II SEMESTER B.Sc., GENETICS THEORY SYLLABUS
CYTOGENETICS

Program Name	B.Sc.	Semester	II
Course Title	CYTOGENETICS		
Course Code:	DSCGT-2	No. of Credits	3
Contact hours	56 Hours	Duration of SEA/Exam	3 hrs.
Formative Assessment Marks	20	Summative Assessment Marks	80

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1: Understand the Laws of Mendel, gain insight in to various types of gene interaction

CO2: Gain knowledge on the principles of Linkage and crossing, analyze the construction genetic map.

CO3: Comprehend the phenomenon of extra nuclear inheritance.

CO4: Gain Knowledge and understand the mechanism of sex linkage and sex determination.

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

Course Outcomes (COs)/(POs)	DSCGT2
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 out comes whose attainment is attempted in this course. Mark 'X' in the intersection cell if course outcome addresses a particular program outcome.

Content	56 Hrs.
Unit-I	**14 hrs.**
• **History of Genetics:** Concept of allele, gene and genome, Phenotype and Genotype; Heredity, variation, Pure lines and Inbred Lines. Mendelian experiments on pea plants - Law of Segregation; Monohybrid cross, Back cross and Test cross, Law of independent Assortment: Dihybrid cross in pea plant, Back cross and Test cross. • **Multiple Alleles**: Definition, ABO blood groups and Rh factor in Human, Related Genetic Problems. • **Gene Interactions:** Incomplete inheritance and co- dominance, non- epistasis (Comb pattern in fowl). Epistatic interactions- Complementary gene interaction (9:7) (Flower colour in *Lathyrus odoratus*) Supplementary gene interaction (9:3:4) (Grain colour in *Zea mays*) Dominant epistasis (Fruit colour in *Cucurbita pepo*) Recessive Epistasis (Coat color in mouse).	

Unit-II	14
• **Linkage:** Definition of Linkage, Coupling and Repulsion hypothesis, Linkage group- Drosophila, Types of linkage- complete linkage and incomplete linkage, Factors affecting linkage- distance between genes, age, temperature, radiation, sex, chemicals and nutrition. • **Crossing over:** Definition and types of crossing over: Germinal and Somatic crossing over. Stern's experiments in Drosophila, Creighton and Mc Clintock experiment in maize. Molecular mechanism of crossing over - Holiday model. Interference and coincidence, Construction of genetic map (Drosophila). Significance of linkage and crossing over. • **Extra nuclear inheritance:** Characteristic features of Cytoplasmic Inheritance, Mitochondrial DNA, Chloroplast DNA, Sigma factor in Drosophila, Shell coiling in snail. Cytoplasmic Male Sterility (CMS) in maize.	
Unit-III	**14**
• **Sex Linkage:** Definition, non – disjunction, Chromosome theory of inheritance. Bridges theory of non-disjunction. Attached X- chromosome. Sex linkage in Drosophila, Poultry. Sex linked inheritance in man (Colour-blindness, Haemophilia). • **Sex Determination** □ Chromosome theory of Sex determination: XX- XY, XX-XO, ZZ-ZW, Genic balance theory of Bridges, Intersexes and Super sexes in Drosophila, Y chromosome in sex determination of Melandrium. Environment and sex determination, Hormonal control of Sex determination (Free martins). Gynandromorphs. • Dosage compensation - Lyon's hypothesis, Hyper activation of X in Drosophila and random inactivation in human.	
Unit-IV	**14**
Chromosomal aberrations: Numerical: Euploidy (Monoploidy, Haploidy and Polyploidy) Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomy, Nullisomy and Trisomy. Structural – Deletions- Notch wing in Drosophila (Terminal, Interstitial), Duplication-Bar eye in Drosophila (Tandem, Reverse tandem and Displaced), Translocation- Rheo discolor (Simple, Isochrome, Reciprocal, Displaced) and Inversions (Pericentric and Paracentric), Inversion heterozygote and polymorphism. Significance of chromosomal aberrations.	

IV SEMESTER B.SC., GENETICS (HONS) THEORY SYLLABUS
DISCIPLINE SPECIFIC CORE COURSE DSCC
THEORY PAPER: DSCC5GENT4: HUMAN GENETICS AND GENETIC COUNSELLING

1. Course Description:

Semester: IV	Course Title: **Human Genetics and Genetic Counselling**
Course Code:	Course Type: **DSCC5GENT4**
Course Credits	4
Total hours :	**56**
Formative Assessment Marks: **40**	Summative Assessment Marks:**60**
Duration of DSC	4Hours

2. Course Objectives:

- Study the Human chromosome and chromosomal Inheritance pattern in Human.
- Understand the components of immune system and the role of genes in immune development.
- Comprehend prenatal diagnosis method and use of cell therapy and gene therapy for genetic disease.
- Understand the objective of Genetic counseling and its steps involved.

3. Course Outcomes:

After the successful completion of the course, the student will be able to:

- Understand the nomenclature of Human chromosome and chromosomal inheritance pattern.
- Understand cells of immune system, structure of immunoglobulin and role of MHC in transplantation.
- Understand Prenatal diagnosis method and gene therapy for treating Genetic disease.
- Appreciate Genetic counselling and steps involved in it.

4. Course Content

Content	56 Hrs
UNIT I: Human chromosomes and chromosomal Inheritance Pattern a. Human Chromosomes: Normal and abnormal Human Karyotype: Paris Nomenclature, Flowkaryotyping, FACS - Fluorescence Activated Cell Sorter. b. Genetic Diseases and Inheritance Pattern: Autosomal inheritance- Dominant (Eg. Adult polycystic kidney and Neurofibromatosis) Autosomal inheritance- Recessive (Eg. Albinism, Sickle cell anemia) X-linked – Recessive: (Eg. Duchene muscular dystrophy) X-linked Dominant- (Eg. Hypophosphatemia) Y-linked inheritance- Holandric gene (E.g. Testes determining factor - TDF) Multifactorial inheritance: (Eg. Congenital malformations: Cleft lip and palate, Rheumatoid arthritis and Diabetes) Mitochondrial diseases: (Eg. Leber's hereditary optic neuropathy).	14

Unit 2: Immunogenetics **a. Introduction to immunology-** types and properties of antigens, antibodies, B and T Cells, Immunity types - Innate and acquired. Immune response - Humoral and Cell mediated. **b.** Genetics of immune system – antibody gene rearrangement and class switching. Inherited immunodeficiency- Ex. X- linked agammaglobulinaemia. **c.** Major Histocompatibility Complex- Types, HLA disease associations. Transplantation, graft-rejection and immunosupressors. Concept of immunization	14
Unit 3: Prenatal diagnosis and gene therapy **a.** Indications for prenatal diagnosis; Methods- Noninvasive method- Ultrasonography and Fetal echocardiography, Invasive methods - Amniocentesis, Chorionic villus sampling; Pre-conception and pre-implantation genetic diagnosis- Teratogen exposure in early pregnancy, Genetic testing and screening. **b.** Gene therapy with reference to SCID Stem cells- Properties, types and sources. Cord blood banking and Stem cell therapy	14
Unit 4: Genetic Counseling: **a.** Symbols used in pedigree studies, Pedigree construction and analysis, Pedigree analysis for the inheritance pattern of genetic diseases. **b.** Genetic Counseling. –Introduction to Genetic counseling; Historical overview, stages of counseling, scope of genetic counselling. **c.** Roles and responsibilities of Counselor and Consultant - needs, rights; Ethical, legal and social issues (ELSI), Acts and Amendments.	14

5. References:

1. Basic Human Genetics by EJ. Manage and A.P. Manage (1997 India Reprint) a Rastogi Publications, Meerut.
2. Emery's Elements of Medical Genetics- Peter Turnpenny, SlanEllard 15th Edition. 2017.
3. Essentials of Human Genetics by S.M. Bhatnagaretal (1999) IV edition. Orient Longman.
4. Genetic basis of common diseases by R. A. King et al, Oxford University Press 2002.
5. Genetics in Medicine by M.W. Thompson et al, 5 Edition, W.B. Sounders Company, London 1996.
6. Human Cytogenetics. Denise Rooney Oxford University Press, 2001.
7. Human Genetics – Bruce.R.Korf. 2000
8. Human Genetics: Concepts and Applications by Lewis R (2001) McGrawHi; Boston.
9. Human Genetics by S.D. Gangane (2nd Edition-Reprint 2001), B.L Churchill Livingstone Pvt. Ltd., New Delhi.
10. Medical Genetics. Lynn Jorde John CareyMichael Bamshad. 2015.
11. Mendelian inheritance in Man by-Mc. Kusick V.A, (1998), 12 Edition, John Hopsins University Press.
12. Molecular Basis of Inherited Diseases, (6th Edition-1989) by Scriver, C.R. A.L. Beudit. W.S. Styabnd D. Valle (Eds) Mc Graw Hill, New York.

VI SEMESTER B.SC., GENETICS

Program Name	**B.Sc. Genetics**	Semester	**VI**
Course Title	**GENES AND DEVELOPMENT (Theory)**		
Course Code:	**DSCC5GENT7**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2.5 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course outcome: By the end of the course the students will be able to

CO1. Understand the role of genes in early development.
CO2: Conceptualize the molecular and cellular mechanisms controlling early development of organisms.
CO3: Understand the role of the genes in cell differentiation and determination.
CO4: Relate recent advances in clinical embryology.

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

Course Outcomes(COs)/ Program Outcomes(POs)		T5	P5	T6	P6	T7	P7	T8	P8	T9	P9	T10	P10
I.	Core competency					x							
II.	Critical thinking					x							
III.	Analytical reasoning					x							
IV.	Research skills					x							
V.	Teamwork					x							

Chapter	Content	60 Hours
	Unit I	
01	**Basic concepts:** • Model organisms for genetic analysis: Insect- *Drosophila*, Nematode- *C. elegans* Amphibian- *Xenopus laevis*; Fish- *Danio rerio* (Zebra fish), Mammals- *Mus musculus*. • **Basic concepts of development**: - Potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic gradients, pattern formation, cell fate and cell lineage.	**15 hrs**

	• Nuclear transplantation experiment: *Xenopus* and *Acetabularia*. • Switching genes on and off during development; Tissue specific methylation, Differential expression of haemoglobin genes.	
02	**Unit II** **Fertilization and Development**: • Types of egg based on amount and distribution of yolk, Fertilization, cleavage and its types, patterns of cleavage, Gastrulation; Morphogenetic movements and formation of germ layers in Frog. • Organogenesis in Frog-neural induction and the formation of early nervous system; role of organizer.	**15 hrs**
03	**Unit III** **Genetics of embryonic development in Plants, *Drosophila and mammals*:** • **Apical-basal axis formation, flowering in *Arabidopsis*;** Stages of early embryonic development- 2 cells, octant stage and dermatogens stage. Transition from vegetative to floral development, ABC model and homeotic genes, mad box genes. Genetics of anther development and pollen formation. • **Development of *Drosophila* body plan:** role of maternal genes, polarization of body axes during oogenesis, role of zygotic genes in establishment of body axis, Homeotic gene expression; Imaginal disc and its development. • **Pattern formation and gene expression in mammalian embryos**: Axes formation and Hox genes; Genetics of gonadal differentiation in Human.	**15 hrs**
04	**Unit IV** **Clinical Embryology:** • Gametogenesis, Follicular development, ovulation, fertilization and implantation. • Embryonic stem cells and their applications • Hormonal control of reproduction, Gonadal malformation and their genetic basis • Reproductive failure and causes of infertility; Young syndrome and KALIG gene mutation • Assisted Reproductive Technology: IUI, IVF, ICSI.	**15 hrs**

CourseArticulationMatrixrelatescourseoutcomesofcoursewiththecorrespondingpr ogramoutcomeswhoscattainmentisattemptedinthiscourse. Mark 'X" in the intersection cell if a course outcome addresses a particular program outcome.

PAPER: POPULATION AND EVOLUTIONARY GENETICS (Theory)

Program Name	**B.Sc. Genetics**	Semester	**VI**
Course Title	**POPULATION AND EVOLUTIONARY GENETICS**		
Course Code:	**DSCC5GENT8**	No.of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2.5 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

- **Course outcomes: After completion of the course, the student will be able to:**

CO1. Understand the concepts of population and quantitative genetics
CO2. Describe Hardy-Weinberg principle and its importance in population genetics
CO3. Conceptualise mating patterns, inbreeding coefficient and genetic polymorphism.
CO4. Understand molecular evolution in protein and DNA sequences

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

Course Outcomes(COs)/ Program Outcomes(POs)		T5	P5	T6	P6	T7	P7	T8	P8	T9	P9	T10	P10
I.	Core competency							x					
II.	Critical thinking							x					
III.	Analytical reasoning							x					
IV.	Research skills							x					
V.	Teamwork							x					

CourseArticulationMatrixrelatescourseoutcomesofcoursewiththecorrespondingprogramoutcomeswhoseattainmentisattemptedinthiscourse. Mark 'X" in the intersection cell if a course outcome addresses a particular program outcome.

Unit	Content	Hours:60
	Unit I	
01	**Basic Concepts:** • Population genetics: Definition & Meaning, Mendelian Population and scope of population genetics. Gene and genotype frequencies, Mating patterns, Random and Non-random mating. • Hardy-Weinberg principle, Extension of H-W principle to multiple alleles and sex-linked alleles. Factors affecting Hardy Weinberg Equilibrium.	**15 hrs**

	• Quantitative Genetics: (a) Traits controlled by two loci, three loci and multiple loci (b) Heritability, measurement of variability. • Heterosis, transgressive inheritance; Inbreeding and Inbreeding coefficient.	
02	**Unit II** **Selection and Speciation:** • Natural Selection, types of selection - Balancing Selection, Mutation–Selection Balance, Mutation–Drift Balance. • Concept of fitness in natural selection. • Isolating mechanisms and Classification – (a) Geographic isolation (b) Reproductive isolation – (i) Pre-mating isolation – Climatic, Seasonal, Habitat, Ethological (ii) Post-mating isolation – gametic mortality, zygotic mortality, hybrid inviability and hybrid sterility. • Evidence for speciation, Mode of speciation: Allopatric, Parapatric, Sympatric; Co-speciation: sexual selection, Co-evolution and convergent evolution.	**15 hrs**
03	**Unit III** **Theories of Evolution:** • Emergence of Evolutionary Theory: Lamarckism and Darwin's Theory of Evolution, Lamarckism and Neo-Darwinism. • Origin of basic organic monomers and polymers, Spontaneous generation, Louis Pasteur's experiment, Oparin and Haldane's theory of origin of life, Miller-Urey Experiment. • Evolutionary time scale: Eras, periods and epoch, Major events in evolutionary time scale.	**15 hrs**
04	**Unit IV** **Molecular Basis of Evolution:** • Molecular evolution; concept of neutral theory of molecular evolution; Molecular divergence and molecular clocks. • Molecular tools in phylogeny; classification and identification. Genetic Variation in natural populations; Chromosomal and protein polymorphism, Balanced polymorphism. • Protein and nucleotide sequence analysis and construction of phylogentic tree using tools of Bioinformatics.	**15hrs**