

Detailed course matrix and scheme of evaluation for subject: Life Sciences (3-year B.Sc. course) effective from 2016-17

SEMESTER I	Course code	Course Title	Hrs/week	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
	Theory							
	LS101T	Biosystematics & Diversity of Plants	4	4	3	70	30	100
Practical								
	LS101P	Biosystematics & Diversity of Plants	3	2	3	35	15	50

SEMESTER II	Course code	Course Title	Hrs/week	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
	Theory							
	LS201T	Biosystematics & Diversity of Animals	4	4	3	70	30	100
Practical								
	LS201P	Biosystematics & Diversity of Animals	3	2	3	35	15	50

SEMESTER III	Course code	Course Title	Hrs/week	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
	Theory							
	LS301T	Plant anatomy & physiology	4	4	3	70	30	100
Practical								
	LS301P	Plant anatomy & physiology	3	2	3	35	15	50

*Internal Assessment:

Theory (30 marks): Class test – 15 marks; Seminar Report – 05 marks; Seminar Presentation – 05 marks; Attendance – 05 marks

Practical (15 marks): Class test – 05 marks; Class Record – 05 marks; Attendance – 05 marks

SEMESTER IV

Course code	Course Title	Hrs/week	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
Theory							
LS401T	Animal anatomy & physiology	4	4	3	70	30	100
Practical							
LS401P	Animal anatomy & physiology	3	2	3	35	15	50

SEMESTER V

Course code	Course Title	Hrs/week	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
Theory							
LS501T	Cell & Molecular biology	3	3	3	70	30	100
LS502T	Developmental biology	3	3	3	70	30	100
Practical							
LS501P	Cell & Molecular biology	3	2	3	35	15	50
LS502P	Developmental biology	3	2	3	35	15	50

SEMESTER VI

Course code	Course Title	Hrs/week	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
Theory							
LS601T	Ecology & Environmental biology	3	3	3	70	30	100
LS602T	Genetics & Evolution	3	3	3	70	30	100
Practical							
LS601P	Ecology & Environmental biology	3	2	3	35	15	50
LS602P	Genetics & Evolution	3	2	3	35	15	50

Detailed Course Content
of B.Sc. with Life Sciences
(effective from 2016-17)

LS101T BIOSYSTEMATICS AND DIVERSITY OF PLANTS

52 hours | 4 hours / week | 4 credits

Unit 1: Introduction to Biosystematics of Plants

04 hours

Botanical Nomenclature: Principles and a brief account of ICBN & ICNCP.

Botanical literature: Floras, Revisions, Monographs, Indices, Journals. Herbarium – Preparation, maintenance and Importance; Important herbaria of the world.

Botanical garden – a brief account and importance; Important botanical gardens of the world.

Unit 2: Viruses & Bacteria

06 hours

Viruses- General characters, diversity (Morphological and Structural) and classification. Nomenclature of viruses. Morphology, Ultra structure and reproduction of TMV, Cauliflower Mosaic Virus and T₄ Phage.

Bacteria - General characters, diversity and classification. Morphology, ultrastructure and reproduction of *Bacillus* and *E.coli*. Cyanobacteria & Mycoplasma : General characters, diversity and classification.

Unit 3: Non-vascular plants

16 hours

Fungi: Occurrence, general characters, diversity and classification (Ainsworth 1972). Economic importance

Algae: Occurrence, general characters and classification (Fritsch 1945). Economic importance.

Bryophytes : General characters and classification, (Proskauer 1957) Fossil Bryophytes. Ecological and economic importance.

Unit 4: Vascular plants

26 hours

Pteridophytes: Occurrence, general characters, diversity and classification (Reimers 1954). Brief account on stelar evolution, heterospory and seed habit. Fossil Pteridophytes - Types of fossils and fossilization.

Gymnosperms: Occurrence, general characters, diversity and classification (Pilger and Melchior (1954). A brief account of economic importance, origin and evolution of Gymnosperms. Fossil Gymnosperms

Angiosperms: Origin of Angiosperms. Occurrence, general characters, diversity and classification. Salient features and importance of the following families:

Dicots: Magnoliaceae, Nymphaeaceae, Caryophyllaceae, Malvaceae, Euphorbiaceae, Rubiaceae, Scrophulariaceae, Asclepiadaceae, Asteraceae.

Monocots: Alismataceae, Arecaceae, Poaceae, Cyperaceae, Zingiberaceae, Liliaceae and Orchidaceae.

Recommended readings:

Non-vascular Plants

1. Alexopoulos C.J. & Mims C.W. 1990. Introductory mycology, 5th edn Wiley Eastern Limited, New Delhi.
2. Fritsch, F.E. 1961. Structure and reproduction in algae, Vol. I, II. Cambridge University Press, London.
3. Bhatia, K.N. 1984. A treatise on Algae. S. Chand and Company, New Delhi.
4. Bold, H.C. and Wynne, M.J. 1978. Introduction to Algae: Structure and reproduction. Prentice Hall, Engle Wood Cliffs, New Jersey.
5. Chopra, R.N & Kumar, P.K. 1988. Biology of Bryophytes. New Age International Publisher, New Delhi.
6. Contract, F. H., Kimball, P.C. and Jay, L. 1998. Virology. Prentice Hall, Englewood Cliff, New Jersey.
7. Kumar, H.D. 1990. Introductory Phycology. Affiliated East West Pvt. Ltd. Bangalore.

8. Pandey, B.P. 1994. Fungi. S. Chand and Company Ltd, New Delhi.
 9. Parihar N.S. 1970. An Introduction to Embryophyta, Vol. I Bryophyta. Central Book. Dept. Allahabad, India.
 10. Pelezar, M.C. (Jr.) Cjan, E.C.S. and Kreig, N.R. 1998. Microbiology. 5th edition, McGraw Hill Book Company. Singapore.
 11. Prescott G.W, 1978. The Fresh Water Algae, Pictured key Nature series, WM .G.Brown Company, IOWA.
 12. Rashid, A. 1998. An introduction to Bryophyta, Vikas Publishing House Pvt. Ltd., New Delhi.
 13. Schlegel, H.G. 1993. General Microbiology. 7th Edition, Cambridge University Press, Cambridge, U.K.
- Smith, G.M. 1950. Cryptogamic Botany Vol. I. McGraw Hill Book Company, New York.

Vascular Plants

Pteridophytes and Gymnosperms :-

1. Parihar. N.S. 1977. The morphology of Pteridophytes, Central book Dept, Allahabad, India.
2. Bhatnagar and Moitra. A. 1996. Gymnosperms. Poplei. New Age International Ltd. New Delhi.
3. Chamberlain. C.J. 1986. Gymnosperms, structure and evolution. CBS Publications, New Delhi.
4. Chopra. G.L and Verma. V. 1988. Gymnosperm. Pradeep Publications, Jalandhar, India

Angiosperms :-

1. Cronquist. A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.
2. Davis. P.H. and Heywood. V.H. 1973. Principles of Angiosperm taxonomy, Robert and E. Kriegen Publications, New York.
3. Heywood. V.H and Moore. D.M. 1984. Current concept in plant taxonomy, Academic Press, London.
4. Sambamurthy. A.V.S.S. 2005. Taxonomy of Angiosperm. IK International Publishers, New Delhi.
5. Lawrence. G.H.M. 1951. Taxonomy of vascular plants, Mac Milan, New York.

LS101P BIOSYSTEMATICS AND DIVERSITY OF PLANTS

3 hours/ week | 2 credits

1. Measurement of dimension of microorganism by Micrometry.
2. Studying Bacteria - Gram staining
3. Identification of Saprolegnia, Pythium, Phytophthora, Albugo, Rhizo[pus, Aspergillus, Penicillium, Peziza, Puccinia, Tikka and Alternaria.
4. Study of representative species of Cyanophyceae – Microcystis, Oscillatoria, Nostoc, Scytonema. Chlorophyceae ; Scenedesmus, Hydrodictyon, Spirogyra, Desmids, Coleochaete, Ulva, Caulerpa. Charophyceae: Chara and Nitella.
Xanthophyceae : Botrydium, Phaeophyceae : Ectocarpus and Sargassum.
Rhodophyceae: Batrachospermum and Polysiphonia.
5. Study of morphology and anatomy of vegetative and reproductive structures of : Marchantia, Lunularia, Porella, Anthoceros, Sphagnum and Funaria.
6. Field visits to natural vegetations rich in non-vascular plants
7. Pteridophytes: Study of morphology, anatomy of vegetative and reproductive structures of Psilotum, Salaginella, Lycopodium, Equisetum, Ophioglossum, Marattia, Osmunda, Pteris, Marsilia.
Fossil pteridophytes subjected to the availability of materials / slides.
8. Gymnosperms: Study of morphology, anatomy of vegetative and reproductive structures of Zamia, Cupressus, Cryptomeria, Araucaria, Ephedra, Gnetum. Fossil Gymnosperms subjected to the availability of materials/slides.
9. Angiosperms: Herbarium preparation, Description of a taxon using technical terms.
10. Derivation of a taxon to respective family using Floras.
11. Study of local flora and field visit to various Botanical gardens to study the vegetation.

LS201T BIOSYSTEMATICS AND DIVERSITY OF ANIMALS

52 hours | 4 hours / week | 4 credits

Unit 1: Introduction to Biosystematics of Animals

04 hours

Systematics of Animals: Meaning, Nomenclature, Principles of Classification, Major branches of invertebrates & vertebrates and their relationships. Minor phyla.

Unit 2: Invertebrates

22 hours

Classification, general characters, diversity and economic importance of Phylum Protozoa, Porifera, Coelenterata, Ctenophora, Platyhelminthes, Aschelimenthes, Annelida, Arthropoda, Mollusca and Echinodermata.

Economic importance: Apiculture, Sericulture, Vermiculture, Lac culture.

Unit 3: Vertebrates

20 hours

Origin, systematic position and characteristics of Vertebrates.

Diversity, Salient features and Classification of classes Pisces, Amphibia, Reptilia, Aves and Mammals (up to orders).

External features, Digestive, Respiratory, Circulatory, Excretory, Nervous and Reproductive systems: Shark, Frog, Rabbit.

Economic importance of Vertebrate phyla.

Unit 4: Adaptations & Animal Behaviour

06 hours

Adaptations – Aquatic, Terrestrial, Aerial (Volant). Adaptive radiations in Reptiles & mammals.

Animal Behaviour - Ethogram, Learning, Instincts, Motivation, Cooperation and conflicts, Social organization in Primates.

Recommended readings:

Invertebrates

- 1) Bames, R.D. 1968. Invertebrate Zoology, 2nd Edn. Saunders, Philadelphia.
- 2) Barrington, E.J.W. 1967. Invertebrate structure and function, Nelson, London.
- 3) Hyman, L.H. 1940-67. The invertebrates, Vol. I-VI. McGraw-Hill, New York.
- 4) Marshall, A.J. and Williams W.D. (Eds). 1995. Text book of Zoology–Invertebrates Ed., Vol. I, A.I.T.B.S. Publications.
- 5) Richard Brusca & Gary J. Brusca 2003. Invertebrates, Sinaver Associates. Inc., Publisher
- 6) A manual of Zoology part 1 non- chordates - Ekambaranatha Ayyar.

Vertebrates

- 1) Parker, J & W. Haswell, 1995. Textbook of Zoology – Vertebrates. The Macmillan Press Ltd., U.K.
- 2) Young J.Z. Life of Vertebrates, ELBS edition.
- 3) Eckert and Randall. Animal Physiology – Mechanisms and adaptations. CBS Publishers, 2000.

LS201P BIOSYSTEMATICS AND DIVERSITY OF ANIMALS

3 hrs/week | 2 credits

Invertebrates:

Identification and classification of

1. Phylum Protozoa – Paramecium, Vorticella, Plasmodium, Euglena, Trypanosoma, Noctiluca, Entamoeba(Amoeba).
2. Porifera - Leucosolenia, Gemmule, Euspongia(Bath sponge), Euplectella(Venus flower basket), Hyalonema (glass rope sponge).
3. Coelenterata – Obelia, Aurelia, Sea anemone Physalia, Velella, Porpita, Corals – Fungia, Astrea, Gorgonia, Meandrina (Brain coral), Tubifora (Slag horn coral), Penantula (Sea pen).
4. Platyhelminthes-Liver fluke, tape worm, planaria.
5. Aschelminthes- Ascaris, Ancylostoma (Hook worm), Schistosoma (Blood worm) Filarial worm.
6. Annelida - Earth worm, Nereis, Aphrodite, leech, sabella, Tubifex, Arenicola.
7. Arthropoda- Lepas, Balanus, Centipede, Millipede, Scorpion, Peripatus, Limulus, Prawn, Crab, Lobster, Grass hopper, mouth parts of insects : butterfly, mosquito, honeybee, housefly and cockroach.
8. Mollusca - Sepia, Octopus, chiton, Patella, Dentalium, fresh water mussel, pila globosa (snail), Nautilus, Murex, Xanchus, Cyprea.
9. Echinodermata - Sea urchin, Starfish, Sea cucumber, Brittle star, sea lilly.
10. Demonstration of Dissections –
11. Reproductive, Digestive and Nervous system of male and female Cockroach, Silkworm.
12. Earth worm – Nervous system (nerve ring) and setae mounting, Rat- Nervous system.

Vertebrates:

1. Identification and classification of vertebrates – Shark, Eel, Tetradon, Macropodus, Ophiocephalus, Narcine, Protopterus, Stegostoma, Salamander, Ichthyophis, Calotes, Mabuya, Phrynosoma, Draco, Varanus, Chamaeleon, Naja naja, Viper, Sphoenodon, Ostrich, Archaeopteryx, Owl, Vamphyrus, Loris, Pangolin, Porcupine.
2. Demonstration of Dissection: Rat nervous, Arterial and venous system, Reproductive system of male and female.
3. Life cycle of Frog.
4. Identification of skulls of chordates.
5. Dentition of chordates
6. Visit to National Parks, Zoos, Sanctuaries, Butterfly park.

LS301T PLANT ANATOMY & PHYSIOLOGY

52 hours | 4 hrs / week | 4 credits

Unit 1: Primary vascular system

13 hours

Organization of primary plant body, apical meristems and primary growth, Primary xylem - composition, Primary phloem - composition, the role of auxins in the development of the primary vascular system.

Cell wall: Structure and development of the cell wall - Structure (light microscopic and ultramicroscopic structure), composition of the cell wall, Cell wall development, role of cytoskeleton in wall development and genetic control of wall development.

Meristem: Definition, classification of meristem, Apical meristems of Shoot and Root apex, relevant theories pertaining to structure and organization of root apex and shoot apex: Shoot Apex: Apical Cell Theory, Tunica Corpus Theory, Zonation Theory.

Root Apex: Histogenic boundaries; Quiescent center; Formation of leaf primordia, Transitional tissue regions, The primary peripheral thickening meristem of Monocotyledons.

Unit 2 : Secondary vascular system

13 hours

Development of the secondary vascular system of the stem and root. Role of the vascular cambium, the effect of secondary growth on the primary body on leaf and branch traces.

Secondary Xylem: Structure and development of secondary xylem, Secondary xylem of gymnosperms and dicotyledons. Patterns of distribution of xylary elements and rays, Tyloses, Genetic control of differentiation of secondary xylem. Evolution in secondary xylem of dicotyledons.

Secondary phloem: Gross and Ultra structure, development of the phloem. Nature and development of the cell wall of sieve elements. Nature of protoplast of sieve elements, Nature and function of P-protein, Distinctive features of phloem of gymnosperms, The nature and function of companion cells and Strasburger cells.

Nodal anatomy: A general account

Anomalous secondary growth: *Aristolochia*, *Boerhaavia*, *Dracaena*.

Periderm: Structure and development, formation of rhytidome, Lenticels

Secretory tissues in plants : Internal secretory structures and External secretory structures.

Ecological adaptations: Xerophytes, Mesophytes, Hydrophytes, Epiphytes, Parasites and Mangroves.

Unit 3: Ascent of Sap

06 hours

Water relation of a plant cell: Water potential, osmotic potential, pressure potential, membrane and their permeability mechanism of water absorption, SPAC concept.

Ascent of sap: Vital and physical forces.

Mineral nutrition: Importance of nutrients, major and minor elements, their deficiency disorders and treatments. Passive and active transport of solutes across the membranes, ion transport in roots, mechanism of translocation, sources and sink concept.

Unit 4: Photosynthesis & Respiration

07 hours

Photosynthesis: General concepts and historical backgrounds, photosynthetic apparatus, mechanism of absorption of light, Absorption spectrum, Emerson's enhancement effect, two pigment system-PS-I and

PS–II. Non cyclic and cyclic electron transport system. Photophosphorylation, carbon assimilation-the Calvin cycle, C₄ cycle and the CAM pathway. Photorespiration and its significance.
Respiration: Types of respiration, mechanism of respiration, Glycolysis, Krebs's Cycle, Electron transport system. Oxidative phosphorylation, Energetics of biological oxidation, respiratory inhibitors.

Unit 5: Growth & Metabolism

07 hours

Growth hormones: Definition, Kinetics, growth hormones, biosynthesis, transport and physiological effects of Auxins, Cytokinins, Gibberellins, Abscisic acid and ethylene, mechanism of hormone action.

Nitrogen metabolism: Introduction, nitrogen fixation, biochemistry of nitrogen fixation, role of *nif* genes and Leghaemoglobin.

Unit 6: Photobiology

06 hours

Circadian rhythms, photoperiodism, vernalization, phytochromes, biochemical signalling involved in flowering, dormancy, seed germination and senescence.

Recommended readings:

Plant Anatomy:

1. Katherine Easn, 1996. Anatomy of seed plants, First Wiley prints, New Delhi.
2. Cutter, D.G. 1971. Plant anatomy- Part-1. Cell and Tissues. Edward Arnold, London.
3. Cutter, D.G. 1971. Plant Anatomy, Part II, Cell and tissues, Edward Arnold, London.
4. Chand, S. 2005. Plant Anatomy, S, Chand and Company Ltd., New Delhi.
5. Metcalf C.R and L. Chalk, 1950, Anatomy of Dicotyledons. Leaves, Stems and wood in relation to taxonomy with Notes on Economic users II Vols. Clerodendron press, Oxford.
6. Pandey, Plant Anatomy, Chand and Company Ltd, New Delhi.
7. Cutler Botha and Stevenson (2007) Plant anatomy an applied approach. Black well publishing, UK.
8. Fahn A.1990, Plant anatomy, 4th edition, Pergamon press, Oxford.

Plant Physiology:

9. Conn, E.E., Stumpf, Bruening, G. and Doi, R.H. 1987. Outlines of Biochemistry, John Wiley and Sons, New York.
10. Wilkins, M.B. (eds). 1989. Advanced physiology, Pitman publishing Ltd, London.
11. Salisbury and Ross, 2005. Plant physiology, CBS publication, New Delhi.
12. Zeiger, 2006. Plant physiology, Sinaere publisher.
13. Trivedi and Verma, 2007. A text book of physiology, biochemistry and biotechnology, S. Chand and Co., New Delhi.
14. Tiaz & Zeiger, 2010. Plant Physiology, 5th edition, Dincoln Taiz & Eduardo Zugier, Parima Publishing, New Delhi.
15. W.G Hopkins and W.P.A Huner Introduction to plant physiology 4th edition, 2011.

LS301P: PLANT ANATOMY & PHYSIOLOGY

3 hours / week | 2 credits

1. Free hand section of Stem: Helianthus (Normal), Cucurbita and Peperomia (Special features).
2. Study of anomalous secondary growth of stem: Boerrhavia, Aristolochia and Draceana.
3. Study of leaf anatomy of Isobilateral (Nerium) and Dorsiventral leaf (Ficus)
4. Study of stomata: Paracytic, anisocytic, anamocytic, Diacytic types.
5. Study of root anatomy : Aerial root (Ficus), Orchid root.
6. Study of Ecological adaptation – Xerophyte (Nerium), Mesophyte (Hydrophyte (Hydrilla)
7. Wood anatomy-TLS & RLS of
Gymnospermous wood (Pinus/Araucaria) & Angiospermous wood(Michelia)
8. Plant Microtechnique - Microtomy, Maceration.
9. Determination of water potentials by following drops methods.
10. Hydroponics study of deficiency symptoms (chlorosis, necrosis)
11. Separation of chlorophylls and carotenoids by Ascending paper chromatography
12. Bioassay of Phyto hormones – Auxins, Cytokinins, Gibberllins, Abssic acid, Ethylene
13. Determination of lipid activity
14. Estimation of Leghaemoglobin in the nodules.

LS401T: ANIMAL ANATOMY & PHYSIOLOGY

52 hours | 4 hours / week | 4 credits

Unit 1 **05 hours**

Integument and derivatives: Structure and functions of skin (Mammals), scales, claws, nails, hairs, feathers and horns.

Unit 2 **14 hours**

Comparative account of heart (Fish, Frog, Reptile, Bird and Mammals), eyes –compound and camera eye, gills (fish) and lungs (Mammals), skull (rabbit), limbs - fore limbs & hind limbs (mammals).

Unit 3 **07 hours**

Histophysiology : Liver, Kidney, Spleen, Testis, Ovary, Pituitary, Pancreas.

Unit 4 **05 hours**

Respiration and Circulation: Types of respiration, Respiratory pigments, transport of O₂ and CO₂, Open and closed circulation, Blood composition and function.

Unit 5 **04 hours**

Excitable nature of the Nerve Impulse. Origin and propagation of action potential. Propagation of action potential across cell membrane and synaptic junction.

Unit 6 **03 hours**

Excretory patterns in vertebrates: ammonotelism, ureotelism and uricotelism.

Unit 7 **07 hours**

Contractile cytoplasmic streaming, Ameboid Movement, Ciliary, Flagellar and Muscular movements. Contraction of smooth, cardiac, skeletal muscle fibers. The sliding Filament Mechanism of Muscular Contraction. Mechanism of Contraction & involvement of muscle proteins.

Unit 7 **07 hours**

Feeding and digestion: Feeding patterns in vertebrates. Chemical and mechanical digestion, Stimulation of gastro-intestinal secretions, Digestion of carbohydrates, lipids and proteins. Nutritive types, vitamins, minerals, energy requirements, nutrition requirements of different ages. Nutritional disorders.

Recommended readings:

- 1) Parker, J&W. Haswell, 1995. Textbook of Zoology – Vertebrates. The Macmillan Press Ltd., U.K.
- 2) Stephen A. Miller & John P. Harley 2001, Zoology. The Animal Kingdom. Wm. C Publishers.
- 3) Berme, R.N. and Levy MN Principles of Physiology, Mosby Year Book. Inc.1996.
- 4) Eckert and Randall. Animal Physiology – Mechanisms and adaptations. CBS Publishers, 2000.
- 5) Schmidt-Nielsen. Animal Physiology. Cambridge Univ. Press, 2000.
- 6) D. Jenson. The Principles of Physiology. Appleton-Century-Crofts, 1996.
- 7) Prosser CL. Comparative Animal Physiology. WB Saunders and Company, 1973.

LS401P ANIMAL ANATOMY & PHYSIOLOGY

3 hrs / week |2 credits

1. Identification and functions of scales (fishes), claws, nails, hairs, horns, feathers, Hoofs and nests.
2. Felid visits to Research institutes, national parks and natural vegetations.
3. Vertebre – Procoelous (Frog), Amphicoelous (Bird), Amphiplateous (Rabbit).
4. Skulls in vertebrates : Frog, Bird, Mammal, rabbit, dog, man, turtle.
5. Histology sections of Testis, Ovary, Liver, Pancreas, Kidney, Spleen, intestine.
6. Microtomy – Organ fixing, Block making, Sectioning and staining of any one organ (rat)
7. Determination of oxygen consumption and metabolic rate in fish.
8. Rate of protein digestion by trypsin.
9. Acetylcholine activity in tissues
10. Determination of ATPase activity in tissues

LS501T: Cell and Molecular Biology
39 hours | 3 hours/week | 3 credits

Unit 1: Techniques in Biology

04 hours

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2: Cell as a unit of Life

02 hours

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Unit 3: Cell Organelles

12 hours

Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.

Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.

ER, Golgi body & Lysosomes: Structures and roles.

Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.

Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4: Cell Membrane and Cell Wall

04 hours

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Unit 5: Cell Cycle

04 hours

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 6: Genetic material

05 hours

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, θ (theta) mode of replication, replication of linear, ds-DNA, replicating the 5' end of linear chromosome including replication enzymes.

Unit 7: Transcription (Prokaryotes and Eukaryotes)

04 hours

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code

Unit 8: Regulation of gene expression

04 hours

Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes.

Recommended readings:

1. Cell and Molecular Biology. De Roberts and De Roberts., Saunders College, USA 6th edition.
2. Molecular Cell Biology. Lodish, Berk, Zipursky, Matsudaira, Baltimore & Darnell. Freeman Press, 6th edition.
3. Cell Biology. Karp G., McGraw Hill book comp. New York. 6th edition. 2010.
4. The Cell : A molecular approach. Cooper, G.M. ASM Press, USA. 5th edition. 2009.
5. Chromatin structure and function. Wolfe, A., Academic press, New York 1995.
6. Cell Biology. Pollard. J.P. and Earnshaw, W.C. Saunders. 2002.
7. The Cell –A molecular approach. Cooper, G.M. Princeton Publishers. NY, 2000.
8. Molecular Cell Biology. Lodin, H., Berk, A., Zipursky, S.L., Matsudain, P., Baltimore, D. and Darneil, T. Will Freeman Company, NY, 6th edition.
9. Molecular biology of the cell. Albert, B., Johnson, A., Raff, M., Robert, K., Walter, P. Garland Sciences, NY, 5th edition.
10. Karp, G. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc. 2010.
11. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia. 2006.
12. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. 5th edition. 2009.
13. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
14. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco. 2009.

LS501P: Cell and Molecular Biology

3 hours/week | 2 credits

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

Cell Biology

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated muscle fiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells/cheek epithelial cells using vital stain Janus green.
7. Study of mitosis and meiosis -temporary mounts and permanent slides (*Allium cepa*, Grass hopper/*Drosophila*)
8. Study the effect of temperature, organic solvent on semi permeable membrane.
9. Demonstration of dialysis of starch and simple sugar.
10. Study of plasmolysis and deplasmolysis on Rhoeo leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
13. Study DNA packaging by micrographs.
14. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Molecular Biology

1. Isolation of nucleic acids from plant (young leaves, *Allium cepa*) and animal (butterfly or silkworm larva, adult Uzi fly, *Drosophila* larva) by CTAB and SDS-Proteinase K method
2. Isolation of plasmid DNA from bacterial culture using DNA extraction kit
3. Extraction of total RNA from bacterial culture using RNA isolation kit
4. Estimation of DNA content by Diphenylamine(DPA) method
5. Estimation of RNA by Orcinol method
6. Estimation of protein by Bradford method
7. Separation of nucleotide bases by paper chromatography
8. Agarose gel electrophoresis of DNA and RNA
9. Polyacrylamide gel electrophories of proteins

LS502T: DEVELOPMENTAL BIOLOGY

39 hours | 3 hours / week | 3 credits

Unit 1: Introduction to developmental biology; Early development- Fertilization-types, Types & mechanisms of cleavage. Gastrulation: Cell movement and formation of germ layers in frog & chick and mouse, Concept of cell type determination, competence and differentiation, Creation of specific organs (organogenesis – chick) **5 hours**

Unit 2: Organizer concept: Primary organizer, embryonic stem cell, development of vertebrate nervous system (chick) Formation of neural tube, regions of brain. **3 hours**

Unit 3: Genetics of pattern formation: *Coenorhabditis*, *Drosophila*, *Arabidopsis thaliana*, Maternal gene and formation of body axes, Homeotic gene function, Imaginal disc development, Axes formation in vertebrate, Hox genes. **6 hours**

Unit 4: Post embryonic development:

- Metamorphosis- endocrine control of metamorphosis in amphibian and insects.
- Regeneration – Cellular processes in regeneration, Sources, determination of polarity, regulation of regeneration. **6 hours**

Unit 5: Gametogenesis in plants:

Microsporogenesis & male gametophyte :- Anther wall Structure and development- Endothecium, Middle layers, Tapetum, Nuclear behaviour in tapetal cells and Sporogenous tissue; Formation of vegetative and generative cells, Formation of pollen wall – Structure and development and abnormal pollen grains.

Megasporogenesis & female gametophyte :- Structure and development of ovules, Types and parts of ovules. Structure and development of female gametophyte, Types of female gametophytes, Structure of Mature Embryo sac, Embryo sac haustoria. **9 hours**

Unit 6: Fertilization and embryogeny: Structure of style and stigma, Pollen germination and pollen tube growth. Path of pollen tube, pollen tube discharge, Double fertilization: triple fusion and syngamy. Central cell as the second gamete of the flowering plant. Structure and types of endosperm, Physiology and cytology of endosperm and functions of endosperm and endosperm haustoria. Classification of Embryogeny, early embryogenesis and mature embryo of Dicotyledons – *Capsella bursa pastoris* and mature embryo of monocotyledons- *Najus lacerata* and Grass. **10 hours**

Recommended readings:

1. Alberts *et al*, Molecular Biology of The Cell. 6th edition, Garland, 2014.
2. Scott F. Gilbert, Developmental Biology, Sinauer, 2003.
3. Kalthoff, Analysis of Biological Development, McGraw Hill, 1996.
4. Lewin, Genes VIII, Pearson, 2004.
5. Monk, Mammalian Development – A Practical Approach, IRL, 1987.
6. O’Rahilly and Muller, Human Embryology and Teratology, Wiley, 1992.

7. Rana, Human Embryology Made Easy, Harwood, 1998.
8. Wolpert, Principles of Development, Oxford, 2002.
9. Singh, P. 2001. Essentials of Plant Breeding, Kalyani Publishers, Hyderabad.
10. Allard, R. W. 1999. Principles of Plant Breeding. John Willey & Sons. New York.
11. Dana, S. 2001. Plant Breeding. Naya Udyog. Calcutta.
12. Singh. B. D. 1995. Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.

LS502P: DEVELOPMENTAL BIOLOGY

3 hrs / week | 2 credits

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

1. Study of whole mounts of frog and chick- early developmental stages
2. Study of chick development from live eggs (window viewing) & permanent embryo mounting
3. Study of section of chick embryo through selective developmental stages
4. Dissection and mounting of imaginal discs of *Drosophila* / silk worm
4. Videos showing selective embryonic events like cleavage; gastrulation
5. Measurement of animal/plant cell size using ocular and stage micrometer.
6. Micro and mega sporogenesis in higher plants-slides only
7. Pollen germination in-vivo and in-vitro
8. Study of gamete/spores in algae, moss, liverwort, pteridophyte and gymnosperm
9. Embryo development in flowering plant- slides only; dissection of endosperm and embryo
10. Study of apical and lateral meristem, hypertrophy and hyperplasia
11. Mounting of endosperm – *Cucumis* sp.
12. Mounting of embryo – *Cyamopsis* / *Tridax* sp.

LS601T: ECOLOGY & ENVIRONMENTAL BIOLOGY
39 hours | 3 hrs / week | 3 credits

Unit 1: Introduction: Definition of Ecology. Principles and Scope of Ecology, Laws of thermodynamics, Basic laws of energy flow: energy flow models, biogeochemical cycles. Ecosystem- concept and principles, structure and function of ecosystem, classification of ecosystem and composition, food chain, food webs, trophic levels, ecological pyramids. Ecological succession- Introduction, definition of succession and types. **10 hours**

Unit 2: Population & Behavioural Ecology; Population growth and structure, Regulation, Intra and Inter specific interactions. Community Ecology; Biotic community concept, community analysis, community stability, dynamics and equilibria, methods of studying ecosystem. Productivity-definition, types, measurements of Biomass and productivity in terrestrial and aquatic communities. Foraging behaviour, mating behaviour, mating systems, colouration and mimicry. **10 hours**

Unit 3: Natural resources: Renewable and non-renewable resources, forest resources- use and over exploitation, deforestation, case studies. Timber extraction , mining, dams and their effects on forests and tribal people; Water resources- use and over utilization of surface and ground water, floods, drought, conflicts over water, dams, benefits and problems; Mineral resources- use and exploitation, environmental effects of extraction and use of mineral resources, case studies; Agricultural resources- World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizer- Pesticide problems, water logging and salinity, case studies; Energy resources- growing energy needs, conventional and non-conventional energy resources, use of alternative energy sources, case studies; Land resources- Land as a resource, Land degradation, landslides, soil erosion and desertification. **10 hours**

Unit 4: Biodiversity and Conservation: Biogeographical classification of India, Biodiversity at Global, National and Local levels, India as a mega diversity nation, Threats to biodiversity, habitat loss, poaching of wildlife, man wildlife conflicts, endangered and endemic species of India, Ex-situ and In-situ conservation of Biodiversity. **5 hours**

Unit 5: Population & pollution: Pollution-Definition, Types, sources and effects of pollution. Solid waste management- types, effects and control measures, disaster management- floods, cyclone and landslides. Human population explosion, environment and human health, Human rights, Information technology and environmental health, case studies; Environmental Protection Act (EPA) - Air, Water, Wildlife, Forest conservation Acts, Public awareness. **4 hours**

Recommended readings

1. Kormondy EJ, Concepts of Ecology, Prentice Hall, 1962.
2. Odum E P, Fundamentals of Ecology, 3rd Edition, Saunders, 1971.
3. Phillipson F H, Ecological energetics, Edward Arnold, 1980.
4. Eiseth G D et.al., Population Ecology, Van Nos, Stand Co., 1981.
5. Kumar H D, General Ecology, 1st Edition, Vikas Publishing House Pvt. Ltd., 1995

LS601P: ECOLOGY & ENVIRONMENTAL BIOLOGY
3 hrs / week | 2 credits

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

1. Determination of dissolved oxygen in given water sample by Winkler's method
2. Estimation of Primary Productivity of Lake/ Pond System
3. Sampling techniques for plankton
4. Plotting of survivorship curves from hypothetical life table data
5. Productivity and Biomass estimation of plants
6. To determine minimal quadrat area for sampling in the given simulation sheet
7. To determine soil texture, soil density, bulk density, particle density and pore space
8. To determine water holding capacity and percolation rate of soil
9. To determine COD, BOD, Total solids
10. Determination of hardness of water.
11. Soil analysis: pH, Inorganic and organic contents
12. Study through specimens/photographs/slides of parasitic angiosperms, Saprophytic angiosperms, VAM fungi, Root nodules, Coralloid roots, Mycorrhizal roots, Velamen roots, Lichen as pollution indicators.
13. Principle and function of Sechi disc, Atmometer, Anemometer, Hygrometer, Hair hygrometer, Luxmeter, Rain guage, Soil thermometer, Min-Max thermometer.

LS602T: Genetics and Evolution
39 hours | 3 hours/week | 3 credits

Unit 1: Introduction to Genetics **02 hours**
Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension **05 hours**
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and codominance, Multiple alleles, lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping **05 hours**
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping

Unit 4: Mutations **05 hours**
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor Mutations.

Unit 5: Sex Determination **02 hours**
Chromosomal mechanisms, dosage compensation

Unit 6: History, theories and evidences of evolution **08 hours**
Major Events in History of Life, Lamarckism, Darwinism, Neo-Darwinism, Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse.

Unit 7: Processes of Evolutionary Change **05 hours**
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit 8: Species Concept, macroevolution and extinction **08 hours**
Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric), Macroevolution and Macroevolutionary principles (example: Darwin's Finches), Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

Recommended readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. Principles of Genetics. VIII Edition. Wiley India. 2008
2. Snustad, D.P., Simmons, M.J.). Principles of Genetics. V Edition. John Wiley and Sons Inc. 2009
3. Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. X Edition. Benjamin Cummings. 2012
4. Russell, P. J. Genetics- A Molecular Approach. III Edition. Benjamin Cummings. 2009
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
6. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
7. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. Evolution. Cold Spring, Harbour Laboratory Press. (2007).

8. Hall, B. K. and Hallgrímsson, B. Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers 2008.
 9. Campbell, N. A. and Reece J. B. Biology. IX Edition, Pearson, Benjamin, Cummings. 2011
- Douglas, J. Futuyma. Evolutionary Biology. Sinauer Associates. 1997

LS602P: GENETICS & EVOLUTION

3 hours / week | 2 credits

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/ pictures
6. Charts:
 - a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
 - b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report
