B.Sc.), Hons. with Research in Biotechnology,** provided they have accumulated a minimum of **166-170** credits.

MLD- Multi-disciplinary; VAC-Value Added Course; AEC-Ability Enhancement Course SEC-Skill Enhancement Course.

Lab Course includes Biotechnological laboratory Techniques/Practical related to the subjects

Credit Distribution Table

Semester	Major	Minor	Multi-disciplinary	AEC-1	AEC-II	SEC	VAC	Vocational course/Summer Internship	Research Project	Total Credits	Award (Minimum Credits)
I	8	4	3	2	2	3	2			24	
II	8	4	3	2	2	3	2			24	
Summer vacation								4**	I Year Credits	48	**UG Certificate (52)**
III	8	4	3	2	2		2			21	
IV	12	4		2*	2*		2			20-22	
Summer vacation								4***	II Year Credits	41-43	**UG Diploma (93-95)**
V	12	4				3				19	
VI	12	4						02-04#		18-20	
Summer vacation									III Year Credits	37-39	**UG-Degree (126-130)**
VII	16	4								20	
VII (Hons)	16	4								20	**4 -Year UG Degree (Hons) (166-170)**
or											
VII (Hons.) with Research	4	4				m			12	20	**4 -Year UG Degree (Hons) with Research (166-170)**
Total Credits	92	32	9	06-08	06-08	9	8	0	IV Year Credits	166-168	

*In IV Semester, a candidate may choose wither either one or both of AEC-1 and AEC2 Courses
**Compulsory for those who seek exit after First Year
*** Compulsory for those who seek exit after Second Year
# Only to be earned by those students who have not taken exit either in I or II year

Note: For more details regarding the course structure kindly see Ordinance 15-B (XV-B) (Academic) from JMI website.

Semester I
Biochemistry & Metabolism (Code: BBT-101(T))
Major

Credits: 4 MM:100

UNIT- I: Introduction to Biochemistry (10 Periods)

A historical prospective: Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different levelsof structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.
Carbohydrates: Structure, Function, and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT- II (15 Periods)

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.
Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT- III (15 Periods)

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid,Biotin vitamin B12, Tetrahydrofolate and metallic ions.

UNIT IV (8 Periods)

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

Practicals

1. To study activity of any enzyme under optimum conditions.
2. To study the effect of pH, temperature on the activity of salivary amylase enzyme.
3. Determination of - pH optima, temperature optima, Km value, Vmax value, Effect of inhibitor (Inorganic phosphate) on the enzyme activity.

4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry**: (i)** Verification of Beer's law, estimation of protein. (**ii)** To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins

Suggested Readings

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freemanand Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WHFreeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley andSons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd

Cell Biology (Code: BBT-102(T))
Major

Credits: 4 MM: 100

UNIT- I (10 Periods)

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, and cell fractionation.
Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition, and membrane transport.

UNIT- II (15 Periods)

Membrane Vacuolar system, cytoskeleton, and cell motility: Structure and function of microtubules, Microfilaments, and Intermediate filaments.
Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis, and functions including role in protein secretion.

UNIT- III (15 Periods)

Lysosomes: Vacuoles and microbodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis.
Chloroplasts: Structure and function, genomes, biogenesis
Nucleus: Structure and function, chromosomes and their structure.

UNIT- IV (8 Periods)

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.
Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Practicals

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. JohnWiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8thedition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition.ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7thedition. Pearson Benjamin Cummings Publishing, San Francisco.

Plant Diversity-I (Code: BBT-103 (T))
Minor

Credits: 4 MM: 100

UNIT- I Algae: (12 Periods)

General character, classification and economic importance. Life histories of algae belonging to various classes: Chlorophyceae – *Volvox, Oedogonium* Xantho phyceae –*Vaucheria*Phaeophyceae – *Ectocarpus*Rhodophyceae-*Polysiphonia*

UNIT- II Fungi: (10 Periods)

General characters, classification & economic importance. Life histories of Fungi: Mastigomycontina-*Phytophthora* Zygomycotina-*Mucor* Ascomycotina- *Saccharomyces* Basidomycotina-*Agaricus* Deutromycotina-*Colletotrichum*

UNIT- III Lichens and Plant Diseases: (10 Periods)

Classification, general structure, reproduction and economic importance. Plant diseases: Casual organism, symptoms and control of following plant diseases. Rust & Smut of Wheat.White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

UNIT- IV Bryophytes: (08 Periods)

General characters, classification & economic importance.
Life histories of the following: *Marchantia, Funaria.*

Practicals

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia andFunaria
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

Suggested Readings

1. Agrios, G.N. 1997 Plant Pathology, 4thedition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4 th edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2ndEd.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.
10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3 rd edition, Cambridge University Press, Cambridge.
11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

Essential Mathematics (Code: BBT-104(T))
MLD

Credits: 3 MM: 75

Unit-I (10 Periods)

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. 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 (10 Periods)

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 (10 Periods)

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 (10 Periods)

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: $dy/dx+P(x).y=Q(x)$.

Tutorials: To be designed and taught by the teacher

Suggested Readings:

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 and Co. Ltd.
4. Frank Ayres, J.R.,1992, Theory and Problems of Differential Equations, (Schaum's OutlineSeries) McGraw Hill Inc.
5. Pishkunov, N.,1981, Differential and Integral Calculus, CBS Publishers and distributors.
6. Shanti Narayan, 1999, Differential and Integral Calculus, S. Chand and Co. Ltd.
7. Frank Ayres, J.R..,1992, Theory and Problems of Differential Equations, (Schaum's OutlineSeries) McGraw Hill Inc.
8. Pishkunov, N.,1981, Differential and Integral Calculus, CBS Publishers and distributors.
9. Khalil Ahmad, 2013, Text Book of Differential Equations, Real World Education Publishers,New Delhi. 10. Khalil Ahmad, 2013, Text Book of Calculus, Real World Education Publishers,New Delhi.

Biotechnology and Human Welfare (Code: BBT-105(T))

SEC

Credits: 3 MM: 75

UNIT- I (8 Periods)

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT- II (8 Periods)

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT- III (8 Periods)

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB..

UNIT- IV (8 Periods)

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT- V (8 Periods)

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E. coli*, human genome project.

Practicals

(Wherever wet lab experiments are not possible the principles and concepts can be demonstratedthrough any other material or medium including videos/virtual labs etc.)

1. Perform of ethanolic fermentation using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples

4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)

Suggested Readings

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.

Introduction to Biodiversity (Code:BBT-106 (V))

VAC

Credit: 2; MM:50

UNIT-I (7 Periods)
Introdution

Definition of biodiversity, comprehensive understanding: (taxonomic, spatial levels, endemism), levels of biodiversity (microbial, genetic, species, ecosystem, landscape), drivers of biodiversity

UNIT-II (8 Periods)

Distribution of biodiversity

Evolution of biodiversity, overview of ecological communities, number of species worldwide, Global distribution and change in biodiversity over time in different regions of the world, concept of diversity hot-spots; Biodiversity in India (past and present); methodology of analysis of different species groups.

UNIT-II (15 Periods)

Biodiversity loss, Consequences and Restoration

Monitoring of different species groups; analysis of causes and extinction/changes in biodiversity in India and worldwide , (causes: vulnerability to extinction; changing of the environment; (Habitat fragmentation and destruction) climate change; overexploitation; Consequences: loss of gene pool, loss of ecosystem services, livelihood)
Biodiversity restoration strategies: Principles, definitions, degradation, tools and methods, restoration and ecosystem functioning, case studies

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

Semester II

Mammalian Physiology (Code: BBT-201 (T))
Major

Credits: 4 MM:100

UNIT- I: Digestion and Respiration (15 Periods)

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice
Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

UNIT- II: Circulation (15 Periods)

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism ofcoagulation of blood.
Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.

UNIT- III: Muscle physiology and osmoregulation (8 Periods)

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.
Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT- IV: Nervous and endocrine coordination (10 Periods)

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters
Mechanism of action of hormones (insulin and steroids)
Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

Practicals

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

Suggested Readings

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt AsiaPTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI

Plant Anatomy & Physiology (Code: BBT-202 (T))
Major

Credits: 4 MM:100

UNIT- I: Anatomy (8 Periods)

The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventraland isobilateral leaf)

UNIT- II: Plant water relations and micro & macro nutrients (15 Periods)

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.
Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport

UNIT- III: Carbon and nitrogen metabolism (15 Periods)

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point
Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT- IV: Growth and development (10 Periods)

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)
Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization

Practicals

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by *Tradescantia* leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

Suggested Readings

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Esau, K. 1977 Anatomy of Seed Plants. Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. J. Wiley & Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4thedition, W.H.Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th ed. Sinauer Associates Inc .MA, USA

Animal Diversity-I (Code: BBT-203 (T))
Minor

Credits: 4; MM: 100

UNIT- I (15 Periods)

Outline of classification of non-chordates up to subclasses, coelomate, Acoelomata, symmetries, Duetrostomes, Protostomes
Protozoa: locomotion, reproduction, evolution of sex, general features of *Paramoecium* and *Plasmodium*, pathogenic protozoans
Porifera: General characters, outline of classification, skeleton, canal system

UNIT- II (15 periods)

Coelenterata: General Characters, Outline of classifications, Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.
Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.
Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT- III (10 Periods)

Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting.
Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT- IV (8 Periods)

Mollusca: general features, Outline of classification, Shell Diversity; Torsion in gastropoda,
Echinodermata: General features, Outline of Classification Larval forms
Hemichordata: Phylogeny: Affinities of *Balanoglossus*

Practicals

1. Identification and Classification of Any these of the following –
Porifera*:* *Scypha, , Leucosolenia, Euspongia, Hylonema, Euplectella Cnidaria: Medrepora, Millepora, Physalia, Porpita, Valella, Aurelia, Metridium* **Platyhelminthes**:*Taenia, Fasciola,* Aschelminthes*: Ascaris, Ancylostoma, Enterobius* **Annelida:** *Pheretima, Hirudinaria, Chaetopterus, Nereis, Aphrodite* **Arthropoda:** *Julus, Scolopendra, Peripatus, Carcinus, Limulus, Lepisma, Dragonfly, Musca, Acheta* **Mollusca:** *Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen*
Echinodermata: *Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton*
Hemichordata: *Balanoglossus*
2. Identification of slides with two points of identification.
Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules ofsponges, L.S. *Hydra, Obelia, Bougainvillia,* Larvae of *Fasciola,* Seta of Earthworm, Radula
3. Ecological Note – On any of the specimens in Exercise No 1
Models of dissection of Earthworm, Cockroach

Earthworm: Digestive, Nervous System,
Cockroach: Digestive Reproductive, Nervous System

Suggested Readings

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. andNelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. TheMcGraw-HillCompanies.

Chemistry-I (Code: BBT-204 (T))
(MLD)

Credits: 3 MM: 75

UNIT- I: Alcohols

Classification and nomenclature

Dihydric alcohols- Nomenclature, methods of preparation, chemical reactions of vicinal glycols, eg: Oxidative cleavage using (Pb(OAc)4) & HIO4 and pinacol-pinacolone rearrangement.
Trihydric alcohols- Nomenclature and methods of preparation, chemical reactions of glycol

UNIT -II: Phenols

Nomenclature, structure and bonding of phenols, Physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenol. Electrophilic aromatic substitution, acylation and carboxylation, mechanism of Fries rearrangement, claisen rearrangement, Reimer Tiemann reaction.

UNIT- III: Ethers and Epoxides

Nomenclature of ethers and methods of their preparation, Physical properties.Chemical reactions-Cleavage and autoxidation, Ziesel's method.

Synthesis of epoxides, Acid and base catalysed ring opening, reaction of Grignards and organolithium reagents with epoxides.

UNIT-IV: Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes from acid chlorides, synthesis of ketones from nitriles and from carboxylic acids. Physical properties, Mechanism of nucleophilic addition to Carbonyl compounds. Condensation with ammonia and its derivatives. Witting reaction, Mannich reaction.

Practicals

1. Determination of melting point (M.P) of unknown organic compounds.
2. Synthesis of Aspirin (Acetyl salicylic acid) by conventional method.
3. Determination of boiling point (B.P) of organic liquids.
4. Flame test of organic compounds

Suggested Readings

1. Organic Chemistry by P.Y. Bruice
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi

Bioinformatics and Biostatistics (Code: BBT 205 (T))

SEC

Credits: 3 MM: 75

UNIT -I (10 Periods)

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. **Searching Databases:** SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

UNIT- II (10 Periods)

Protein Information Sources: PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Microarrays, Mass Spectrometry. Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

Biostatistics

UNIT- III (10 Periods)

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT- IV (10 Periods)

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square testfor goodness of fit and analysis of variance (ANOVA).

Correlation and Regression. Emphasis on examples from Biological Sciences

Bioinformatics Practicals

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Suggested Readings

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.

Biostatistics Practicals

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

Suggested Readings

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley andSons Inc.

Enterpreneurship Development (Code:BBT-206 (V))

VAC

Credits: 2; MM:50

UNIT-I (10 Periods)

Introdution and Establishing an Enterprise

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship. Forms of Business Organization, Project Identification, Selection of the product, Project

formulation, Assessment of project feasibility.

UNIT-II (10 Periods)

Financing the Enterprise and Marketing Management

Importance of finance / loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans,Inventory direct and indirect raw materials and its management.
Meaning and Importance, Marketing-mix, product management – Product line, Product mix,stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT-III (10 Periods)

Enterpreneurship and International Business (10 Periods)

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports.
Project Report on a selected product should be prepared and submitted.

Suggested Readings

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.

Semester – III

Genetics (Code: BBT-301(T))

Major

Credits: 4 MM: 100

UNIT- I (12 Periods)

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms.

Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, **Law of segregation & Principle of independent assortment**. Verification of segregates bytest and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele,essential and lethal genes, penetrance and expressivity.

UNIT- II (12 Periods)

Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition–unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINEs & LINEs, middle repetitive multiple copy genes, noncoding DNA.

Genetic organization of prokaryotic and viral genome.

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT -III (12 Periods)

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors andsex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT- IV (12 Periods)

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping.

Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting.

Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems

of mating, evolutionary genetics, natural selection.

Practicals

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of - Barr Body -*Rhoeo* translocation.
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition JohnWiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and SonsInc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition.Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction toGenetic Analysis, W. H. Freeman & Co.

General Microbiology (Code: BBT-302 (T))

Major

Credits: 4 MM:100

UNIT- I (12 Periods)

Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.
Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT- II (12 Periods)

Cultivation and Maintenance of microorganisms: Nutritional categories of micro- organisms, methods of isolation, Purification and preservation.

UNIT- III (12 Periods)

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.
Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways
Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores

andsporulation in bacteria.

UNIT- IV (12 Periods)

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

Practicals

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hangingdrop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from differentsources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

Suggested Readings

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition.John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBSPublishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12thedition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill BookCompany.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5thedition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition.Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Animal Biotechnology (Code: BBT-303 (T))
Minor

Credits: 4 MM:100

Unit I (10 periods)

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer

UNIT II (14 Periods)

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III (14 Periods)

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV (10 Periods)

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Practicals

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

Suggested Readings

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientificpublishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- genesand genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

Chemistry-II (Code: BBT-304 (T))

MLD

Credits: 3 MM: 75

Unit –I: Arenes and Aromaticity (10 Periods)

Structure of benzene-molecular formula and Kekule structure, Stability and carbon-carbon bond lengths in benzene, Aromaticity-the Huckel rule, Aromatic electrophilc substitution –general pattern of the mechanism, effect of substituent groups. Mechanism of nitration, halogenation, sulphonation, Friedal-Crafts alkylation, Friedal-Crafts acylation.

Unit -II: Haloalkanes and Haloarenes (10 Periods)

Nomenclature and classes of alkyl halides, methods of preparation, Nucleophilic substitution in haloalkanes. Mechanisms of nucleophilic Substitution (SN2 and SN1) reactions, □- Elimination, mechanisms of □-elimination.

Methods of formation of Haloarenes, Nucleophilic aromatic substitution Through addition elimination and the elimination addition mechanisms (Benzyne mechanisms)

Unit- III: Amines (10 Periods)

Structure and nomenclature of amines, the stereochemistry of amines, separation of a mixture of primary, Secondary, and tertiary amines structural features affecting basicity of amines preparation of alkyl and arylamines by reduction of nitro compounds and nitriles, reductive amination of aldehydes and ketones compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction.

Reaction of amines, electrophilic aromatic substitution in aryl amines. Reactions of amines with nitrous acid, synthetic transformations of aryl diazonium salts, azo coupling.

Unit- IV: Heterocyclic Compounds (10 Periods)

General introduction to heterocyclic systems, Five-membered rings-Structure of pyrrole, furan and thiophene, electrophilic substitution in pyrrole, furan and thiophene, Six-membered rings-Structure of pyridine, basicity of pyridine, electrophilic and nucleophilic substitution in pyridine.

Practicals

1. Detection of extra element from a given organic compound, Sulphur (S).
2. Detection of extra element from a given organic compound, Nitrogen (N).
3. Test for detection of halogens in a given organic compound
4. Recrystallization of benzoic acid.

Suggested Readings

1. Organic Chemistry by P.Y. Bruice
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi .
3. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.

Medical Biotechnology (BBT-305 (V))
VAC

Credits: 2 MM: 50

UNIT- I (10 Periods)

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.
Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: (*S.aureus, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. Leprae*) and gram negative bacteria: (*E.coli, N. gonorrhoea, P. aeruginosa, S. typhi, Y. pestis, V. cholerae, T. Pallidum, Rickettsiaceae, Chlamydiae*) Resistance to antimicrobials: Biochemical mechanisms of resistance, Genetics of resistance; Laboratory safety regulations.

UNIT- II (05 Periods)

Viral disease and diagnosis- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses. Antiretrovirals.

UNIT- III (10 Periods)

Enzyme Immunoassays:
Enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Immuno florescence.

UNIT- IV (05 periods)

Molecular Diagnostics:
Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphismand plasmid finger printing of bacterial pathogens. flowcytometry and cell sorting.

Practicals (Any 3)

1. Identification of pathogenic bacteria (any two) based on cultural, morphological andbiochemical characteristics.
2. Staining methods: Gram's staining permanent slides showing Acid fast staining,

Capsulestaining and spore staining.
3. Perform/demonstrate RFLP and its analysis
4.Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
5. A kit-basd detection of a microbial infection (Widal test)
6. Perform one immuno diagnostic test

Suggested Readings

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg'sMedical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
4. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
5. Bioinstrumentation, Webster
6. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
7. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited byPaniker CKJ). University Press Publication.

SEMESTER – IV

Molecular Biology (Code: BBT-401 (T))
Major

Credits: 4 MM: 100

UNIT- I: DNA structure and replication (12 Periods)

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT- II: DNA damage, repair and homologous recombination (12 Periods)

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT- III: Transcription and RNA processing (12 Periods)

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing ofpre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT- IV: Regulation of gene expression and translation (12 Periods)

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Post-translational modifications of proteins.

Practicals

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

Suggested Readings

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. JohnWiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIIIEdition. Lippincott Williams and Wilkins, Philadelphia.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell.VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) MolecularBiology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub

Immunology (Code: BBT-402 (T))
Major

Credits: 4 MM: 100

UNIT- I (12 Periods)

Immune Response - An overview, components of the mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T- cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT- II (12 Periods)

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germline & somatic mutation), antibody diversity.

UNIT- III (12 Periods)

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT- IV (12 Periods)

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

Practicals

1. Differential leucocyte count
2. Total leucocyte count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibodies and antigens.
8. ELISA.

Suggested Readings

2. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th editionSaunders Publication, Philadelphia.
3. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11theditionWiley-Blackwell Scientific Publication, Oxford.
4. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freemanand Company, New York.
5. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition GarlandScience Publishers, New York.
6. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
7. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Enzymology (Code: BBT-403 (T))
Major

Credits: 4 MM: 100

UNIT - I (15 Periods)

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.
Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).
Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.

UNIT – II (15 Periods)

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor.
Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-:chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase.
Enzyme regulation: Product inhibition, feedback control, covalent modification.

UNIT – III (08 Periods)

Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative co- operativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg, Fatty Acid synthase.

UNIT – IV (10 Periods)

Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes, Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *invitro* & i*nvivo.*

Practicals

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

Suggested Readings

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M.Botham,Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons,1995.
4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
5. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press1999
6. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004
7. Practical Enzymology Hans Bisswanger Wiley–VCH 2004
8. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press2002

Plant Diversity-I (Code: BBT-404 (T))

Minor

Credits: 4 MM: 100

UNIT- I Algae: (14 Periods)

General character, classification and economic importance. Life histories of algae belonging to various classes: Chlorophyceae – *Volvox, Oedogonium* Xantho phyceae –*Vaucheria*Phaeophyceae – *Ectocarpus*Rhodophyceae-*Polysiphonia*

UNIT- II Fungi: (14 Periods)

General characters, classification & economic importance. Life histories of Fungi: Mastigomycontina-*Phytophthora* Zygomycotina-*Mucor* Ascomycotina- *Saccharomyces* Basidomycotina-*Agaricus* Deutromycotina-*Colletotrichum*

UNIT- III Lichens and Plant Diseases: (12 Periods)

Classification, general structure, reproduction and economic importance. Plant diseases: Casual organism, symptoms and control of following plant diseases. Rust & Smut of Wheat.White rust of Crucifers. Late blight of Potato. Red rot of Sugarcane. Citrus Canker.

UNIT- IV Bryophytes: (10 Periods)

General characters, classification & economic importance.
Life histories of the following: *Marchantia, Funaria.*

Practicals

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.

Suggested Readings

1. Agrios, G.N. 1997 Plant Pathology, 4thedition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4 th edition,John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1996 (2ndEd.) Introduction to Algae.
4. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology.Cambridge Univ. Press.
9. Vander-Poorteri 2009 Introduction to Bryophytes. COP.
10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3 rd edition, Cambridge UniversityPress, Cambridge.
11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands

Developmental Biology (Code: BBT-405 (V))
VAC

Credit: 2 MM: 50

UNIT- I: Gametogenesis and Fertilization (05 Periods)

Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk**.**

UNIT- II: Early embryonic development (10 Periods)

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence,de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT- III: Embryonic Differentiation (10 Periods)

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translationlevel Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT- IV: Organogenesis (05 Periods)

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

Practicals (Any 3)

1. Identification of developmental stages of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of developmental stages of *Anopheles*.
4. Study of the developmental stages of *Drosophila* from stock culture/ photographs..
5. Study of different types of placenta.

Suggested Readings

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 ComputerPress.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

Semester-V

Bioprocess technology (Code: BBT-501 (T))

Major

Credits: 4 MM: 100

UNIT-I (10 Periods)

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT- II (15 Periods)

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT- III (13 Periods)

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT- IV (10 Periods)

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

Practicals

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

Suggested Readings

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2ndedition, Elsevier Science Ltd.

Plant Biotechnology (Code: BBT-502 (T))
Major

Credits: 4 MM: 100

UNIT I (12 Periods)

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II (13 Periods)

In vitro haploid production Androgenic methods: Anther culture, Microspore culture andogenesis Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT – III (13 Periods)

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

UNIT – IV (10 Periods)

Plant Growth Promoting bacteria, Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

Practicals

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

Suggested Readings

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue

andOrgan Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

Recombinant DNA Technology (Code: BBT-503 (T))
Major

Credits: 4 MM: 100

UNIT- I (12 Periods)

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors(Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT-(Reverse transcription) PCR

UNIT- II (12 Periods)

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT -III (12 Periods)

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT -IV (12 Periods)

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Practicals

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells

7. Transformation of competent cells.
8. Demonstration of PCR

Suggested Readings

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing,Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution.Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7thedition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

Ecology and Environment Management (Code:BBT-505 (T))
(SEC)

Credits: 3; MM:75

UNIT-I (10 Periods)

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT- II (12 Periods)

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production &decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

UNIT-III (10 Periods)

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations ,Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup : Case studies

UNIT-IV (8 Periods)

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

Practicals

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or

terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

Suggested Readings

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House

4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmenta lpollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforsement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication.
11. Gupta Meetu (2018)

Semester – VI

Bio-Analytical Tools (Code: BBT-601(T))

Major

Credits: 4 MM: 100

UNIT- I (10 Periods)

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT- II (15 Periods)

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT- III (15 Periods)

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT -IV (08 Periods)

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS- PAGE), agarose-gelelectrophoresis, pulse field gel electrophoresis, immuno- electrophoresis,isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and theirapplications**.**

Practicals

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. JohnWiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7thedition. Pearson Benjamin Cummings Publishing, San Francisco.

Environmental Biotechnology (Code: BBT-602 (T))
Major

Credits: 4 MM: 100

UNIT -I (12 Periods)

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

UNIT- II (12 Periods)

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT- III (12 Periods)

Treatment of municipal waste and Industrial effluents. Bio-fertilizers.

Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT- IV (12 Periods)

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Practicals

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method.

Suggested Readings

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening andJesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T.Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

Animal Diversity- II (Code: BBT-604 (T))
Minor

Credits: 4 MM: 100

UNIT- I: Proto-chordates, Pisces and Ambhibia (12 Periods)

Proto-chordates: Outline of classification, General features and important characters of *Herdmania, Branchiostoma*
Origin of Chordates
Pisces: Migration in Pisces, Outline of classification Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT- II: Reptilia, Aves and Mammalia (12 Periods)

Reptelia: Classification, Origin
Aves: Classification, Origin, flight- adaptations, migration
Mammalia: Classification, Origin, dentition

UNIT- III: Comparative anatomy of vertebrates I (10 Periods)

Comparative anatomy of various systems of vertebrates: Integumentary, digestive respiratorysystems.

UNIT- IV: Comparative anatomy of vertebrates II (14 Periods)

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system,Brain, Eye, Ear.
Autonomic Nervous system in Mammals

Practicals

1. Identification & Classification upto order of the following: Proto-chordata: *Salpa, Doliolum, Herdmania, Branchiostoma*
2. Cyclostomata*: Myxine, Petromyzon*
3. Chondrichthyes: *Scoliodon, Zygnea, Pristis, Trygon, Raja, Chimaera*
4. Ostiechthyes: *Labeo, Mystus, Catla, Hippocampus, Anabas, Echeneis, Lophius, Polypeterus*Amphibia: *Rana, Hyla, Amblystoma, Necturus, Proteus.*
5. Reptiles: *Hemidactylus, Calotes, Draco, Phrynosoma, Naja Vipera, Bungarus*Aves*: Columba,Alcedo, Passer*
6. Mammalia: *Ornithorhynchus, Macropus, Didelphes, Dasypus*
7. An Ecological Note on any one of the specimens in Experiment 1
8. Identification of the following slides
9. Mammalian Histology: Liver, Lung, Intestine, Kidney, Ovary, Testes Slides of *Salpa, Doliolum,* Spicules of *Herdmania,* Tadpole of Frog
10. Preparation of a permanent mount of *Salpa,* Placoid scales, spicules of*Herdmania,* Pharynax of *Amphioxus,* Tadpole Larva of frog
11. Identification of endoskeletons of frog and rabbit.

Suggested Readings

1. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett

Publishers Inc.
2. Kardong, K.V. (2005) Vertebrates Comparative Anatomy, Function and evolution. IV Edition.McGraw-Hill Higher Education.
3. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition.TheMcGraw-HillCompanies.
4. Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
5. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press

Semester – VII
Research Ethics (Code: BBT-701 (T))
Major

Credits: 4 MM: 100

UNIT- I (12 Lectures)

Ethical Guidelines for Biomedical Research on Human Participants: The Nuremberg Code of 1947, Declaration of Helsinki, basic and general ethical principles, Benefit-risk assessment, Informed consent process, waiver of consent, Distributive justice, Compensation for research-related harm, Post research access and benefit sharing,

UNIT- II (14 Lectures)

Value of research and its impact; Planning, managing and conducting research; role and responsibility of institutional ethics committee (IEC), composition of ethical committee; Conflict of interest and authorship responsibility, plagiarism; Research misconduct and policies for handling misconduct; Collaborative research- national and international; Clinical trials- vaccine/drug/ development/stem cells, phase 0, I, II, III and IV; Bioavailability/bioequivalence study.

UNIT- III (14 Lectures)

CPCSEA guidelines for laboratory animal facility: animal care and role of veterinarian, animal procurement, quarantine, stabilization and separation, surveillance, diagnosis, treatment and control of disease; personal hygiene, animal experimentation involving hazardous agents, role of Institutional Animal Ethics Committee (IAEC); Physical facility (building) and upkeep of animals, caging, food, water, sanitation and cleanliness.

UNIT- IV (8 Lectures)

Waste disposal, pest control, record keeping, SOPs; Personnel training, anaesthesia and euthanasia, transport of laboratory animals, Laboratory animal ethics, Transgenic animals, Transgenic plants, maintenance and breeding, animal cross-breeding, justification for use, species and numbers, management of pain and distress.

Suggested Readings

1. The Ethics of Medical Research on Humans - by Claire Foster.Publisher: Cambridge University Press (13 September 2001).
2. The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust: 74 (International Library of Ethics, Law, and the New Medicine) - by David B. Resnik. Publisher: Springer International Publishing AG; 1st ed. 2018 edition (23 January 2018).
3. Research and publication ethics paperback –by Noushad Husain. Publisher : Shipra publications (1 January 2023).
4. National Ethical Guidelines for Biomedical and Health. National Ethical Guidelines for Biomedical and Health. ICMR - Bioethics Unit (https://ethics.ncdirindia.org).
5. Compendium of CPCSEA: (https://ccsea.gov.in).

Biosafety & Radiation Safety (Code: BBT-702 (T))
Major

Credits: 4 MM: 100

Unit 1 (10 Lectures)

Biosafety: Introduction to biosafety and health hazards concerning biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms.

UNIT II (10 Lectures)

Biosafety Guidelines: Biosafety guidelines and regulations (National and International); The concept of containment level, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP), Role of Institutional Biosafety Committees (IBSC).

Unit-III (14 Lectures)

Structure of matter, nuclear stability, interaction of radiation with matter; Routes of entry into the body, Surface and air contamination, General control of the radiation risk; Electromagnetic spectrum, properties of non-ionizing and ionizing radiation, electron and ions, radiation units; Choice and use of monitoring instruments, Personal monitoring, Monitoring the internal risk, Regulation principles of detection and measurement, , methods of measuring radioactivity, different methods of counting and counters.

Unit-IV (14 Lectures)

Biological effects of ionizing radiation, cell survival assay, modification of cell survival,
chromosome aberration and gene mutation, radiation damage and repair, somatic and genetic effects of radiation, hazards of non-ionizing radiation and their control, properties and biological effects of UV radiation, UV in treatment of skin disorders, properties and biological effects of LASER, properties, biological effects and application of microwave radiation and ultrasonic waves.

Suggested Readings

1. Roy R.R. & Nigam B.P Nuclear Physics, Theory and Experiment, Wiley.
2. Halliday D, Introductory Nuclear Physics, 2nd Edition, John Wiley.
3. Knoll G.F. Radiation detection and measurements, John Wiley.
4. Altman K.I. Gobes G.B. & Okada S. Radiation Biochemistry, Vol. I & II AP
5. Alper T. Cellular Radiology, Cambridge University Press.
6. Coggle J.E. Biological Effects of Radiation. 2nd edition, Taylor & Francis.
7. Chadwick K.H. &Leenbouts H.P. Molecular Theory of Radiation Biology, Springer Verlag.
8. McAingh T.F. (eds) Physics in Medicine and biology, encyclopedia, Pergamon Press.
9. Atlik F.H. Introduction to Radiological Physics and Radiation Dosimetry, John Wile
10. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
11. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Genomics and Proteomics (BBT-703 (T))
Major

Credit: 4 MM: 100

UNIT-I (12 Periods)

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT- II (12 Periods)

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT- III (12 Periods)

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

Unit -IV (12 Periods)

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution.
Reproducibility of 2D-PAGE. Mass spectrometry-based methods for protein identification. De novo sequencing using mass spectrometric data

Practicals

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

Suggested Readings

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
5. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III,1989.
6. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
7. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and SonsInc.
8. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition.Benjamin Cummings.
9. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
10. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
11. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.