

**DEPARTMENT OF BIOTECHNOLOGY
JAMIA MILLIA ISLAMIA
NEW DELHI-110 025, INDIA**

B.Sc. Biotechnology Semester System

COURSE STRUCTURE AND SYLLABI

YEAR OF SEMESTER SYSTEM INTRODUCTION - 2012

B. Sc. Biotechnology Course/Syllabus Structure

Semester I			Semester II		
Papers	Credits	Marks	Papers	Credits	Marks
1. Ess. Chemistry	4	100	1. Microbiology	4	100
2. Ess. Mathematics	4	100	2. Biochemistry	4	100
3. Animal Diversity I	4	100	3. Animal Diversity II	4	100
4. Plant Diversity I	4	100	4. Plant Diversity II	4	100
5. General English I	2	50	5. General English II	2	50
6. Islamiat I	2	50	6. Islamiat II	2	50
7. Urdu I	2	50	7. Urdu II	2	50
8. Lab Course I	8	200	8. Lab Course II	8	200
Total	30	750	Total	30	750

Semester III			Semester IV		
Papers	Credits	Marks	Papers	Credits	Marks
1. Ecology	4	100	1. Developmental Biology	4	100
2. Genetics	4	100	2. Molecular Biology & Genetic Engineering	4	100
3. Immunology	4	100	3. Catalysis, Protein and Enzymes	4	100
4. Cell Biology	4	100	4. Plant Pathology and Crop Protection	4	100
5. General English III	2	50	5. General English IV	2	50
6. Lab Course III	8	200	Lab Course IV	8	200
Total	26	650	Total	26	650

Semester V			Semester VI		
Papers	Credits	Marks	Papers	Credits	Marks
1. Human Physiology	4	100	1. Animal Biotechnology	4	100
2. Medical Biotechnology	4	100	2. Plant Biotechnology	4	100
3. Plant Physiology	4	100	3. Food Biotechnology	4	100
4. Environmental Biotechnology	4	100	4. Bioinformatics and Biostatistics	4	100
5. Lab Course V	8	200	5. Lab Course VI	8	200
Total	24	600	Total	24	600

	Total Credits	Total Marks
Grand Total (Sem I to Sem IV)	160	4000

*2 credits = 2 Periods per Week; 4 credits = 4 Periods per Week

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Semester I

Papers	Credits	Marks
1. Essential Chemistry	4	100
2. Essential Mathematics	4	100
3. Animal Diversity I	4	100
4. Plant Diversity I	4	100
Lab Course I	8	200
Total	24	600

Semester II

Papers	Credits	Marks
5. Microbiology	4	100
6. Biochemistry	4	100
7. Animal Diversity II	4	100
8. Plant Diversity II	4	100
Lab Course II	8	200
Total	24	600

Semester III

Papers	Credits	Marks
9. Ecology	4	100
10. Genetics	4	100
11. Immunology	4	100
12. Cell Biology	4	100
Lab Course III	8	200
Total	24	600

Semester IV

Papers	Credits	Marks
13. Developmental Biology	4	100
14. Molecular Biology & Genetic Engineering	4	100
15. Catalysis, Protein and Enzymes	4	100
16. Plant Pathology and Crop Protection	4	100
Lab Course IV	8	200
Total	24	600

Semester V

Papers	Credits	Marks
17. Human Physiology	4	100
18. Medical Biotechnology	4	100
19. Plant Physiology	4	100
20. Environmental Biotechnology	4	100
Lab Course V	8	200
Total	24	600

Semester VI

Papers	Credits	Marks
21. Animal Biotechnology	4	100
22. Plant Biotechnology	4	100
23. Evolution and Behavior	4	100
24. Bioinformatics and Biostatistics	4	100
Lab Course VI	4	100
Total	24	600
Grand Total (Sem I to Sem IV): 6 Semesters	144	3600

Essential Chemistry

Unit I: Elements, compounds and reactions: Empirical, molecular, structural and skeletal formulae. Balancing equations and ionic reactions. Electronic structure.

Chemical Bonding: Ionic bond; energy changes, lattice energy Born Haber Cycle, Covalent bond-energy changes, Potential energy curve, coordinate bond: Werner's Theory, effective atomic numbers, isomerism in coordinate compounds. Hydrogen bonding, Vander Waal's forces, hybridisation and resonance, Valance Shell Electron Repulsion theory (VSEPR). Molecular orbital theory, Linear combination of atomic orbitals (LCAO) method.

Unit II: Thermodynamics and thermochemistry: Enthalpy, entropy, free energy and the principles of bioenergetics; Hess's Law, heat of a reaction, effect of temperature on heat of reaction, at constant pressure (Kirchoff's Equation) heat of dilution, heat of hydration, heat of neutralization and heat of combustion, Flame temperature

Unit III: Solutions and polymers: Properties of water, dispersions, electrolytes, acids and bases, buffers. RedOx reactions; principles of oxidation and reduction. Addition, condensation and Ionic polymerization's, solutions of polymers, good solvents, bad solvents, solubility parameter, solutions viscosity and determination of intrinsic viscosity. Industrial applications of polymers.

Unit IV: Colloids and Dyes: Colloidal state, classification of colloidal solution, true solution, colloidal solution and suspensions, preparation of sol, Purification of colloidal solutions, General and optical properties of colloids, stability of colloids, coagulation of lyophobic sols, electrical properties of sols, kinetic properties of colloids: Brownian motion, size of colloidal particle, emulsions, gels, colloidal electrolytes and applications of colloids, Natural and synthetic dyes, components and properties of dyes, pigments.

Recommended Books

1. Basic Inorganic Chemistry, FA Cotton, G Wilkinson, and Paul L. Gaus, 3rd Edition (1995), John Wiley & Sons, New York.
2. Concise Inorganic Chemistry, JD Lee, 5th Edition (1996), Chapman & Hall, London.
3. Organic Chemistry, Paula Y. Bruice, 2nd Edition (1998), Prentice-Hall, Intl Edition.
4. Organic Chemistry, R. T. Morrison and R. N. Boyd, 6th Edition (1992), Prentice-Hall of India (P) Ltd., New Delhi.
5. Organic Chemistry, I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
6. Organic Chemistry, LG Wade Jr., 5th Edition. 2001. Prentie Hall Intl INC. USA.
7. Organic Chemistry, J. Clayden, N. Greeves, S. Warren, and E. Wothers, , Oxford Univ. Press, Oxford (2001).

Essential Mathematics

UNIT I: Functions: Concept of functions, its domain and range, graphs of some well known functions, even and odd functions, polynomial functions, absolute value functions, greatest integer function, signum function, algebra of functions, composite functions. Inverse of a function, exponential, hyperbolic and logarithmic functions, trigonometric functions, inverse functions of trigonometric functions.

Unit-II: Differential and Integral Calculus With Applications: Limit at a point, properties of limit, Computation of limits of various types of functions, Continuity at a point, Continuity over an interval, Types of discontinuities, Derivative by First Principle, Differential of sum, product and quotient function. Differential of a function of a function, Logarithmic differential. Maxima and Minima. Equation of tangent and normal, Integration as the inverse process of differentiation, indefinite integral, anti-derivative or primitive function, standard formulae, the fundamental laws of integration, methods of integration: by substitution, by parts, by long division, by partial fractions, Integration of Algebraic and Transcendental functions.

UNIT-III: Applications Of Integration: Definition of definite integral as the limit of sum. The fundamental theorem of calculus (without proof), evaluation of definite integrals, transformation of definite integrals by substitution, evaluation of definite integrals by parts. Properties of definite integrals and problems based on these properties. Area bounded by a curve, between two ordinates and X-axis, area between two curves.

UNIT-IV: Differential Equations: Order and degree of differential equations, Solution of differential equations of first order and first degree, variable separable, Homogeneous differential equations, Solution of linear differential equations of 1st order, Solution of linear differential equations of 2nd order with constant co-efficient including particular integral.

Recommended Books

1. Shanti Narayan, 1999, Differential and Integral Calculus, S. Chand & Company Ltd.
2. Frank Ayres, Jr., 1992, Theory and Problems of Differential Equations, Schaum's Outline Series, McGraw Hill Book Company.
3. N. Piskunov, Differential and Integral Calculus, 1981, CBS Publishers & Distributors.
4. Frank Ayres, Jr., 1992, Theory and Problems of Differential Equations, Schaum's Outline Series, McGraw Hill Book Company.
5. Khalil Ahmad, 2012. Text Book of Calculus, World Education Publishers, New Delhi, 2012.

Animal Diversity I**Unit I: Introduction to Invertebrate**

General Principles of Taxonomy and Animal classification. Salient features and classification up to order in nonchordates.

Unit II: Phylum-Protozoa, Porifera and Coelentrata

General characters of Protozoa: Type study of *Plasmodium vivax*. Protozoa and Human diseases. Origin of Metazoa, metamerism and symmetry. Type study of *Sycon*, with reference to reproduction and development. Polymorphism, Corals and Coral reef.

Unit III: Phylum-Platyhelminthes and Nematohelminthes, Annelida

General characters Study of *Taenia*, Parasitic adaptations. Type study of *Ascaris lumbricoides*. Types and significance of Coelom, Study of Nephridial system in annelids.

Unit IV: Phylum Arthropoda, Mollusca, Echinodermata and Minor Phyla

General characters: Social insects and their life cycle, Torsion and detorsion in gastropods, General Characteristics, Life history and development of asterias (star fish). General introduction of minor phyla and its example.

Recommended Books

1. Barnes, R. S. K., 2001. The invertebrates: a synthesis. Blackwell Science.
2. Brusca, R. C., Brusca, G. J., 2003. Invertebrates. Sinauer Associates; Palgrave.
3. Dawkins, R., Wong, Y., 2005. The ancestor's tale: a pilgrimage to the dawn of life. Phoenix, London.
4. Gullan, P. J., The insects: an outline of entomology. Wiley-Blackwell, Oxford.
5. Hickman, C. P., 2008. Animal diversity. McGraw-Hill.
6. McGavin, G., Lewington, R., 2001. Essential entomology: an order-by-order introduction. Oxford University Press.
7. Moore, J., Overhill, R., 2006. An introduction to the invertebrates. Cambridge University Press.
8. Naylor, P., 2005. Great British marine animals. Sound Diving Publications.
9. Pough, F. H., Janis, C. M., Heiser, C. B., 2005. Vertebrate life. Prentice Hall.
10. Ruppert, E. E., Fox, R. S., Barnes, R. D., 2003. Invertebrate zoology. Brooks/Cole.
11. Tudge, C., 2002. The variety of life : a survey and a celebration of all the creatures that have ever lived. Oxford University Press.
12. R.L. Kotpal-Modern Textbook of Zoology-Invertebrates

Plant Diversity I**Unit I: Algae**

General characteristics-habitats-habits

Cell structure: Prokaryotic-eukaryotic, Reproduction: Vegetative- asexual-sexual life cycle patterns, Classification: salient features of algal divisions, Structure and reproduction with reference to the following algal forms (no development)- *Chlamydomonas*, *Volvox*, *Chara*, *Oedogonium*, *Ectocarpus* and *Polysiphonia*.

Cyanobacteria: General features, Heterocyst, Reproduction and economic importance with special reference to *Nostoc*.

Unit II: Fungi

General characteristics-habit-nutrition

Cell structure: Unicellular-mycelial, Reproduction: Vegetative- asexual-sexual-fruiting bodies-lifecycle patterns, Classification: salient features of fungal classes (Alexopolus), Structure and reproduction with reference to the following fungal forms (no development)- *Albugo*, *Phytophthora*, *Puccinia*, *Alternaria*, *Agaricus* and *Saccharomyces*

Lichens: General features-Types-Structure-Importance

Unit III: Bryophytes

General characteristics-habitat-habit, Classification, gametophyte-sex organs- sporophyte- alternation of generations with special reference to *Riccia*, *Marchantia* and *Funaria* (no developmental aspects), Importance

Unit IV: Pteridophytes

General features, Classification: general survey of divisions, Stele system, Heterospory, Type study of the following forms (no developmental aspects): *Lycopodium*, *Selaginella* and *Equisetum*.

Recommended Books

1. Alexopoulos CJ, Mims CW and Blakwell M. 1996. Introductory Mycology, John Wiley & Sons, Inc.
2. Kumar HD. 1988. Introductory Phycology, Affiliated East-West Press Ltd. New Delhi.
3. Parihar NS. 1996. Biology and Morphology of Pteridophytes, Central Book Depot.
4. Stewart WN and Rathwell GW. 1993. Paleobotany and the Evolution of Plants, Cambridge University Press.
5. Vashishta PC. 1991. Pteridophyta (Vascular Cryptogam), S. Chand & Co. Ltd. Delhi.
6. Pandey, Mishra & Trivedi. 2001. A Text Book of Botany, Vol. I and II. Publishing House, New Delhi.
7. Harmful Algae 2002: Proceedings of the Xth International Conference on Harmful Algae, St. Pete, Florida, USA, 21-25 October 2002". Stedinger K. A., J.H. Landsberg, C.R. Tomas, and G.A.Vargo (eds) 2004. Developing country libraries and scientists can request free of charge delivery.
8. Portraits of Marine Algae: an historical perspective, by Michael J. Wynne (2006) University of Michigan Herbarium.
9. Williams, JE & Woinarski, JCZ (eds) Eucalypt ecology: individuals to ecosystems, Cambridge University Press, Cambridge, 1997.

Microbiology**Unit I: History and microbial diversity**

The microscope, spontaneous generation, biogenesis, fermentation, germ theory of diseases; Prokaryotes and Eukaryotes, Microalgae, Microfungi, Protozoa, Bacteria and Viruses, Bacterial size, shapes and pattern of arrangement

Unit II: Bacterial Genetics and Virus

Structures external to cell wall: Flagella, Pili, Capsule, sheath, Prosthecae and stalk. The cell wall structure of Gram positive and Gram negative bacteria. Structures internal to cell wall: Cytoplasmic membrane, Cytoplasmic inclusion and nuclear material. Conjugation, Transduction, Transformation; Isolation of auxotrophs.

Unit III: Reproduction, Nutritional and Control

Reproduction and growth of bacteria: Modes of cell division, Growth curve: Lag, exponential, stationary and death phase. Nutritional types of bacteria: Phototrophs, Chemotrophs, Autotrophs, Heterotrophs, Obligate parasites. Bacteriological media, Selective media, Differential media, Maintenance and Storage media. Control of microorganisms: Definitions and fundamentals of control, Physical agents/processes for control: high temperatures, low temperature, dessication, osmotic pressure, radiation, filtration, host parasite interaction: pathogenicity, virulence and infection, Defense mechanisms of host: physical barriers, chemical barriers, biological barriers.

Unit IV: Introduction to Food biotechnology

Introduction to Food Processing, Food Spoilage and Food Borne Diseases, Food Preservation and Fermented Food Products.

Recommended Books

1. Pelczar and Krieg. 1986. Microbiology, McGraw Hill.
2. Prescott H and Klein. 2000. Microbiology, McGraw Hill.
3. Roland M. Atlas. 1987. Microbiology, Foundation and Applications, Prentice.
4. Stanier 1986. General Microbiology, McMillan Publishing House Co.
5. Davis. 1980. Microbiology. Harper & Row.
6. Bauman, R. W., Machunis-Masuoka, E., Microbiology: with diseases by taxonomy. Benjamin Cummings, London.
7. Dale, J., Park, S., Molecular genetics of bacteria. Wiley-Blackwell, Oxford.
8. Madigan, M. T., Brock, T. D., 2008. Brock biology of microorganisms. Pearson Benjamin Cummings, San Francisco, Calif.
9. Willey, J. M., Sherwood, L., Prescott, L. M., Prescott's microbiology. McGraw-Hill Higher Education McGraw-Hill [distributor], London.
10. Safe Food. 2003. Bacteria, Biotechnology, and Bioterrorism, Marion Nestle, University of California Press.
11. Farmageddon: Food and the Culture of Biotechnology. 1999. Brewster Kneen New Society Publishers 1999

12. Encyclopedia of Biotechnology in Agriculture and Food, Dennis R, Heldman, CRC Press. 2010.
13. Food-Borne Pathogens, Methods and Protocols. 2005. Edited by Catherine Adley, Humana Press.
14. Introduction To Food Biotechnology (Contemporary Food Science). 2002. Perry Johnson-Green, CRC Press.
15. Applications of Biotechnology to Traditional Fermented Foods. 1992. Board on Science and Technology for International Development National Academies Press (NAP).

Biochemistry**Unit I: Aspects of organic chemistry**

Functional groups, nomenclature and structure of classes of organic compound; Isomerisation: geometrical and optical isomers; osmosis and dialysis

Unit II: Life and Biomolecules

Identifying features of living matter, general properties of biomolecules; molecular logic of life, central role of carbon; The nomenclature, structures, properties and biological significance of:

Carbohydrates: monosaccharides, oligosaccharides and polysaccharides.

Lipids: fatty acids (saturated and unsaturated), triglycerides, phospholipids, lipoproteins, sphingolipids, sphingomyelins, cerebrosides, gangliosides, sterols and liposomes.

Nucleic acids: nitrogen bases, nucleosides and nucleotides, DNA and RNA.

Unit III: Metabolism

Principles of metabolism: anabolism and catabolism; bioenergetics and the significance of ATP.

Outlines of the following pathways/cycles (including name & structure of intermediates, name of enzymes and regulatory aspects):

Glycogenolysis, glycolysis, fermentation, TCA cycle, HMP pathway, Glycogen synthesis and degradation, Gluconeogenesis, Cori cycle.

Unit IV: Oxidative phosphorylation and other metabolism

Oxidation of even chain, odd chain and unsaturated fatty acids, Fatty acid biosynthesis. Mobilization & transport of amino groups from amino acids, Urea cycle. Flow diagrams of degradation and biosynthesis of nucleotides. Electron transport, the chemiosmotic mechanism, inhibitors and uncouplers.

Recommended Books

1. Lehninger, Nelson & Cox. 2008. Principles of Biochemistry. Palgrave & MacMillan.
2. Voet and Voet. 2011. Biochemistry. John Wiley & Sons.
3. Stryer. Biochemistry. 2011. WH Freeman.
4. Zubay GL. Biochemistry. 1999. William C Brown Publishers
5. Harper's Illustrated Biochemistry. 2009. McGraw-Hill Medical
6. Lippincott's Illustrated Reviews of Biochemistry. 2010. L Williams & Wilkins.

Animal Diversity II**Unit I: Origin & General Characteristics of Chordates**

Chordate characters, origin and evolution of chordate groups, Scheme of Chordate classification.

General Characteristics of primitive chordates, Structure and affinities of *Balanoglossus*, and *Herdmania*.

Unit II: Cyclostomes and Pisces

General characteristics of Cyclostome and of Pisces, migration, Accessory respiratory organs in fishes

Unit III: Amphibia and Reptiles

Origin, general characteristics & classification up to orders, Parental care
General characteristics & classification up to order, Identification of poisonous and non-poisonous snakes, Biting mechanism, Venom and antivenom, Extinct reptiles.

Units IV: Aves and Mammals

General characteristics, Flight adaptation and migration in birds, Origin and of bird, General characteristics of Prototheria, Metatheria & Eutheria
Evolution of horse and Man.

Tissue types and histology of liver, kidney, pancreas, stomach, intestine, thyroid gland, testes and ovary.

Recommended Books

1. Green N.P.O. et al., 1995, Biological Sciences, Second Edition, Cambridge University Press.
2. Kotpal R.L., 2001, Modern Text Book of Zoology, Vertebrates, Rastogi Publication, Meerut, India.
3. Parker T.J. and Haswell W.A., 1990, A Text Book of Zoology, Vol. II Revised by A.J. Marshall.
4. Sinha, A.K., Adhikari, S., and Ganguli, B.B., 2001, Biology of Animals (Vol.-II & III), New Central Book Agency, Calcutta.
5. Subramoniam, T., 2002, Developmental Biology, Narosa Publishing House Pvt. Ltd., New Delhi.
6. Parker, T.J. and Haswell, 1995, A Text Book of Zoology (Vol. I & II), 7th Edition, Low Price Publication, Delhi.
7. Leeson & Leeson, 1984, Histology, WB Saunders – Igaku Shoin Publication Philadelphia & Tokyo.
8. R.C. Kotpal. Modern text book of Zoology-Vertebrates.

Plant Diversity II**Unit I: Gymnosperms**

General features, evolution, distribution, external features, comparative anatomy, reproduction, affinities and economic importance with special reference to *Cycas*, *Pinus*, *Gnetum* and *Ephedra*.

Unit II: Plant Nomenclature and Systematics

Units of classification, Binomial nomenclature, Outlines and relative study of the important systems of classification of Bentham and Hooker's system, Engler and Prantel's and Hutchinson system.

Introduction of terms: Chemotaxonomy, Cytotaxonomy, Molecular Taxonomy and Numerical taxonomy (brief account only).

Unit III: Angiosperms

General features, Life cycle, Androgenesis and gynogenesis, Pollination biology, Self and inter-specific incompatibility, Embryo and seed development.

Unit IV: Diagnostic Features

Vavilov's theory of Centres of origin, Study of the diagnostic features of the families with a brief account of the economically important plants: Cruciferae, Leguminaceae, Compositae, Solanaceae and Graminae.

Recommended Books

1. Bhatnagar, S.P. and Moitra, A., 1996, Gymnosperms New Age International Pvt. Ltd., New Delhi.
2. Davis, P.H. and Heywood, V.H., 1973, Principles of Angiosperms Taxonomy, Robert E. Krieger Pub. Co., New York.
3. Grant V., 1971, Plant Speciation, Columbia Univ. Press, London.
4. Harrison, H.J., 1971, New Concepts of Flowering Plant Taxonomy, Hieman Educational Books Ltd., London.
5. Nordenstam, B., El Ghazaley, G. and Kassar, M., 2000, Plant Systematics for 21st Century, Portland Press Ltd., London.
6. Takhtajan, A.L., 199, Diversity and Classification of Flowering Plants, Columbia Univ. Press, New York.
7. Pandey, Mishra & Trivedi, 2001, A Text Book of Botany, Vol. II & III, Vikas Publishing House Pvt. Ltd., Delhi.
8. Vashishta, 1976, Botany for Degree Students (Algae, Fungi, Bryophyto & Gymnosperms) Gymnosperms (Vol. III), S. Chand & Co. Ltd., Delhi.
10. Biswas, C. and Johri, B.M., 1998, The Gymnosperms, Springer Verlag.

Ecology**Unit I: Ecosystems and Edaphic Factors**

Concept and components of an ecosystem, Structure and Function, Energy flow, Nutrient Cycles, Introduction, types and characteristic features of the Forest, Grassland, Desert and Aquatic (Pond, Ocean) ecosystems, Soil formation, Mineralization and Humification, Soil profile, Soil texture, Soil moisture and Cation exchange capacity, Biogeography

Unit II: Population and Community Ecology

Basic concepts, Population characteristics, Population dynamics, Characteristics of a community, Community structure, Community dynamics (ecological succession), Concept of Habitat and Niche.

Unit III: Environmental Pollution

Cause, effects and control measures of : Air (CO₂, SO₂, NO_x, O₃ CFC, PAN, Green house effect), Water (Cd, Hg, Pb, F, As, BOD), Noise and Radiation (Strontium and Cesium) pollution., Solid waste management, Biomagnification, Methalmoglobinemia , Global warming and Climate change (cause and consequences).

Unit IV: Environmental Laws

Environmental Impact Assessment, Environmental planning and National Environment Policy

Recommended Books

1. Ian L. Pepper, Charler P. Gevba, Mark L. Brusseau, Pollution, 1996, Science, Edited, Academic Press.
2. Sharma, P.D., 1993. Environmental Biology and Toxicology.
3. Chapman, J.L. and M.J. Reiss, 1995, Ecology, Principle and Applications, Cambridge University Press,.
4. Verma, P.S., V.K. Agarwal, 1998, Environmental Biology Principles of Ecology, S. Chand & Co. Ltd.,
5. De, A.K., 1993, Environmental Chemistry, Wiley Eastern Ltd.
6. Kormondy, E.J., 1989, Concept of Ecology, Prentice-Hall of India Pvt. Ltd.
7. Abbasi, S.A. and Abbasi, N., 2002, Renewable Energy Sources and their Environmental Impact, Prentice-Hall of India Pvt. Ltd., New Delhi.
8. Ecology, 1992. LSE-02, Blocks 1-4, Indira Gandhi National Open University.
9. Biotechnology of Biofertilizers. 2002. Edited by Sadasivam Kannaiyan, Kluwer Academic Publishers.

Genetics

Unit I: Chromosome Theory of Inheritance: The chromosome theory of heredity, Sex chromosomes, Sex linkage, the parallel behaviour of autosomal genes and chromosomes.

Unit II: Mendelian Genetics: Mendelian laws of inheritance, Monohybrid cross and the law of segregation, Dihybrid cross and law of independent assortment, Chromosome theory of inheritance, Multiple allele, lethal allele, Blood group, Rh factor, Gene interactions, Modified dihybrid ratio.

Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Three point testcross, Interference, Calculating recombinant frequencies from selfed dihybrids, examples of linkage maps, The X^2 test mitotic segregation in humans.

Unit III: Fine Structure of Genes and Chromosomes: The concept of promoter, Coding sequence, Terminator, Induction of gene for expression.

Structural organisation of chromatids, Centromeres, Telomeres, Chromatin, Nucleosome organisation; Euchromatin and heterochromatin; Special chromosomes (e.g., polytene and lampbrush chromosomes), Banding patterns in human chromosomes. Structural and numerical aberrations involving chromosomes; Hereditary defects – Klinefelter, Turner, Cri-du-Chat and Down syndromes. Mutations – spontaneous and induced, Chemical and physical mutagens.

Unit VI: Extrachromosomal inheritance and Molecular Genetics: coiling of shell in snails, Mitochondrial and chloroplast genetic systems, population genetics: Hardy-Weinberg equilibrium, Gene and genotypic frequencies.

Recommended Books

1. Strickberger M.W., 2002, Genetics, Prentice Hall, India.
2. Steves Jones. 2000. The Language of the Genes, HarperCollins
3. Matt Ridley. 2003. Nature via Nurture: Genes, Experience, & What Makes Us Human. HarperCollins
4. Aggarwal VK and Verma VS. Genetics. S. Chand
5. EJ Gardner, MJ Simmons and DP Snustad. 1991. Principles of Genetics. John Wiley & Sons.
6. EJ Gardner, MJ Simmons and DP Snustad. Genetics. 2011. Jones & Bartlett.
7. Benjamin A Pierce. Genetics: A conceptual Approach. 2011. WH Freeman.

Immunology**Unit I: Defence mechanisms**

Non-specific defence mechanism: Innate immunity, non-specific effector mechanisms, inflammatory response, phagocytosis, complement activation

Acquired immunity: The development of the concepts of acquired immunity: cell mediated and humoral immunity. Nature of the immune response, primary and anamnestic responses. Cellular cooperation between lymphocytes, sub-populations of lymphocytes and the role of macrophages in antigen presentation

Unit II: Lymphoid system

The development of the immune system in human. Structure and function of the thymus, spleen, bone marrow, lymph nodes and gut-associated lymphoid tissue. Maturation of lymphocytes in the primary lymphoid organs

Unit III: Receptors & signals

The classes, nature, structure and function of the immunoglobulins. T-cell receptor for antigen: structure and function. Structure and function of the MHC antigens, roles of cytokines. The activation and regulation of the complement system

Unit IV: Transplantation

The laws of transplantation. Immunological rejection of transplanted tissues/organs. Significance of Graft versus Host (GVH) reaction in transplantation of immunocompetent tissues

Recommended Books

1. Immunology - Jains Kubay, (2001) Second Edition, W H Frecman & Com. New York.
2. Cellular and Molecular Immunology 3rd ed. Abul K. Abbas Andrew K. Lichtman Jordan S. Pober
3. Introduction to Immunology - John W. Kinball.
4. Fundamentals of Immunology - Otto S. View and others.
5. Essentials of Immunology - Ian & Roitt - Blackwell Scinentific Publications.
6. Fundamentals of immunology - William C. Boyed (Wiley Toppan).

Cell Biology**Unit I: Cells and organelles**

Introduction: Cell as a basic unit of living system, Biochemical composition of cell, the cell theory, ultrastructure of cell

Cytoskeleton: The Nature of the Cytoskeleton and endomembranous system, intermediate filaments, microtubules, cilia and centrioles, actin filaments, actin-binding proteins.

Cell membranes: Architecture and dynamics (models); Membrane composition, the lipid bilayer/membrane; A summary of membrane functions – simple diffusion, Facilitated transports, Active transport, Endocytosis, Pinocytosis, Phagocytosis, Exocytosis. Introduction to important receptors in cell membrane.

Unit II: Molecule and Protein Trafficking

The compartmentalization of higher cells, transport of molecules into and out of organelle membranes, the endoplasmic reticulum, transport from the ER through the Golgi Apparatus, transport from the trans Golgi network to lysosomes, transport from the plasma membrane via endosome: Endocytosis, molecular mechanisms of vesicular transport; introduction to transit peptide, signal peptide and translocons.

Unit III: Nucleus and Cell Cycle

Genome organization, structure and function of nucleus, nuclear envelope, structure of chromatin, nucleosome and chromosome, cell cycle, mitosis and meiosis.

Unit IV: Eukaryotic cell organelles and functions

Structure and functions of the following cell organelles: endoplasmic reticulum, Golgi complex, lysosome, ribosome and mitochondria.

Principles & applications of differential centrifugation in the fractionation of cellular organelles and Svedberg unit; endosymbiotic theories.

Recommended Books

1. De Robertis, E.D.P. & De Robertes, E.M.F., 2001, Biology, Cell and Molecular Biology, Lea & Febiger.
2. Bruce Albert, A., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D., 2000, Molecular Biology of Cell, 4th Edition, Garland Publishing Inc., New York, USA.
3. Lodish, H., 1999, Molecular Cell Biology, W.H. Freeman & Co. 4th Ed.
4. Darnell, J.E., 2000, Molecular Cell Biology, W.H. Freeman & Co.

DEVELOPMENTAL BIOLOGY

Unit I: Principles and basic concepts: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; roles of mutants and transgenics in study of development.

Model Systems in Biotechnological studies: Definition of 'Model System', Introduction to some important model systems including *Saccharomyces cerevisiae*, *Arabidopsis thaliana* (Plant); *D. melanogaster*, *C. elegans* (invertebrates); *Xenopus laevis*, Chicken, Mouse, Zebrafish (vertebrates).

Unit II: Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers and their fates in animals; embryogenesis,

Unit III: Morphogenesis and organogenesis in animals: Kinds of cleavages, stages of embryo, life cycle of *Dictyostelium* and its regulation; proximal and distal pattern and axes formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*; early development of eye and limb in vertebrates; differentiation of neurons, post-embryonic larval development and metamorphosis; brief introduction to environmental factors that regulate normal development; sex determination. Development of *Drosophila*.

Unit IV: Embryogenesis, Morphogenesis and organogenesis in plants: Embryo sac development and double fertilization in plants, establishment of symmetry in plants; seed formation, structure and germination. Organization of shoot and root apical meristem and leaf primordia and floral meristems and floral development in *Arabidopsis thaliana*,
Life control mechanisms: Programmed cell death, apoptosis, senescence and aging and regulatory factors.

Recommended Books

1. Gilbert SF, 9th Edition. 2010. Developmental Biology. Sinauer Associates
Free material online:
2. http://9e.devbio.com/pdfs/Developmental_Biology_8e_Ch20.pdf
3. <http://9e.devbio.com/contents.php?sub=1>
4. http://en.wikipedia.org/wiki/Developmental_biology
5. Fujimoto K, Ishihara S, Kaneko K (2008). Hogeweg, Paulien. ed. "Network Evolution of Body Plans". PLoS ONE 3 (7): e2772.
6. Christ B, Schmidt C, Huang R, Wilting J, Brand-Saberi B (January 1998). "Segmentation of the vertebrate body". Anat. Embryol. 197 (1): 1-8.
7. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E, Smith J (2002). Principles of development (2nd ed.). Oxford university press.

Molecular Biology and Genetic Engineering**Unit I: Life, Nucleic acids and Genome**

Molecular basis of life, models of DNA structure, RNA structure, brief history of development of double helical model of DNA.

C-value paradox, cot curve and its significance, repetitive DNA, satellite DNA.

Unit II: Organization of chromosome and gene

Chromosome structure in Eukaryotes and Prokaryotes, chromatin, nucleosome, histones and non-histones; fine structure of gene, split genes, overlapping genes, gene clusters, transposons and retrotransposons.

Unit III: Central Dogma of Molecular Biology

DNA replication: DNA-Protein interaction, DNA-binding motifs, models of DNA replication, enzymology of DNA replication; Process of DNA replication: initiation, elongation and termination.

Transcription and mRNA processing: Transcription machinery in Prokaryote and Eukaryotes, initiation, elongation and termination of transcription; capping, polyadenylation and splicing of transcripts, mRNA and its stability.

Translation: Genetic code and its nature, tRNA & aminoacyl synthetases, rRNA and ribosomes in Prokaryotes and Eukaryotes; Process of translation: initiation, peptide elongation and peptide termination. Regulation of gene expression.

Unit IV: Gene Mutation and Molecular Evolution

Somatic vs germinal mutation, Mutant types, Selective Systems, Induction of mutation, Chromosomal mutations, Changes in chromosome structure mutation and cancer.

Introduction to DNA based phylogenetic trees and DNA bar coding

Recommended Books

1. Freshney, R. I., 2000, Culture of Animal Cells 'A Manual of Basic Technique', Published by Willey & Liss publication.
2. Atala, A. 2000, Methods of Tissue Engineering, Academic Press, 1st Ed.
3. Harrison & Rae, 1997, General Techniques of Cell Culture, Cambridge University Press.
4. Masters, J.R. 2000. Animal Cell Culture: A Practical Approach, Oxford University Press, 3rd Edition.
5. Friefelder, D., 1993, Molecular Biology, Jones and Bartlett, London.
6. Hoffee, P.A., 1998, Medical Molecular Genetics, Fence Creek Publishing, Madison Connecticut, USA.
7. Albert B, Bray D, Lewis J, Raff M, Roberts K. and Watson JD. 2002, Molecular Biology of the Cell, Garland Publishing Inc. New York, USA.

Catalysis, Proteins and Enzymes**Unit I: Catalysis**

Criteria for Catalysis - Homogeneous catalysis, acid-base, Enzymatic catalysis, Catalysis by metal salts, Heterogeneous catalysis - concepts of promoters, inhibitors and poisoning, physisorption, chemisorption, theories of catalysis.

Unit II: Amino acids and Protein

Amino acids: Structure, nomenclature and general properties, Peptide bond; Primary structure of proteins: end group analysis, amino acid composition, specific peptide cleavage and sequence determination; Secondary structure: peptide group, Helical structures: alpha-helix & other polypeptide helices, Beta-pleated sheets; Protein stability: Electrostatic interactions, hydrogen bond & hydrophobic forces, Disulphide bond, General idea of tertiary and quaternary structure of proteins.

Unit III: Vitamins and Enzymes

Vitamins of B-group: their coenzyme forms, recommended dietary allowance (RDA), source and biochemical function. Fat soluble vitamins: RDA, sources and function. Enzymes: historical perspective, naming and classification, enzyme units, specificity & stereospecificity, Enzyme kinetics: Michaelis-Menten equation and its transformations, significance of kinetic parameters K_s , K_m and K_{cat} , Catalytic mechanisms of Enzyme, Preferential binding of transition state, Proximity & orientation effects, Detail mechanism of action of chymotrypsin. Enzyme inhibition, regulation and influence by factors. Various uses of enzymes: enzymes in food processing, medicine, diagnostics and production of new compounds.

Unit IV: Techniques in protein

Introduction to: Lambert-Beer law, Spectro-photometry and colorimetry, General spectroscopy, Electrophoresis (1-, 2- & 3-Dimensional), chromatography, MALDI, peptide mass fingerprinting (PMF), Ramachandran plot, NMR, X-Ray, Circular Dichorism, FTIR.

Recommended Books

1. Voet & Voet, 2000, Biochemistry, John Wiley, New York
2. Zubay, 1995, Biochemistry, Brown Publishers.
3. Lehninger, 2000, Principles of Biochemistry, CBS Publishers.
4. L. Stryer, 2002, Biochemistry, W.H. Freeman.
5. Harper, 2003, Biochemistry, McGraw-Hill.

Plant Pathology and Crop Protection**Unit I: Plant Pathology**

History and present status of plant pathology, Host pathogen interaction: penetration and disease development, role of cell wall degrading enzymes and toxins, recognition mechanism and signal transduction during plant pathogen interaction.

Unit II: Plant Diseases

Definitions and terms, General symptoms, Study of the following diseases with reference to effects, symptoms, causal organisms and disease cycle: Fungal disease- White rust of crucifers, Late blight of potato, Black rust of wheat, Leaf spot disease of groundnut, Red rot of sugarcane, Bacterial disease- Citrus canker, Viral disease- Mosaic disease of Tobacco, Little leaf of Brinjal.

Unit III: Disease resistance and management

Morphological, anatomical and biochemical, host defense mechanisms against pathogens and pests, basal resistance, systemic acquired resistance, induced systemic resistance. Gene for gene hypothesis, Cloning of resistance genes (R genes) and a virulence genes (Avr) genes from plants and pathogens, induced response to herbivores, genetic engineering for the production of resistance plants to pathogens and pests. Principles of Plant Viral Disease Management.

Unit IV: Crop Protection

Control of plant diseases: exclusion, eradication, protection and therapy; Fungicides inorganic and organic; protectants and systemic fungicides and their mode of action; cultural and biological control. Virus Induced gene silencing. Case studies of economically important causative agents with specific references to crop plants: Plant virus interactions – Potyvirus and horticultural crops

Recommended Books

1. Alexopoulos CJ, Mims CW and Blakwell M. 1996. Introductory Mycology, John Wiley & Sons, Inc.
2. Kumar HD. 1988. Introductory Phycology, Affiliated East-West Press Ltd. New Delhi.
3. Parihar NS. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad.
4. Stewart WN and Rathwell GW. 1993. Paleobotany and the Evolution of Plants, Cambridge University Press.
5. Vashishta PC. 1991. Pteridophyta (Vascular Cryptogam), S. Chand & Co. Ltd. Delhi.

6. Pandey, Mishra & Trivedi. 2001. A Text Book of Botany, Vol. I and II. Publishing House, New Delhi.
7. Harmful Algae 2002: Proceedings of the Xth International Conference on Harmful Algae, St. Pete, Florida, USA, 21-25 October 2002".
8. Stedinger K. A., J.H. Landsberg, C.R. Tomas, and G.A.Vargo (eds) 2004
9. Portraits of Marine Algae: an historical perspective, by Michael J. Wynne (2006) University of Michigan Herbarium.
10. Williams, JE & Woinarski, JCZ (eds) Eucalypt ecology: individuals to ecosystems, Cambridge University Press, Cambridge, 1997

Human Physiology**Unit I**

Musculoskeletal system: Bones, ligaments, tendons, cartilages and muscles. Physiology of muscle contraction in skeletal and smooth muscles.

Nervous system: Central and peripheral nervous systems, structure and functions of neurons and brain, action potential, IPSP, EPSP, synaptic transmission, neurotransmitters, nerve conduction mechanism.

Unit II

Circulatory system: Structure and functions of heart and blood vessels, cardiac output, hemoglobin, blood coagulation, O₂ and CO₂ transport, components and functions of blood

Respiratory system: Structure and function of lungs, pulmonary circulation, regulation of respiration.

Unit III

Digestive system: Parts of digestion system, digestions and absorption of protein, carbohydrates, lipids and nucleic acids.

Reproductive system: Male and female sex organs, Reproductive mechanisms, functional morphology of reproductive organs, gametogenesis, menstrual cycle, hormonal control of reproduction.

Unit IV

Endocrine system: Endocrine glands: structure and functions, endocrine hormones and their functions.

Recommended Books

1. Guyton, A.C. and Hall, J.E., 2000, A Text Book of Medical Physiology, Xth Edition, W.B. Saunders Company.
2. Ganong, H, 2003, Review of Medical Physiology, 21st Edition, McGrawHill.
3. Strand Fluer, 1978, Physiology (a regulatory system approach) McMillan Pub. Co.
4. David Shier, Jakie, Butler & Lewis, 1996, Human Anatomy & Physiology, WCB, USA.

Medical Biotechnology**Unit I: Introduction of Medical Biotechnology**

Tools in medical biotechnology, methods of nucleic acid analysis, the polymerase chain reaction, DNA finger printing, Southern blot and Western blot analysis; RAPD, AFLP, RFLP

Unit II: Principles of Clinical Cytogenetics

Introduction, chromosome abnormalities, Disorders of the autosomes and the sex chromosomes, Mendelian disorders with cytogenetic effects, mitochondrial genetics.

Unit III: Mutations and Developmental Disorders

Mutation: mutagens, causes and consequences, mutation types
Genetic variations in individuals and population, polymorphism
Developmental Disorders, Birth Defects and prenatal diagnosis- prenatal prevention and management of genetic disease, genetic counseling for prenatal diagnosis

Unit IV: Cancer Genetics and Treatment of Genetic Diseases

Genetics of Cancer- genetic basis of cancer, oncogenes, tumor suppressor genes, tumor progression, cancer diagnosis and therapies.
Introduction, current state of treatment of genetic diseases, treatment strategies, molecular treatment of disease.

Recommended Books

1. Turnpenny PD. 2012. Emery's Elements of Medical Genetics, 14th Edition, Churchill Livingstone.
2. Nussbaum, McInnes, Willard Saunders. Thompson & Thompson Genetics in Medicine, 7th Edition.
3. Pongracz J, Keen M. Medical Biotechnology. 2009. Churchill Livingstone.

Plant Physiology

Unit I: Plant water relations: Physiochemical properties of water, water potential and its components, ascent of sap, transpiration, guttation, mechanism of stomatal conductance, translocation of solutes and factors influencing these physiological processes.

Unit II: Plant Metabolism:

Photosynthesis: Pigments and their roles, organization of PSII and PSI and their inter-relation, light-dependent and light-independent phases, photophosphorylation, mechanism of CO₂ fixation in C₃, C₄ and CAM plants, photorespiration. Factors influencing rate of photosynthesis.

Respiration: Aerobic and anaerobic respiration, brief account of glycolysis and Krebs cycle, ETS & oxidative phosphorylation, respiratory quotient (R.Q.) and its significance, determination of R.Q. for various substrates.

Unit III: Nitrogen Fixation and Plant Nutrition

Nitrogen fixation: Non-symbiotic and symbiotic nitrogen fixation, plant-microbe interaction, structure of N₂-fixing nodules, mechanism of nodulation, assimilation of ammonia, brief account of nod factors, nodulins, flottillins, flavanoids and nif genes.

Plant nutrition: Macro- and micronutrients, Hoagland nutrient media, definition and significance of hydroponics and aeroponics, mineral deficiency and deficiency symptoms.

Unit IV: Plant Growth regulation: Synthesis and roles of auxins, cytokinins, gibberellins, abscisic acid ethylene, brief account of photoperiodism and vernalization.

Introduction of the terms: Stress physiology, stress proteins, types of biotic and abiotic stress, oxidative stress, plant antioxidants, stress-responsive elements, halophytes and mangroves.

Recommended Books

1. Hopkins, W.G., 1999, Introduction to Plant Physiology, John Wiley & Sons, Inc. New York, USA.
2. Salisbury, F.B. & Ross, C.W., 1992, Plant Physiology, 4th Edition, Wadsworth Publishing co. California, USA.
3. Taiz, L & Zeiger, E, 2010, Plant Physiology, IV Edition, Sinauer Associates Inc. Publishers, Massacher setts USA.
4. Devlin & Witham, 1983, Plant Physiology, Van Nostrandv, Reinhold Co.

Environmental Biotechnology**Unit I: Biomass and Bio-energy**

Renewable and non-renewable resources, Biomass as source of energy, Composition of Biomass (Cellulose, hemicellulose, lignin), Biomass conversion, Petroleum plants, Hydrocarbon from higher plants, The Liquid and Gaseous Fuel (Ethanol, Biogas and Hydrogen production).

Unit II: Bioremediation

In situ and *Ex situ* bioremediation, Phytoremediation, Transgenic plants for phytoremediation, Use of Genetically Engineered Organisms for removal of specific pollutants, Bio-pesticides and Genetic manipulation of pesticide-degrading microorganisms, Biotechnology for Air and Water Pollution Abatement.

Unit III: Introduction of the terms: Biosensors, Biofilm, Biostimulation, Bioaugmentation, Biosorption, Bioleaching (direct and indirect bacterial leaching), Dissolved oxygen, BOD, Single cell protein, Vermitechnology.

Unit IV: Biodiversity and Conservation

Introduction- Definition of Genetic, Species and Ecosystem diversity, Value of biodiversity (consumptive and productive use, social and ethical values), Hot spots of biodiversity, Endangered and endemic species in India, Principle of Conservation, Genetic resources and conservation strategies, Sustainable development.

Recommended Books

1. Ian L. Pepper, Charler P. Gevba, Mark L. Brusseau, Pollution, 1996, Science, Edited, Academic Press.
2. Sharma, P.D., 1993. Environmental Biology and Toxicology.
3. Chapman, J.L. and M.J. Reiss, 1995, Ecology, Principle and Applications, Cambridge University Press,.
4. Verma, P.S., V.K. Agarwal, 1998, Environmental Biology Principles of Ecology, S. Chand & Co. Ltd.,
5. De, A.K., 1993, Environmental Chemistry, Wiley Eastern Ltd.
6. Kormondy, E.J., 1989, Concept of Ecology, Prentice-Hall of India Pvt. Ltd.
7. Glick, R. & Jack J. Pasternok, 1994, Molecular Biotechnology – Principles and applications of recombinant DNA, American Society for Microbiology Press.
8. Chatterji, A.K., 2002, Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd., New Delhi.
9. Abbasi, S.A. and Abbasi, N., 2002, Renewable Energy Sources and their Environmental Impact, Prentice-Hall of India Pvt. Ltd., New Delhi.
10. Alan Creg. 2011. Environmental Biotechnology. Oxford Publication.

Animal Biotechnology**Unit I**

Principles and objectives of animal biotechnology; physical and chemical procedures; aseptic techniques; types of chemical agents and their applications/limitations.

Unit II

Mammalian cell culture systems; Solid versus liquid culture; continuous versus batch culture; bioreactors (e.g. stirred tank, airlift, hollow fibre); scaling up; Establishment and maintenance of mammalian cell cultures
Tissue culture; cells as factories/products; cell lines (nomenclature, establishment, maintenance, lifespan, fusion, genetic manipulation, storage); Selection and separation of mammalian cells; Cloning techniques (dilution, micromanipulation, media, etc); separation techniques (e.g. size/sedimentation; FACS; immunological methods).

Unit III

Microbial cell culture: Isolation and identification; selective media; indicator and index organisms; detection of food-borne pathogenic bacteria; virus culture (coliphages);
Quantitative microbiology: Bacteriological counting procedures; numerical standards; standard/viable counts; bioassays; assaying survival (e.g. heat and/or UV); D and/or Z values.

Unit IV

Economic importance of insects. Lac culture, Sericulture, Apiculture and Prawn culture (send to animal biotechnology); Sterilization and disinfection
Requirements for culture Media (types/applications in mammalian and microbial cell culture); other growth conditions (e.g. pH, atmosphere, temperature, osmolality).

Recommended Books

1. T.A. Brown Gene Cloning 5th Edition Blackwell Publishing; 2010
2. S.B. Primrose, Richard M. Twyman, R. W. Old; Principles of Gene Manipulation by Blackwell Science, 2001
3. E.L. Winnacker; From Genes to Clones. 1987. Wiley & Sons Canada, Limited, John.

Plant Biotechnology**Unit I: Plant Cell and Tissue Culture technology**

Introduction, Cell and tissue culture techniques, Types of cultures, Cell culture, Protoplast fusion and somatic hybridization, Micropropagation, Plant regeneration pathways (somatic embryogenesis and organogenesis) and artificial seed technology

Unit II: Application of Cell and Tissue Culture

Production of somaclonal variation, Applications of micropropagation, Embryogenesis (A method of mass propagation), Stress tolerance in plants and production of secondary metabolites.

Unit III: Transgenic Plants and Crop Improvement

Transgene plants with beneficial traits (biotic stresses, Virus resistance, Abiotic stresses) and Diagnostics in Agriculture and Molecular breeding (ELISA, DNA probe, Screening of linked markers), Bioethics in plant genetic engineering

Unit IV: Agricultural Biotechnology and Molecular markers

Biotechnology in biocontrol (Baculoviruses, Microbial toxins), Nitrogen fixing bacteria (Nitrogen cycle, fixation, leghaemoglobin, nitrogenase system and hydrogenase system), Introduction: RFLP, RAPD and DNA fingerprinting.

Recommended Books

1. Callom, J.A., Ford - Lloyd, B.V. and Newbury, H.J., 1997, Biotechnology and Plant Genetic Resources, Conservation and use, CAB International, Oxon, U.K.
2. Chrispeds, M.J. and Sadana, D.E., 1994, Plants Cell Culture, Bios Scientific Publishers, Oxford, U.K.
3. Vasis, I.K. and Thorpe, T.A., 1994, Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
4. Razdan, M.K., 1993, An Introduction to Plant Tissue Culture, Published by Oxford and I.B.H. Publishing Co. Pvt. Ltd. New Delhi.
5. Plant Biotechnology: The genetic manipulation of plants Adrian Slater. 2008. Nigel Scott and Mark Fowler, Oxford University Press, Plant Biotechnology: New Products and Applications. 1999. Edited by J Hammond, P McGarvey and V Yusibov, Springer-Verlag
6. Plant Biotechnology: A Practical Approach. 2003. HS Chawla Science Publishers
7. Biotechnology in Agriculture: Proceedings of the First Asia-Pacific Conference on Agricultural, Biotechnology, Beijing, China, August 20-24 1992, Edited by Chongbiao You, Zhangliang Chen and Yong Ding. Springer-Verlag
8. Agricultural Biotechnology 1997. Edited by A Altman, CRC Press.
9. Plant Biotechnology and Transgenic Plants. 2002. Edited by Kirsi-Marja Oksman-Caldentey and Wolfgang, Barz, CRC Press

Evolution and Behavior**Unit I**

Emergence of evolutionary thoughts: Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutations; the evolutionary synthesis. The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms

Unit II

Origin of cells and unicellular evolution: Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; anaerobic metabolism, photosynthesis and aerobic metabolism.

Unit III

The Mechanisms: Concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

Unit IV

Brain, Behavior and Evolution: Approaches and methods in study of behavior; proximate and ultimate causation; altruism and evolution-group selection, kin selection, reciprocal altruism; neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behavior; social communication; social dominance; use of space and territoriality; mating systems, parental investment and reproductive success; aggressive behavior; habitat selection and optimality in foraging; orientation and navigation.

Recommended Books

1. Dylan Evans and Howard Selina. *Introducing Evolution*. OTH Penguin. 2010
2. Fabian. *Evolution*. Cambridge University Press.
3. Charles Darwin. *Voyage by the Beagle*. PUK Penguin. 1989
4. Matt Ridley. *The Origin of Virtue*. USA/Penguin. 1998.
5. Gerard Cheshire. *The Evolution*. St. Martin Pr. 2008.
6. Carl Zimmer. *Evolution*. Harpercollins. 2006.
7. Paul Amos Moody. *Introduction to Evolution*. Harper and Row. 1970.
8. SVS Velori. *Organisational Behavior*. Jaico Publishing House. 2005
9. Edmond Odescalchi. *The Evolution of Behavior*. 2003.
10. JE Mazur. *Learning and Behavior*. Pearson College Div. 2005.
11. Jonathan Flint. *How Genes Influence Behavior*. Ingram. 2010.

Biostatistics and Bioinformatics

Unit I: Introduction: Introduction to computing, computers and information technology; Personal computers, operating systems, data storage, the internet and the world wide web, hypertext markup language

Unit II: Databases: Introduction to standard nucleotide, protein and bibliographic databases relevant to bioinformatics, BLAST, SWISS-PROT, PubMed

Nucleotide sequence alignment and amino acid sequence data Context, application and significance in biological sciences, interpretation of data, introduction to basic proteomics

Unit III: Applications: Analysis of the role of molecular biology, microbiology, biochemistry, genetics, chemical engineering and cell biology in molecular biotechnology. Graph preparation using excel and PPT presentations

Unit IV: Regulating the use of biotechnology and patenting biotechnology inventions.

Recommended Books

1. Biostatistics, Experimental Design and Statistical Inference, 1993. JF Zolman Oxford University Press.
2. Biostatistics. A Foundation for Analysis in the Health Sciences. 2009. Wayne W Daniel, John Wiley & Sons.
3. Biostatistics, A Guide to Design, Analysis and Discovery. 2007. Ronald N Forthofer, Eun Sul Lee and Michael Hernandez, Academic Press.
4. Biostatistics Concepts and Applications for Biologists. 1993. BG Williams, CRC Press. 1993.
5. Biostatistical Analysis, Jerrold H Zar. 2009. Prentice-Hall (Pearson Education).
6. Introduction to Biostatistics, Robert Sokal and James Rohlf. 1987. WH Freeman. 1987
7. Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins. 2004. Edited by AD Baxevanis and BFF Ouellette, John Wiley & Sons.
8. Bioinformatics: Genes, Proteins and Computers. 2003. Edited by CA Orengo, JM Thornton and DT Jones, BIOS Scientific Publishers.
9. Bioinformatics: The Machine Learning Approach. 2001. Pierre Baldi and Soren Brunak, MIT Press.
10. Bioinformatics: Andrzej Polanski and Marek Kimmel. 2001. Springer-Verlag.
11. Bioinformatics: Sequence and Genome Analysis. 2004. David W Mount Cold Spring Harbor Laboratory Press.
12. Bioinformatics: Volume 1: Data, Sequence Analysis and Evolution. 2008. Edited by Jonathan Keith Humana Press.
13. Bioinformatics: Volume 2: Structure, Function and Applications. 2008. Edited by Jonathan M Keith, Humana Press.

---END OF SYLLABUS---

**B.Sc. Biotechnology
(Semester System)
DEPARTMENT OF
BIOTECHNOLOGY
JAMIA MILLIA ISLAMIA**

YEAR ONE

Semester I Credits 24

Paper 1	Paper 2	Paper 3	Paper 4	Lab
Essential Chemistry	Essential Mathematics	Animal Diversity I	Plant Diversity I	Lab Course I
4 Credits	4 Credits	4 Credits	4 Credits	8 Credits
100 Marks	100 Marks	100 Marks	100 Marks	200 Marks

Semester II Credits 24

Paper 5	Paper 6	Paper 7	Paper 8	Lab
Microbiology	Biochemistry	Animal Diversity II	Plant Diversity II	Lab Course II
4 Credits	4 Credits	4 Credits	4 Credits	8 Credits
100 Marks	100 Marks	100 Marks	100 Marks	200 Marks

YEAR TWO

Semester III Credits 24

Paper 9	Paper 10	Paper 11	Paper 12	Lab
Ecology	Genetics	Immuology	Cell Bology	Lab Course III
4 Credits	4 Credits	4 Credits	4 Credits	8 Credits
100 Marks	100 Marks	100 Marks	100 Marks	200 Marks

Semester IV Credits 24

Paper 13	Paper 14	Paper 15	Paper 16	Lab
Developmental Biology	Molecular Biol & Genet. Engg	Catalysis, Proteins and Enzymes	Plant Pathology & Crop Protection	Lab Course IV
4 Credits	4 Credits	4 Credits	4 Credits	8 Credits
100 Marks	100 Marks	100 Marks	100 Marks	200 Marks

YEAR THREE

Semester V Credits 24

Paper 17	Paper 18	Paper 19	Paper 20	Lab
Human Physiology	Medical Biotechnology	Plant Physiology	Environmental Biotechnology	Lab Course V
4 Credits	4 Credits	4 Credits	4 Credits	8 Credits
100 Marks	100 Marks	100 Marks	100 Marks	200 Marks

Semester VI Credits 24

Paper 21	Paper 22	Paper 23	Paper 24	Lab
Animal Biotechnology	Plant Biotechnology	Evolution and Behavior	Biostatistics & Bioinformatics	Lab Course
4 Credits	4 Credits	4 Credits	4 Credits	8 Credits
100 marks	100 marks	100 marks	100 Marks	200 Marks

Total Semesters = 6 Credits per Semester = 24 Total Credits 6 x 24 = 144 Marks per Credit = 25 Course Total Marks 144 x 25 = 3600
Elementary Subjects: Credits = 16 (400 Marks) Grand Total = 3600 + 400 = 4000 Marks