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BENGALURU CITY UNIVERSITY
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BE BOUNDLESS

BENGALURU CITY UNIVERSITY

Syllabus for

B.Sc., Genetics (UG)

CHOICE BASED CREDIT SYSTEM (CBCS)

Framed According to the State Educational Policy (SEP 2024)

I and IV SEMESTERS

[To be implemented from the academic year 2025-26]

BENGALURU CITY UNIVERSITY, BENGALURU
Proceedings of the meeting of BOS (UG) in Zoology and Genetics

Ref: 1) BCU/BOS/SEP/376/2024-25 Dated, 29-01-2025
2) BCU/Syn/BOS/Zoology & Genetics (UG)/404/2024-25 Dated 03-03-2025

The Chairperson – BOS in Zoology / Genetics, Bengaluru City University, Bengaluru greeted the BOS Members before the commencement of the meeting

A meeting of Board of Studies in Zoology and Genetics of BCU was held on 11th and 12th March 2025 (during 10.30am to 4.30pm) at Department of Zoology, Bengaluru City University, Bengaluru to scrutinize the drafted syllabus pertaining to B.Sc. Zoology and Genetics, Bengaluru City University in accordance with SEP-2024

Agenda 1: Approval of Syllabi for 3rd – 4th Semester B.Sc., Zoology and B.Sc., Genetics under SEP-2024
Resolution: The proposed syllabus for 3rd – 4th Semester B.Sc., Zoology and B.Sc., Genetics (both theory and practical) and as well as the scheme of examination were scrutinized thoroughly, finalized with appropriate inclusion(s) deletion(s) of the contents and finally approved on 12th March 2025.

Agenda 2: Approval of panel of examiners for B.Sc., Zoology and B.Sc., Genetics for the academic year 2025-2026
Resolution: The given panel of examiners for UG Zoology and Genetics for the year 2025-2026 were scrutinized thoroughly, finalized with appropriate inclusion(s) deletion(s) of the contents and finally approved.
The meeting was concluded with the chairperson thanking all the members for rendering cooperation for the smooth conduct of the meeting.

The following BOS members attended the meeting

Sl.No	Name of the Chairman / Member	Designation	Signature
1.	Dr.B P Harini, Professor & Chairperson, Dept. of Zoology, Bangalore University, Bengaluru-560056 (Ph.No:9448939066)	Chairperson	
2.	Dr. Ashalatha, Associate Professor, Vijaya College, R.V. Road, Bengaluru-560004 (Ph.No.9480019720)	Member	B. Ashalatha 11/3/25
3.	Dr. Rama Krishnaiah, Associate Professor, M.S Ramaiah College, Bengaluru (Ph.No.9611928200)	Member	
4.	Gopala Krishna, Associate Professor, Dept. Genetics & Biotechnology, Vijaya College, R.V. Road, Bengaluru-560004 (Ph.No.7019272375)	Member	ABSENT
5.	Dr. Salma Banu, Associate Professor, Seshadri Puram, First Grade College, Yelahanka (Ph.No. 9886703351)	Member	Salma B
6.	Dr. Shubha M, Assistant Professor, Department of Zoology, BMS College for Women, Basavanagudi, Bengaluru – 560 004 (Ph.No. 9900782822)	Member	
7.	Dr.C.E. Thriveni, Assistant Professor, V.V. Puram College of Science, Bengaluru-4. (Ph.No. 9902452934)	Member	Dr. C.E. Thriveni
8.	Dr. Anil G.B. Assistant Professor, MES Degree College of Arts, Science & Commerce, Malleshwaram, Bengaluru (Ph.No.9611325048)	Member	
9.	Dr. Abhinandini I, David, Associate Professor, Maharanis College for Womens, Mysore, (Ph.No. 9964123301)	Member	
10.	Dr. J.S. Asha Devi, Professor, Dept. of Zoology, Yuvarajas College Mysore (Ph.No.9448258374	Member	ABSENT
11.	Dr. Rakesh H, Faculty, Dept. of Zoology, BUB	Co-opt Member	Rakesh. H
12.	Dr. Shalini M, Faculty, Dept. of Genetics, BUB	Co-opt Member	M. Shalini

Yours Sincerely,

(B.P.HARINI)
BOS Chairperson- BCU

PROFESSOR AND CHAIRPERSON
Department of Zoology
Bangalore University, Jnanabharathi
Bengaluru - 560 056

F O R E W O R D

As per the recommendations made by State Education Policy (SEP) led by Prof. Sukhdeo Thorat commission, the Government of Karnataka has reinforced the three-year degree programme from the academic year 2024-25. The new changes come close on the heels of students and colleges who have expressed concerns over the lack of clarity in pursuing a four-year programme as per NEP. As per the recommendations, now colleges can offer degrees with three majors with a general degree in all six semesters; three majors up to fourth semester, and specialization in one subject in fifth and sixth semester or; a single subject specialization from first semester with minors. In addition to majors and specialization courses, the three subjects will be compulsory. First, a course with practical (skill) orientation which is linked to the theoretical major course and is expected to improve employability. Students have to learn two languages: Kannada/ other Indian languages, and English. The third compulsory subject is value or moral education which will include teaching constitutional moral values/ principles of equality, liberty, fraternity, national unity, non-discrimination and similar values. Two electives that can be selected by the students based on the availability of courses may be discipline based or distinctly related to discipline-based majors. It is recommended that a tutorial or assignment with a project component based on the survey which will give or involve practical experience may be included. It is also suggested that skill enhancement course with a tutorial based on the survey/laboratory be introduced for single subject specialization and deep specialization in 5th and 6th semesters. The examination pattern will be 80:20 (80 for the semester-end exam, and 20 for internal assessment). Likewise, for practical oriented science subjects, the examination pattern will be 40:10 (40 for the semester-end practical exam, and 10 for internal assessment).

The prominent features of the new scheme framework are:

1. Colleges can offer degrees with three majors - three majors up to fourth semester, and specialization in one subject in fifth and sixth semester or; a single subject specialization from first semester with minors. In addition to majors and specialization courses, the three subjects will be compulsory.
2. Students have to learn two languages: Kannada/other Indian languages, and English.
3. The third compulsory subject is value or moral education which will include teaching constitutional moral values/ principles of equality, liberty, fraternity, national unity, non-discrimination and similar values.
4. Two electives that can be selected by the students based on the availability of courses may be discipline based or distinctly related to discipline-based majors.

I am delighted to present curriculum structure pertaining to B.Sc., Degree in subject Genetics. I hope that the curriculum structure and syllabus will pave the way for overall development of the student community. I ensure that, students community will procure the benefits at large in higher education.

Dr. B. P. HARINI
Chairperson-BOS (UG)
Zoology & Genetics
Bengaluru City University

BENGALURU CITY UNIVERSITY

DEPARTMENT OF GENETICS

Credit framework for Science Stream (B. Sc.,) with 3-major subjects (3 + 2 C)

Semester	CORE-1 (T + P)	CORE-2 (T + P)	CORE-3 (T + P)	Elective (E)	Languages (1 & 2)	Compulsory Skill	Total credits
I semester	3 +2 = 5	3 +2 = 5	3 +2 = 5		L-1= 3 L-2= 3	C-1 (Constitution Values) = 2	**23**
II semester	3 +2 = 5	3 +2 = 5	3 +2 = 5		L-1= 3 L-2= 3	C-2 (Constitution Values + Environmental Studies) = 4	**25**
III semester	3 +2 = 5	3 +2 = 5	3 +2 = 5	E-1= 2	L-1= 3 L-2= 3		**23**
IV semester	3 +2 = 5	3 +2 = 5	3 +2 = 5	E-2= 2	L-1= 3 L-2= 3	Skill-1 = 2 (Pr.knowd.)	**25**
V semester (2 T^^ + 1 P)	3 +2 = 5 3 +0 = 3	3 +2 = 5 3 +0 = 3	3 +2 = 5 3 +0 = 3			Skill-2 = 2 (Pr.knowd.)	**26**
VI semester (2 T^^ + 1 P)	3 +2 = 5 3 +0 = 3	3 +2 = 5 3 +0 = 3	3 +2 = 5 3 +0 = 3			Skill-3 = 2 (Pr.knowd)	**26**
Total	**36**	**36**	**36**	**4**	**24**	**10**	**148**

All numerical may read as credits

Note- **(Two theory): 2** T ^^ with approval from Academic bodies.

BENGALURU CITY UNIVERSITY
DEPARTMENT OF GENETICS
PROPOSED CURRICULUM SUBJECTS FOR B. Sc., Genetics (UG) 2025-26

Sem	Paper Code	Title of the paper	Total no. of hours	Hours /Week	Marks	Internal Assessment*	Total Marks	Credits
1st and 2nd Semester (Revised as per SEP 2025-2026)								
I	DSCGT-1	Cell Biology	56	04	80	20	100	3
	DSCGP-1	Practical Cell Biology	30	03	40	10	50	2
II	DSCGT-2	Cytogenetics	56	04	80	20	100	3
	DSCGP-2	Practical Cytogenetics	30	03	40	10	50	2
3rd and 4th (Framed as per SEP 2025-2026)								
III	DSCGT-3	Molecular Genetics	56	04	80	20	100	3
	DSCGP-3	Practical Molecular Genetics.	30	03	40	10	50	2
	Elective-1 DSGE-1	Clinical Genetics	28	02	40	10	50	2
IV	DSCGT-4	Developmental Genetics	56	04	80	20	100	3
	DSCGP-4	Practical Developmental Genetics	30	03	40	10	50	2
	Elective-2 DSGE-2	Bioinstrumentation	28	02	40	10	50	2
	SKILL -1: DSGS-1	SKILL ENHANCEMENT COURSE -1: Laboratory Diagnosis in Genetics Lab	30	02	10	40	50	2
V	DSCGT-5	Human Genetics	56	04	80	20	100	3
	DSCGP-5	Practical Human Genetics	30	03	40	10	50	2
	DSCGT-6	Population and Evolutionary Genetics	56	04	80	20	100	3
	SKILL-2: DSGS-2	SKILL ENHANCEMENT COURSE -2: Molecular tools in Human Diseases	30	02	10	40	50	2
VI	DSCGT-7	Genetic Engineering	56	04	80	20	100	3
	DSCGP-6	Genetic Engineering	30	03	40	10	50	2
	DSCGT-8	Applied Genetics	56	04	80	20	100	3
	SKILL-3 DSGS-3 / INTERNSHIP*	SKILL ENHANCEMENT COURSE -3: Genetic Counselling	30	02	10	40	50	2

NOTE *:

- Internship shall be discipline specific of 90 hours (2credits) with a duration of 4 to 6 weeks.
- Internship may be fulltime or part time (FT during semester holidays in the academic session).

- Internship mentor/Supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- The students should submit the final internship report (90 hours of internship) to the mentor for the completion of the internship.
- The detailed guideline and formats shall be formulated by the universities separately as prescribed in accordance to UGC guidelines.

Internship for the graduate program as per UGC guidelines

Course Title	Discipline specific
No. of Contact hours	90
No. of Credits	2
Method of Evaluation	Report submission + Presentation and Viva

Syllabus for B.Sc., in Genetics

Introduction

The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills in Genetics and allied courses, as well develop scientific orientation, spirit of enquiry problem solving skills and human and professional values which foster rational and critical thinking in the students. This course serves as plethora of opportunities in different fields right from classical to applied Genetics.

Program Outcomes in B.Sc., Genetics (UG):

PO1 – Students can gain knowledge on various structure and function of cell organelles.

PO2 –Understand and apply the basic principles and applications of cytogenetics.

PO3 – Comprehend the structure and function of gene. Understand and analyse the organization of genetic material in prokaryotes and eukaryotes.

PO4 – Apply the knowledge and understand the inheritance pattern of genetic diseases, its diagnosis and current trend of treatment and control measures, gain insight to immunology.

PO5 – Understand the role of genes in Plant and animal development and correlate the recent advances in clinical embryology.

PO6 –Comprehend the genetics basis of evolution.

PO7 – Understand and apply various biometrical, computational tools in genetics, Apply the knowledge of genetics in Diagnostics and Genetic Engineering.

PO8 – Apply the knowledge of Genetics in Research and development, crop improvement and Animal welfare. Understanding the role of genetic principles in biotechnology, pharmaceuticals and other fields

Program Specific Outcomes in B.Sc., Genetics (UG):

PSO1-Understand and correlate the concepts of cytology, cytogenetics, Molecular genetics, Human Genetics, Gene Regulation, Developmental Genetics, Plant and Animal cell culture and Applicative Genetics.

PSO2- Understand the basic principles and develop skills for using various Laboratory and analytical instruments and equipment.

PSO3- Perform practical as per laboratory standards in Cytology, cytogenetics, molecular genetics, Human genetics, Developmental genetics, Plant and Animal Cell culture and applicative Genetics.

PSO4- Adapt to Interdisciplinary approach of science.

PSO5- Teamwork and leadership skills including group analysis of data, working together in the research laboratory, joint compositions of written reports, substantive participation in research group meetings, etc.

PSO6- Contributes the knowledge for Nation building.

Graduate Attributes in B.Sc., Genetics

Some of the characteristic attributes a graduate in Genetics should possess are:

Develop fundamental skills required to enter the professional world of Genetics.

Adapt and appreciate interdisciplinary approach of Research.

Efficient communication, Critical thinking and problem-solving capacity:

Ethical awareness / reasoning:

Outline of blue-print of the question papers to be prepared (% of share in each category proposed by Govt.)

THEORY

Short answer questions: 20%	**2x 10 =20**
Explanatory questions: 40%	
(to test overall understanding of subject):	**6 x 5 = 30**
Essay type questions: 40% 30	**3 x 10 = 30**
	Total Marks: 80
	IA marks: 20
	Total: 100

PRACTICALS

Total Practical exam Marks:	**40**
IA marks:	**10**
Total:	**50**

I SEMESTER B.Sc., GENETICS THEORY SYLLABUS
CELL BIOLOGY

Program Name:	**B.Sc., Genetics**	Semester:	**I**
Course Title:	**CELL BIOLOGY**		
Course Code:	**DSCGT-1**	No. of Credits:	**3**
Contact hours:	**56 Hours**	Duration of SEA/Exam:	**3 hrs**
		Hours / Week:	**3 hrs**
Formative Assessment Marks:	**20**	Summative Assessment Marks:	**80**

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

Course Outcomes (COs)/(POs)	**DSCGT1**
I Core competency	X
II Critical thinking	X
III Analytical	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 inter section cell if a course outcome addresses a particular program

Course Pre-requisite(s): outcome.

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

- **CO1.** Understand the basic principles of different types of Microscopes and its application
- **CO2**. Understand the structure and function of all the cell organelles.
- **CO**3. Comprehend the mechanism of cell division, cellular aging and cell death and its regulation.
- **CO4**. Develop comprehensive understanding on the organization of Prokaryotic and eukaryotic chromosome.

Contents	**56**
Unit-	**14**
• Microscopy: Introduction, history, Principle and Optical Components of microscope: Eye piece, Eye piece tube, Objective lenses, Coarse and Fine Focus knobs, Stage and stage clips, Aperture, Illuminator, Condenser, Condenser Focus Knob, Iris Diaphragm • Types of microscopes: Light microscopes -Simple, Compound and Stereo, • Phase contrast, Fluorescence, electron microscopy- TEM and SEM, Confocal and Optical pathway in different microscopes. Biological applications of Microscopy: High resolution imaging, immune histochemistry, high-content screening and high throughput imaging. Clinical and Forensic applications.	
Unit-II	**14**

Ultrastructure and functions of Cytoplasmic organelles: • **Concept of cell: -** Discovery of cell, cell theory, Cell as a basic unit, Classification of cell types – virus, Prokaryotes, eukaryotes, Comparison between plant and animal cells. • **Plasma membrane:** –Fluid mosaic model, chemical composition, functions of plasma membrane –Osmosis, Diffusion, active and passive transport, bulk transport. • **Nucleus:** Morphology, nuclear envelope, nucleoplasm. Nucleolus-Nucleosome model. • **Mitochondria**: -Kreb's cycle, BIS oxidative phosphorylation. • **Other organelles**: Structure and functions of Endoplasmic reticulum, Golgi bodies, Lysosomes, and peroxisomes.	
Unit-III	**14**
• **Ultra structure of Chromosome:** Organization of prokaryotic chromosome, Macro- molecular organization. Ultrastructure of a Chromosome-Primary and Secondary constriction, Telomeres, SAT-bodies, Heterochromatin and euchromatin. Special chromosomes- structure of Polytene and Lampbrush chromosome. Comparison between prokaryotic and eukaryotic chromosome. • **Cell Cycle Regulation**: 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. **Cell senescence and Cell death:** Cellular features of Senescence-spontaneous and induced, Mechanism of Programmed cell death and its significance. Fundamental processes of necrosis.	
Unit-IV	**14**
• **Chromosomes** – Definition, description of chromatin structure, 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 Ideogram. • **Special types of Chromosomes**: Structure and Significance of Special type of Chromosomes: Polytene, Salivary gland chromosome in Drosophila, Lamp brush chromosome in amphibian Oocyte. Supernumerary B Chromosome.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs1-15)

Pedagogy:

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
House Examination/Test	10
Written Assessment/Presentation/Project/Term	05
Classroom Performance/Participation	05
Total	**20 Marks**

PRACTICAL PAPER: CELL BIOLOGY

Program Name:	**B.Sc., Genetics**	Semester:	**I**
Course Title:	**CELL BIOLOGY**		
Course Code:	**DSCGP-1**	No. of Credits:	**2**
Contact hours:	**30 Hours**	Duration of SEA/Exam:	**3 hrs**
		Hours / Week:	**3 hrs**
Formative Assessment Marks:	**10**	Summative Assessment Marks:	**40**

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

CO1: Demonstrate the working principles of various microscopes and calculate numerical aperture.

CO2: Measure cell dimensions and study cellular structures using micrometry and staining techniques.

CO3: Identify stages of mitosis and meiosis through permanent slides and squash preparations.

CO4: Observe specialized cell structures like polytene chromosomes and mitochondria using vital and differential staining

Experiment	**30 hrs**.
1. Demonstration of optical components of microscope and calculation of numerical aperture. 2. Demonstration experiments: Fluorescence, laser scanning, Phase contrast, confocal and scanning electron microscopes. 3. Measurement of cells using Micrometer (plant / animal cells). 4. Observation of permanent slides to study various stages of mitosis 5. Study of different stages of mitosis from Temporary squash preparation of onion root tips. 6. Observation of permanent slides to study stages of meiosis 7. Study of different stages of meiosis from temporary squash preparation of Onion flower bud/ Grasshopper Testis. 8. Temporary squash preparation of salivary gland of Drosophila to study Polytene chromosome. 9. Vital staining of yeast cells to study mitochondria. 10. Study of the cells using toluidine/methyl green pyronine blue staining.	

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Note: submission of practical record is mandatory as a part of practical examination.

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	05
Class room Performance/Participation	05
Total	**10 Marks**

References

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.

3 Roberts, K., Alberts, B., Johnson, A., Walter, P., & Hunt, T. (2002). Molecular biology of the cell. *New York: Garland Science*.

4 Cooper, G. M., Hausman, R. E., & Hausman, R. E. (2007). *The cell: a molecular approach* (Vol. 4). Washington, DC: ASM press.

5 Snustad, D. P., & Simmons, M. J. (2015). *Principles of genetics*. John Wiley &

6 Singh, S. P., & Tomar, B. S. (2008). *Cell biology*. Rastogi Publications, Meerut,

7 Gupta, P.K. (2010). Cytogenetics. Rastogi Publications, Meerut, India.

8. Veerakumari. L. (2019). Bioinstrumentation. MJP Publishers, Chennai-600005.

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 of 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 a 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.	

PRACTICAL PAPER: CYTOGENETICS

Program Name	**B.Sc.**	Semester	**II**
Course Title	**CYTOGENETICS**		
Course Code:	**DSCGP-2**	No. of Credits	**3**
Contact hours	**30 Hours**	Duration of SEA/Exam	**3 hrs.**
Formative Assessment Marks	**10**	Summative Assessment Marks	**40**

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

CO1: Handle and maintain *Drosophila* cultures and identify sex differences and common mutants**.**

CO2: Solve genetic problems on Mendelian and non-Mendelian inheritance patterns**.**

CO3: Perform experiments on polyploidy and chromosomal changes in plants.

CO4: Analyze human genetic traits like ABO blood group and Barr body through lab techniques.

Experiments	**30**
1. Culturing and maintenance of *Drosophila.* *2.* Observation of Sexual dimorphism in Drosophila. *3.* Mounting of sex comb in *Drosophila.* 4. Study of drosophila mutants- body colour mutant, wing mutant and eye mutants. 5. Study of ABO blood group system in Human. 6. Genetic problems on Monohybrid, Dihybrid cross, epistasis and No mendelian Inheritance 7. Genetic problems on Multiple alleleism and sex linkage *8.* Induction of polyploidy in *Allium sepa.* *9.* Study of translocation in *Rheo.* 10. Preparation of buccal epithelial smear and observation of Barr body.	

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	0
Classroom Performance/Participation	5
Total	**10 Marks**

References

1 Snustad and Simmons, Principles of Genetics, 6th Edition, 2015 John Wiley

2 William S. Klug (Author), Michael R. Cummings (Author), Charlotte A. Spencer, Concepts of Genetics, 11th Edition ,2019 Pearson Publcation

3 Genetics: A Molecular Approach, 3rd Edition by Peter j Russell, Pearson India, 2016.

4 Brown T A, Genetics: A Molecular Approach, 3rd Edition, Garland Science

5 Gupta P K, Genetics, 5th Edition, Rastogi Publications. 2022.

6 Veer Bala Rastogi, Genetics 4th Edition 2019.

7 Verma P.S. and Agarwal V.K,Genetics, 9th Edition, S.Chand and co.

Scheme of Practical Examination
I- Semester

PAPER I: CELL BIOLOGY **[Code: DSCG –P1]**
(Practical based on DSCG-T1)

Duration: 03 hrs. **Max Marks: 40**

Scheme of Valuation

1. Preparation of temporary squash to study Mitosis/ meiosis /Polytene chromosome
(Preparation -6 marks, Identification-2marks, comment – 4 marks) **(10 marks)**
2. Measure the area of the given cell using micrometry. **(8marks)**
(calibration and performance:4 marks; calculation & comment-4 marks)
3. Perform vital staining/Toluidine blue/ Methyl green pyronine staining of the given sample. (Preparation -3marks, comments – 2 marks) **(5 marks)**
4. Identify and comment on A, B, C and D
(A&B-Microscopes C&D stages of mitosis/meiosis (**12 marks)**
(Identification-1 mark; comments-2 marks)
5. Record- (**5 marks)**

II Semester
PAPER II: CYTOGENETICS [Code: DSCG -P2]
(Practical Based on Theory Paper: DSCG-T2)

Duration: 3 hrs. **ax Marks: 40**

Scheme of Valuation

1. Prepare a smear of buccal epithelium to identify Barr body**.** **(12 marks)**
(Preparation -6 marks, Identification-2marks, comment- 4marks)
2. Prepare a temporary squash of *Allium cepa*/ *Rheo discolor*. (**8 marks)**
(Preparation -5 marks, Identify & comment- 3marks
3. Mount the sex comb of *Drosophila* / Blood typing - **(7marks)**
(Preparation -4 marks, comments- 3marks)
4. Genetic problems (Any two- multiple allele/sex linkage, Gene interactions) **(4x2=8 marks)**
5. Record- (**5 marks)**

Scheme of Internal Assessment Marks:

Theory:

Sl. No.	**Particulars**	**IA Marks**
1	Attendance	05
2	Internal Tests (Minimum of Two)	10
3	Assignments /Seminar / Case Study / Project work / Reports on - Field visits made for observation and collection of data etc.,	05
	TOTAL Theory IA Marks	**20**

Practicals:

Sl. No.	Particulars	IA Marks
1	Practical Test	05
2	Active participation in practical classes (Attendance)	05
	TOTAL Theory IA Marks	**10**

III SEMESTER B.Sc., GENETICS THEORY SYLLABUS
MOLECULAR GENETICS

Program Name:	**B.Sc., Genetics**	Semester:	**III**
Course Title:	**Molecular Genetics**		
Course Code:	**DSCGT-3**	No. of Credits:	**3**
Contact hours:	**56 Hours**	Duration of SEA/Exam:	**3 hrs**
		Hours / Week:	**4 hrs**
Formative Assessment Marks:	**20**	Summative Assessment Marks:	**80**

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

Course Outcomes (COs)/(POs)	**DSCGT-3**
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 inter section cell if a course outcome addresses a particular program

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

CO1: Describe the structure and function of biomolecules.

CO2: Appreciate and illustrate the chemical composition of the genetic material and its replication.

CO3: Describe the process of gene expression in prokaryotes and eukaryotes.

CO4: Explain the concept of transposition, mutation.

Content	56 Hrs
Unit-I	**14 hrs**
DNA as genetic material: Proof of transforming principle: Griffith's transformation experiment; Transforming principle: Avery, McLeod, McCarty & Hershey and Chase experiments; Central Dogma of Molecular Biology. RNA as genetic material - Fraenkel and Singer experiment. **Structure and Functions of Nucleic Acids:** Structure of DNA: Watson and Crick's double helical structure of DNA (Watson-Crick model); Chargaff's rule; Alternative forms of DNA - A, B and Z; Denaturation and renaturation of DNA**.** Types and structure of RNA: mRNA, tRNA (Clover leaf model), and rRNA. **DNA replication**: **Prokaryotic replication**: Enzymes and proteins involved in replication; Initiation: Origin of replication, Replication fork, Primosome, Replisome; Elongation- Synthesis of leading and lagging strands; Termination. Types of Replications- Rolling circle and theta mode of Replication. **Eukaryotic replication**: Enzymes and proteins involved in replication; Mechanism - Initiation, elongation, termination and linear replication.	
Unit-II	**14 hrs**
Transcription in Prokaryotes: RNA Polymerase; Promoter region; Role of sigma factors. Mechanism of transcription- Initiation, Elongation and termination ("rho" dependent and "rho" independent). **Transcription in Eukaryotes**: Eukaryotic RNA Polymerases; Transcription factors; Promoters and enhancers. Mechanism of transcription- Initiation, Elongation and Termination. Post-transcriptional modifications- Methylation, polyadenylation, and splicing. **Translation:** Genetic code and its general characteristics; Wobble's hypothesis. Components of translation machinery- mRNA, tRNA (charging of tRNA, aminoacyl tRNA synthetases); ribosome structure and assembly. Mechanism of translation in both prokaryotes and Eukaryotes. Post-translational modification of proteins.	
Unit-III	**14 hrs**
Gene expression in Prokaryotes and Eukaryotes: Inducible operon – Structure, mechanism and catabolite repression of Lac Operon. Repressible operon – Structure, mechanism and Attenuation of Trp Operon. Regulation of Gene expression in Eukaryotes.	
Unit-IV	**14 hrs**

Transposable Elements: Introduction, types and classification; Class I (Retrotransposons), Class II (DNA transposons), Autonomous vs non autonomous TEs, Mechanism of transposition- DNA transposon transposition and retrotransposon transposition, controlling elements in Bacteria (IS elements), *Drosophila (*p elements), Maize (AC-DS elements), Evolutionary role of transposal elements.	

Reference:

1. Becker, W. M., & Kleinsmith, L. J. (2017). *World of the cell* (9th ed.). Benjamin Cummings.
2. Cooper, G. M. (2013). *The cell* (6th ed.). Sinauer Associates.
3. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (2007). *An introduction to genetic analysis* (9th ed.). Freeman.
4. Hames, B. D., & Hooper, N. M. (2011). *Instant notes in biochemistry* (4th ed.). Viva Books.
5. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E., Silver, L. M., & Veres, R. C. (2016). *Genetics: From genes to genomes*. Tata McGraw Hill.
6. Harvey, L., Arnold, B., Lawrence, S., Zipursky, P. M., David, B., & James, D. (2018). *Molecular cell biology* (6th ed.). Freeman.
7. Lodish, J. H., & Baltimore, D. (2016). *Molecular cell biology* (8th ed.). Scientific American Books.

III SEMESTER B.Sc., GENETICS PRACTICAL SYLLABUS
PRACTICAL PAPER: MOLECULAR GENETICS

Program Name:	**B.Sc., Genetics**	Semester:	**III**
Course Title:	**Molecular Genetics**		
Course Code:	**DSCGP-3**	No. of Credits:	**2**
Contact hours:	**30 Hours**	Duration of SEA/Exam:	**3 hrs**
		Hours / Week:	**3 hrs**
Formative Assessment Marks:	**10**	Summative Assessment Marks:	**40**

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

CO1: Understand the working principle and handling of instruments.
CO2: Perform the isolation of DNA from various sources.
CO3: Characterize the eye pigments in *Drosophila* using paper chromatography.
CO4: Demonstrate the effects of mutation and appraise the applications of molecular markers.

Sl. No.	Practical Contents	
1.	Instrumentation- Micropipette, Glass Homogenizer, Glass bead sterilizer, PCR machine, Electrophoretic unit, PAGE, Centrifuge, Ultra-centrifuge.	
2.	Extraction of genomic DNA from coconut endosperm.	
3.	Extraction of genomic DNA from liver tissue.	
4.	Extraction of genomic DNA from bacteria.	
5.	Chromatography Technique: Separation of eye pigments in wild type and mutant *Drosophila.*	
6.	Paper chromatography: Separation of chlorophyll from leaf.	
7.	Study of replication/transcription/translation through charts and models.	
8.	Study of transposable elements: Bacteria (IS elements), *Drosophila* (P elements), Maize (AC-DS elements).	

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment, Test

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
CI: House Examination/Test	10
C2: Written Assessment/Presentation/Project/Term Papers/Seminars	05
Attendance	05
Total	20

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	05
Class Room Performance / Attendance	05
Total	10

Scheme of Practical Examination

III Semester B.Sc., Genetics

Subject: **MOLECULAR GENETICS (DSCGP-3)**

Duration: 3 hours
Max. Marks: 40

1.	Isolation of DNA from coconut endosperm/ Bacteria/liver	12 marks
2.	Separate the chlorophyll from leaf pigment / *Drosophila* eye pigments by using ascending paper Chromatography	09 marks
3.	Identify and comment on replication/transcription/translation/instrumentation	08 marks
4.	Identify and comment on Spotter A (Bacteria (IS elements), *Drosophila* (P elements), Maize (AC-DC elements).	06 marks
5.	Record	05 marks
	Total	**40 marks**

III SEMESTER B.Sc., GENETICS ELECTIVE – 1 THEORY SYLLABUS
CLINICAL GENETICS

Program Name:	**B.Sc., Genetics Elective – 1**	Semester:	**III**
Course Title:	**Clinical Genetics**		
Course Code:	**DSGE – 1**	No. of Credits:	**2**
Contact hours:	**28 Hours**	Duration of SEA/Exam:	**1.5 hrs**
		Hours / Week:	**2 hrs**
Formative Assessment Marks:	**10**	Summative Assessment Marks:	**40**

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

Course Outcomes (COs)/(POs)	DSGE-1
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 inter section cell if a course outcome addresses a particular program

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

CO1: Understand the History and impact of genetics in medicine.
CO2: Understand the screening of genetic diseases.
CO3: Understand Prenatal diagnostic methods.
CO4: Understand the medical and physical examination.

Contents	28 hrs.
Unit-I	
The History and Impact of Genetics in Medicine: The Origins of Medical Genetics; Types of Genetic Disorders - single gene disorders, Chromosomal disorders, Polygenic disorders, Somatic cell genetics, mitochondrial disorders). Screening for Genetic Disease: Screening Those at High Risk; Carrier Testing for Autosomal Recessive and X-Linked Disorders; Pre-symptomatic Diagnosis of Autosomal Dominant Disorders.	14 hrs
Unit-II	
Prenatal Testing and Reproductive Genetics: Techniques Used in Prenatal Diagnosis; Prenatal Screening; Indications for Prenatal Diagnosis; Special Problems in Prenatal Diagnosis; Termination of Pregnancy; Preimplantation	14 hrs

Genetic Diagnosis; Assisted Conception and Implications for Genetic Disease; Non-Invasive Prenatal Diagnosis; Prenatal Treatment Information gathering, medical evaluation, Physical examination and investigations.	

References:

1. Manage, E. J., & Manage, A. P. (1997). *Basic human genetics*. Rastogi Publications.
2. Turnpenny, P., & Ellard, S. (2017). *Emery's elements of medical genetics* (15th ed.). Elsevier.
3. Bhatnagar, S. M., & Others. (1999). *Essentials of human genetics* (4th ed.). Orient Longman.
4. King, R. A., Rotter, J. I., & Motulsky, A. G. (2002). *Genetic basis of common diseases*. Oxford University Press.
5. Thompson, M. W., McInnes, R. R., & Willard, H. F. (1996). *Genetics in medicine* (5th ed.). W.B. Saunders Company.
6. Rooney, D. (2001). *Human cytogenetics*. Oxford University Press.
7. Korf, B. R. (2000). *Human genetics*. Wiley-Blackwell.
8. Lewis, R. (2001). *Human genetics: Concepts and applications*. McGraw-Hill.
9. Gangane, S. D. (2001). *Human genetics* (2nd ed., Reprint). B.L. Churchill Livingstone Pvt. Ltd.
10. Jorde, L. B., Carey, J. C., & Bamshad, M. (2015). *Medical genetics* (5th ed.). Elsevier.
11. McKusick, V. A. (1998). *Mendelian inheritance in man* (12th ed.). Johns Hopkins University Press.
12. Scriver, C. R., Beaudet, A. L., Sly, W. S., & Valle, D. (Eds.). (1989). *The molecular basis of inherited diseases* (6th ed.). McGraw Hill.

IV SEMESTER B.Sc., GENETICS THEORY SYLLABUS
DEVELOPMENTAL GENETICS

Program Name:	**B.Sc., Genetics**	Semester:	**IV**
Course Title:	**Developmental Genetics**		
Course Code:	**DSCGT-4**	No. of Credits:	**3**
Contact hours:	**56 Hours**	Duration of SEA/Exam:	**3 hrs**
		Hours / Week:	**4 hrs**
Formative Assessment Marks:	**20**	Summative Assessment Marks:	**80**

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

Course Outcomes (COs)/(POs)	**DSCGT-4**
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 inter section cell if a course outcome addresses a particular program

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

CO1: Understand the early development of model organisms.

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.

Content	**56 Hrs**
Unit - I	**14 hrs**
Model organisms for genetic of development: *Drosophila, C. elegans, Xenopus laevis*; *Danio rerio*, *Mus musculus*. **Basic concepts of development**: Potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic gradients, pattern formation, cell fate and cell lineage. **Nuclear transplantation experiment**: Xenopus and Acetabularia.	
Unit - II	**14 hrs**
Genetics of embryonic development in Plants, *Drosophila* and mammals: Apical-basal axis formation, in Arabidopsis. Transition from vegetative to floral development, ABC model and homeotic genes.	

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. **Gene expression in Humans:** Axes formation and Hox genes; Genetics of gonadal differentiation in Human.	
Unit - III	**14 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 and neuronal induction in Frog.	
Unit - IV	**14 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.	

References:

1. Bhojawani, S. S., & Bhatnagar, S. P. (2000). *The embryology of angiosperms*. Vikas Publication House.
2. Carlson, B. M. (1996). *Pattern's foundation of embryology*. McGraw Hill Inc.
3. Howell, S. H. (1998). *Molecular genetics of plant development*. Cambridge University Press.
4. Lewin, B. (2001). *Genes VII*. Oxford University Press.
5. Russo, V. E. A., Brody, S., Cove, D., & Okkolenghi. (1992). *Development: The molecular genetic approach*. Springer-Verlag.
6. Snustad, D. P., & Simmons, M. J. (2003). *Principles of genetics* (3rd ed.). John Wiley & Sons.
7. Tamarin, R. H. (2000). *Principles of genetics* (6th ed.). W.C. Brown Publishers.
8. Wolpert, L., Beddington, R., Jessell, T., Lawrence, P., Meyerowitz, E., & Smith, J. (2002). *Principles of development* (2nd ed.). Oxford University Press.
9. Gilbert, S. F. (2003). *Developmental biology*. Sinauer Associates.
10. Wolpert, L. (1999). *The art of the genes: How organisms make themselves*. Oxford University Press.
11. Wilkins, A. S. (1993). *Genetic analysis of animal development* (2nd ed.).
12. Forgacs, G., & Newman, S. A. (2005). *Biological physics of the developing embryo*. Cambridge University Press.

IV SEMESTER B.Sc., GENETICS PRACTICAL SYLLABUS
PRACTICAL PAPER: DEVELOPMENTAL GENETICS

Program Name:	**B.Sc., Genetics**	Semester:	**IV**
Course Title:	**Developmental Genetics**		
Course Code:	**DSCGP-4**	No. of Credits:	**2**
Contact hours:	**30 Hours**	Duration of SEA/Exam:	**3 hrs**
		Hours / Week:	**3 hrs**
Formative Assessment Marks:	**10**	Summative Assessment Marks:	**40**

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

CO1: To make direct and daily visual observations of living embryos of different organisms
CO2: Understand the early development in frog and *Drosophila*
CO3: Understand and appreciate the role of genes in development in *Drosophila* a n d Arabidopsis
CO4: To understand the early developmental stage of chick embryos

Sl. No.	Practical Content	Units
1.	Study of eggs and cleavage patterns of frog.	
2.	Study of early development in Blastula and Gastrula of frog.	
3.	Isolation and identification of virgin Fruit flies using Virgin band.	
4.	Isolation and identification of *Drosophila* egg.	
5.	Demonstration of imaginal discs in *Drosophila.*	
6.	Study of early Development – axis formation in *Drosophila* (using chart).	
7.	Study of Floral meristem (ABC model) development in Arabidopsis (using chart).	
8.	Observation of the chick embryo development using slides (24, 36 and 48-hours development).	

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment, Test

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
CI: House Examination/Test	10

C2: Written Assessment/Presentation/Project/Term Papers/Seminars	05
Attendance	05
Total	20

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	05
Class Room Performance / Attendance	05
Total	10

Scheme of Practical Examination
IV Semester B.Sc., Genetics
Subject: DEVELOPMENTAL GENETICS (DSCGP-4)

Duration: 3 hours
Max. Marks: 40

1	Isolation and identification of virgin fruit flies using Virgin band.	10 marks
2	Mounting of *Drosophila* egg.	05 marks
3	Study of early Development – axis formation in *Drosophila* /ABC model in Arabidopsis using charts and models.	04 marks
4	Identify and Comment on A to D with neat labelled diagrams. Types of eggs / Cleavage pattern/ Frog development / chick development	16 marks (4 x4 = 16)
5	Class Record	05 marks
	Total	**40 marks**

IV SEMESTER B.Sc., GENETICS ELECTIVE – 2 THEORY SYLLABUS
BIOINSTRUMENTATION

Course Description

Program Name:	**B.Sc., Genetics Elective - 2**	Semester:	**IV**
Course Title:	**Bioinstrumentation**		
Course Code:	**DSGE-2**	No. of Credits:	**2**
Contact hours:	**28 Hours**	Duration of SEA/Exam:	**1.5 hrs**
		Hours / Week:	**2 hrs**
Formative Assessment Marks:	**10**	Summative Assessment Marks:	**40**

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

Course Outcomes (COs)/(POs)	DSGE-2
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 inter section cell if a course outcome addresses a particular program

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

CO1: Understand the basic principles of different laboratory equipments.
CO2: Know the uses of the analytical equipments in various biological applications.
CO3: Adapt to Interdisciplinary approach of science.
CO4: Student can acquire knowledge to handle various instruments in related to his research work.

Contents	28 hrs
Unit - I	**14 hrs**
Microscopy: Introduction, and history of Microscopy, Principle of microscopy, **Types of microscopes:** Optical pathway in different microscopes and applications of Light microscope - Simple and Compound microscope, Stereo microscopy, fluorescent microscopy, electron microscopy (transmission and scanning), Phase contrast, Confocal microscope.	

Unit - II	14 hrs
Instrumentation: Principles, Components and Applications: pH meter; Thermometer; Centrifugation, Ultra-centrifugation, Colorimeter; Spectrophotometer, Chromatography. Principles and applications of autoclave, Hot air oven, Incubator, Laminar air flow chamber / Biosafety cabinets, BOD Incubator. Nuclear Magnetic Resonance (NMR), Agarose Gel electrophoresis	

References:

1. Ninfa, J., & Ballou, D. P. (1998). *Fundamental laboratory approaches for biochemistry and biotechnology* (2nd ed.). Wiley.
2. Freshney, R. (2015). *Culture of animal cells: A manual of basic technique and specialized applications* (7th ed.). Wiley-Blackwell.
3. Sharma. (2010). *Instrumental methods*. S. Chand & Co.
4. Cromwell, L. (2003). *Biomedical instrumentation and measurements*.
5. Geddes, L. A., & Baker, L. E. (2003). *Principles of applied biomedical instrumentation*. Wiley.

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
House Examination/Test	05
Classroom Performance/Participation	05
Total	**10 Marks**

MODEL QUESTION PAPER FOR ELECTIVE

Time: 1.5 Hrs
Maximum Marks: 40

Instructions to Candidates:

1. All sections/parts are compulsory.
2. Draw neat labelled diagrams wherever necessary.

PART- A

I. Answer any *FIVE* of the following: (5x2=10)

1.
2.
3.
4.
5.
6.

PART- B

II. Answer any *FOUR* of the following: (4x5=20)

1.
2.
3.
4.
5.
6.

PART- C

III. Answer any *ONE* of the following: (1x10=10)

1.
2.
3.

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