BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course)

Syllabus for Genetics
(V & VI Semester)

2023-24

Guidelines For Model Curriculum

1. The Universities shall promote Double Major model as prescribed in the Model Curriculum Table.
2. For Arts/Humanities/Social Science - V & VI sem, three core papers (DSC) to be selected in each semester.
   For Science – Ensure two core papers (DSC) should get minimum of 12 credits/or 2 major subjects of 24 credits (4+2 patterns)
   (1 hour of Lecture or 2 hours of practical/field work per week in a semester is assigned one credit and core subject theory courses/papers will have 4 credits, while practical are assigned 2 credits)
3. Formative assessment and summative assessment to be followed in the ratio of 40:60.
4. Selection of Open electives: The university shall follow curriculum and credit frame work for Undergraduate program of published by UGC. **Open Electives – Courses from other Disciplines (9 Credits)**
   - Students are not allowed to choose or repeat courses as open electives already undergone at the higher secondary level (12th class)
   - All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines given below.

Natural and Physical Sciences	Mathematics, Statistics, & Computer Applications	Library, Information, and Media Sciences	Commerce and Management	Humanities and Social Sciences:
Students can choose basic courses from disciplines such as Natural Science, for example, Biology, Botany, Zoology, Biotechnology, Biochemistry, Chemistry, Physics, Biophysics, Astronomy and Astrophysics, Earth and Environmental Sciences, etc.	Courses under this category will facilitate the students to use and apply tools and techniques in their major and minor disciplines. The course may include training in programming software like Python among others and applications software like STATA, SPSS, Tally, etc. Basic courses under this category will be helpful for science and social science in data analysis and the application of quantitative tools	Courses from this category will help the students to understand the recent developments in information and media science (journalism, mass media, and communication)	Courses include business management, accountancy, finance, financial institutions, fintech, etc.,	The courses relating to Social Sciences, for example, Anthropology, Communication and Media, Economics, History, Linguistics, Political Science, Psychology, Social Work, Sociology, etc. will enable students to understand the individuals and their social behavior, society, and nation. Students be introduced to survey methodology and available large-scale databases for India. The courses under humanities include, for example, Archaeology, History, Comparative Literature, Arts & Creative expressions, Creative Writing and Literature, language(s), Philosophy, etc., and interdisciplinary courses relating to humanities. The list of Courses that can include interdisciplinary subjects such as Cognitive Science, Environmental Science, Gender Studies, Global Environment & Health, International Relations, Political Economy and Development, Sustainable Development, Women's and Gender Studies, etc. will be useful to understand society.

BSc.-Science: Curriculum and Credit Framework for Undergraduate Programme

Sem.	Discipline Specific Courses - Core (DSC), Elective (DSE)(Credits) (L+T+P)	Minor/ Multidisciplinary/ Open Elective (OE) Courses(Credits) (L+T+P)	Ability Enhancement Courses (AEC)(Credits)(L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC-A1(4), A2(2) DSC-B1(4), B2(2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC-A3(4), A4(2), DSC-B3(4), B4(2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2)(1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)	26/25
Students exiting the programme after securing 46 credits will be awarded UG Certificate in Disciplines A and B provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during the first year.						
III	DSC-A5(4), A6(2), DSC-B5(4), B6(2)	OE-3 (3)/ India and IndianConstitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**:AI/Cyber Security/Finan- cial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G) /Cultural (2) (0+0+4)/ SEC (2)	25
IV	DSC-A7(4), A8(2), DSC-B7(4), B8(2)	India and Indian Constitution (3) / OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. &Inv. Aw. /AI /Cyber Security (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after securing 92 credits will be awarded UG Diploma in Disciplines A and B provided they secure additional 4 credits in skill based vocational courses offered during first- or second-year summer term.						
V	DSC-A9(4), A10(2), A11(4), A12(2);	DSC-B9(4), B10(2), B11(4), B12(2)		**SEC-4**: Employability Skills/Cyber Security (3) (2+0+2)		27
VI	DSC-A13(4), A14(2), A15(4), A16(2);	DSC-B13(4), B14(2), B15(4), B16(2)		Internship (2)		26
Students exiting the programme after 3-years will be awarded UG Degree in Disciplines A and B as double majors upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						

Internship for graduate Programme (As Per UGC & AICTE)

Course title	Internship Discipline specific
No of contact hours	90
No credits	2
Method of evaluation	Presentations/Report submission/Activity etc.,

- Internship shall be Discipline Specific of 90 hours (2 credits) with a duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session)
- Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.

Subject Expert Committee Members for Genetics

S.NO.	Name & Organization	Designation
1	Prof.KVijaykumar,DepartmentofZoology,GulbargaUniversity,Kalaburagi.9480060508,katepaga63@gmail.com	Chairman
2	Prof.PMBasha,DepartmentofZoology,BangaloreUniversity,Bengaluru. 9448701652,pmbashabub@rediffmail.com	Member
3	Prof.VijaykumarBMalashetty,DepartmentofZoology,VSKUniversity,Ballari.9343011567,vijaymalashetty@gmail.com	Member
4	Dr.S.Basavarajappa,MysoreUniversity,Mysuru.9449203241 ornithoraj11@gmail.com	Member
5	Prof.Nagaraj,DepartmentofZoology,KuvempuUniversity,Shivamogga. 9620485338REPEATED	Member
6	Prof.B.Vasanthkumar,DepartmentofZoology,SirMVGovtCollege,Bhadravathi,Shimoga	Member
7	Prof.B.K.Meera,AssociateProfessor,MaharaniClusterUniversity,Bengaluru(9886409382)	Member
8	Smt.KareemunnisaSyed,Associateprofessor,Dept.ofZoology,NrupathungaUniversity, Bengaluru(9964300991)REPEATED	Member
9	Dr.GangadharaRao,AssociateProfessor,Govt.Women'sCollege,Kolar. 9448984956	Member
10	Prof. Shankarappa S. Hatti, Govt. College, Dept. of Zoology, SedamRoad,Kalaburgi.9980391964	Member
11	Dr.ZebaParveenDept.ofZoology,BiBiRazaWomen'sDegreeCollege,Kalaburagi.9448092786	Member
12	Dr. Asiya Nuzhath F.B, Associate Professor, Dept. of Zoology, TumkurnUnversity,Tumakuru.9844029441	Member
13	Ms.. Akshatha, Special Officer, KSHEC, Bengaluru.9535487108	Member Convener

Bengaluru City University Subject Committee BOS members for Genetics

SN	Name& Organization	Designation
1	Dr. P. MAHABOOB BASHA, Prof. of Zoology, Bangalore University, Bangalore-560056.	Chairman
2	Dr. HEMALATHA A. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001.	Member
3	Dr. SHABANA BEGUM. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001	Co-opted Member(E)
4	Dr. LATHA, V. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001	Co-opted Member(E)
5	Mr. CHANDRAPPA, Associate Prof. of Zoology, GFGC, Yelahanka, Bangalore. 9886884996.	Member
6	Mrs. DHANALAKSHMI. N, Asst. Prof of Zoology, Vijaya College, RV Road, Bangalore-560004.	Member
7	Dr. C.E. TRIVENI, V.V. Puram College of Science, K. R. Road, Bangalo	Member
8	Dr. SHUBHA M, Assistant Professor in zoology, BMS College for Women, Bengaluru-560004.	Member
9	Ms. PAVANA KAMATH, Asso. Professor, The Oxford College for Science, HSR layout, Bengaluru	Co-opted Member
10	Dr. CRUSTUS JUDE A.L, Professor & Dean, Kristujayanti College, Bengaluru	Co-opted Member
11	Dr. RAMAKRISHNAIAH TN, Asso. Professor of Genetics, MS Ramaiah College, Bengaluru.	Co-opted Member
12	Dr. RADHA DAYANIDHI, Asst. Professor of Genetics, MS Ramaiah College Bengaluru	Co-opted Member
13	Dr. PRATHIBHA KY, Professor of Botany, Maharani Cluster University, Bengaluru. Co-opted Member	Co-opted Member
14	Dr. SURESH KUMAR, Asso. Professor of Botany, Maharani Cluster University, Bengaluru.	Co-opted Member

Note:

1. Sl. No 3 &4 were co-opted in the place of Superannuated BOS members.
2. Sl. No 9 -14 were co-opted as they are subject teachers teaching Genetics subject and who framed the syllabus as per the directions of KHEC, Bangalore

(P. MAHABOOB BASHA)
Chairman, BOS (UG), BCU

V SEMESTER B.Sc. GENETICS

Program Name	**B.Sc. Genetics**	Semester	**V**
Course Title	**GENE REGULATION AND DNA REPAIR (Theory)**		
Course Code:	**DSCC5GENT5**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2.5 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

2. Course outcome: After completion of the course, students will be able to:

CO1. Comprehend various types of DNA repair mechanisms and the associated diseases
CO2. Interpret epigenetic gene regulation
CO3. Summarise gene expression profile
CO4. Comprehend gene expression at various levels

3. **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.	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.

Unit	**Content**	**Hours:60**
	Unit I	**14 hrs**
01	**DNA repair:** • Single strand and double strand DNA damage • **Direct DNA repair** -Photo reactivation, 3'-5' exonuclease activity of DNA polymerase (proof reading), 06 methyl guanine, methyl transferase • **Excision repair-** Base excision repair, Nucleotide excision repair, Mismatch repair, SOS repair Mitochondrial DNR repair.	

	• **Repair defects**- Gene defect, symptoms and incidence involved in Xeroderma pigmentosum, Ataxia Telengetasia, Fanconi anemia and Cocyane syndrome	
02	**Unit II**	**16 hrs**
	Epigenetic Gene regulation: • Introduction to Epigenetic Gene regulation and its types- transcriptional and translational regulation**.** • **DNA Modification**- Cytosine modification-CpG island, role of DNA methyl transferases (DNMT) in DNA methylation, DNA methyl binding proteins, DNA demethyl transferases; Genomic imprinting**.** • **Histones and Epigenetic Modification**- Organisation of eukaryotic DNA- Nucleosome model, process of Histone methylation, acetylation and phosphorylation, nucleosome remodelling • **RNA based Epigenetic Modification -**Role of small noncoding RNAs –miRNA, si RNA, sno RNA in translational regulation, Role of Long non –coding RNA in gene regulation. Mechanism of X chromosome inactivation in human female.	
03	**Unit III**	**16 hrs**
	Regulation of gene expression: • Spatial and temporal gene regulation of gene expression. • Transcriptional control: RNA polymerases, cis-elements, transcription factors, • Post Transcriptional Control: RNA editing –Adenosine to inosine, cytoplasmic control of mRNA stability Environmental impact on transcription: Heat shock genes • RNA interference: mechanisms and enzymology; RISC complex formation; regulation of gene expression by miRNP pathway, Antisense RNA technology	
04	**Unit IV**	**14 hrs**
	Gene expression analysis: • RNA expression analysis-DNA microarray, RT-PCR method • Promoter Analysis- Expression of Reporter gene/ promoter fusion in host cells, chromatin Immunoprecipitation method • Protein Expression Analysis: Western blotting, 2D-Gel Electrophoresis • Methylation sensitive restriction enzymes and Fluorescence *in situ* hybridization	

Practical Paper: GENE REGULATION AND DNA REPAIR

- **Course Description**

Semester: **V**	Course Title: **GENE REGULATION AND DNA REPAIR**
Course Code:	Course Type: **DSCC5GENP5**
Course Credits:	**2**
Total contact hours : **56-**	Duration of MD: **4 Hours**
Formative Assessment Marks: **25**	Summative Assessment Marks: **25**

- **Course Outcome:**

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

- Isolate DNA from different tissues
- Stain and observe DNA and RNA in cells
- Understand the methodology involved in DNA and RNA blotting
- Analyse the effects of mutations in Human beings

Paper Code	Experiment/Practical	Hours 56
1.	Isolation of RNA from blood/ tissue sample	03
2.	Expression of heat shock protein and induction of puffs in Polytene chromosome of Drosophila.	03
3	Study of mutant s in Drosophila.	02
4	DNA specific staining – Feulgen/ Toluidine blue staining of fixed cells	04
5	RNA specific staining- pyronine staining	04
6	Protein Profiling-SDS PAGE.	04
7	DNA profiling-AGE	04
8	Demonstration of Western Blotting Technique	06
9	Study of 2D-gel electrophoresis, FISH and chromatin Immunoprecipitation-Principle and applications.	06
10	Study of Mutation involved in Xeroderma Pigmentosum, Ataxia Telengetasia, Fanconi Anemia.	02

References:

- Molecular Cell Biology, Lodish H et al., - Freeman
- The Cell: A Molecular Approach, Cooper GM - Sinauer
- Molecular Biology of the Cell, Alberts B et al., - Garland
- Genomes, Brown TA – Garland
- Human Molecular Genetics, Strachan T and Read AP – Garland Science
- Modern Genetic Analysis, Griffiths AJF et al., - Freeman

Pedagogy:

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	20
Seminars/Assignment/ Minor project	15
Participation in class/ Attendance	05
Total	40

PAPER: PLANT CELL AND TISSUE CULTURE TECHNOLOGY (Theory)

Program Name	**B.Sc. Genetics**		Semester	**V**
Course Title	**PLANT CELL AND TISSUE CULTURE TECHNOLOGY (Theory)**			
Course Code:	**DSCC5GENT6**		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

- Understand the basic principles of plant tissue culture
- Explain the role of media, sterilization, and methodology of tissue culture.
- Comprehend various types of plant tissue culture
- Apply plant tissue culture technique in crop improvement.

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									

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.

Chapter	**Content**	**Hours:60**
	Unit I	
01	**Introduction to Plant Tissue Culture:** • Definition, History of plant tissue culture research, Totipotency of cells, differentiation, dedifferentiation and redifferentiation. • Methods of sterilization -physical and chemical methods, • Media preparation - Murashige and Skoog's (MS medium), phytohormones, medium for micro-propagation. • Role of chemicals -Macronutrients, micronutrients, Vitamins, amino acids and growth regulators in plant tissue culture. Callus subculture maintenance and growth measurements.	**14 hrs**

02	**Unit II**	**16 hrs**
	Basic Principles of Plant Tissue Culture: • Techniques of cell and tissue culture: Preparation of explant materials, initiation of cultures, micro propagation. • Direct and indirect organogenesis and Somatic embryogenesis, artificial (synthetic) seeds, embryo culture, callus culture, meristem culture and organ culture. • Clonal Propagation: Shoot-tip and axillary bud culture of ornamental and horticulturally important plants.	
03	**Unit III**	**16 hrs**
	Types of Plant Tissue Culture and Application: • Methods and Applications of Suspension culture, Protoplast isolation, culture and fusion, Endosperm culture, Embryo culture and Embryo rescue technique. • Anther Culture: Development of haploids, diploidization and its applications. • Production of somaclones and gametoclones, Somaclonal variation and *in vitro* selection for crop improvement. • Production of secondary metabolites and Industrial application of plant tissue culture for production of Secondary metabolites. • Cryopreservation and Germplasm conservation.	
04	**Unit IV**	**14hrs**
	Plant Biotechnology and Crop Improvement: • Applications of Plant Genetic Engineering – crop improvement, fiber quality, herbicide resistance, insect resistance and virus resistance. • Agrobacterium mediated gene transfer. • Genetic modification – transgenic plants for pest resistance (Bt-cotton); herbicide resistance (Round Up Ready Soybean); improved agronomic traits (flavrSavr tomato, Golden rice); Improved horticultural varieties.	

PRACTICAL: **PLANT CELL AND TISSUE CULTURE TECHNOLOGY**

- **Course Description**

Semester: **V**	Course Title: **Plant Cell And Tissue Culture Technology**
Course Type:	Course Code: **DSCC5GENP6**
Course Credits:	**2**
Total contact hours : **56 -**	Duration of MD: **4 Hours**
Formative Assessment Marks: **25**	Summative Assessment Marks:**25**

2.Course Outcome:

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

- Prepare artificial nutrient media, preparing independently,
- Apply various sterilization procedures for media, glassware, and biological materials,
- Morphogenesis--, clonal propagation methods,
- Isolation of plasmid DNA individually and as a group.

PRACTICAL PAPER: PLANT CELL AND TISSUE CULTURE TECHNOLOGY

Sl.No	Practical/experiment	Hours
1	Tissue Culture Laboratory; washing chamber, media preparation laboratory, sterilization laboratory, inoculation laboratory, culture room.	**04**
2	Tissue culture requirements; glassware, water distillation Unit, chemicals. Instruments: Autoclave, pH meter, sterile airflow chamber (Laminar flow).	**02**
3	Preparation of Media, Sterilization: Media, Explant, glassware.	**04**
4	Inoculation, Callus Induction and Clonal Propagation.	**04**
5	Protoplast isolation and culture	**04**
6	Induction of embryogenic callus and encapsulation of artificial seeds.	**04**
7	Study of methods of gene transfer: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, and micro projectile bombardment.	**02**
8	Steps involved in genetic engineering- Production of Bt. Cotton, Golden rice and FlavrSavr tomato.	**03**
9	Isolation of plasmid DNA.	**03**

References:

- Text Book: Botany-Plant tissue culture and its biotechnological applications, by B. R. C. Murthy & V. S. T. Sai, Venkateswara Publications, Guntur, 2017
- Books for Reference: 1. Pullaiah. T. and M.V.Subba Rao. 2009. Plant Tissue Culture. Scientific Publishers, New Delhi.
- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
- Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques, and Applications. John Wiley & Sons Inc. U.S.A.

Pedagogy:

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	20
Seminars/Assignment/Minor project	15
Participation in class/Attendance	05
Total	**40**

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**	**15 hrs**
	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.	
03	**Unit III**	**15 hrs**
	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.	
04	**Unit IV**	**15 hrs**
	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.	

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

Practical Paper: Genes and Development

• **Course Description**

Semester: **VI**	Course Title: **GENES AND DEVELOPMENT**
Course Type:	Course Code: **DSCC5GENP7**
Course Credits:	**2**
Total contact hours : **56 -**	Duration of MD: **4 Hours**
Formative Assessment Marks: **25**	Summative Assessment Marks:**25**

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

- To make direct and daily visual observations of living embryos of different organisms
- Understand the early development in frog and Drosophila
- Understand and appreciate the role of genes in development in Drosophila and Arabidopsis
- To understand the early developmental stage of chick embryos

Sl. No	Practical	Hrs
1	Study of eggs and cleavage patterns	**02**
2	Study of early development in Blastula and Gastrula of frog	**02**
3	Isolation and identification of virgin flies using Virgin band	**03**
4	Isolation and identification of *Drosophila* egg from Yeast media	**03**
5	Mounting of imaginal discs in *Drosophila*	**04**
6	Study of early Development – axis formation in *Drosophila* using chart	**03**
7	Study of Floral meristem development in *Arabidopsis* (ABC model) using chart	**02**
8	Observation of the chick embryo development using slides (24,36 and 48hrs development)	**02**
9	Cell Viability test using Trypan blue	**03**

Pedagogy:

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	20
Seminars/Assignment/Minor project	15
Participation in class/Attendance	05
Total	**40**

References:

- Bhojawani, S.S, and Bhatnagar, S.P. (2000): The embryology of Angiosperms Vikas Publication House, New Delhi.
- Carlson, B.M. (1996): Pattern's foundation of embryology. McGraw Hill Inc. N.Y.
- Howell, S.H. (1998): Molecular genetics of plant development. Cambridge University Press, Cambridge.
- Lewin. B. (2001): Genes VII. Oxford University Press. Oxford.
- Russo, V.E.A., Brody, S., Cove. D. And Okkolenghi (1992): Development. The
- Molecular genetic approach. Springer Verlag Berlin.
- Snustad, D.P., and Simmons, M.J. (2003): Principles of Genetics, 3 Edn. John Wiley and Sons, inc. N.Y.
- Tamarin, R.H. (2000): Principles of Genetics 6 Edn. W.C. Brown Publishers, London.
- Wolpert, L.et.al. (2002): Principles of development, 2d ed. Oxford University Press, Oxford.
- Developmental Biology (2003) - Gilbert S. F, SinauerAsso.
- Principles of Development (2002) - Wolpert L et al., Oxford University Press
- The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
- Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
- Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge University Press.

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**

PRACTICAL PAPER: POPULATION AND EVOLUTIONARY GENETICS

- **Course Description**

Semester: **VI**	Course Title: Genes and Development
Course Type:	Course Code: **DSCC5GENP8**
Course Credits:	**2**
Total contact hours : **56**	Duration of MD: **4 Hours**
Formative Assessment Marks: **25**	Summative Assessment Marks:**25**

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

- Understand the fundamental math/statistics behind population genetic data analyses.
- Use empirical methods and tools to describe levels and patterns of genetic diversity and differentiation in populations and to infer and assess population genetic structure.
- Use corresponding population genetics software to analyse, interpret, and visualize population genetic data.

Sl. No.	Practical	Hours 56
1.	Study of population genetics problems- Population Genetics- Gene and Genotype Frequencies, Heretability and Polygenic variance (Min 3 problems in each)	**6**
2	Experiments on natural selection, male selection, female selection, genetic drift- Population size, sampling error.	**4**
3	Bioinformatics basic tools- BLAST, FASTA and RASMOL	**4**
4	Analysis of Protein and DNA sequences	**4**
5	Study and construction of phylogenetic tree using Bioinformatics tools.	**4**
6	Project related to Genetics such as: Cytogenetics, Molecular, Microbial, quantitative, population and evolutionary Genetics	**8**

References:

- Principles of Genetics by D. Peter Snustad and Michael J Simmons
- Genetics: A Conceptual Approach by Benjamin A. Pierce
- The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonal
- Genes in the Environment- Rosie S. Hails, Wiley-Blackwell Publications, 2003.
- Hartl. D.L. (1988): A primer of population genetics. Sinauer sunderland USA.
- Li. W and Graur (1990): Fundamental of Molecular evolution. Sinauer associates Sunderland bd, USA.
- Price, P.W. (1996): Biological evolution. Saunders pub. Philadelphia.
- Russo, V.E.A., Brody, S., Cove. D. And Okkolenghi (1992): Development. The molecular genetic approach. Springer Verlag Berlin.
- Snustad, D.P., and Simmons, M.J. (2003): Principles of Genetics, 3¹ Edn. John Wiley and Sons, inc. N.Y.
- Strickberger, M.W. (1996); Evolution, 2ndEdn. Jones and Barlett Pub. London.

• Strickberger, M.W. (1996): Genetics, 3rdEdn. Prentice Hall of India, New Delhi.
• Tamarin, R.H. (2000): Principles of Genetics 6 Edn. W.C. Brown Publishers, London.
• Wolpert, L.et.al. (2002): Principles of development, 2d ed. Oxford University Press, Oxford

Pedagogy:

Formative Assessment	
Assessment Occasion	**Weightage in Marks**
House Examination/Test	**20**
Seminars/Assignment/Minor project	**15**
Participation in class/Attendance	**05**
Total	**40**

For B.Sc., III Year V and VI semesters

GENETICS AND ANOTHER SUBJECT AS DOUBLE MAJORS IN THIRD YEAR

Sem	Disp.	Paper Code	Title	C	T	P	Du.Ex	IA	E	T
V	DSC	**DSCC5GENT5**	Gene regulation and DNA Repair	4	4		2.5 hr	40	60	100
		DSCC5GENP5	Practical - Gene regulation and DNA Repair	2		4	3 hr	25	25	50
		DSCC5GENT6	Plant cell and Tissue Culture Technology	4	4		2.5 hr	40	60	100
		DSCC5GENP6	Practical - Plant cell and Tissue Culture Technology	2		4	3 hr	25	25	50
VI	DSC	**DSCC5GENT7**	Genes and Development	4	4		2.5 hr	40	60	100
		DSCC5GENP7	Practical -Genes and Development	2		4	3 hr	25	25	50
		DSCC5GENT8	Population and Evolutionary genetics	4	4		2.5 hr	40	60	100
		DSCC5GENP8	Practical- Population and Evolutionary genetics	2		4	3 hr	25	25	50

(C: credits; Institutional hours-T: theory; P: Practical; Du.Ex: Duration Exam hrs; Exam evaluation Pattern-IA: Internal Assessment; E: Exam marks; T: Total)

Scheme of Practical Examination

V Semester
DSCC5GENP5- Gene Regulation and DNA Repair

Duration: 03 Hours **Max. Marks 25**

Practical Examination Model Paper

1. Extract RNA from the given sample (Blood/ Tissue) and comment on the result. 07
2. Perform DNA/ RNA specific staining and write the principle 06
3. Make a temporary preparation of Polytene chromosome, identify Balbiani rings and comment on the result. 06
4. Identify the spotters and comment on - 3*2=6
   a. DNA/ Protein Profile
   b. 2D Gel electrophoresis/FISH/ Immunoprecipitation
   c. DNA repair defects

Scheme of Valuation

1. Extract RNA from the given sample and comment on the result
   (Extraction -5 marks, Comment – 2 marks)
2. DNA/RNA specific staining
   (Performance -2 marks, Principle-2 marks, Result- 2 marks)
3. Polytene chromosome
   (Performance-3 marks, Result-1 mark, Comment- 2 marks)
4. Spotters- Identification 0.5 marks, Comment-1.5 marks

Practical Paper VI

DSCC5GENP6- Plant Cell and Tissue Culture Technology

Duration: 03 Hours **Max. Marks 25**

Practical Examination Model Paper

1. Isolate Plasmid DNA from the given sample and Write the procedure and principle for the same. **08**

OR

Isolate Protoplast from the given sample. Write protocol and discuss the result.

2. Prepare artificial seeds from the given material and Write the protocol. **06**

3. Perform the steps involved in sterilization and inoculation of explants and write the flow chart for the same. **05**

4. Identify and comment on the following spotters- **2*3=6**

a. Gene transfer method - Agrobacterium mediated/ Direct gene transfer method

b. Production of Bt. Cotton/ Golden rice, FlavrSavr tomato

Scheme of Valuation

1. Isolate Plasmid DNA /protoplast
(Extraction -5 marks, protocol and principle – 3marks)
2. Artificial seeds
(Performance -3marks, Result- 1 mark, Protocol-2marks)
3. Inoculation of explants
(Inoculation-3marks, flow chart-2marks)

(Student has to demonstrate each step of sterilization and inoculation)

4. Each spotter – (Identification -1 mark, comment-2 marks)

VI Semester

Practical l Paper VII
DSCC5GENP7- Genes and Development

Duration: 3 hours **Max. Marks: 25**

1. Mount and identify any 3 imaginal discs from larva of *Drosophila*. Comment on the result 07

2. Perform cell viability assay using Trypan blue staining. Calculate the percentage of cell viability in the given sample. 06

3. Isolate Virgin flies and identify the virgin band 03

4. Identify and comment on the following 3*3=9

   a. Frog early development stage slides – blastula, gastrula

   b. Developmental stages of chick embryo- 24 hrs. 36 hrs and 48hrs.

   c. Axis specification in *Drosophila*, ABC model in *Arabidopsis*

Scheme of Valuation

1. Imaginal disc
(mounting and identification each 2 marks, result - 1 mark)
2. Cell viability test
(performance and result – 4 marks calculation – 2 marks)
3. Isolation of Virgin flies
(Isolation - 1 mark, Identification of Virgin band -2 marks)
4. Each spotter: Identification -1 mark, comment - 2 marks)

VI Semester

Practical Paper VII

DSCC5GENP8- Population and Evolutionary Genetics

Duration: 3 hours **Max. Marks: 25**

1. Project dissertation submission and viva 10
2. Solve any two genetic problem 2*5=10
   a. Population Genetics
   b. Heritability
3. Analyse the DNA or Protein sequence using Bioinformatics tools 05

Scheme of valuation

1. Project assessment
   (Project report -6 marks, Viva 4 marks)
2. Problems in Genetics: 5 marks each
3. Analysis of sequence: 3 marks; Result-2 marks