I SEMESTER B.SC., GENETICS (HONS) THEORY SYLLABUS
DISCIPLINE SPECIFIC CORE COURSE DSCC
THEORY PAPER: DSCC5GENT1: CELL BIOLOGY AND GENETICS

Course Title: Cell Biology and Genetics Code DSCC5GENT1	Course Credits:04
Total Contact Hours: 56	Duration of DSC: 4Hours
Formative Assessment Marks: 40	Summative Assessment Marks:60

Course Outcomes:

By the end of the course the students will be able to

1. Understand the structure and function of all the cell organelles.
2. Know about the chromatin structure and its location.
3. Understand the Mendel"s laws and its deviations.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)		1	2	3	4	5	6	7	8	9	10	11	12
I.	Core competency	x											
II.	Critical thinking	x											
III.	Analytical reasoning	x											
IV.	Research skills	x											
V.	Team work	x											

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X" in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

Chapter	Content	Hours 56
	Unit - 1	14
01	Ultrastructure, chemical composition and functions of Plasma membrane. Ultrastructure and functions of Cytoplasmic organelles: Mitochondria, Kreb's cycle, BIS oxidative phosphorylation, Endoplasmic reticulum, Ribosomes, Lysosomes, Golgi bodies and Cytoskeleton.	
02	Nucleus: Morphology, nuclear envelope, nucleoplasm, nucleolus and chromatin.	

03	Ultra structure of Eukaryotic Chromosome: Macro-molecular organization- Nucleosome model. Primary and Secondary constriction, SAT-bodies, Special chromosomes- structure and function of Polytene and Lampbrush chromosome	JS
Chapter	Unit – 2	14
04	Molecular Basis Cell Cycle and Cell Division: G1, S, G2 and M phase, Checkpoints. Mitosis: Stages, Mitotic apparatus, cytokinesis, Mitogens and Inhibitors, Significance. Meiosis: Stages, Synaptonemal complex, crossing over and chiasma formation, Significance.	8hrs
05	Cell senescence and Cell death: cellular features of Senescence- spontaneous and induced, Programmed cell death, Mechanism of cell death and significance.	JS
06	Cancer Biology: Introduction to cancer, Benign and malignant, Sarcoma, Carcinoma, Lymphoma and leukemia, Properties of malignant cells.	
Chapter	Unit – 3	14
07	Biography of Mendel and his experiments: Law of Segregation: Monohybrid cross, back cross and Test cross, Genetic Problems related. Law of Independent Assortment: Dihybrid cross, Back cross and Test cross, Genetic Problems related.	JS
8	Multiple Alleles: Definition, ABO blood groups and Rh factor in Human, Genetic Problems related.	PPA
9	Gene Interactions: Deviations from Mendelism: Incomplete inheritance and co-dominance. Complementary gene interaction (9:7), Supplementary gene interaction(9:3:4), Recessive Epistasis, Non-Epistasis (with an example for each trait)	PPA
Chapter	Unit – 4	14
10	Linkage: Linkage definition, cis and trans arrangement of genes, Linkage group in *Drosophila* and man. Types of linkage – complete and incomplete linkage maps. Linkage map – E.g. *Drosophila*, construction of linkage maps. Crossing over - Types, mechanism of crossing over, interference and coincidence, Factors affecting linkage and crossing over, significance of linkage and crossing over.	PPA
11	Human Cytogenetics: Normal Human karyotype (Male & Female)	JS
12	Clinical features and Karyotype of Syndromes: Cri-du-chats, Down's, Edward's, Patau's, Turner's, and Klinefelter's.	JS

Text Books:

1. Karp, G. (2009). *Cell and molecular biology: concepts and experiments*. John Wiley & Sons.
2. Russell, P. J., Hertz, P. E., McMillan, B., & Benington, J. (2020). *Biology: the dynamic science*. Cengage Learning.

III Semester B.Sc., GENETICS
Theory Syllabus
Paper – GNT 301: CYTOGENETICS

52 Hrs.

14 Hrs.

UNIT I

a. Physical Basis of Inheritance:

- Definition, Description of chromatin structure, Chromosome theory of inheritance.
- Eukaryotic Chromosome: Macro-molecular organization. Primary and Secondary constriction, Sat-bodies, Telomeres, Histones, DNA, Nucleosome
- Heterochromatin and Euchromatin and its significance.
- Ultra structure of Chromosome - Nucleosome model, Karyotype and Idiogram.

b. Special types of Chromosomes:

- Structure and Significance of Special type of Chromosomes: Polytene
- Chromosome - Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte.
- Supernumerary B Chromosome.

13 Hrs.

UNIT II

a. Sex Linkage:

- Definition of sex linkage
- Meiotic behavior of chromosome and non - disjunction. Bridges theory of non-disjunction.
- Sex linkage in *Drosophila.*
- Sex linked genes in poultry, moths and man
- Sex linked inheritance in man (Colour-blindness, Haemophilia)
- Attached X-chromosome.

b. Extra Chromosomal Inheritance / Cytoplasmic Inheritance:

- Characteristic features of Cytoplasmic Inheritance.
- Inheritance of : Mitochondrial DNA, Chloroplast DNA, Kappa articles in *Paramecium*, Sigma factor in *Drosophila*, Shell coiling in snail.
- Cytoplasmic Male Sterility (CMS) in maize.

14 Hrs.

UNIT III

a. Linkage:

- Definition of Linkage, Coupling and Repulsion hypothesis, Linkage group- *Drosophila*, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage- distance between genes, age, temperature, radiation, sex, chemicals and nutrition, Significance of linkage.

b. Crossing over:

Crossing over- definition and types of crossing over: Germinal and Somatic crossing over.

Cytological basis of crossing over: Stern's experiments in *Drosophila,* Creighton and Mc Clintock experiment in maize.

Mechanism of crossing over: Chiasma type theory, Breakage first theory, Contact first theory, Strain or torsion theory.

Molecular mechanism of crossing over - Holiday model, Crossing over in *Drosophila.*

Interference and coincidence, Steps in Construction of genetic map *(Drosophila).*

UNIT IV **11 Hrs.**

Chromosomal aberrations:

Numerical: Euploidy (Monoploidy, Haploidy and Polyploidy)
Polyploidy- Autopolyploidy and Allopolyploidy.
Aneuploidy- Monosomy, Nullisomy and Trisomy.

Structural - Deletions (Terminal, Interstitial), Duplication (Tandem, Reverse tandem and Displaced), Translocation (Simple, Isochrome, Reciprocal, Displaced) and Inversions (Pericentric and Paracentric).

Significance of chromosomal aberrations.

V Semester B.Sc., GENETICS
Theory Syllabus
Paper – GNT 501: RECOMBINANT DNA TECHNOLOGY

40 Hrs.

14 Hrs.

UNIT I

a. Introduction to RDT:

Overview of major steps involved

b. Tools for RDT:

Enzymes:

Restriction endonucleases: Types, Nomenclature, Recognition sequences, cleavage pattern; Modification of cut ends DNA ligases

Other enzymes: A brief account of alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA polymerase and S_1 endonuclease.

Vectors:

Properties of an ideal vector, Cloning and expression vectors in prokaryote and eukaryotes.

Cloning vectors:

i) Prokaryotic vectors:

Plasmids- pBR 322; pUC 18;

Bacteriophages- Lambda phage, Cosmids.

ii) **Eukaryotic vectors:** YAC vectors; Shuttle vectors- Yeast and *E. coli.*

iii) For higher plants:

Integrative DNA transfer- *Agrobacterium* vectors-Ti plasmid

Non integrative- DNA transfer-Plant viral vectors (CaMV)

For animals: Animal viral vectors- SV 40, SV- GT5, Retroviruse and Adenoviruse.

UNIT II **13 Hrs.**

a. Isolation and construction of a desired gene:

mRNA isolation

cDNA library

Genomic library

b. Gene transfer methods:

Agrobacterium mediated gene transfer- Binary and Cointegration method.

Direct gene transfer methods:

Chemical method-Calcium phosphate method and DEAE - **(Diethylaminoethyl) Dextran mediated DNA transfer**

Lipofection

Electroporation

Microinjection

Gene gun method

c. **Synthesis of gene:**
Sangers di deoxy method
Organo chemical synthesis

d. **Selection and screening of recombinants:**
Identification and selection of transformed cells:
Direct methods-Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation /nutrition
Indirect methods- Colony hybridization, Immunochemical detection
Use of selectable and scorable genes:
a) Selectable genes: Plants- npt; Animals-*TK*
b) Scorable genes: Plants-Gus; Animals-*lux*

UNIT III **13 Hrs.**

a. **Technique for RDT:**
Gel electrophoresis: AGE and SDS-PAGE
PCR - Principle and applications
Hybridization: Southern; Northern; Western;
Autoradiography – Principle and applications
DNA foot prints
DNA microarray and DNA chips.

b. **Applications:**
Transgenic animals: Methodology to create transgenic animals (mouse).
Applications of Transgenic Knock-out Mouse, Sheep, Fish, Cow.
Transgenic Plants: Resistance to diseases (Pathogen resistance to viral, fungal and bacterial); insects (*Bt* gene transfer).
Fertilizer management – organization of *nif* gene in *Rhizobium*.

V Semester B.Sc., GENETICS
Theory Syllabus
Paper – GNT 502: BASIC HUMAN GENETICS

40 Hrs.

13 Hrs.

UNIT I

a. Human Chromosomes:

Normal Human Karyotype: Paris Nomenclature, Flow karyotyping (Quantification of DNA of individual chromosomes) FACS- Fluorescence Activated Cell Sorter

b. Genetic Diseases and Inheritance Pattern:

Autosomal inheritance- Dominant
(Ex. Adult polycystic kidney, Achondroplasia and Neurofibromatosis)

Autosomal inheritance- Recessive
(Ex. Albinism, Sickle cell anaemia, Phenylketonuria)

X-linked – Recessive: (Ex. Duchenne muscular dystrophy-DMD)

X-linked- Dominant : (Ex. Xg blood group)

Y-linked inheritance : Holandric gene (Ex. Testes determining factor - TDF)

Multifactorial inheritance :
(Ex.Congenital malformations: Cleft lip and palate, Rheumatoid arthritis and Diabetes)
Mitochondrial diseases: (Ex. Leber's hereditary optic neuropathy)

c. Pedigree studies and Genetic Counselling:

Symbols used in pedigree studies, Pedigree analysis and construction, Pedigree analysis for the inheritance pattern of genetic diseases, Genetic Counselling.

- Stage 1: History and pedigree construction
- Stage 2: Examination
- Stage 3: Diagnosis
- Stage 4: Counselling
- Stage 5: Follow up

UNIT II **14 Hrs.**

a. Immunology and Immunogenetics:

Introduction to immunology- antigens, antibodies, B and T Cells
Immunity- Innate and acquired.
Immune response - Humoral and Cell mediated
Genetics of immune system – Antibody gene rearrangement and class switching.
Inherited immunodeficiency- Ex. X- linked agammaglobulinaemia.
Major Histocompatibility Complex- Types,
HLA disease associations.
Transplantation, graft-rejection and immunosupressors
Concept of immunization

b. **Oncogenetics:**

A brief account of cancer-definition, types-Benign and Malignant; Sarcoma, Carcinoma, Lymphoma and Leukaemia 5M

Properties of malignant cells,

Types of genes - Proto oncogenes, Oncogenes, 3M Difference between V-onc and C – onc oncogenes, Tumor Suppressor genes-p53, pRb.

Chromosomal abnormalities associated with the specific malignancies- Acute Promyelocytic Leukaemia(APL),Chronic Myeloid Leukaemia(CML) and Acute lymphoblastic leukaemia (ALL)

UNIT III **13 Hrs.**

Dermatoglyphics:

Introduction and Patterns.

Dermatoglyphics in clinical disorders- Down's syndrome, Turner's syndrome, Klinefelter's syndrome and Cri du chat syndrome.

Clinical applications, Advantages and Limitations.

b. **Prenatal Diagnosis:**

Introduction and types

Invasive Prenatal diagnosis - Amniocentesis, Chorionic villus sampling.

Non – Invasive Prenatal diagnosis – Ultrasonography.

c. **Genetics and Society:**

Eugenics: Positive and negative, Euthenics, Euphenics 5M

Human genome project – introduction and significance

Gene therapy with reference to SCID

Stem cells- Properties, types and sources.

A brief account on Cord blood banking and Stem cell therapy.