MICROBIOLOGY MAJOR – SYLLABUS

Course 5

Course Structure (Semester III)

Course	Title of the Course	No. of Hrs/Week	No. of Credits
5	Cell biology and Genetics	3	3
	Cell biology and Genetics-Practical	2	1

SEMESTER-III

COURSE 5: CELL BIOLOGY AND GENETICS

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives:

1. Explain cell theory, organelles, the cell cycle, and cytoskeleton functions.
2. Describe cell membrane, nuclear envelope, nucleolus, and basics of cancer development.
3. Illustrate protein sorting, signal transduction, apoptosis, and specialized chromosomes.
4. Apply Mendelian genetics, including crosses, inheritance patterns, and allele frequencies.
5. Understand linkage, crossing over, Hardy-Weinberg law, natural selection, genetic drift, and sex determination.

II. Course Outcomes: On completion of this course students will be able to:

1. Distinguish prokaryotic and eukaryotic cell structures, describe major cell organelles and cytoskeletal elements, and explain the regulation of the cell cycle and mitosis.
2. Understand membrane structure and transport, nuclear organization, and basic concepts of cancer.
3. Learn about cell signaling mechanisms, protein transport pathways, and the regulation of apoptosis.
4. Gain knowledge of Mendelian inheritance and its extensions, including specialized chromosomes, pedigree analysis, multiple alleles, and epistasis.
5. Describe linkage and crossing over, apply population genetics principles, and differentiate modes of sex-linked and extranuclear inheritance.

III. Syllabus of Theory:

Unit 1 **09 Hrs**

1.1 Cell theory and cell organelles (Mitochondria, Chloroplasts, Lysosomes, Glyoxysomes and Peroxisomes, Golgi apparatus and ER).

1.2 Prokaryotic cell, eukaryotic cell (plant cell and Animal cell).

1.3 Cell cycle and its check points. Mitosis.

1.4 Cytoskeleton: Structure and organization. Role of actin, myosin and intermediate filaments, microtubules.

Unit 2 **09 Hrs**

2.1 Structure and functions Cell membrane, proton pumps (Na^+–K^+ pump, Ca^{2+}-calmodulin, etc.) and their distribution.

2.2 Endocytosis: Phagocytosis, Pinocytosis, Exocytosis.

2.3 Nuclear envelope: Structure of nuclear pore complex, nuclear lamina, Nucleolus; Transport across nuclear membrane.

2.4 Elementary knowledge of cancer development and causes; Oncogenes and suppressor genes.

Unit 3 **09 Hrs**

3.1 Basic structure of cell signalling systems; first messengers and intracellular secondary messengers.

3.2 Cell-to-cell signalling: Eukaryotes-endocrine hormone signalling, cytokine signalling; prokaryotes-quorum sensing, bacterial pheromones.

3.3 Protein sorting and Transport; Intracellular signal transduction pathways (GPCR, ERK Pathway).

3.4 Apoptosis: Programmed Cell Death; Brief note on Stem cells.

Unit 4 **09 Hrs**

4.1 Mendelian Genetics: Mendel's Laws (Laws of dominance, segregation and Independent assortment).

4.2 Deviations from mendel's laws: Incomplete dominance, co-dominance, epistasis.

4.3 Chromosome theory of inheritance: Multiple alleles, lethal alleles.

Unit – 5 **09 Hrs**

5.1 Linkage and Crossing over; Theories of linkage; Significance of Linkage. Crossing over; Types of crossing over and mechanism of crossing over. Difference between linkage and crossing over.

5.2 Sex determination; Sex linked inheritance.

5.3 Theory of Evolution: Natural selection; Genetic drift.

IV. Co-curricular activities:

1. Create 3D models of cell organelles and demonstrate their functions.
2. Observe mitosis, cell structures, and apoptosis using prepared slides.
3. Solve monohybrid, dihybrid, problems.
4. Use interactive software or games to explore linkage, crossing over, and sex-linked inheritance.

V. Reference Books:

1. A.J.F Griffiths, S. R Wessler, S. B Carroll & J. Doebley, An Introduction to Genetic Analysis, 10th Ed., W.H. Freeman & Company (New York) 2010.

2. Geoffrey M. Cooper and Robert E. Hausman - The Cell a Molecular Approach.

3. Bruce Alberts, Rebecca Heald, et al. Molecular Biology Of The Cell.

4. Arnold Berk (Author), Chris A. Kaiser (Author), Harvey Lodish (Author), Angelika Amon (Author), Molecular Cell Biology.

5. Benjamin Lewin, Genes.

6. Eldon John Gardner, Michael J. Simmons, D. Peter Snustad, Principles of Genetics.

7. Karp G, John Wiley, Cell Biology.

8. Jane B. Reece (Author), Martha R. Taylor (Author), Eric J. Simon (Author), Jean L. Dickey, Campbell Biology: Concepts and Connections.

9. Veer Bala Rastogi, Genetics; B D Singh, Genetics.

SEMESTER-III

COURSE 5: CELL BIOLOGY AND GENETICS

Practical	Credits: 1	2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Observe and analyze cell structure, organelles, and cell viability.
2. Examine mitosis, meiosis, and identify cancer cells using microscopy.
3. Apply genetic principles to study linkage, recombination, and gene mapping.

II. Laboratory/Field exercises:

1. Yeast cell counting and Viability.
2. Study a representative plant (Chlorella) and animal cell (Amoeba) by microscopy.
3. Study of ultrastructure of cell (Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Lysosomes, SER and RER).
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
5. Mitosis from onion root tips.
6. Meiosis of flower buds.
7. Identification and study of cancer cells by photomicrographs.
8. Study of Linkage, recombination using marker-based data from Drosophila.