DRAFT SYLLABUS UNDER AUTONOMY

LIFE SCIENCES

LIFESCIENCES AT THE MOLECULAR AND CELLULAR LEVELS

SEMESTER I **COURSE : S.LSC.1.01**

CELL BIOLOGY **[45 lectures]**

LEARNING OBJECTIVES:

(1) To understand the concept of a cell as the basic unit of life
(2) To study the structure organization, growth, regulation, movement and interactions in cells with an emphasis on eukaryote cells.

UNIT-1 **[15 lectures]**

1. CELL AS A UNIT OF LIFE:
Prokaryotes, Eukaryotes (plant, yeast, animal cell) (1 Lec.)

2. CELL MEMBRANE:
2.1 Membrane Structure and Function (4 Lec.)
2.1.1 Chemical composition of membranes
Membrane lipids
Membrane proteins
2.1.2 Functions of membranes: Transport, Cell-cell interactions, Receptors (eg; insulin receptor with link to diabetes)
2.1.3 Membrane Model: Fluid Mosaic Model (Freeze fracture technique)

2.2 MEMBRANE TRANSPORT: (5 Lec.)
2.2.1 Active Transport: 1) Uniport, Symport, Antiport
(one example each) 2) Primary, Secondary
Passive Transport: 1) Simple diffusion
(one example each)2) Facilitated diffusion (Carrier proteins, Channels)
3) Osmosis
2.2.2 Membrane transport associated disease : cystic fibrosis
2.2.3 Bulk transport: endocytosis and exocytosis

2.3 MEMBRANE JUNCTIONS : (4 Lec.)
2.3.1 Occluding: Tight
2.3.2 Anchoring: Desmosomes, Hemi desmosomes

2.3.3 Communicating: Gap, Chemical synapses, Plasmodesmata

3. CELL WALL: (1 Lec.)
Structure and function of Plant Cell Wall: Primary and secondary wall.

UNIT-2 **[15 lectures]**

1. RIBOSOMES: (2 Lec.)
Structure and function of Prokaryotic and Eukaryotic ribosomes

2. ENDOPLASMIC RETICULUM: (4 Lec.)
RER: structure and role in protein synthesis and glycosylation of proteins eg; human blood groups
SER: structure and function

3. GOLGI: (3 Lec)
Structure, Origin and Relationship with the ER
Role in storage and secretion of glycoproteins

4. LYSOSOMES AND PEROXISOMES: (4 Lec.)
4.1 Lysosomes
4.1.1 Structure & types of lysosomes
4.1.2 Lysosome cycle
4.1.3 Fuctions of lysosome
4.1.4 Lysosome associated disease: Tay Sachs
4.2 Peroxisomes
4.2.1 Structure and Function
4.2.2 Peroxisome associated disease: Zellweger syndrome

5. MITOCHONDRIA: (2 Lec)
5.1 Structure and function
5.2 Mitochondria associated disease: LHON

UNIT-3 **[15 lectures]**

1. PLASTIDS: (2 Lec)
1.1 Types of plastids
1.2 Structure and function of chloroplast

2. CYTOSKELETAL ELEMENTS: (5 Lec.)
2.1 Microfilaments:
2.1.1 Structure and function in plant & animal cells (sarcomere structure)
2.1.2 Microfilament associated disease: DMD

2.2 Microtubules:
Structure and role in mitotic spindle & cilia/flagella

2.3 Intermediate filaments:
Structure and function

3. CELL CYCLE AND CELL DIVISION:

3.1 Cell cycle (G0, G1, G2, M phases) (1 Lec.)
3.2 Mitosis and Meiosis and their significance (3 Lec.)

4. NUCLEUS: (4 Lec.)

4.1 Structure of an interphase nucleus: nuclear membrane, nucleolus, nucleosome.
4.2 Heterochromatin & Euchromatin
4.3 Specialized chromosomes: polytene and lampbrush chromosomes

C.I.A. Mid Semester Test, Quiz

LIFESCIENCES AT SYSTEMS, ORGANISM AND COMMUNITY LEVELS

SEMESTER I **COURSE : S.LSC.1.02**

CLASSICAL GENETICS **[45 lectures]**

LEARNING OBJECTIVES :

(1) To get an overview and conceptual understanding of the nature of genetic material, mechanisms, inheritance, concept of a gene and genetic disorders.
(2) To gain analytical skills by a problem solving approach to Mendelian inheritance and Human pedigrees.

UNIT-1 **[15 lectures]**

1. Gene as a unit of heredity: Organisation of genes on chromosomes: (6 Lec.)

1.1 Structure of a Prokaryotic genome: eg; *E.coli*
1.2 Structure of a Eucaryotic genome: packaging of DNA to chromosome
1.3 Evidence of DNA as genetic material: Griffith's experiment, Avery & Mcleod's experiment

2. Mendelian Inheritance: (8 Lec.)

2.1 Concept of alleles, dominance & recessivity, homozygous, heterozygous, phenotype, genotype
2.2 Mendel's laws: Law of segregation of alleles, Law of Independent Assortment
2.3 Monohybrid, dihybrid and trihybrid ratios: test cross and self cross, Punnet square and branch diagram for determining ratios of genotypes and phenotypes, chi square analysis for mono-hybrid and di-hybrid ratios

3. **Concept of cytoplasmic inheritance** (1 Lec.)

UNIT-2 **[15 lectures]**

1. **Extensions of Mendel's laws**: Incomplete dominance; co-dominance; multiple genes; Multiple alleles; Lethal alleles; Gene interactions: Epistasis- dominant and recessive; Penetrance and expressivity; Extrinsic factors- temperature, nutrition; Intrinsic factors- Sex (sex limited; sex influenced), age; Pleiotropy (10 Lec.)

2. **Study of human pedigrees**: Modes of inheritance: sex-linked dominant & recessive autosomal dominant & recessive (5 Lecs.)

UNIT-3 **[15 lectures]**

1. **Concept of Karyotype**: The Human Karyotype (1 Lec.)

2. **Molecular Concept of a Gene** (2 Lec.)

3. **Mutations**: (12 Lec.)

3.1 Classification of mutations: germ line versus somatic; spontaneous v/s induced; point v/s chromosomal (giving examples of *Drosophila* mutants)

3.2.1 Point Mutations: Base substitution: transitions, transversions; Frame-shift: addition, deletion

3.2.2 Chromosomal mutations: Structural: deficiency, duplication, inversion, translocation

Numerical: aneuploidy, euploidy, concept of non-dysjunction

3.2.3 Mutations in humans: human genetic disorders: sickle cell anemia, Philadelphia chromosome disorder, Down's syndrome, Turner's syndrome, Fragile X syndrome.

C.I.A. Mid Semester Test, Quiz

LIFESCIENCES AT THE MOLECULAR AND CELLULAR LEVELS

SEMESTER II **COURSE : S.LSC.2.01**

FUNDAMENTALS OF BIOCHEMISTRY AND ANALYTICAL TECHNIQUES [45 lectures]

LEARNING OBJECTIVES:

(1) To understand the physiological significance of water and study the structure and properties of proteins , carbohydrates , lipids and nucleic acids in a living system.
(2) To get an overview of analytical techniques used in the study of cells and biomolecules.

UNIT-1 **[15 lectures]**

1. TYPES OF BONDS: COVALENT AND NON COVALENT (1 lec.)

2. PHYSIOLOGICAL ROLE OF WATER: (4 Lec,)
2.1 Structure of water.
2.2 Dissociation and Ionic Product
2.3 Ionic interaction with water
2.4 Concept of pH and Buffers
2.5 Buffering Systems in a living cell

3. CARBOHYDRATES: (5 Lec.)
3.1 Classification & structure of Carbohydrates.
3.1.1 Monosaccharides: 1) Aldose & Ketose (one example each)
2) C3 to C6 (one example each)
3.1.2 Disacharides: Maltose, Cellobiose, Lactose & Sucrose
3.1.3 Polysaccharides: Starch, Glycogen & Cellulose
3.2 Properties & Reactions of Glucose & Fructose:
3.2.1 Isomerism
3.2.2 Oxidation & Reduction
3.2.3 Esterification
3.2.4 Glycoside formation.

4. LIPIDS: (5 Lec.)
4.1 Bloor's classification of lipids
4.2 Simple lipids (one example each).
4.3 Complex lipids (one example each)
4.4 Derived lipids (one example each)
4.5 Fatty acids: Types, nomenclature & properties (upto C18)

UNIT-2 **[15 lectures]**

1. AMINOACIDS AND PROTEINS: (7 Lec.)

1.1 Classification and Structure of Amino acids, and concept of iso-electric pH
1.2 Chemical reaction with acid/alkali, Ninhydrin, Sanger's reaction
1.3 Classification of Proteins based on function & shape
1.4 Protein Structure: Primary structure and the concept of 'N' and 'C' terminal, peptide bond formation, characteristics of peptide bond, secondary structures: α helix & β sheets, tertiary & quaternary structure

2. NUCLEIC ACIDS: (8 Lec.)

2.1 Structure of nucleosides and nucleotides
2.2 Structure of a poly nucleotide
2.3 Forms of DNA: 'A', 'B' and 'Z'
2.4 Types of RNA: mRNA, tRNA, rRNA, snRNAs
2.5 Differences between DNA and RNA

UNIT- 3 **[15 lectures]**

1. SEPARATION OF ORGANELLES: (2 Lec.)

1.1 Differential centrifugation
1.2 Density gradient centrifugation

2. SEPARATION OF MACROMOLECULES: (6 Lec.)

2.1 Salting in and Salting out
2.2 Paper chromatography
2.3 Thin layer chromatography
2.4 Electrophoresis

3. COLORIMETRY: (2 Lec.)

Beer Lambert's law & principle of a colorimeter

4. MICROSCOPY: (5 Lec.)

4.1 Principle of Light Microscopy
4.2 Electron microscopy: SEM, TEM
4.3 Fluorescence microscopy
4.4 Confocal Microscopy

C.I.A. Mid Semester Test, Quiz

LIFESCIENCES AT SYSTEMS, ORGANISM AND COMMUNITY

LEVELS

SEMESTER II **COURSE : S.LSC.2.02**

EVOLUTION, BIODIVERSITY & ECOLOGY [45 Lectures]

LEARNING OBJECTIVES :

(1) To study the different hypothesis put forward to explain the origin of life.
(2) To understand the various theories of evolution, the process of natural selection and the evolution of man.
(3) To study the diversity of life, speciation and the interaction of living organisms with their abiotic environment.
(4) To understand the concept of populations and their dynamics.

UNIT-1: ORIGIN OF LIFE & EVOLUTION [15 lectures]

1. Origin of life

1.1 Origin of earth and earth's atmosphere (1 Lec.)
1.2 Origin of life on Earth:
1.2.1 Theories of origin of life: Overview of Creation myths/ Divine creation; Spontaneous generation; Cosmozoic hypothesis; Steady state; Biochemical origin. (1 Lec.)
1.2.2 Spontaneous generation- Abiogenesis and Biogenesis (1 Lec.)
1.2.3 Biochemical theories: Origin of macromolecules; Miller's experiment; RNA world (Proteins, RNA, DNA as first macromolecules) (2 Lec.)
1.2.4 Origin of cells: Protocells; Coacervates; Microspheres; Membranes; Autotrophs to Heterotrophs; Prokaryotes to Eukaryotes; Evolution of eukaryotic organelles: chloroplasts/ mitochondrion (3 Lec.)

2. Evolution

2.1 Pre Darwanian ideas; Darwin's theory of natural selection, evidences and objections (2 Lec.)

2.2 Evidences for evolution (1 Lec.)
2.3 Modern synthetic theory of evolution: role of mutations, effects of chance, and natural selection (1 Lec.)

2.4 Geological time scale (1 Lec.)
2.5 Evolution of man (2 Lec.)

UNIT-2: BIODIVERSITY **[15 lectures]**

1. Concept of Biodiversity (1 Lec.)
2. Types & Measurements of Biodiversity (2 Lec.)
   (α, β and γ diversity, diversity indices , genetic diversity & methods to enumerate)
3. Variation in local biodiversity (1 Lec.)
   Niche Assembly Theory of Biodiversity and Unified Neutral Theory of Biodiversity
4. Challenges to Biodiversity:Factors affecting Biodiversity (6 Lec.)

4.1 Natural Factors: Speciation

4.1.1 Species: Concept of species: Physiological species, Biological species, evolutionary species

4.1.2 Speciation and macroevolution: Allopatric, sympatric, and parapatric

4.1.3 Reproductive isolation mechanisms: pre-zygotic, post-zygotic

4.1.4 Variations in speciation rates and the significance of speciation

4.1.5 Phylogeny and Biodiversity: concept of phylogeny and diversity, constructing a simple phylogenetic tree

4.2 Anthropogenic Factors: exploitation of wild living resources, expansion of agriculture, forestry & aquaculture, habitat loss & fragmentation, introduction of new species, pollution of soil, water & air, Global climate change.

5. Conservation of Biology (3 Lec.)
   Conservation & management strategies for sustainable use of biodiversity.
6. Economic value of Biodiversity (2 Lec.)

UNIT-3: ECOLOGY **[15 lectures]**

1. Ecosystems and biosphere: concept of ecosystems, trophic structure of the ecosystem, food chains, food webs and ecological pyramids, energy flow in an ecosystem, terrestrial and aquatic ecosystems (one example of each) (2 Lec.)

2. Population ecology:Concept of population, Natality, mortality, survivorship curves, population age pyramids, carrying capacity, growth curves, human growth rate and growth curves. (1Lec.)

3. Community interactions: Interspecific and intraspecific; positive and negative(3 Lec.)

4. Behavior and ecology: Innate and learned behavior , fixed action patterns, oriented movement, habituation, imprinting, associative learning, spatial learning, cognition and problem solving, development of learned behaviors, foraging behavior, courtship and mating behavior in birds, sexual selection. Biological rhythm and migration, Altruism, Inclusive fitness and social learning. (9 Lec.)

C.I.A. Mid Semester Test, Quiz

PRACTICALS

SEMESTER I COURSE : S.LSC.1.PR

Practical I	**Practical II**
Cell Biology	**Genetics**
Good Lab Practice	χ 2 test
i)Microscopy ii) Onion Peel Staining	i) *Drosophila* mutants ii) Slides/Photos of Sickle-cell
Cytoplasmic Streaming in Hydrilla	Study of Karyotype
Study of Mitosis	Pedigree Analysis
DNA/RNA Histochemical Staining	DNA Extraction + DPA test

SEMESTER II COURSE : S.LSC.2.PR

Practical I	**Practical II**
Biochemistry & Analytical Techniques	**Evolution, Biodiversity & Ecology**
Concepts of Molarity/Normality	i) Halteres of housefly ii) Insect mouth parts
pH – using solutions of different concentrations with universal indicator	Quadrat analysis & Transect analysis
Beer' s Law	Biodiversity: Plants
Cell Fractionation – Succinate dehydrogenase and Starch granules localisation	Biodiversity: Animals
Qualitative Analysis- Sugars (mono & disaccharides, ketose & aldose, reducing & non-reducing) Proteins & Lipids	Homologous & Analogous Organs in Plants & Animals

REFERENCES

COURSE 1.01: Cell Biology

1. Molecular biology of the cell 5th Ed. (2008)
   B.A. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walters,

   Garland Science Publication

2. Cell and Molecular Biology – concepts and experiments – 4th Ed. G. Karp (2005)
   John Wiley & Sons Inc.

3. The World of Cell, 5th Ed. (2003)
   W. M. Becker, L. J. Kleinsmith, J. Hardin

   Pearson Education (Singapore)

4. The Cell – A Molecular approach, 4th Ed. (2007)
   G. M. Cooper, R. E. Hausman

   ASM Press Washington, D.C.

5. Molecular Cell Biology – 6th Ed. (2008)
   H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, M. P. Scott, A. Bretscher,

   H. Ploegh, P Mortsudira

   W. H. Freeman & Company, N.Y.

6. Cell Biology (1992)
   Smith and Wood

   Chapman and Hall

7. "Cell and Molecular Biology" – 8th Edition
   EDP De Robertis and EMF De Robertis

   K. M. Varghese and Co. (1987)

COURSE 1.02: Genetics

1. Concepts of Genetics – W. S. Klug, M. R. Cummings, C. A. Spencer. 8th Edition, Pearson Education International (2006)

2. Introduction to Genetic Analysis – A. J. Griffiths, S. R. Wessler, R. C. Lewontin, S. B. Carroll. 9th Edition, Freeman and Company (2008)

3. "Molecular Biology of the Gene" – J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 5th Edition, Pearson Education (2004)

4. "Principles of Genetics" – P. Snustad, M. Simmons, 4th Edition, John Wiley and Sons Co., (2006)

5. "Genetics : A Conceptual Approach" – B. Pierce, 3rd Edition, Freeman & Co., (2008)

6. 'iGenetics" – Peter Russell, 2nd Edition, Pearson International, (2006)

7. "Human Genetics – Concepts and Applications" – 5th Edition Mc Graw Hill, (2003)

8. "Genetics : The Continuity of Life" – D. J. Fairbanks, W.R. Andersen, Brooks/Cole Publishers (1999)

COURSE :2.01 : Biochemistry

1. "Principles of Biochemistry" – 5th Ed. M. M. Cox, D. Lehninger, Macmallin & Co. (2008).

2. 'Biochemistry' – 5th Ed. J. M. Berg, J. L. Tymoczko and L. Stryer; Freeman and Co. Publishers, (2002)

3. 'Biochemistry' – 2nd Ed. U. Satyanarayanan and U. Chakrapani; Books and Allied P. Ltd. (2007)

4. "Outlines of Biochemistry" – 4th Ed. E Conn and P. K. Stumpf; John Wiley and Sons (1976)

5. "Textbook of Biochemistry" – 4th Ed., E. S. West, W. R. Todd, H. S. Mason, J. Van Bruggen Oxford and IBH Publishing Co. (1966)

6. "Principles and Techniques of Practical Biochemistry" 2nd Ed., B. L. Williams and K. Wilson, Edward Arnold Publishers; (1981)

7. "Principles and Techniques of Biochemistry and Molecular Biology" – 6th Ed. K. Wilson and J. Walker, Cambridge University Press (2006)

COURSE :2.02 : Origin of Life, Ecology Biodiversity

1. The World of Biology, Solomon E. P., Berg L. R. 8th Edition, Saunders College Publishing. (2008)

2. Essential Biology, N Campbell, J. Reece, Simon E. J., 3rd Edition, Pearson Education Inc. (2007)

3. Biology; N. A. Campbell, J. B. Reece, L. A. Umy, M. A. Cain et al, 8th Edition, Pearson Benjamin Cummings (2008)

4. Biology, Life on Earth, Teresa Audersirk, Gerald Audersirk, 5th Edition, Prentice – Hall International Inc.

5. Strickbergers Evolution : the integration of genes, organisms and population, Brian K. Hall, B. Halleirimsson, 4th Edition, Jones and Barrlett Publishers. (2008)

6. Biology, S. Alters, B. Alters, John Wiley & Sons (2006)

7. Ecology, M. Cain, W. Bowman, S. Hacker, Sinauer Associates Inc.

8. Fundamentals of Ecology, E. P. Odum, G. W. Barrett, 5th Edition, Brooks Cole Inc.

9. Ecology, N. S. Subrahmanyan, A. V. S.S. Sambamurty, Narosa Publishing