Detailed course matrix and scheme of evaluation for M.Sc. in Life Sciences (CBCS scheme) 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	Organismal biology	4	4	3	70	30	100
LS102T	Biological chemistry	4	4	3	70	30	100
LS103T	Reproductive biology	4	4	3	70	30	100
LS104T	Evolutionary biology	4	4	3	70	30	100
LS105T	Biochemical techniques	2	2	2	35	15	50
Practical							
LS106P	Organismal biology & Biological Chemistry	4 × 2	4	4	70	30	100
LS107P	Reproductive & Evolutionary biology	4 × 2	4	4	70	30	100

SEMESTER – II

Course code	Course Title	Total No. of hours	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
Theory							
LS201T	Parasitology & Pathology	4	4	3	70	30	100
LS202T	Immunology	4	4	3	70	30	100
LS203T	Microbiology	4	4	3	70	30	100
LS204T	Molecular Genetics	4	4	3	70	30	100
LS205T	Research Methodology	2	2	2	35	15	50
Practical							
LS206P	Parasitology, Pathology & Immunology	4 × 2	4	4	70	30	100
LS207P	Microbiology & Molecular Genetics	4 × 2	4	4	70	30	100

*Internal Assessment:
Theory (30 marks): Class test – 15 marks; Seminar Report – 05 marks; Seminar Presentation – 05 marks; Attendance – 05 marks
Practical (30 marks): Class test – 15 marks; Class Record – 10 marks; Attendance – 05 mark

SEMESTER – III

Course code	Course Title	Total No. of hours	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
Theory							
LS301T	Genomics & Proteomics	4	4	3	70	30	100
LS302T	Genetic Engineering& Biotechnology	4	4	3	70	30	100
LS303T	Systems Biology	4	4	3	70	30	100
LS304T	Open Elective	4	4	3	70	30	100
Practical							
LS305P	Genomics, Proteomics & Systems Biology	4 × 2	4	4	70	30	100
LS306P	Genetic Engineering& Biotechnology	4 × 2	4	4	70	30	100

SEMESTER – IV

Course code	Course Title	Total No. of hours	Total credits	Duration of examination (hrs)	Maximum marks	*Internal Assessment	Total marks
Theory							
LS401T	Biomedical Sciences	4	4	3	70	30	100
LS402T	Bioinformatics & Computational biology	4	4	3	70	30	100
LS403T	Mathematical biology & Biostatistics	4	4	3	70	30	100
LS404T	Applied Biology	4	4	3	70	30	100
Practical							
LS405P	Biomedical Sciences & Bioinformatics	4 × 2	4	4	70	30	100
LS406P	Research Project & Dissertation**	-	4	4	70	30	100

*Internal Assessment:
Theory (30 marks / 15 marks): Class test – 15 /05 marks; Seminar Report – 05/2.5 marks; Seminar Presentation – 05/2.5 marks; Attendance – 05/05 marks
Practical (30 marks): Class test – 15 marks; Class Record – 10 marks; Attendance – 05 marks
**Research Project: Examination will include evaluation of dissertation, oral presentation and viva-voce: (50+10+10) = 70 marks; Internal assessment (15+15) = 30 marks will be evaluated on the basis of mid-semester poster presentation & colloquium showing research progress.

*************Semester I*************

LS101T: ORGANISMAL BIOLOGY

52 hours: 4 credits

Unit 1: Variety of Life **6 hours**

Classification, five kingdoms, prokaryotes, viruses, kingdom fungi, kingdom protoctista, kingdom plantae, kingdom Animalia. Chemicals of life: carbohydrates, proteins, lipids, nucleic acids.

Histology: Simple and complex plant tissues; epithelial, connective, muscle and nerve tissue in animals.

Unit 2: Nutrition

Autotrophic nutrition: **4 hours**

Grouping organisms according to energy and carbon sources, importance of photosynthesis, structure of leaf, photosynthetic pigments, biochemistry of photosynthesis, metabolism of glycerate phosphate and triose phosphate, factors affecting photosynthesis, C4 photosynthesis, mineral nutrition of plants and animals, compensation points.

Heterotrophic nutrition: **3 hours**

Forms, feeding mechanisms in a range of animals, the alimentary canal in humans, nervous and hormonal control of digestive secretions, summary of fate of absorbed food materials, nutrition in humans.

Unit 3: Energy utilisation **4 hours**

Cellular respiration, ATP generation, gaseous exchange in flowering plants, gaseous exchange in mammals, respiratory diseases in Man, ATP utilization during exercise and training.

Unit 4: Transportation **9 hours**

Transportation in Plants: Movement of water through flowering plants, transpiration and movement of water through leaf, ascent of sap in xylem, uptake of water and mineral salts by roots, translocation of mineral salts, translocation of organic solutes in phloem.

Transportation in Animals: Water and nutrient transport at cellular level, General characteristics of blood vascular system in animals, composition of blood, formation of tissue fluid, functions of mammalian blood heart and circulation, blood vessels. Fluid transport across intestinal epithelium and blood-brain barrier.

Unit 5: Coordination and control **6 hours**

Plants: Plant movements, growth substances, synergism and antagonism, phytochrome and effects of life on plant development, vernalisation and flowering

Animals: Evolution of nervous system, sensory receptors, structure and function of receptors in vertebrates and non-vertebrates; skeletal system, neuro-muscular coordination.

Unit 6: Homeostasis, Excretion & Osmoregulation **7 hours**

Control systems in biology, control of blood glucose and temperature. Significance of excretion and osmoregulation, nitrogenous excretory products and environment, Excretion and osmoregulation in representative animals, formation of urine in humans, human kidney, ADH, control of blood pH and blood sodium level. Water conservation in plants and algae.

Unit 7: Growth & Reproduction **13 hours**

Definition of growth, patterns of growth, measurement of growth, growth and development in flowering plant, role of hormones in human growth and development.

Asexual reproduction- types, advantages and disadvantages, artificial propagation in plants, cloning, sexual reproduction in flowering plants & vertebrates. Human reproductive system, sexual reproduction in humans, human intervention in reproduction.

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Recommended readings:

1. Taylor DJ, Green NPO, & Stout GW, Biological Science, 3rd edition, CUP, 1997.
2. Reece JB & Campbell NA, Biology, 6th edition, 2008.
3. Roberts MBV, Biology-A functional approach, 4th edition, 2013.
4. Miller KR & Levine JS, Biology, student edition, 2010.

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LS102T: BIOLOGICAL CHEMISTRY

52 hours: 4 credits

Unit 1 **01 hour**

Introduction*:* Development and scope of Biochemistry, Biochemical composition of living organisms.

Unit 2 **07 hours**

Carbohydrates metabolism: Glycolysis-entry of other carbohydrates into glycolysis, the fates of pyruvate, the citiric acid cycle, the energetics of glucose metabolism. Enzymatic control of glycolysis and TCA cycle. Outline of pentose phosphate pathway and its significance. The Cori's cycle, Outline of gluconeogenesis and glycogen metabolism. The amphipathic and integrating role of the citric acid cycle. Substrate level phosphorylation. Regulation of blood sugar level and Diabetes mellitus. Glycogen storage disorder.

Unit 3 **09 hours**

Amino acids, Proteins and their metabolism: Protein and non-protein amino acids, structure and classification of amino acids and their properties. Peptides-The peptide bond, biologically important peptides. Proteins-Classification based on composition, shape and function, color reaction. Structural organization – primary, secondary, tertiary and quaternary structures, denaturation.

Amino acid metabolism- General reactions of amino acid metabolism- transamination, deamination and decarboxylation. The urea cycle and its regulation. Biosynthesis of glycine, alanine cysteine and aspartic acid. Biosynthesis of biologically active amines-epinephrine, nor-epinephrine, histamine and poly amines. Disorders of aminoacid metabolism- PKU and AKU.

Unit 4 **09 hours**

Lipids, Bio-Membranes and their metabolism: Classification of lipids and biological function.Fatty acids; classification based on structure, properties of fatty acids. Acyl glycerols; Hydrolysis, Rancidity, acid, saponification and iodine values. Phosphoglycerides; structures and biological roles, Sphingolipids; phosphosphingolipids - sphingomyelins; Glycosphingolipids - gangliosides and cerebrosides. Prostaglandins; An overview of biological roles, structure of PGE_2 and PGF_{2a}. Waxes of biological importance, Lipoproteins; types and functions, Membranes; Behaviour of amphipathic lipids in water, formation of micelles, bilayers and vesicles. Lipoproteins- types and functions. Functions and chemical composition of biological membranes, Fluid mosaic model. Steroids- Function of cholic acid, cholesterol, androgen and estrogens. The beta- oxidation pathway- even and odd numbered saturated and unsaturated fatty acids, Structure and functions of fatty acyl synthase. Energetics of total oxidation. General scheme of biosynthesis of fatty acids, Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis

Unit 5 **06 hours**

Nucleic acid and their metabolism: Structure and Properties - Nitrogen Bases, Nucleosides, Nucleotides, Polynucleotides**.** Nucleic acid metabolism- Biosynthesis of Purine and Pyrimidines, Denovo and Salvage pathways, Biodegradation of Purines and Pyrimidines.

Unit 6 **09 hours**

Bioenergetics and biological oxidation: Bioenergetics- Energy transformations in living systems, free energy concept. Exergonic and endergonic reactions, ATP and other high energy compounds, energy coupling of Biological oxidation; Step-wise process of biological oxidation, standard reduction potentials of some biochemically important half-reactions, calculation of energy yields from biological oxidation reduction reactions. Mitochondrial electron transport chain-components, schematic representation indicating sites of ATP synthesis. Oxidative phosphorylation-Chemiosmotic theory (an outline)

Unit 7 **11 hours**

Enzymes: Introduction, Classification Characteristic and their specificity. Theories of interaction between active sites and substrate, Energy of activation, cofactors, coenzymes. Enzyme assays and International Units

Enzyme kinetics; Factors affecting the rate of enzyme-catalyzed reactions- enzyme concentration, substrate concentration, pH, and temperature. Michaelis-Menten equation, Significance of K_m and V_{max} and their determination using LineWeaver- Burk plots.

Enzyme inhibition; reversible and irreversible, Reversible-competitive, noncompetitive, uncompetitive inhibition with graphical representations using L-B plots. Brief mention of allosteric enzymes and isoenzymes. Biotechnological and clinical application of enzymes.

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Recommended readings:

1. Gilbert, H.F. 2002. Basic concept of biochemistry. McGraw Hill professional, New York.
2. Down. M.B. 1999. Biochemistry. Lipincott Willam and Wilkins, London.
3. Cambell, M. and Farrell, D. 2005. Biochemistry. Thomson Books/Cole.
4. Stryer, L 1999. Biochemistry. W.H. Freeman and Company, New York.
5. Power and Chatwal. 2000. Biochemistry. Himalayan publishing house, New Delhi.
6. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry 3rd or 4th edition Pub WH Freeman Co.
7. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.
8. Mathews, Van Holde and Ahern, Biochemistry by 3rd edition, Pub Pearson education
9. Stryer, L. Biochemistry 4th Edn. W.H. Freeman and Co. NY.
10. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2nd edition Pub: Tata.
11. Voet, D., Voet J.G. (2004). Biochemistry 2nd Edn.
12. Devlin, T.M. (1997). Biochemistry with clinical correlations, Wiley-Liss Inc. NY
13. Zubey G.L. Parson, W.W., Vance D.E (1994). Principles of Biochemistry WmC Brown publishers. Oxford
14. Edwards and Hassall. Biochemistry and Physiology of the cell 2nd Edn. McGraw Hill Co. UK. Ltd.

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LS103T: REPRODUCTIVE BIOLOGY
52 hours: 4 credits

Unit 1: **Reproduction in Plant kingdom**

Non Vascular Plants: Concept of asexual and sexual reproduction in nonvascular plants, Regeneration, Alternation of generation (metagenesis/heterogenesis), Sporophytes and Gametophytes. **02 hours**

Vascular plants: Induction of flowering; flower as a modified determinate shoot. Floral organs, transition of shoot apex to flowering apex, Flower development: genetic and molecular aspects, ABC model (*Arabidopsis thaliana*). **04 hours**

Unit 2: The Anther wall **08 hours**

Structure and functions, microsporogenesis, callus deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 3: The ovule **07 hours**

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte–megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac.

Unit 4: Pollination and fertilization **03 hours**

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization, polyembryony and apomixes.

Unit 5: Reproduction in animal kingdom **09 hours**

Invertebrates: Concept of Asexual and sexual reproduction in invertebrates, Reproductive structures and Reproduction in Coelenterates, Annelida, Arthropoda (with special reference to insects), Mollusca and Echinodermata, hormones and pheromones and their role in sex differentiation and gonadal activity, Gamete diversity and comparative embryonic development, Role of endosymbionts in reproductive manipulation of invertebrates.

Vertebrates: Reproductive structures and Reproduction in Fishes, Amphibians, Reptiles, Birds and Mammals, environmental and hormonal control of sex differentiation and gonadal activity, Reproductive patterns, Ovipary, Ovo-vivpary and vivipary.

Unit 6: Reproduction in mammals **09 hours**

The female reproductive system: comparative anatomy and physiology (rat and human), ovarian hormones, two cell theory of Estrogen biosynthesis, Autocrine, Paracrine and Endocrine regulation of ovarian functions, Reproductive cycles (rat and human) and their regulation, sperm transportation in the female reproductive tract.

The male reproductive system: comparative anatomy and physiology (rat and human), testes and sex accessory glands, spermatogenic cycle (kinetics and hormonal regulation), testicular endrogens, Autocrine, Paracrine and Endocrine regulation of testicular functions, sperm transportation in male tract (rat and human), Semen and its biochemical nature.

Unit 7: Fertilization **07 hours**

Pre-fertilization events, biochemistry of fertilization and post fertilization events, implantation and its hormonal regulation, delayed implantation, Placenta as an endocrine tissue, foeto-placental unit, gestation and its hormonal regulation, reproductive health (male and female), Human Contraception and Human assisted reproductive Technologies (ET, EFT, IUT,ZIFT, GIFT, ICSI, PROST), sperm bank, *In vitro* fertilization (IVF), Demographic terminologies used in family planning.

Unit 8: Regulation of reproduction **03 hours**

The pituitary gland: functional cytology, adenohypophyseal hormones, the hypothalamus, the neuro secretory cells, mammary gland and endocrinology and lactation

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Recommended readings:

Plant reproductive biology:

1. Bhojwani, S.S. & Bhatnagar, S.P. The embryology of Angiosperms. Kalyani publishers, New Delhi. 2001.
2. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. Comparative Embryology of Angiosperms. Vol. I and II. Springer Verlag.

Animal reproductive biology:

1. Balinsky, B.I. An introduction to embryology. 5th ed. WB Sunders Co. West Washigton Square, Philadelphia.
2. Bodemer, C.W. 1968. Modern embryology. Holt, Reinhart Winston Inc. NY. Chicago.

LS104T: EVOLUTIONARY BIOLOGY
52 hours: 4 credits

Unit 1: **Historical Review of Evolutionary Concept** **06 hours**

Pre-Darwinian ideas – List of contributors influencing Darwin indicated as a timeline. Lamarckism – Merits and demerits. Darwinism – Merits and demerits, Post-Darwinian era – Modern synthetic theory; biomathematics and the theory of population genetics leading to Neo-Darwinism

Unit 2: **Life's Beginnings** **05 hours**

Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Origin of photosynthesis – Evolution of oxygen and ozone buildup. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes

Unit 3: **Evidences of Evolution** **04 hours**

Paleobiological – Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods). Anatomical – Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic – Transitional forms/evolutionary intermediates; living fossils. Phylogenetic – a) Fossil based – Phylogeny of horse as a model. b) Molecule based – Protein model (Cytochrome C); gene model (Globin gene family)

Unit 4: **Sources of Evolution – Variations as Raw Materials of Change** **06 hours**

Types of variations – Continuous and discontinuous; heritable and non-heritable. Causes, classification and contribution to evolution – Gene mutation; chromosomal aberrations; recombination and random assortment (basis of sexual reproduction); gene regulation . Concept of micro- and macro-evolution – A brief comparison

Unit 5: **Forces of Evolution – Qualitative Studies Based on Field Observations** **07 hours**

Natural selection as a guiding force – Its attributes and action Basic characteristics of natural selection. Colouration, camouflage and mimicry, Co-adaptation and co-evolution, Man-made causes of change – Industrial melanism; brief mention of drug, pesticide, antibiotic and herbicide resistance in various organisms. Modes of selection, Polymorphism, Heterosis and Balanced lethal systems. Genetic Drift (Sewall Wright effect) as a stochastic/random force – Its attributes and action. Basic characteristics of drift; selection vs. drift, Bottleneck effect. Founder principle

Unit 6: **Forces of Evolution – Quantitative Studies Based on Biomathematics** **05 hours**

Population genetics – Gene pool; gene/allele frequency; genotypic frequency; phenotypic frequency (simple problems for calculation). Conservation of gene frequencies (when selection does not operate) – Hardy-Weinberg's Law of Genetic Equilibrium. Alterations in gene frequency (when selection operates) – Calculation based on Selection Coefficient and Fitness). Fluctuations in gene frequency (when drift operates) – Calculation based on standard deviation

Unit 7: **Product of Evolution – Speciation** **05 hours**

Concept of species as a real entity, Mechanisms of speciation – Allopatric; sympatric; peripatric, Patterns of speciation – Anagenesis and Cladogenesis; Phyletic Gradualism and Punctuated Equilibrium (Quantum Evolution), Basis of speciation – Isolating mechanisms

Unit 8: **End of Evolution – Extinction** **02 hours**

Periodic extinctions, Mass-scale extinctions – Causes and events

Unit 9: **Evolution of Plants and Fungi** **07 hours**

Origin of land plants – Terrestrial algae and Bryophytes; alternation of generations. Early vascular plants – Stelar evolution; Sporangium evolution. Angiosperms – Phylogeny of major groups. Fungi

Unit 10: **Human Ancestry and Phylogeny** **05 hours**

Primate characteristics and unique Hominin characteristics. Primate phylogeny leading to Hominin line. Human migration – Theories. Brief reference to molecular analysis of human origin – Mitochondrial DNA and Y-chromosome studies.

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Recommended readings:

1. Ridley, M. (2004) Evolution. III Edn. Blackwell

2. Hall, B. K. and Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett

3. Zimmer, C. and Emlen, D. J. (2013) Evolution: Making Sense of Life. Roberts & Co.

4. Futuyma, D. (1998) Evolutionary Biology. III Edn. Sinauer Assoc. Inc.

5. Barton, Briggs, Eisen, Goldstein and Patel. (2007) Evolution. Cold Spring Harbor Laboratory Press

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LS105T: BIOCHEMICAL INSTRUMENTATION

26 hours: 2 credits

Unit 1: Spectroscopic Techniques **06 hours**

Principle of UV-Visible absorption spectrophotometry, instrumentation and applications, Flourimetry: Phenomena of fluorescence, intrinsic and extrinsic fluorescence, instrumentation and applications

Unit 2: Chromatography **07 hours**

Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), preparative and analytical applications, LPLC and HPLC. Principle and applications of: Paper Chromatography, Thin Layer Chromatography. Molecular Sieve Chromatography, Ion Exchange Chromatography, Affinity Chromatography

Unit 3: Electrophoresis **07 hours**

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native and denaturing gels. Agarose gel electrophoresis, buffer systems in electrophoresis. Electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification. Molecular weight determination, Isoelectric Focusing of proteins

Unit 4: Centrifugation **06 hours**

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic)

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Recommended readings:

1. Principles & techniques in practical biochemistry. Wilson, K and Walker, J.M. Foundation books, New Delhi, 1994
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York).
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi)

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LS106P: ORGANISMAL BIOLOGY & BIOLOGICAL CHEMISTRY

52 × 2 hours: 4 credits

Organismal biology

Plant organismal biology:

1. Free hand section of Stem: Helianthus (Normal), Cucurbita and Peperomia (Special features).
2. Study of leaf anatomy of Isobilateral (Nerium) and Dorsiventral leaf (Ficus)
3. Study of root anatomy: Aerial root (Ficus), Orchid root.
4. Determination of water potentials by following drops methods.
5. Separation of chlorophylls and carotenoids by ascending paper chromatography
6. Estimation of Leghaemoglobin in the nodules.

Animal organismal biology:

1. Identification and functions of scales (fishes), claws, nails, hairs, horns, feathers, Hoofs and nests.
2. Skulls in vertebrates: Frog, Bird, Mammal, rabbit, dog, man, turtle.
3. Histology sections of Testis, Ovary, Liver, Pancreas, Kidney, Spleen, intestine.
4. Determination of oxygen consumption and metabolic rate in fish.
5. Rate of protein digestion by trypsin.
6. Determination of Acetylcholine activity in tissues
7. Demonstration of dissections – digestive, nervous and reproductive system of male and female cockroach, silk moth, Rat; Mounting: setae of earthworms and mouth parts of cockroach.

Biological chemistry

1. Extraction and assay of acid phosphates from peas.
2. Extraction and assay of Invertase from yeast.
3. Extraction and assay of Urease from horse-gram.
4. Analysis of kinetic parameters of salivary amylase (Specific activity, K_m and V_{max})
5. Estimation of reducing glucose.
6. Estimation of protein.
7. Estimation of inorganic phosphate by Fiske-Subbarao method.
8. Estimation of AChE activity and acetylcholine content

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LS107P: REPRODUCTIVE & EVOLUTIONARY BIOLOGY

52 × 2 hours: 4 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.

Reproductive biology

Plants

- Morphology of the reproductive parts of flower
- Tests for pollen viability: *in vitro* pollen germination, Tetrazolium test
- Vegetative reproduction: Artificial methods (Grafting, Cutting, Gootee and Layering).
- Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
- Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in different media using hanging drop method.
- Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
- Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.

Animals

- Identification of sperms in insects, Annelida, Amphibians and Mammals (Slides).
- Sperm count and mobility (Rat/Humans)
- Examination of vaginal smear rat from live animals
- Examination of histological sections (photomicrographs or permanent slides) of rat and human: testes, epididymis, accessory glands of male reproductive system, ovary, fallopian tube, uterus, cervics and vagina.
- Study of modern contraceptive devices.
- Dissection of male and female reproductive systems of *Bombyx mori*, Cockroach and Rat.

Evolutionary biology

Evidences of fossils

1. Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era

2. Connecting links/transitional forms - Eg. Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus

3. Living fossils - Eg. *Limulus, Peripatus* ,*Latimeria, Sphaenodon*

4. Vestigial, Analogous and Homologous organs using photographs, models or specimen

Variations

5. Sampling of human height, weight and BMI for continuous variation

6. Sampling for discrete characteristics (dominant vs. recessive) for discontinuous variations e.g. hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data categorization into 16 groups based on the combination of 4 traits; assigning each subject to the respective group)

Selection Exemplifying Adaptive strategies

7**.** Coloration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life**)** using specimens

Neo-Darwinian Studies

8. Calculations of genotypic, phenotypic and allelic frequencies from the data provided
9. Simulation experiments using coloured beads/playing cards to understand the effects of selection and Genetic drift on gene frequencies

Phylogeny

10. Digit reduction in horse phylogeny (study from chart),
11. Study of horse skull to illustrate key features in equine evolution
12. Study of monkey and human skull - A comparison to illustrate common primate and unique Hominine features

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*************Semester II*************

LS201T: PARASITOLOGY & PATHOLOGY

52 hours: 4 credits

Unit 1:

Introduction to Parasitology: Comparative aspects of symbiosis (mutualism, commensalism, parasitism), types of hosts (definitive, intermediate, paratenic, accidental, reservoir host) and parasites (ectoparasites & endoparasites, facultative & obligatory parasites, pseudoparasites, occult parasitism, aberrant parasitism), host-parasite interactions (hypobiosis, zoonosis). **3 hours**

Ecology & evolution of parasites: Parasite ecology, parasite populations (macro & microparasites, population structure, multiple species infections), modes of parasitic reproduction (asexual, viviparity, hermaphroditism), parasitic transmission, epidemiology and parasite evolution. **2 hours**

Unit 2: **Molecular Parasitology**: Molecular mechanisms of susceptibility & resistance, immunity & immune responses, and xenobiotics. **3 hours**

Unit 3: **Animal parasites**

Life-cycle, biology, distribution, disease and clinical management of a protozoan parasite: *Entameoba histolytica*, *Plasmodium* sp., *Trypanosoma* sp., *Leishmania* sp.

Life-cycle, biology, distribution, disease and clinical management of helminth, nematode and arthropod parasites: Flat worms, blood flukes, liver flukes, intestinal flukes and lung flukes, hookworms, pinworms, lungworms, root knot nematodes, Ascarids; lice, bugs, fleas, ticks & mites. **10 hours**

Unit 4: **Plant parasites and pests**

Classification, occurrence, biology and management of plant parasites: *Cuscuta, Striga, Viscum, Loranthus.*

Agriculturally important insect pests and parasites: Pests and parasites of commercially important crops (vegetables, cereals, pulses, fruits etc.) **8 hours**

Unit 5: **Introduction to plant & animal pathology**:

Importance of plant diseases, disease concept, disease description and diagnosis, disease cycle terminology, life-cycle strategies of plant pathogens, host-pathogen interactions and co-evolution.

Principles of animal pathology including etiology, course and termination of diseases. **4 hours**

Unit 6: **Plant pathogens**:

Fungal: Study of Oomycetes, Ascomycetes, Basidiomycetes as disease causing agents; disease cycle, host resistance, gene for gene concept, disease management with special emphasis on biological control.

Bacterial, Viral and Nematode pathogens of plants: Life cycle of selected pathogens affecting agricultural crops (Beans, tomato, rice, grapes, citrus, groundnuts, Ladies finger, tobacco), integrated management by cultural, chemical, biological and host resistance method, importance of plant quarantine in disease management. **10 hours**

Unit 7: **Study of animal pathogenesis**: Various degenerations, infiltration, necrosis, endogenous and exogenous pigmentations associated with animal pathology, circulatory and growth disturbances, reversible and irreversible cell injuries, different types of inflammation with special emphasis on chemical mediators. **3 hours**

Stress and age-related disorders, terminal diseases and their management **4 hours**

Unit 8: **Fungal, viral and bacterial diseases of animals including disease management**: Foot & mouth diseases of cattle,bird flu, mastitis in cattle, Grasserie, Flacherie, Muscardine, Pebrine (in silkworm and economically important insects), cocciodiosis,scrapie, brucellosis, Q fever, marine white spot disease. **5 hours**

Recommended readings:

1. George N. Agrios, Plant pathology, 5th edition, Elsevier academic press, 2000
2. R.S.Singh, Plant pathogens, Oxford and IBH publishing co., 1994
3. G.L.Schumann & C.J. D'Arcy, Essential Plant Pathology, 2nd edition, 2009
4. K. Starr Chester, Nature and prevention of plant diseases, 2006
5. JD Smyth, An Introduction to Animal Parasitology, 3rd edition, CUP, 1994
6. S.H. Gillespie & P.M. Hawkey ed. Medical Parasitology – A Practical Approach, OUP,1995
7. F.E.G. Cox ed., Modern Parasitology, Blackwell Publishing, 1993.
8. JD Smyth, An Introduction to Animal Parasitology, 3rd edition, CUP, 1994
9. S.H. Gillespie & P.M. Hawkey ed. Medical Parasitology – A Practical Approach, OUP,1995
10. F.E.G. Cox ed., Modern Parasitology, Blackwell Publishing, 1993.

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LS202T: IMMUNOLOGY

52 hours: 4 credits

Unit 1: Introduction to Immunology: Historical account; Cells and organs of immune system; Lymphocytes, their origin and differentiation (B-Lymphocytes and T-Lymphocytes); antigens, types and classification; complement system and its biological functions; types of immune responses; mechanism of immune response. **7 hours**

Unit 2: Types of Immunity: Innate and acquired, humoral and cellular;
Humoral immunity - B-lymphocytes and their activation; structure and function of immunoglobulins; immunoglobulin classes and subclasses, genetic control of antibody production, monoclonal antibodies and diagnosis, idiotypes and idiotypic antibodies
Cellular immunity - Major histocompatibility complex. Thymus derived lymphocytes (T cells) their classification, antigen presenting cells (APC) - macrophages, dendritic cells, langerhans cells, their origin and functions; mechanisms of phagocytosis; identification of cell types of immune system; immunosuppression, immune tolerance. **13 hours**

Unit 3: Immune hypersensitivity: Mechanisms of T cell activation, cytokines and their role in immune response; Leukocyte migration and inflammation; hypersensitivity of macrophage activation and granuloma formation, immune regulations, immune response to infectious organisms, Vaccines. **6 hours**

Unit 4: Immunotechniques and their applications: Immunodiffusion, immunoblot, immunofluorescence, immunoaffinity, ELISA, agglutination, immunoprecipitation, immunoelectrophoresis, cross-linking. **10 hours**
Unit 5: Transplantation and Grafting: Graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanisms of immunity to tumor antigens. **10 hours**

Unit 6: Autoimmunity: Auto-antibodies in humans, pathogenic mechanisms, experimental models of auto immune diseases, treatment of auto immune disorders**.** **6 hours**

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Recommended readings:

1. Roitt's Essential Immunology, by Delves, Martin, Burton & Roitt, 12th edition, Wiley-Blackwell, , 2011.
2. Kuby Immunology. Owen, Punt, Stranford, 7th edition, Macmillan, 2013.
3. Cellular & Molecular Immunology, Abbas et al., 7th edition, Elsevier, 2011.

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LS203T: MICROBIOLOGY

52 hours: 4 credits

Unit 1: Introduction to Microbiology: History of microbiology, composition of microbial world, development of microbiology as a science, disciplines of microbiology and evolution of microorganisms.
Characteristic features and classification of Viruses, Bacteria, Actinomycetes, Eukaryotic microbes (Algae, Fungi, Protozoa, Nematodes). Recent trends in microbial taxonomy (chemotaxonomy, numerical taxonomy, DNA taxonomy, serological methods, genetic methods, ecological methods). **6 hours**

Unit 2: Culturing, maintenance and control of Microbes: Micro and macro nutrients, growth factors. Nutritional types of bacteria. Types of media (simple, complex, special), isolation, purification, Mass culturing, maintenance, effect of environmental factors on microbial growth- temperature, moisture, light, oxygen etc., control of microbial growth (disinfection and sterilization). Growth kinetics, generation time, growth curve. Aerobic, anaerobic, batch, continuous and synchronous cultures. IMViC tests. **10 hours**

Unit 3: Food & Dairy Microbiology: Microbes in food, food spoilage, food preservation, fermented foods, toxins and food poisoning. General account of Milk and milk products, contamination of milk, source of contamination, micro flora of milk and milk products, pasteurization, preservation of milk and dairy products. **10 hours**

Unit 4: Agricultural microbiology: Micro flora of rhizosphere, rhizoplane, and phylloplane, Biological Nitrogen fixation, application of mycorrhizae and biofertilizers. **6 hours**

Unit 5: Atmospheric and aquatic microbiology- Air borne microbes, air samplers, air borne diseases, Microbes of marine and fresh water, microbes in potable water, water purification, waste water and sewage disposal, bioremediation. **10 hours**

Unit 6: Industrial microbiology: Industrially useful microbes, microbial fermentation - alcohol, wine and yoghurt, microflora of humans and domestic animals. **10 hours**

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Recommended readings:

1. McCormick T, Essentials of Microbiology, Research & Education, NJ, 1998.
2. Waites M, Morgan N, Industrial Micro Biology, Blackwell Science, London, 2001.
3. Lynne I *et.al.*, Microbiology for health careers, Thomson Delmer Learning, NY, 1999.
4. Schelegel, H.G., General Microbiology, Cambridge University Press, London, 1996.
5. Thomas D. Brock, Michael T. Madigan, Biology of Microorganisms, Science, 10th edition
6. Pelczar, Microbiology, Tata McGraw-Hill. 1998
7. Elmer H. Marth, James L. Steele Applied dairy microbiology, CRC Press, 2001
8. Roger Y. Stanier, General microbiology, Science, 1987
9. Lansing M. Prescott, John P. Harley, Donald A. Klein, Microbiology, Science, 2001
10. Funke Case Tortora, Cram, Microbiology, Education – 2006

LS501T: MOLECULAR GENETICS
52 hours: 4 credits

Unit 1: Introduction to molecular genetics **04 hours**

History of molecular biology, prokaryotic and eukaryotic cell composition, organization of chromosomes in prokaryotic and eukaryotic cells, model organisms in the study of molecular biology (*E. coli, Sachharomyces, Arabidopsis, C. elegans, Drosophila, Mus musculus, Homo sapiens*).

Unit 2: Organization of genome **10 hours**

The genome (prokaryotic, eukaryotic and mitochondrial), Organization of chromatin, histones, nucleosome, structure of anaphase chromosome, ultrastructure of centromere, types of chromosome (based on number and position of centromere), function of centromere (secondary and tertiary constriction, NOR), Telomeres, Special types of chromosomes (Polytene and lampbrush), physiology of chromosomes, Non coding DNA and genes, repetitive DNA sequences, satellite DNA.

Unit 3: DNA replication, repair and recombination **10 hours**

The replicon- unit of replication (mapping of origin of replication, replicon in bacterial vs eukaryotic genomes, rolling circle model of DNA replication, bacterial replication and cell cycle, plasmid propagation and plasmid incompatibility), Primosomes and Replisomes (apparatus for DNA replication, DNA polymerases, Okazaki fragments, Leading and Lagging strand synthesis, common events in priming replication at origin, methylation regulating initiation at origin), DNA repair mechanisms, recombination (breakage and reunion involves heteroduplex DNA, Holliday junction).

Unit 4: Transcription and post-transcriptional modifications **08 hours**

Transcription complex (promoters, factors, RNA polymerases), initiation-elongation-termination of transcription, mono-cistronic and poly-cistronic RNAs, Transcription factors and their functions (zinc-fingers, helix-loop-helix, leucine zippers, homeo domains, steroid receptors), inhibitors of transcription, Post transcriptional modifications of m-RNA, t-RNA and r-RNA, apparatus for nuclear splicing (spliceosome and lariat formation, alternative splicing, self-splicing by group I introns).

Unit 5: Translation **08 hours**

Genetic code- General features of Genetic code. Mechanism of protein synthesis: initiation, elongation and termination in Prokaryotes and eukaryotes. Inhibitors of protein synthesis Post-translational modifications, Signal hypothesis – signal sequences, signal recognition particle.

Unit 6: Protein sorting **04 hours**

Introduction, signal sequences, translocation of secretory proteins across ER, protein modification in ER, protein targeting to mitochondria and chloroplast, protein targeting to the nucleus, receptor mediated endocytosis and sorting of internalised proteins, inhibitors of protein synthesis.

Unit 7: Epigenetics **04 hours**

Introduction, heterochromatin and histone interactions, polycomb and trithorax, CpG Islands, genomic imprinting, epigenetic effects and inheritance, prions.

Unit 8: Gene regulation in prokaryotes, eukaryotes and phages **04 hours**

Transcriptional and post-transcriptional control of gene expression in prokaryotes and eukaryotes: control at initiation (RNA polymerase-promoter interactions), a panoply of operons (Lactose and Tryptophan operon), control of RNA structure (termination and anti-termination), Phage strategies (lytic cascade and lysogenic repression).

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Recommended readings:

1. Cell and Molecular Biology. De Roberts and De Roberts., Saunders College, USA 6th edition.
2. Molecular Biology. Lodish, Berk, Zipursky, Matsudaira, Baltimore & Darnell. Freeman Press, 6th edition.
3. Cell Biology. Karp G., McGraw Hill book comp. New York. 2010 6th edition.
4. The Cell: A molecular approach. Cooper, G.M. ASM Press, USA 2009, 5th edition.
5. Genes V: Benjamin Lewin. Oxford University Press, 1995
6. Cell Biology. Pollard. J.P. and Earnshow, W.C. Saunders, 2002.
7. Molecular biology of the cell. Albert, B., Johnson, A., Raff, M., Robert, K., Walter, P. Garland Sciences, NY, 5th edition.
8. The Cell –A molecular approach. Cooper, G.M. Princeton Publishers, NY, 2000.
9. Molecular Cell Biology. Lodin, H., Berk, A., Zipursky, S.L., Matsudain, P., Baltimore, D. and Darneil, T. Will Freeman company, NY, 6th edition.

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LS205T: RESEARCH METHODOLOGY
26 hours: 2 credits

Unit 1: Foundations of Research

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs applied research**.** **4 hours**

Unit 2: Research Design

Need for research design: Features of good design, important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs. **7 hours**

Unit 3: Data Collection, Analysis and Report Writing

Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology. **10 hours**

Unit 4: Ethical Issues

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement. **5 hours**

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Recommended readings:

1. Louis Cohen, Research Methods in Education (6th Edition), Lawrence Manion, and Keith Morrison, Paperback Publications, 2007.
2. Robert K. Yin, Case Study Research: Design and Methods: (Applied Social Research Methods), Paperback Publications, 2003.
3. Jane Ritchie and Jane Lewis, Qualitative Research Practice: A Guide for Social Science Students and Researchers, Paperback, 2003.
4. Stephen F. Davis, Handbook of Research Methods in Experimental Psychology, Black Well Publications, London, 2005.
5. Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
6. Walliman, N. 2011.Research Methods- The Basics. Taylor and Francis, London, New York.
7. Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
8. C.R.Kothari: Research Methodology, New Age International, 2009
9. Coley, S.M. and Scheinberg, C.A. 1990, “Proposal writing”. Stage Publications

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LS205P: PARASITOLOGY, PATHOLOGY & IMMUNOLOGY

52×2 hours: 4 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.

Parasitology & Pathology

1. Field collection & identification of protozoan parasites

- *Trypanosoma*
- *Plasmodium*
- Amoeba
- *Nosema bombysis*
- *Leishmania*
- *Trichomonas, ,*
- *Entamoeba*
- *Toxoplasma*
- *Gregarina,*
- *Giardia* and *Eimeria,*

2. Field collection & identification of Parasitic Arthropods (lice, fleas, Ticks, mites, Uzi fly)

3. Field collection & identification of vectors: Mosquitoes, Leaf hoppers, Thrips and Jassids

3. Field collection & identification of soil and animal nematode parasites and platyhelminthes.

4. Methods of studying plant diseases- Scoring, Collection and preservation of samples

5. Culturing of Nematodes – Isolation and pathogenesis

6. Identification of disease pathology in

Plants: Tikka of ground nuts, Blast of rice, Mosaic of bhindi, Powdery mildew of grapes, Leaf spot of bean, Citrus canker.

Animals: Grasserie, Flacherie, Muscardine, Pebrine, Foot and mouth diseases, Mastitis in cattle, coccidiosis, Scrapie, Brucellosis, Bird flu, Q Fever, Marine White Spot Disease in fishes.

7. Identification of insect pests of agricultural crops – Leaf roller, mealy bugs, stem borers, sap suckers.

8. Field Visit to study crop diseases.

Immunology:

1. Separation of serum from blood samples
2. Isolation and enumeration of lymphocytes using haemocytometer
3. Isolation and enumeration of spleen cells
4. Purification of IgG from serum by ammonium sulphate fractionation method – Dialysis
5. ABO Blood group typing
6. VDRL/ WIDAL test
7. Immunodiffusion tests: Ouchterlony double immunodiffusion method (DID) and Single Radial immunodiffusion (SRID, Mancini method)
8. Demonstration of ELISA

9. Immunoelectrophoresis: Countercurrent IEP & Rocket IEP
10. Isolation and enumeration of lymphocytes using haemocytometer
11. Survey of structural plant defences: viz. cuticle, wax, lignin, bark, thorns, prickles, trichomes, armour in different plants species including thigmonasty, camouflage, mimicry.
12. Survey: Quantitative and qualitative secondary metabolites in plants: alkaloids, glycosides, glycosinolates, terpinoids, phenolics, gammosis etc. in healthy and diseased plant/plant organs.

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LS206P: MICROBIOLOGY & MOLECULAR GENETICS

52×2 hours: 4 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.

Microbiology

1. Study of disinfectants and different methods of sterilization
2. Preparation of media for culturing bacteria,fungi and yeast
3. Isolation and identification of microbes – from soil and plant materials
4. To perform sub-culturing – streaking techniques (T streaking)
5. Study bacterial growth curve & effect of pH,temperature, UV light on bacterial growth.
6. Staining of microorganisms – Gram staining, Negative staining AFB staining, staining of fungi.
7. To perform antibiotic resistance assay
8. Enumeration of CFU of *E. coli* by serial dilution and spread plate method
9. Conjugation experiment
10. Microbes of milk and milk products – SPC
11. Milk quality testing by Methylene blue dye reductase test
12. Measurement of fungal microbes
13. Field visits: Dairy and Brewery

Molecular Genetics

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

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************Semester III*************

LS301T: GENOMICS & PROTEOMICS

52 hours: 4 credits

Unit 1: Genomics and the Human Genome project: History, organization and goals of human genome project, Mapping strategies, current status of various maps; DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical/similar genes, Diversity in size and organization of genes. General aspects of the structure of *E. coli*, *Arabidopsis*, rice, yeast, *Drosophila, C. elegans* and mouse genome **13 hours**

Unit 2: Gene families: Multigene families – Classical gene families, families with large conserved domains, families with small conserved domains, Gene super families, Gene families in clusters, Pseudogenes, Repetitive DNA and transposable elements, Origin of gene families (Haemoglobin, Myoglobin as examples).

6 hours

Unit 3: Comparative Genomics: Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, Overview of prokaryotic and eukaryotic genomes, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes. **7 hours**

Unit 4: Genome wide analysis: Global study of Genome activity, Transcriptome and its analysis, Proteomics, Synthetic genomics **6 hours**

Unit 5: Protein characterization: Amino acids; proteins as polypeptides- classification of proteins, Backbone flexibility- Φ and ψ- Properties of amino acids-Hydrophobicity, EIIP, Molecular weight, α and β propensities etc. Proteome and Proteomics Proteins as workhorse molecules of life, -protein separation & analysis using 2D Gel Electrophoresis, protein arrays; Liquid chromatography, Mass spectrometry- Protein-protein interaction; Detection of functional linkages. **7 hours**

Unit 6: Protein structure analysis: Structure prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Interatomic forces and protein structure, covalent interaction, hydrogen bonds, hydrophobic and hydrophilic interaction, charge/dipole interaction, Vander waals forces, steric interaction, Determining protein structure, Homology modeling, CASP, *Ab initio* prediction, Molecular dynamics & conformational energy calculation, Prediction of function. **13 hours**

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Recommended readings:

1. T.A. Brown, Genomes, Bios, 2002.
2. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
3. Dale & Schartz, From Genes to Genomes, Wiley, 2003.
4. Hawley and Mori, The Human Genome, Academic, 1999.
5. Lewis, Human Genetics, WCB, 1999.
6. Liebler, Introduction to Proteomics, Humana, 2002.
7. Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.

8. Primrose & Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
9. Strachan and Read, Human Molecular Genetics, Wiley, 1999.
10. Sudbery, Human Molecular Genetics, Prentice Hall, 2002.

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LS302T: GENETIC ENGINEERING & BIOTECHNOLOGY

52 hours: 4 credits

Unit 1: Introduction to Recombinant DNA technology: An overview of structure and function of nucleic acids**,** role of enzymes used in Genetic Engineering (endo- & exonucleases, RNase, DNase, restriction endonucleases) DNA methylation, RNA modification, role of kinases, phosphatases, bacteriophage polynucleotide kinase, Ligases. Vectors employed in recombinant DNA technology, – cloning plasmids (pBR322, pUC19/18, Ti) cosmids, phagemids, shuttle vectors, ARS, mini chromosomes, BACs, PACs, YACs, Expression vectors used for expression of proteins in bacteria, yeast, plants and animal cell lines. **9 hours**

Unit 2: Gene cloning and expression: Various techniques and strategies used in gene cloning in prokaryotes (*E. coli*) and eukaryotes (*S. cerevisiae*, *Pichia pastoris*), gene transfer methods: Physical, Chemical and Biological. Transformation into bacteria and yeast, transfection into plant and animal cells, selection of recombinant cells, expression of recombinant proteins. **4 hours**

Unit 3: Gene Screening and Isolation: Isolation and purification of nucleic acids, Construction of genomic and cDNA libraries, Selection of probes and labeling,Blotting of DNA / RNA and hybridization, Colony, plaque screening and hybridization. **5 hours**

Unit 4: DNA sequencing: Dideoxy and chemical methods, sequence assembly, automated sequencing, and applications of DNA sequencing (synthetic oligonucleotides), Next Generation Sequencing (NGS). **3 hours**

Unit 5: Application of recombinant DNA technology: Overview of transgenic plants and GMO (Bt cotton, golden rice, tomato, corn, brinjal, cow, sheep, poultry, fish). Gene therapy: rationale, types of gene therapy (additive, replacement), gene therapy vectors (viral, non-viral), gene therapy drawbacks, gene therapy clinical trials and outcome, integration of gene and cell therapy. **6 hours**

Unit 6: Bioethics and IPR

Introduction to ethics: deontology & consequentialism, ethics codes, relationship to law; Human subject research: history and standards; federal regulation of research, protection; Genetics & ethics: privacy and confidentiality, discrimination & commercialization; Introduction to IPR, Patents-Gene Patenting, Trademarks, Copyrights, Industrial Designs, Geographical Indications, Future Developments of Intellectual Property Rights. **5 hours**

Unit 7: Animal cell culture & tissue engineering

Media for culturing cells and tissues. Preparation of animal cell culture media, sterilization and storage. Sterilization of various equipments and apparatis. Short-term primary culture, adherent and suspension cells, maintenance of cell lines.Cryopreservation.

Stem cell isolation and culture, mechanical forces, cell adhesion and migration, polymeric scaffolds, biomimetic materials, tissue engineering using bone as an example. **8 hours**

Unit 8: Plant tissue culture

Media constitutents, selection, preparation, isolation of single cells, suspension cultures, applications of cell culture. Cellular totipotency, cytodifferentiation, organogenic differentiation, somatic embryogenesis, practical applications of haploid cell production, techniques of plant regeneration from pollen embryos, gynogenesis, haploid production through distant hybridization, diploidization to raise homozygous diploids, applications, limitations, triploid production, callusing, organogenesis, applications of endosperm culture, transgenic plants. **8 hours**

Unit 9: Bioprocess engineering

Screening and selection of industrial microorganisms, Bioreactors – types, basic functions, design and components, construction, temperature control, aeration, agitation systems, sterilization of fermenters, air supply and medium, aseptic inoculation and sampling methods. **4 hours**

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Recommended readings:

- Introduction to Genetic Engineering by Nicholl. Cambridge Low Price Edition, 2010.
- Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications, 1993.
- Genes VIII by Benjamin Lewis. Oxford University & Cell Press, 2003
- Genetic Engineering Vol. 1-4 (Williamson Edition)
- Recombinant DNA by Watson et al., 1983.
- Vectors by Rodriguer and Denhardt, 1987.
- Molecular cloning Volumes I, II and III. Sambrook & Maniatis (1989, 2000). Cold Spring Harbor laboratory Press, New York, USA.
- Furrow et al., Bioethics (6th ed. 2008).
- Intellectual property rights: innovation, governance and the institutional, Birgitte Andersen, Law – 2006

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LS303T SYSTEMS BIOLOGY

52 hours: 4 credits

Unit 1: Introduction: Systems biology as a new perspective, scope and application of systems biology. Systems structure –Biological systems, metabolic systems, signal transduction systems, neural networking systems, pathways, dynamics, response to perturbation, stress response, Heat shock response. **7 hours**

Unit 2: Control of enzyme activity & metabolic pathways: Introduction, control of activities of the single enzymes, controlling the activity by change in covalent structure of enzymes, models account for the behavior and regulation of enzymes, significance of allosteric and cooperative behavior of enzymes. Metabolic pathways -general consideration, amplification of signals, formulation of theories for control of metabolic pathways, examples Regulation of glycolysis, gluconeogensis and glycogen metabolism.

13 hours

Unit 3: Enzymes in organized systems:

- Models of multi-enzyme complexes
- Pyruvate dehydrogenase from *E.coli* and mammalian Tissues.
- Tryptophan synthase. **6 hours**

Unit 4: Gene expression: Introduction, analysis of gene expression , different tools available for analysis of gene expression, measurement of gene expression by Micro arrays, RNAi types of micro arrays, analysis of micro array gene expression data, Relating Expression data to other biological information – Predicting binding sites of proteins to DNA, Predicting protein-protein interactions and protein functions, Predicting functionally conserved modules, Reverse-engineering of gene regulatory networks. **13 hours**

Unit 5: Introduction to proteomics and genomics: Genomics and Proteomics as a foundation for Systems Biology, Strategies relating to In-silico Modeling of biological processes, Metabolic Networks, Signal Transduction Pathways, Gene Expression Patterns. Applications of Systems Biology Markup language (SBML), E-cell and V- cell Simulations and Applications; Synthetic genomics – Methods and applications **9 hours**

Unit 6: Bioinformatics in Drug and Vaccine Design: Introduction, The drug discovery process, Techniques in drug and vaccine designing. **4 hours**

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Recommended readings:

1. Jonathan Pevsner, "Bioinformatics and Functional Genomics" 2003 John Wiley & Sons, Inc.
2. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I & II. - Blackwell science publishers.
3. ICRF handbook of genome analysis, by NK Spurr, BD Young, SP Bryant. Volumes I & II. - Blackwell science publishers
4. Daniel P. Berrar, Werner Dubitzky, Martin Granzow, “A Practical Approach To Microarray Data Analysis” 2003 Kluwer Academic Publishers ISBN: 1-4020-7260-0
5. Molecular Modeling Principles and Applications, Andrew R. Leach, II ed. 2001. Prentice Hall
6. Murphy K.P. (ed.) Protein structure, stability, and folding (Humana Press, 2001)
7. Current Protocols in Protein Science, Wiley Publishers, 2005

LS304T: OPEN ELECTIVE

48-56 hours: 4 credits

Open Electives under Faculty of Science

Serial no.	Department	Elective code	Title of the Elective
01	Botany	305(B)	Environmental biology and natural resources
02	Sericulture/ Life Sciences	LS304	Human health & hygiene
03	Biochemistry	304.2 Elective	Biochemistry in daily life
04	Physics	P305	Physics and our world
05	Electronic media	T306	Skills for broadcast media
06	Geography	Paper 3.6	Geography for all
07	Library & Information Science	P306	Information literacy
08	Environmental Science	ES304	Climate change & current issues
09	Microbiology & Biotechnology	MBO-304	Biotechnology in human welfare
10	Fashion & Apparel design	FAD 3.8 OE	Fashion design
11	Psychology		Psychology & life
12	Chemistry	C-304	Chemistry for all
13	Zoology	304	Economic Zoology
14	Mathematics	M307(G)	Mathematics for everyone
15	MCA Programme		Cyberspace
16	Geology		The world of rocks and minerals
17	Statistics	ST304	Statistical methods
18	Human consciousness and yoga sciences	3.6	Yoga & life
19	Home Science		

Open Electives under Faculty of Arts

Serial no.	Department	Elective code	Title of the Elective
01	English		Write it right
02	Social work		Social movements & social action
03	Rural development		Co-operative management
04	Political Science		Indian politics today
05	Centre for Women's studies		Gender and society
06	History		Social movements of India
07	Urdu		Urdu Ghazal
08	Sociology		Themes & perspectives in Sociology
09	Hindi		Samanya Hindi
10	Economics		Economics of globalization
11	Kannada		
12	Performing Arts		Performing Arts and Society
13	Communication		Media and society
14	Telugu		Introductory Telugu course
15	Sanskrit		Sanskrit made easy

			1. Arthasastra 2. Sahitya
16	Gandhian studies		Mahatma Gandhi & contemporary world
17	Ambedkar studies		
18	Foreign languages		
19	Visual arts		
20	Philosophy		

Open Electives under Faculty of Commerce

Serial no.	Department	Elective code	Title of the Elective
1	MBA		Management perspectives
2	M.Com		Finance and banking

Open Elective offered by Department of Life Sciences

Human Health & Hygiene

4 hours / week | 4 credits

Unit 1: Human health & disease **5 hours**

WHO definition of health, disease, disorder; classification of diseases based on source, global distribution of diseases. Vaccination, types of vaccines Smallpox and the role of vaccination, vaccination programmes, safety and effectiveness of vaccines.

Unit 2: Common infectious diseases **16 hours**

Definition of pathogens, terminologies used in infectious disease (aetiology, epidemiology, vector, incubation period, infective period, causative agent, carrier, notifiable disease, epidemic, endemic, pandemic, signs, symptoms, prevention/prophylaxis, treatment).

Water-borne diseases – causative agent, transmission, signs and symptoms, treatment and prevention of Cholera, Typhoid and Paratyphoid.

Air-borne diseases - causative agent, transmission, signs and symptoms, treatment and prevention, resurgence of T.B., Influenza (H1N1)

Vector-borne diseases - causative agent, transmission, signs and symptoms, treatment and prevention, eradication of Malaria, Filaria, Chickungunya, Dengue, Swine

STDs - causative agent, transmission, signs and symptoms, detection, treatment and prevention, eradication of AIDS, Syphilis, Gonorrhoea,

Unit 3: Disinfectants, antiseptics & antibiotics **4 hours**

History (Pasteur, Lister), various antiseptics (hypochlorites, phenol, ethanol, isopropanol, aldehydes, detergents, Chlorxylenol), sterilization techniques (heat treatment, steam treatment, radiation).

Antibiotics (biostatic, biocidal), most commonly used antibiotics, mechanism of action of antibiotics, antibiotic resistance.

Unit 4: Genetic and Life-style disorders **8 hours**

Cardiovascular disorders (atherosclerosis, coronary thrombosis, myocardial infarction, angina), causes and treatment (pacemakers, heart transplant).

Cancer (benign, malignant, oncogenes, metastasis), causes of cancer, prevention and control.

Diabetes (Type I and type II), genetic predisposition, worldwide incidence, clinical symptoms and control.

Ageing (Alzheimer's disease, osteoarthritis, rheumatoid arthritis).

Unit 5: Linkages between Environment and Health **5 hours**

Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

Unit 6: Climate Change and Implications on Public Health **7 hours**

Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain

Unit 7: Perspectives and Interventions in Public Health **7 hours**

Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control

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Recommended readings:

1. Indian Academy of Paediatrics. (2011). *Guidebook on Immunization.* mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore
3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). *Biology Today: An Issues Approach* (3 ed.).
5. Park, K. (2011). *Preventive and Social Medicine.* Benarsi Das Publications, (pp. 16- 19,24-27).
6. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
7. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. *Biotropica, 39(5),* 575-577.
8. Tyler Miller and Scott E. Spoolman 'Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
9. UNDP. (2013). The Human Development Report, The Rise of the South: Human Progress in Diverse World. New York: UNDP, (also available in Hindi).

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LS305P: GENOMICS, PROTEOMICS & SYSTEMS BIOLOGY
52×2 hours: 4 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.

Genomics & Proteomics:

1. Restriction mapping of plasmid DNA
2. RAPD analysis
3. RFLP analysis
4. DNA fingerprinting analysis: Parentage detection
5. Demonstration of EST/ STS/ Microarray analysis
6. Homogenization, fractionation and separation of enzymes/ proteins in plants and animals
7. 2D-PAGE separation of proteins

Systems Biology:

1. Visit to IISc / NCBS (CCAMP) for demonstration of Mass spectroscopy & Microarray platforms
2. Metabolomics: LDH assay
3. Glycomics: Estimation of sugars – fructose and galactose
4. Methods to detect chemically modified proteins through Western blotting

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LS306P: GENETIC ENGINEERING & BIOTECHNOLOGY
52 × 2 hours: 4 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. Callus Induction Techniques
2. Artificial seed production
3. Production of haploid plants by anther and pollen culture
4. *Agrobacterium* mediated transformation
5. Isolation and purification of plasmid DNA from *E. coli*
6. Fibroblast culture from chick embryo
7. Cell disruption techniques
8. Solid-liquid separation methods: Sedimentation.
9. Solid-liquid separation methods: Filtration.
10. Solid-liquid separation methods: Centrifugation.
11. Estimation of percentage of ethanol from fermented broth
12. Estimation of Lactic acid from fermented broth.
13. Production, isolation and purification of biopharmaceuticals/ antibiotics, *Pencillium notatum.*
14. Production of wine using yeast
15. Micro injection and transformation

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**********Semester IV**********

LS 401T: Biomedical Sciences

4 hrs / week | 4 credits

Unit 1: Stem Cells: Definition and characteristics, classification of stem cells (Embryonic stem cells and adult stem cells), stem cell niche, stem cell division and its control, induced pluripotent stem cell generation & application, hemopoietic stem cell disorders: classification and manifestations, principle and procedure of bone marrow transplantation. **8 hours**

Unit 2: Human Cytogenetics: Human Chromosomes and karyotypes, sex determination, X and Y chromosomes, evolution of human chromosomes, Fragile sites mutagenesis studies, causes of chromosome breakage, SCE/MN, In-situ Hybridization, chromosome and cancer, studies of prenatal chromosomes, Somatic cell hybrids in gene mapping, chromosomal disorders/ syndromes. **6 hours**

Unit 3: Cancer Biology: Different types of tumors, factors and mechanism involved in tumor formation, oncogenes, tumor suppressor genes, methods of detection of cancer, tumor markers, treatment-chemotherapy, radio therapy, immunotherapy and gene therapy for cancer. **7 hours**

Unit 4: Human Microbial diseases: Mode of infection, symptoms, epidemiology and control of AIDS, Hepatitis B, Rabies, Tetanus, Typhoid, STD, TB, Cholera, Aspergillosis, Histoplasmosis, Cryptococcosis, Leprosy, H_5N_1 and H_1N_1; Arboviral diseases: Yellow fever, Dengue, Japanese Encephalitis, Chickungunia, Kyasanur forest disease-epidemiology and management. **8 hours**

Unit 5: Haematology and transfusion science: Structure, function and production of blood cells, platelet structure and function haemostasis, fibrinolysis, thrombosis. Types of anaemias, haemoglobinopathies and thalassaemias, Haematological malignancy. Transfusion science, Genetics, inheritance, structure and role of red cell antigens, The preparation, storage and use of blood components, the selection of appropriate blood components for transfusion and possible adverse effects, immune mediated destruction of blood cells, health and safety aspects of handling blood. **11 hours**

Unit 6: Disease diagnostics: Nervous system, perspective and behaviour, Neural disorders and repair.
DNA finger printing in Forensic science and Disease diagnosis. Enzymes in diagnosis of human diseases and Health care. Acetylcholinesterase, angiotensin converting enzyme (ACE), Pseudocholinesterase, 5'- nucleotidase (5NT), Glucose-6-phosphate dehydrogenase (GPD) and other red cell enzymes; CK isoforms, Immunoreactive trypsinogen (IRT) and Chymotrypsin; Amylase isoenzymes, Macroamylases, Isoenzymes (CK, LD, ALP). SGOT and SGPT. Diagnosis of Diabetes mellitus and Glucosurea. Prosthetics and their applications; Biomedical ethics.

12 hours

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Recommended readings:

- Enzyme Technologies for pharmaceutical and biotechnological applications by Herbert A Kirst, Wu-Kuang Yeh, Milton J.
- Developmental Biology, 6th Edition, by Scott F. Gilbert
- Hematology, by William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman Molecular Biology of the Cell, 3rd Edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson

- Caul .E (1992) Immuno-flouresent–antigen detection techniques in diagnostic microbiology, Pub ,Health Lab services
- Cruick shank et.all Medical microbiology
- Goding, M.J.W Monoclonal Antibodies: principles and practice – (1983) Academic press.
- Kuby.J (1992) Immunology 4th Edn. Richard A. Goldsby Kindt & Oshome Eds W.H.Feeman &Co .NY
- Zaiko, G.E (2004) Biotechnology and agriculture & Food industry, Nova publishers
- A. V. Hoffbrand, P. A. H. Moss, J. E. Pettit, Essential haematology- Medical – 2006
- Atul B. Mehta, A. V. Hoffbrand, Haematology at a glance- Medical – 2005

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LS 402T: BIOINFORMATICS & COMPUTATIONAL BIOLOGY

4 hrs / week | 4 credits

Unit 1: Introduction to Bioinformatics and Computational biology: Branches of Bioinformatics, Applications of Bioinformatics. Biological databases: Introduction, Classification of Biological databases, Biological data retrieval systems **9 hours**

Unit 2: Sequence Comparison and Database Search: Introduction, Pair wise alignment, global alignment, local alignment, multiple sequence alignment, scoring a multiple alignment, multiple sequence alignment methods **7 hours**

Unit 3: Dynamic programming approach, Progressive alignment, iterative refinement methods, pattern matching in DNA and protein sequences, PAM matrices, BLAST, FAST and FASTA. **10 hours**

Unit 4: Molecular phylogenetics: Introduction, application of phylogenetic trees, basic terminology- taxa, taxanomy, root, leaf, node, tree, branch, clade, dendogram, cladogram, rooted tree, unrooted tree, scaled tree. **7 hours**

Unit 5: Molecular Clocks: Introduction, basic steps of phylogenetic tree construction, methods of phylogeny, Distance based methods-UPGMA, NJ algorithm, Character based methods- Maximum parisomy method, maximum likelihood method, validating phylogenetic methods-bootstrapping and jack-knifing, study of Phylip, NJ plot, Clustal X, and other popular softwares. **9 hours**

Unit 6: Computer programming: Basics of linux, C, C++, Java, Perl & HTML programming **10 hours**

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Recommended readings:

1) Zhumur Ghosh and Bibekanand Mallick, Bioinformatics, Principles and Applications, Oxford University Press, New Delhi, 2008
2) Teresa Attwood, et.al, Introduction to Bioinformatics, Pearson Education, Singapore, 2006
3) Joao Carlos Setubal et. al., Introduction to Computational Molecular Biology, PWS publishing company, Boston.
4) David W. Mount, Bioinformatics, Sequence and Genome analysis, CBS Publishing House
5) Balagurusamy, Computing Fundamentals And C Programming, McGraw-Hill Education (India) Pvt Ltd, 2008.
6) Arthur M. Lesk, Introduction to Bioinformatics, University of Cambridge, 2002.
7) O'Reilly & Associates, Beginning Perl for Bioinformatics, 1st edition, Sebastopol, CA, 2001.

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LS403T: MATHEMATICAL BIOLOGY & BIOSTATISTICS

4 hrs / week | 4 credits

Mathematical biology

Unit 1: Ratio and Proportions, fractional notations, Permutations and Combinations. **3 hours**

Unit 2: Functions: Linear functions, polynomials, simple rational functions, exponential functions (growth and decay), natural logarithmic functions and periodic functions (sine and cosine only) **4 hours**

Unit 3: Derivatives and Chain Rule, implicit differentiation**.** **6 hours**

Unit 4: Applications: Extrema, graph sketching, optimization, related rates. **6 hours**

Unit 5: Accumulated change and definite integrals (using definite integrals for finding area) for functions. **5 hours**

Unit 6: Partial Differentiation. **2 hours**

Biostatistics:

Unit 1: Descriptive Statistics & Sampling: Basic statistical concepts. Reduction of data frequency distribution. Graphical representation of frequency distribution-histogram, frequency curve, cumulative frequency curve. Measures of central tendency and dispersion. Relative dispersion and coefficient of variation. Measures of skewness and kurtosis.

Random sampling. Simple random sampling and stratified random sampling. Use of random number tables, sample size determination. **6 hours**

Unit 2: Probability and Distributions: Simple space. Events. Probability and conditional probability. Addition and multiplication theorems of probability. Probability distributions. Binomial, Poisson and normal distributions. Illustrations. **4 hours**

Unit 3: Correlation and Regression: Problem of relative variables. Scatter diagram. Product moment correlation coefficient and its properties. Rank correlation coefficient. Simple linear regression. Method of least squares. Curve fitting. Exponential and power curves. Coefficient of determination. **6 hours**

Unit 4: Test of Significance & Design of Experiments: Statistical hypothesis. Type–1 and Type–2 errors, level of significance, size and power of a test. Definition of Chi-square, t and F distributions. Central limit theorem. Tests for the mean, equality of two means, variance (for large and small samples). Large samples tests for proportions. Chi-square test for goodness of fit and for independence of attributes in contingency tables. Confidence interval.

Analysis of variance. One-way and two-way classified data. Design of experiments. Analysis of completely randomized, randomized block and nested designs. **10 hours**

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Recommended readings:

1. Cambell. R.C, Statistics for Biologists, Cambridge University Press, UK, 1967.
2. Fry J.C., Biological data analysis, a practical approach, IRL Press, Oxford, U.K, 1993.

3. Snedecor P.S., Statistical Methods, Affiliated East-West press, New Delhi, 2000.
4. Primer of Biostatistics, 7th edition (2011), Stanton Glantz, McGraw-Hill Medical. ISBN- 13: 978-0071781503.
5. Biostatistics: A Foundation for Analysis in the Health Sciences,10th edition (2013), Wayne W Daniel and Chad L Cross, Wiley. ISBN-13: 978-1118302798.
6. Biostatistical Analysis, 5th edition (2009), Jerrold H. Zar, Pearson. ISBN-13: 978- 0131008465.
7. Applied Calculus, Hughus-Hallet et. Al. Wiley Publishers, 2005
8. An Introduction to the Mathematics of Biology, E.K. Yeargers, R.W. Shonkwiler & J.V. Birkhauser (1996)
9. A Biologist's Basic Mathematics, D.R. Causton, Carollina Biological Supply Company (1983)
10. Calculus and analytic geometry, George Brinton Thomas, Ross L. Finney, Addison-Wesley Pub. Co.,2007

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LS 404T: APPLIED BIOLOGY

4 hrs / week | 4 credits

Unit 1: Apiculture **5 hours**

Biology of Bees, Rearing of Bees, Diseases and Enemies, Bee Economy, Entrepreneurship in Apiculture.

Unit 2: Sericulture & Lac culture **8 hours**

Biology of silkworm, Rearing of silkworms, Pests and Diseases, Entrepreneurship in sericulture.

Biology & distribution of lac insect, extraction of lac and economic importance

Unit 3: Animal Husbandry **6 hours**

a) Poultry - farming techniques, breeds, poultry diseases, economic value.
b) Dairy – breeds of cattle, milch breed, draught breed, dual purpose, common diseases and control, exotic and cross breeds, techniques adopted in cattle breeding.
c) Piggery – different breeds, maintenance and marketing of products.

Unit 4: Aquaculture **13 hours**

Aquarium fish keeping: scope as cottage industry, exotic and endemic species; biology of aquarium fishes (guppy, molly, sword tail, gold fish, angel fish, butterfly fish, blue morph, anemone fish); food and feeding; fish transportation

Pisciculture: Importance, fresh water techniques, brackish and marine fish culture in India, diseases and their control, Pearl culture in India.

Unit 5: Commercial crops **8 hours**

a) Floriculture – commercial production of Roses, Anthurium, Gladiolas, tuberose, Jasmine- propagation and cultivation practices
b) Mushrooms – types, cultivation practices and marketing
c) Plantation crops -Economic importance: coffee, tea, rubber, cardamom; timber-yielding plants: teak, rosewood, *Terminalia, Pterocarpus, Shorea*; Social forestry, Agro-forestry, Silviculture.

Unit 6: Medicinal botany **12 hours**

History, scope, indigenous medicinal sciences; Ayurveda (definition, origin, panchamahabhutas, saptadhatu, tridosha concept, rasayana, common plants used in treatments), Sidhha (origin, basis and plants used), Unani (history, concept)

Conservation of endangered and endemic medicinal plants (definition, red list criteria, botanic gardens, ethnomedicinal plant gardens, biosphere reserves, sacred groves, national parks, ex-situ conservation)

Ethnobotany and folk medicines in India (definition, methods of study, applications, natural products to cure certain diseases – jaundice, cardiac problems, infertility, diabetis, blood pressure, skin diseases)

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Recommended readings:

1. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.

2. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.
3. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
4. Bisht D.S., Apiculture, ICAR Publication.
5. Singh S., Beekeeping in India, Indian council of Agricultural Research, NewDelhi.
6. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
7. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
8. Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
9. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
10. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan, 1972.
11. Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
12. Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
13. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
14. Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.
15. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
16. Text book of applied Zoology, vermiculture, apiculture, lac-culture, sericulture, agriculture, pests and their control. P.V.Jabde, Discovery Pub.House 2005
17. A text book of aquaculture. M.S. Reddy, Discovery Pub.House 2004
18. Earthworms in agriculture. Talashikar, S.C. & A.A.K. Dosni, Daya Pub.2005

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LS405P: Biomedical Sciences & Bioinformatics

52 × 2 hours: 4 credits

Biomedical Sciences:

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. Estimation of SGOT in blood samples by standard curve method
2. Estimation of SGPT in blood samples by standard curve method
3. Estimation of LDH in blood samples by standard curve method
4. Estimation of Creatinine in blood samples by standard curve method
5. Estimation of Cholesterol – hypercholesteremia samples
6. Estimation of Bilirubin
7. Estimation of blood glucose by glucose oxidase method
8. Immunoassay for detection of typhoid (kit method)
9. STD detection by agglutination method (kit method)
10. Chromosomal analysis, bright field technique, GTG and CBC banding
11. NOR staining and sex chromosome identification
12. Identification of organelles by marker enzymes: SDH, LDH, acid phosphatase
13. Fluorescence technique, Q & C banding, FISH
14. Karyotyping- normal karyotyping, Aneuploidy, Aberrations.

Bioinformatics:

1. Searching bibliographic databases for relevant information;
2. Sequence retrieval from nucleic acid and protein databases;
3. Restriction mapping; Sequence (FASTA and BLAST) searches;
4. Pair wise comparison of sequences; Multiple alignment of sequences; Evolutionary studies / Phylogenetic analysis;
5. Identification of genes in genomes; RNA folding; Primer Design;
6. Protein databank retrieval and visualization;
7. Superposition of structures; Secondary structure prediction of proteins;
8. Identification of membrane proteins;
9. Pattern searching in proteins (PROSITE);
10. Pattern searching in nucleic acids; Validation of 3D structures;

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LS406P: Research project & Dissertation

12 hours / week | 6 credits

Paper	Component	Max. marks	Credits
Research Project & Dissertation	Colloquium (IA)	15	**4**
	Poster presentation (IA)	15	
	Dissertation	50	
	Oral presentation & Viva-voce	10+10	
	Total	**100**	

- Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life problem. The students are expected to pursue an in-house research project preferably in alignment with their practical syllabi. An internal guide from the Department of Life Sciences will be assigned to the student. S/he will be responsible for keeping track of the student's progress towards submission of the final dissertation. Additionally, the student may approach him/her at any point of time seeking guidance / suggestion, if required.
- In the mid-semester (date to be announced at the beginning of the semester), the students will be expected to make a poster presentation of their research project highlighting background literature review and showcasing results obtained thus far. S/he will also be required to give a colloquium on the topic. Both the poster and the colloquium will be evaluated by the members of an internal committee constituted by the Coordinator /Chairman of the Department. This will count towards internal assessment (IA).
- After the student has completed his/her research project within the stipulated time, s/he will be required to submit two copies of dissertation approved both by the external as well as internal guide, present the results in an open seminar, and defend the theses through a viva-voce conducted in accordance with existing regulations.