

NORTH-EASTERN HILL UNIVERSITY
B.Sc. Undergraduate Syllabus (For Semester)
Bio-Technology (Hons)

Paper No.	Details of the Paper	Marks	Credits
I T	Cell Biology and Genetics	75	3
I P	Laboratory	25	1
		100	
II T	Biological Chemistry	75	3
II P	Laboratory	25	1
		100	
III T	Biostatistics & Biological Techniques	75	3
III P	Laboratory	25	1
		100	
IV T	Molecular Biology & Immunology	75	3
IV P	Laboratory	25	1
		100	
V T	Recombinant DNA technology	75	3
V P	Laboratory	25	1
VI T	Microbiology & Environmental Biotechnology	75	3
VI P	Laboratory	25	1
		200	
VII T	Animal & Plant Biotechnology	75	3
VII P	Laboratory	25	1
VIII T	Genomics, Proteomics & Computer application	75	3
VIII P	Laboratory	25	1
		200	
	GRAND TOTAL	800	32

Unit 1

Cell As A Basic Unit of Living System and Cell Theory, Origin and Evolution of Cell, Structure, composition and general functions of plasma membrane, cytoskeleton, mitochondria, endoplasmic reticulum, Golgi complex, ribosomes, centrioles and lysosomes.

Unit 2

Nucleus-Nuclear envelope, nuclear matrix, nucleolus. Chromosome types and structure; Special types of chromosomes (polytene, lampbrush, supernumerary-B Chromosome); Eu- and heterochromatin, Sex chromosomes and sex determination, genic-balance theory of sex determination, Dosage compensation, Cell cycle and checkpoints, Mitosis and meiosis.

Unit 3

Mendel's experiments and principle of inheritance, test-cross; Co-dominance and incomplete dominance, multiple alleles (ABO blood groups in man), multifactorial inheritance (skin colour in man), gene interactions (complementary, supplementary, inhibitory and pleiotropic genes). Introduction to Linkage, crossing over and recombination of genes.; Basic concept of cytoplasmic inheritance (with examples of Kappa particles in *Paramecium* and maternal effects on shell coiling in *Lymnaea*).

Unit 4

Mutation- types and rates; Mutagenic agents, Structural and numerical alterations of chromosomes and their significance. Bacterial Genetics-isolation of bacterial mutants (auxotrophic, conditional, lethal and resistant); Detection of mutation in autosomes and X-chromosome in *Drosophila*. Human Genetics- background and history, Human pedigrees, genetic disorders in human and their pattern of inheritance.

Suggested readings

1. Molecular Biology of Cell, Alberts B et al. Garland Publishers, (2010)
2. Molecular Cell Biology, Lodish et al. Scientific American Books (2000)
3. Cell and Molecular Biology, Karp G, John Wiley and Sons. (2009).
4. Cell and Molecular Biology, De Robertis EDP and De Robertis EMF, Lea & Febiger Int. Edition (2006).
5. Principles of Genetics, Gardner EJ and Sunstad DP, John Wiley and Sons, (2008).
6. Genetics, Strickburger MW, Macmillan Pub. Co., (2008).
7. Genetics: Analysis of genes and genomes, Hartl DA and Jones EW, Jones and Bartlett Publication, (2002).

1. Preparation and study of mitotic stages from onion root tip cells.
2. Preparation and study of different stages of meiosis in male grasshopper.
3. Preparation of polytene chromosomes in Dipteran larvae.
4. Extraction of mitochondria and chloroplast.
5. Human karyotype.

Suggested readings

1. Principles of Genetics, Gardner EJ and Snustad DP, John Wiley and Sons, (2008).
2. Principles and Techniques of Practical Biochemistry, Wilson K and Walker J, Cambridge Univ Press, (2006).

Unit 1

Chemical basis of life- composition of living matter, ionization of water, pH, pK, buffer system and their applications; Henderson-Hasselbach equation.

Bio-energetic, concept of entropy, free energy, electrical properties of biological compartments, electro-chemical gradients, membrane potential, chemiosmotic hypothesis.

Unit 2

Classification and structure of carbohydrates, amino acids, proteins and fats. Oxidative phosphorylation, mechanism of ATP synthesis, electron transport chain in bacteria, plants and animals.

Unit 3

Metabolism- basic concepts, glycolysis, citric acid cycle, pentose phosphate pathway and gluconeogenesis, glycogen metabolism, β -Oxidation of fatty acids, fermentation, CO_2 -fixation, C-reduction cycle (C_3 , C_4 CAM). Photorespiration.

Unit 4

Enzymes, protein and non-protein enzymes-classification and nomenclature of enzymes, regulation of enzyme activity (allosteric regulation and Zymogenicity) coenzymes-structure and function; Kinetics of enzyme catalysed reactions, isolation and purification of enzymes.

Suggested readings

1. Biochemistry, D Voet and JG Voet, J Willey and Sons (2001).
2. Biochemistry, G Zubay, Wm.C.Brown Publishers. (2000).
3. Lehninger's Principle of Biochemistry, Nelson DL and Cox MM, Worth Publishers, (2008).
4. Harper's Biochemistry, Murray RK et al., Prentice Hall International (2006).
5. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons, (2005).

Paper II P

Laboratory

75

1. Preparations of buffers.
2. Estimation of proteins (Lowry's Method).
3. Estimation of carbohydrates.
4. Estimation of lipids.
5. Paper chromatography of amino acids.
6. Determination of K_m and V_{max}

Suggested readings

1. An introduction to Practical Biochemistry, Plummer DT, Tata McGraw Hill, (1987).
2. Practicals in Biochemistry, Jayaraman J (1981) Wiley Eastern Publishing Co. Ltd.
3. Principles and Techniques of Practical Biochemistry, Wilson K and Walker J, Cambridge Univ Press, (1994).

Unit 1

Scope of Biostatistics, Samples and population concept, Collection of data sampling techniques, Processing of data presentation of data, Measures of Central tendency- Arithmetic, Harmonic and Geometric Mean, Mode and Median and their applications, merits and demerits; Measures of dispersion- Range, Variance, Standard Deviation Coefficient of variance, their applications, merits and demerits.

Unit 2

Probability and Conditional probability, Correlation and Regression analysis: Linear, bivariate regression analysis, Theoretical distributions- Binomial and Poisson Distribution and their Properties; Normal distribution and its properties, Skewness and kurtosis, Significance tests: The meaning of significance, hypothesis testing, Student's T-test.

Unit 3

Principle and biological applications of biological techniques- Microscopy (optical, TEM and SEM), Colorimetry, Spectrophotometry, Fluorimetry, Chromatography (Gel filtration and ion exchange), Electrophoresis, Electrofocussing, Centrifugation.

Unit 4

Nucleic acid hybridization and FISH, Polymerase chain reaction, Southern Blot, Northern Blot, Western Blot and ELISA.

Suggested readings

1. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (2003).
2. Statistical Methods, Medhi J, Willey Eastern Limited, (1998)
3. Harper's Biochemistry, Murray RK et al., Prentice Hall International (2006).
4. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons, (2005).

Unit 1

Scope of Biostatistics, Samples and population concept, Collection of data sampling techniques, Processing of data presentation of data, Measures of Central tendency- Arithmetic, Harmonic and Geometric Mean, Mode and Median and their applications, merits and demerits; Measures of dispersion- Range, Variance, Standard Deviation Coefficient of variance, their applications, merits and demerits.

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Probability and Conditional probability, Correlation and Regression analysis: Linear, bivariate regression analysis, Theoretical distributions- Binomial and Poisson Distribution and their Properties; Normal distribution and its properties, Skewness and kurtosis, Significance tests: The meaning of significance, hypothesis testing, Student's T-test.

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2. Statistical Methods, Medhi J, Willey Eastern Limited, (1998)
3. Harper's Biochemistry, Murray RK et al., Prentice Hall International (2006).
4. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons, (2005).

Paper III P Biostatistics & Biological Techniques 25

1. Verification of Beer-Lambert's law
2. Simple, compound, phase-contrast and fluorescence microscope
3. Paper chromatography of sugar.
4. Colorimetric estimation of ascorbic acid.
5. Spectrophotometric quantification of DNA
6. Calculation of Mean, Standard Deviation, Frequency distribution graphs and curves
7. Significance test: Chi-square test, Student's t-test for paired data.

Suggested readings

1. Harper's Biochemistry, Murray RK et al., Prentice Hall International (2006).
2. Physical Chemistry of Macromolecules, Tanford C., John Wiley and Sons, (2005).
3. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (2003).
4. Statistical Methods, Medhi J, Willey Eastern Limited, (1998)
5. Advanced Biology Statistics, Oxford University Press; Edmondson A and Druce D (1996).

Unit 1

Nucleic acids as genetic information carriers- experimental evidence; Salient features of viral, prokaryotic and eukaryotic genomes. Basic concepts about the secondary structure of nucleic acids, base pairing and base stacking in DNA molecule. T_m and buoyant density and their relationship with G-C content in DNA. Structure and properties of RNA.

Unit 2

DNA replication in prokaryotes, semiconservative replication; DNA polymerases and other enzymes and protein factors involved in replication; Mechanism of replication in prokaryotes and its differences with eukaryotes. RNA polymerases, promoter, initiation, elongation and termination of RNA synthesis in prokaryotes and its differences with eukaryotes.

Unit 3

Reverse transcriptase; Eukaryotic post-transcriptional processing of RNA; Genetic code- triplet nature, degeneracy and universality. Translation- mechanism in prokaryotes. Regulation of gene expression in Prokaryotes- enzyme induction and repression, Operon concept (Lac operon and Trp operon).

Unit 4

Concept of immunity, innate and adaptive immunity. Lymphoid organs and cells of immune system. Antigen processing and presentation. Immunoglobulins- structure and functions; Antigens-Nature of antigens; Immunogens, Haptens. Forces involved antigen-antibody binding. Antibody- classes and mechanism of production. Differentiation of lymphocytes; clonal selection theory; Genetic basis of antibody diversity. Antigen-antibody reactions; Complement- system and its activation; Monoclonal antibody and its application.

Suggested readings

1. Molecular Biology of the Cell, Alberts B., Bray D, Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc. (2001).
2. Immunology-Understanding the Immune System, Elgert KD, Wiley Liss, (2004).
3. Roitt's essential Immunology, Roitt IM and Delves PJ, Blackwell Science Ltd., (2006).
4. Molecular Biology of the Gene, Watson JD., Hopkins NH., Roberts JW., Steitz JA and Weiner AM (The Benjamin/Cummings Publ.Co.), (2008).
5. Molecular Cell Biology, Darnell J, Lodish H and Baltimore D, Scientific American Books, USA, (2010)

1. Isolation of nuclear DNA and quantitation.
2. Agarose Gel electrophoresis of nuclear DNA.
3. Determination of T_m .
4. Blood smears identification of leucocytes.
5. Determination of antigen-antibody specificity by immunodiffusion.
6. Blood grouping (ABO).

Suggested readings

1. Molecular Cloning: a laboratory manual, Sambrook J., Fritsch EF. and Maniatis T, Cold Spring harbor Laboratory Press, (2000).
2. Introduction to Practical Molecular Biology, DEabre P, John Wiley & Sons Ltd, (1998).
3. Basic and Clinical Immunology. Peakman M, and Vergani D. 2nd edition Churchill Livingstone Publishers, Edinberg. (2009).

Unit 1

Safety measures in recombinant DNA technology, milestone in genetic engineering, introduction to host, *E. coli* strains, yeast (*Saccharomyces cerevisiae*), Fungi (*Aspergillus*), mammalian cell lines (names & genotype). Restriction enzymes: Type I, II, III & IV, mode of action, nomenclature, DNA modifying enzymes and their applications.

Unit 2

Vectors –Plasmid, bacteriophage, cosmids, expression vectors- retroviral promoter based vectors, Artificial chromosomes. Production of defined DNA fragments.

Unit 3

Cloning strategies-Insertion of DNA molecule into a vector; Detection of recombinant molecules, cloning and expression of genes in prokaryotic and eukaryotic systems.

Unit 4

Methods of gene delivery in plants and animals – microinjection, biolistic method, liposome mediated, transformation and electroporation. Transgenic organisms. Gene therapy.

Suggested readings

1. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, D M Glover and B D Hames, IRL Press, Oxford (2002).
3. Gene Cloning and DNA Analysis. 5th ed. Brown TA. Blackwell Publishing, Oxford, U.K. (2006)..
4. Biotechnology-Applying the Genetic Revolution. Clark DP and Pazdernik NJ. Elsevier Academic Press, USA. (2009).

Paper V P

Laboratory

25

1. Isolation and quantification of Plasmid DNA from bacterial cells.
2. Electrophoresis of plasmid DNA.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
4. Demonstration of PCR.

Suggested readings

1. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, D M Glover and B D Hames, IRL Press, Oxford (2002).

Unit 1

History and development of microbiology, germ theory of disease, concept and methods of sterilization, microbial growth curve and factors affecting microbial growth, various forms of microorganisms (bacteria, fungi, viruses, protozoa, PPLOs), gram-positive and gram-negative bacteria, nutritional classification of microorganisms, isolation and pure culture techniques.

Unit 2

Spontaneous and induced variation in microbial populations; genetic recombination in microbes (conjugation, transduction, transformation); strain improvement by selection. Microbes in extreme environments, pathogenic microorganisms. Symbiosis and antibiosis among microbes, N-fixing microbes in agriculture, biofertilizers; Industrial microbes and their uses in production of food (Dairy and SCP) and drugs (penicillin and streptomycin).

Unit 3

Modern fuels and their environmental impacts (methanogenic bacteria and biogas), microbial hydrogen production, conversion of sugars to ethanol. Treatment of municipal wastes and industrial effluents, degradation of pesticides and other toxic chemicals by microorganisms.

Unit 4

Limiting factors of environment, energy transfer and biogeochemical cycling in ecological systems; Environmental problems- ozone depletion, green house effect, water, air and soil pollution; GEMs in environment; Biopesticides, Bio-assessment of environmental quality; Role of environmental biotechnology in management of environmental problems.

Suggested readings

1. General Microbiology, Stainer, RY, Ingraham, JL, Wheelis, ML., and Painter, PR. The Macmillan Press Ltd., (2000).
2. Principles of Microbiology, Atlas RM, Mosby, (1995).
3. Environmental Biotechnology, Concepts and Applications. Hans-Joachim Jordening and Josef Winter. Winter-VCH. 2005
4. Biology of wastewater Treatment. N F Gray. Mc Graw Hill . 2004.
5. Fundamentals of ecology (5th Edition) by EP Odum and GW Barrett, Thomson Books/Cole, 2005.
6. An Introduction to Environmental Biotechnology by Milton Wain Wright. Kluwar Acad Publ. Group, Springer, 1999.

1. Aseptic techniques: preparation of media, cotton plugging and sterilization.
2. Isolation of microorganism from water and soil samples.
3. Isolation of pure cultures by colony streaking and pour plate technique.
4. Antibiotic sensitivity test.
5. Identification of microorganism: Gram and capsule staining.
6. Testing water quality – BOD and COD.

Suggested readings

1. General Microbiology, Stainer, RY, Ingraham, JL, Wheelis, ML., and Painter, PR. The Macmillan Press Ltd., (2000).
2. Environmental Biotechnology, Concepts and Applications. Hans-Joachim Jordening and Josef Winter. Winter-VCH. 2005
3. Fundamentals of ecology (5th Edition) by EP Odum and GW Barrett, Thomson Books/Cole, 2005.

Unit 1

Types and functions of animal tissues, Basic concepts of animal cell culture- primary cell culture and established cell lines; Embryonic Stem cell and Tissue stem cell concepts and its application. Tissue engineering. *In vitro* fertilization, growth factors promoting proliferation of animal cells

Unit 2

Transgenic animal and its application (concept of Dolly), problems and ethics in genetic engineering, Gene Therapy.

Unit 3

Scope and history of Plant Biotechnology; Plant Tissue Culture-tools and techniques, culture media, surface sterilization, callus and suspension cultures; Process of embryogenesis and organogenesis, different modes of plant regeneration; Anther and ovary culture for production of haploid plants, Micropropagation of elite species (axillary bud, shoot tip and meri-stem cultures).

Unit 4

Protoplast isolation, regeneration and fusion for development of Cybrids, Genetic fidelity of tissue culture raised plants. Use of molecular markers in selection of stable genotypes; Production of transgenic plants- direct and vector mediated gene transfer methods, Genetically modified organisms- success stories –Bt Cotton; Intellectual property rights (IPR) and related issues.

Suggested readings

1. Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): R Ian Freshney. Wiley-Liss, (2005).
2. Animal Cell Culture – Practical Approach, Ed . John R W Masters. Oxford Univ Press. (2004).
3. Cell Growth and Division: A Practical Approach, Ed. R Baserga. Oxford Univ Press . 1989
4. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
5. DNA Cloning: a Practical Approach, D M Glover and B D Hames, IRL Press, Oxford 1995.
6. Plant Biotechnology: J. Hammond, P. McGarvey and V Yusibov (Eds)., Springer Verlag, 2000
7. Plant Cell and Tissue Culture for the Production of Food Ingredients: T-J, Fu, G. Singh, and W R Curtis (Eds.);, Kluwer Academic/Plenum Press. 1999.

Paper VII P

Laboratory

25

1. Exposure to animal cell culture and its maintenance.
2. Preparation of culture media, initiation and maintenance of callus.
3. Micro propagation of ornamental plants by auxiliary buds proliferation.

Suggested readings

1. Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): R Ian Freshney. Wiley-Liss, 2005
2. Animal Cell Culture – Practical Approach, Ed . John R W Masters. Oxford Univ Press. 2000.
3. Plant Cell and Tissue Culture for the Production of Food Ingredients: TJ Fu, G. Singh and W R Curtis (Eds.), Kluwer Academic/Plenum Press. 1999.

Paper VIII T Genomics, proteomics and computer application

75

Unit 1

Objectives and function of genome projects- Human and *Arabidopsis*. Concept of structural, physical and functional human genomics. Definition and role of STS in human genomics.

Unit 2

Introduction to proteomics – structural organization of the protein (primary, secondary, tertiary and quaternary). Protein structure function relationship.

Unit 3

Computers- Introduction to Operating systems (Windows, LINUX, Mac). Introduction of programming language (C, C++), algorithm and flow-chart. Data processing- Batch on-line, real-time (applications in industries and bioreactors); Internet applications, Concept of data mining and biological databases.

Unit 4

Classification of biological databases, Biological data formation. Applications of bioinformatics in various fields, application of bioinformatics at various cellular levels (genomics, transcriptomics and proteomics).

Suggested readings

1. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
2. Textbook of Biotechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
3. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).

1. Introduction to NCBI websites.
2. Introduction to biological Databases.
3. Visit to educational institutions/ biotech firms and submit the report.

Suggested readings

1. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
2. Textbook of Biotechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
3. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).

NORTHEASTERN HILTI UNIVERSITY
DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS
SHILONG - 72

B.Sc. BIOTECHNOLOGY SYLLABUS

1st Year

<i>Paper</i>	<i>Course Title</i>	<i>Marks</i>
I	Biological Chemistry and Techniques	80
II	Cell Biology and Genetics	80
III	Laboratory - I	80

2nd Year

IV	Animal Diversity, Physiology and Developmental Biology	80
V	Molecular Biology and Immunology	80
VI	Laboratory - II	80

3rd Year

VII	Microbiology and Environmental Biotechnology	80
VIII	Animal and Plant Biotechnology	80
IX	Biostatistics and Computer Application	50
X	Laboratory - III	80
XI	Project work	30

Unit 1

SL [Chemical basis of life- composition of living matter, ionization of water, pH, pK, buffer system and their applications; Henderson-Hasselbach equation. Bio-energetic, concept of entropy, free energy.] [Electrical properties of biological compartments, electro-chemical gradients, membrane potential, chemiosmotic hypothesis.] MAL

Unit 2

TC [Classification and structure of carbohydrates, amino acids, proteins] and [fats.] HGL
[Oxidative phosphorylation, mechanism of ATP synthesis, electron transport chain in bacteria, plants and animals.] MAL

Unit 3

SL [Metabolism- basic concepts, glycolysis, citric acid cycle, pentose phosphate pathway and gluconeogenesis, glycogen metabolism, β -Oxidation of fatty acids, fermentation.] SC
IB [CO₂-fixation, C-reduction cycle (C₃, C₄ CAM). Photorespiration.] J-B

Unit 4

[Enzymes, protein and non-protein enzymes-classification and nomenclature of enzymes, regulation of enzyme activity (allosteric regulation and Zymogenicity)] HGL
PW [coenzymes-structure and function.] [Kinetics of enzyme catalysed reactions, isolation and purification of enzymes.] HGL

Unit 5

IB [Principle and biological applications of biological techniques- Microscopy (optical, TEM and SEM), Colorimetry, Spectrophotometry, Fluorimetry, Chromatography (Gel filtration and ion exchange), Electrophoresis, Electrofocussing, Centrifugation.] TC

Suggested readings

1. Biochemistry, D Voet and JG Voet, J Willey and Sons (2001).
2. Biochemistry, G Zubay, Wm.C.Brown Publishers. (2000).
3. Lehninger's Principle of Biochemistry, Nelson DL and Cox MM, Worth Publishers, (2008).
4. Harper's Biochemistry, Murray RK et al., Prentice Hall International (2006).
5. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons, (2005).

Unit 1

CS [Structure, composition and general functions of plasma membrane, cytoskeleton, mitochondria, endoplasmic reticulum, Golgi complex, ribosomes, centrioles and lysosomes.] CS

Unit 2

ST [Nucleus-Nuclear envelope, nuclear matrix, nucleolus. Chromosome types and structure; Special types of chromosomes (polytene, lampbrush, supernumerary-B Chromosome); Eu- and heterochromatin, Dosage compensation] Cell cycle and checkpoints, Mitosis and meiosis.] SN

Unit 3

SN [Mendelian inheritance-Mendel's experiments and principle of inheritance, test-cross; Co-dominance and incomplete dominance] multiple alleles (ABO blood groups in man), multifactorial inheritance (skin colour in man), gene interactions (complementary, supplementary, inhibitory and pleiotropic genes). Introduction to Human Genetics- background and history, Human pedigrees, genetic disorders in human and their pattern of inheritance.] LIS

Unit 4

SN [Linkage (linkage maps and sex-linkage), crossing over and recombination of genes] ST
 ST [Sex chromosomes and sex determination, genic-balance theory of sex determination;]
 [Basic concept of cytoplasmic inheritance (with examples of Kappa particles in *Paramecium* and maternal effects on shell coiling in *Lymnaea*).] MAL

Unit 5

MAS [Mutation- types and rates; Mutagenic agents, Structural and numerical alterations of chromosomes and their significance] Bacterial Genetics-isolation of bacterial mutants (auxotrophic, conditional, lethal and resistant)] Detection of mutation in autosomes and X-chromosome in *Drosophila*.] CS

Suggested readings

1. Molecular Biology of Cell, Alberts B et al. Garland Publishers, (2008)
2. Molecular Cell Biology, Lodish et al. Scientific American Books (2000)
3. Cell and Molecular Biology, Karp G, John Wiley and Sons. (1999).
4. Cell and Molecular Biology, De Robertis EDP and De Robertis EMF, Lea & Febiger Int. Edition (2000).
5. Principles of Genetics, Gardner EJ and Sunstad DP, John Wiley and Sons, (2004)
6. Genetics. Strickburger MW. Macmillan Pub. Co., (2005).
7. Genetics: Analysis of genes and genomes, Hartl DA and Jones EW, Jones and Bartlett Publication, (2002).

- ST/Ans/SL
1. Preparations of buffers.
 2. Estimation of proteins (Lowry's Method).
 3. Estimation of carbohydrates.
 4. Estimation of lipids.
 5. Paper chromatography of sugars.
 6. Paper chromatography of amino acids.
 7. Assay of enzyme activity- amylase.
 8. Preparation and study of mitotic stages from onion root tip cells.
 9. Preparation and study of different stages of meiosis in male grasshopper.
 10. Preparation of polytene chromosomes in Dipteran larvae.
 11. Extraction of mitochondria from liver.
 12. Blood grouping (ABO and Rh).
- ST
Pw

Suggested readings

1. Principles of Genetics, Gardner EJ and Snustad DP, John Wiley and Sons, (2000).
2. Principles and Techniques of Practical Biochemistry, Wilson K and Walker J, Cambridge Univ Press, (1994).
3. An introduction to Practical Biochemistry, Plummer DT, Tata McGraw Hill, (1987).
4. Practicals in Biochemistry, Jayaraman J (1981) Wiley Eastern Publishing Co. Ltd.

Paper IV Animal Diversity, Physiology and Developmental Biology 80

Unit 1

PN [Symmetry and metamerism- Salient features of non-chordates and Chordates. Life cycle of parasitic organisms- *Leishmania donovani*, *Plasmodium vivax*, *Fasciola hepatica* and *Wuchereria bancrofti*.] PN

Unit 2

RJ [Chemical foundation of physiology- solutions, osmotic pressure, diffusion, buffers; Structure and function of haemoglobin and blood coagulation; cardiac cycle and ECG; Peripheral circulation- blood pressure and its regulation.] RV

Unit 3

LJ [Types of nutrition; classification of food, extra and intracellular digestion. Mechanism of digestion of proteins, carbohydrates and fats. Production of urea. Respiration- tracheal, branchial, cutaneous and pulmonary; Respiratory pigments] Structure and function of major endocrine glands, hypothalamus, pituitary, pineal, thyroid, pancreas, adrenal and gonads.] LJS

Unit 4

RV [Structure and function of metanephric kidney; physiology of urine formation] [Types of muscles; Ultrastructure of skeletal muscle, physiology of muscle contraction, Structure of neurons and generation of nerve impulses and its propagation.] LJS

Unit 5

JNS [Gametogenesis, fertilization and parthenogenesis. Types of egg and pattern of cleavage. Blastulation and fate map construction in chick, gastrulation in chick upto formation of three germinal layers. Foetal membrane and placental membrane. In vitro fertilization.]

Suggested readings

1. Invertebrate Zoology 6th Ed., Ruppert and Barnes, Harcourt Asia Pvt. Ltd., (1990).
2. Vertebrate Life 4th Ed. Pough et al., Prentice Hall of India, (1998).
3. Developmental Biology, Twyman, Viva Books Pvt. Ltd., (2000).
4. Comparative Endocrinology and Reproduction, KP Joy, Narosa Publishing House (2000).
5. Textbook of Medical Parasitology. 4th Ed., Paniker, Jaypee Brothers (1998).
6. Animal Physiology, Schmidt-Nielsen, Cambridge (2001).

Unit 1 → ST

Nucleic acids as genetic information carriers- experimental evidence; Salient features of viral, prokaryotic and eukaryotic genomes; highly repetitive, moderately repetitive and unique DNA sequences. Basic concepts about the secondary structure of nucleic acids. 5'-3' direction antiparallel strands, base composition, base pairing and base stacking in DNA molecule. T_m and buoyant density and their relationship with G-C content in DNA. Structure and properties of RNA.

Unit 2 → AM

DNA replication in prokaryotes, experimental evidence for semiconservative replication; DNA polymerases and other enzymes and protein factors involved in replication; Mechanism of replication in prokaryotes and its differences with eukaryotes; Inhibitors of DNA replication. RNA polymerases, promoter, initiation, elongation and termination of RNA synthesis in prokaryotes and its difference with eukaryotes.] MAL

Unit 3

CS [Reverse transcriptase; Eukaryotic post-transcriptional processing of RNA] Genetic code- triplet nature, degeneracy and universality. Translation- mechanism in prokaryotes] Regulation of gene expression in Prokaryotes- enzyme induction and repression. Operon concept (Lac operon and Trp operon)] CS

Unit 4 LJ

[Concept of immunity, innate and adaptive immunity. Lymphoid organs and cells of immune system] Antigen processing and presentation. Immunoglobulins- structure and functions; Antigens-Nature of antigens; Immunogens, Haptens. Forces involved antigen-antibody binding. Antibody- classes and mechanism of production.] MAL

Unit 5 LJ

[Differentiation of lymphocytes; clonal selection theory; Genetic basis of antibody diversity. Antigen-antibody reactions; Complement- definition, source and property; Hypersensitivity- definition and types. Autoimmunity and tolerance- definition and types; Major histocompatibility complexes: H2 and HLA classes and functions.] MAL
Monoclonal antibody and its application.)

Suggested readings

1. Molecular Biology of the Cell, Alberts B., Bray D, Lewis J., Raff M., Roberts K and Watson J.D., Garland Publishing Inc. (2001).
2. Immunology-Understanding the Immune System, Elger K.D, Wiley Liss, (1996).
3. Roitt's essential Immunology, Roitt IM and Delves PJ, Blackwell Science Ltd., (2001).
4. Molecular Biology of the Gene, Watson J.D., Hopkins N.H., Roberts J.W., Steitz J.A and Weiner A.M (The Benjamin/Cummings Publ.Co.). (2004).
5. Molecular Cell Biology, Darnell J, Lodish H and Baltimore D, Scientific American Books, USA, (2008)

- AMS, ST [1. Isolation of nuclear DNA from animal tissues. } STAIN
- CS, LS [2. Agarose Gel electrophoresis of nuclear DNA. }
- CS, LS [3. Separation of proteins by SDS-PAGE. }
- CS, LS [4. Blood smears identification of leucocytes by Giemsa stain. }
- CS, LS [5. Determination of antigen-antibody specificity by immunodiffusion. }
- CS, LS [6. Demonstration of Arterial and Venous system of rat. SC
- CS, LS [7. Estimation of blood haemoglobin by haemometer. SC, VMW
- CS, LS [8. Estimation of urea in blood. SC, VMW
- CS, LS → 9. RBC / WBC counting by haemocytometer. S - VMW
- RV [10. Histological studies (permanent slides) of skin, lung, intestine, kidney. Liver, pancreas and gonads of mammals. SC

Suggested readings

- 1. Molecular Cloning: a laboratory manual, Sambrook J., Fritsch EF. and Maniatis T, Cold Spring harbor Laboratory Press, (2000).
- 2. Introduction to Practical Molecular Biology, DEabre P, John Wiley & Sons Ltd, (1998).
- 3. Basic concepts in cell biology and histology, McKenzie, Tata McGraw Hill (1999).

Unit 1 IB

History and development of microbiology, Pasteur's and Lister's contributions, germ theory of disease, concept and methods of sterilization, microbial growth curve and factors affecting microbial growth, various forms of microorganisms (bacteria, fungi, viruses, protozoa, PPL.Os), nature of microbial cell surface, kinds of flagella, gram-positive and gram-negative bacteria, nutritional classification of microorganisms.

Unit 2 IMB

Genetic homogeneity in clonal populations, spontaneous and induced variation arising in microbial populations; genetic recombination in microbes (conjugation, transduction, transformation); Isolation of auxotrophs (replica plating techniques and analysis of mutations in biochemical pathways), strain improvement by selection.

Unit 3 IMB

Microbes in extreme environments, pathogenic microorganisms, defence mechanism against microorganisms, Symbiosis and antibiosis among microbes, N-fixing microbes in agriculture; Industrial microbes and their uses in production of food (Dairy and SCP) and drugs (penicillin and streptomycin).

Unit 4 I MB

Renewable and non-renewable resources, conventional fuel and their environmental impacts. Modern fuels and their environmental impacts (methanogenic bacteria and biogas), microbial hydrogen production, conversion of sugars to ethanol. Treatment of municipal wastes and industrial effluents, degradation of pesticides and other toxic chemicals by microorganisms.

IB Unit 5

[Limiting factors of environment, energy transfer and biogeochemical cycling in ecological systems; Environmental problems- ozone depletion, green house effect, water, air and soil pollution; GEMs in environment.] [Biopesticides, Biofertilizers, Bio-assessment of environmental quality; Role of environmental biotechnology in management of environmental problems.] IB

Suggested readings

1. General Microbiology, Stainer, RY, Ingraham, JL, Wheelis, ML., and Painter, PR. The Macmillan Press Ltd., (2000).
2. Principles of Microbiology, Atlas RM, Mosby, (1995).
3. Environmental Biotechnology, Concepts and Applications. Hans-Joachim Jordening and Josef Winter. Winter-VCH. 2005
4. Biology of wastewater Treatment. N F Gray. Mc Graw Hill . 2004.
5. Fundamentals of ecology (5th Edition) by EP Odum and GW Barrett, Thomson Books/Cole, 2005.
6. An Introduction to Environmental Biotechnology by Milton Wain Wright. Kluwar Acad Publ. Group, Springer, 1999.

Unit 1 - ^{RV} ~~ASL~~ IS

Types and functions of animal tissues, Basic concepts of animal cell culture- primary cell culture and established cell lines, Embryonic Stem cell and Tissue stem cell concepts and its application
Tissue engineering

Unit 2 - ^{SC} ST

Milestones in Genetic Engineering, Molecular Tools - Restriction enzymes, Gene Cloning
Vectors- Plasmids, bacteriophages, phagemids, cosmids and artificial chromosomes, expression vectors, production of defined DNA fragments.

Unit 3 SC

^{CS} [Cloning strategies-Insertion of DNA molecule into a vector; Detection of recombinant molecules. Transgenic organisms] [Objectives and function of genome projects- Human and *Arabidopsis*] ^{AMS}

Unit 4 JS

Scope and history of Plant Biotechnology; Plant Tissue Culture-tools and techniques, culture media, surface sterilization, callus and suspension cultures, Process of embryogenesis and organogenesis, different modes of plant regeneration; Anther and ovary culture for production of haploid plants, Micropropagation of elite species (axillary bud, shoot tip and meri-stem cultures).

Unit 5 JS

^{AMS} Protoplast isolation, regeneration and fusion for development of Cybrids, ^{AMS} [Genetic fidelity of tissue culture raised plants. Use of molecular markers in selection of stable genotypes] [Production of transgenic plants- direct and vector mediated gene transfer methods, Genetically modified organisms- success stories -Bt Cotton; Intellectual property rights (IPR) and related issues.] ^{SC}

Suggested readings

1. Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): R Ian Freshney. Wiley-Liss, 2005
2. Animal Cell Culture - Practical Approach, Ed. John R W Masters.
3. Cell Growth and Division: A Practical Approach, Ed. R Baserga. Oxford Univ. Press. 1987
4. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
5. DNA Cloning: a Practical Approach, D M Glover and B D Hames, IRL Press, Oxford 1995.
6. Plant Biotechnology: J. Hammond, P. McGarvey and V Yusibov (Eds):, Springer Verlag, 2000
7. Plant Cell and Tissue Culture for the Production of Food Ingredients: T-J, Fu, G. Singh, and W R Curtis (Eds.):, Kluwer Academic/Plenum Press. 1999.

Unit 1

PB

Statistical methods of sampling, collection of data, primary and secondary data, tabulation and frequency distribution, graphical representation of data, measures of central tendency, measures of dispersion, probability calculation (Classical and axiomatic definition of probability), Simple problems involving binomial, Poisson and Normal variables, Regression analysis, Correlation coefficient, ANOVA, chi-square test, students' T-test

Unit 2

BR

Computers- general introduction, Hardware and software, organization of computer hardware; Introduction to Operating systems (Windows, LINUX, Mac). Software- system software and application software, languages (low level, high level), Interpreter, compiler. Data processing- Batch on-line, real-time (applications in industries and bioreactors); Internet applications, Role of computers in bioinformatics and its applications; Concept of data mining and biological databases.

Suggested readings

1. Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience, (2002).
2. Textbook of Biotechnology Das H.K., Wiley Dreamtech India Pvt Ltd, (2004).
3. Principles of Genome analysis and genomics, Primrose SB, Twyman RM, Blackwell Science (2002).
4. Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (1983).
5. Statistical Methods, Medhi J, Willey Eastern Limited, (1992).

- CS 1. Aseptic techniques: preparation of media, cotton plugging and sterilization. CS
- IND 2. Isolation of microorganisms from air, water and soil samples, dilution, pour plating and colony purification. → IMB ± 6
- JC 3. Identification of microorganisms: Gram staining methods.
4. Growth curve of microorganisms. → JNS.
5. Testing water quality (BOD, COD).
- ST 6. Isolation of plasmid DNA → AMS/SL
- ARS 7. Restriction digestion of DNA and agarose gel electrophoresis. → AMS/SL
- se 8. Preparation and handling of plant tissue culture media.
9. Induction and maintenance of callus/cell suspension cultures. } → MAL
- fB 10. Biostatistics and computer applications.
11. Submission of Field / study tour report (compulsory; visit some biotechnology department, institute and industrial firms)

Suggested readings

1. Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): R Ian Freshney. Wiley-Liss, 2005
2. Animal Cell Culture – Practical Approach, Ed. John R W Masters. Oxford Univ Press, 2000.
3. Molecular Cloning: a Laboratory Manual, J Sambrook, E F Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
4. Plant Cell and Tissue Culture for the Production of Food Ingredients: TJ Fu, G. Singh and W R Curtis (Eds.), Kluwer Academic/Plenum Press, 1999.