DEPARTMENT OF GENETICS
SYLLABI AND SCHEME OF EXAMINATIONS
FOR
Bachelor of Science (Genetics as Single Major)
Program under NEP-2020

Under multiple entry, exit, internship and Learning Outcomes Based Curriculum and Credit Framework for Bachelor of Science (Genetics as Single Major) Program

DEPARTMENT OF GENETICS

PROGRAMME CODE: USGEN4

Name of the Program: B.Sc.(Genetics as Single Major)

Duration of the Program: Three/Four Years

Total Credits for the Program: 184

Program Specific outcomes

PSO-1 The degree in B.Sc. Genetics will offer skills and knowledge applicable in every field of Life Science.

PSO-2 Genome is the blue print of life to understand its intricate nature & gene analysis is must. Students will be enabled to learn various aspects of Genetics. It will give an insight into evolution of genetic material, genetic code, regulation of gene, gene therapy and human genome project.

PSO-3 B.Sc. Genetics will provide a platform to understand the genetics tools for improvement of human health, plant and animal varieties, developing vaccines, recombinant proteins, probiotics, antibiotics etc.

PSO–4 The course will be first step towards a professional carrier in disease diagnostics, allied biomedical sciences, agriculture science, pharmaceutical science and forensic labs/ institutes as well.

PSO -5 Practical exposures will equip them well to take up challenging jobs in various fields of life sciences as well as industry besides academic and research organizations. Course has promising future both in India and in all prestigious institutions of abroad.

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Credit Structure for Undergraduate Programmes (Single Major) USGEN4

Semester	Discipline-Specific Courses (DSC) / Major Course	Minor(MIC)/ Vocational (VOC)/ Skill Enhancement Courses (SEC)/ Internship	Multidisciplinary courses (MDC) (F.A)*	Ability Enhancement courses (AEC) (F.A)*	Dissertation (F.A)*	Value-Added Courses (VAC) (F.A)*	Total Credits
I	24GENS401DS01 Introduction to Genetics 24GENS401DS02 Diversity of life forms-I	MIC1 @ 4 credits Common Pool Life Science/Multidisciplinary	MDC1 @ 3 credits Common pool of B.Sc. Life Science	AEC1 @ 2 credits Communication Skills from Common pool	1b)SEC1@ 3 credits 24GENS401SE01 Basic techniques in Biology	VAC1 @ 2 credits Yoga Education from Common Pool	22
II	24GENS402DS01 Cytogenetics 24GENS402DS02 Diversity of life forms-II	MIC2 @ 4 credits Common Pool Life Science/Multidisciplinary	MDC2 @ 3 credits Common pool of B.Sc. Life Science	AEC2 @ 2 credits Communication Skills from Common pool	1b)SEC2@ 3 credits 24GENS402SE01 Cytogenetic Techniques 1b)Optional:- Summer Internship for UG certificate in Genetics @4 credits 26GENS402IN01	VAC2 @ 2 credits Digital and Technological solutions from Common Pool	22
Students exiting the programme after second semester and securing 48 credits including 4 credits of summer internship will be awarded UG Certificate in Genetics							
III	25GENS403DS01 Principal of Genetics 25GENS403DS02 Basic Human Genetics	MIC3 @ 4 credits Common Pool Life Science/Multidisciplinary	MDC3 @3 credits Common Pool	AEC3 @ 2 credits Communication Skills Common Pool	1b)SEC3@ 3 credits 25GENS403SE01 Tools and Techniques	VAC3 @ 2 credits Health and wellness from Common Pool	22
IV	Animal Genetics 25GENS404DS01 Plant Genetics 25GENS404DS02 Genetics & Microbes 25GENS404DS03 25GENS404DS04 Medical Genetics	MIC4 @ 4 credits Common Pool Life Science/Multidisciplinary	----------	AEC4 @ 2 credits Communication Skills Common Pool	6a)Optional:- Summer Internship for Diploma in Genetics @4 credits 26GENS404IN01	VAC4 @ 2 credits Sports and Fitness from Common Pool	24
Students exiting the programme after fourth semester and securing 94 credits including 4 credits of summer internship will be awarded UG Diploma in Genetics (Major Genetics and Minor Life Sciences)							
V	Behavioral Genetics 26GENS405DS01 26GENS405DS02 Evolutionary Biology 26GENS405DS03 Genes and Development 26GENS405DS04 Genetic Engineering	MIC5 @ 4 credits Common Pool Life Science/Multidisciplinary	----------	----------	6a)Internship @ 4 credits# 26GENS405IN01	----------	24
VI	Gene and Genomics 26GENS406DS01 Gene Regulation 26GENS406DS02 Cancer genetics 26GENS406DS03 Pharmaco Genetics 26GENS406DS04	MIC6 @ 4 credits Common Pool Life Science/Multidisciplinary	----------	----------	1c)SEC4@ 2 credits 26GENS406SE01 Research Methodology	----------	22
Students will be awarded 3-year UG Degree in Genetics upon securing 136 credits. (Major Genetics and Minor Life Sciences)							
VII	Concept of Genetics 24GEN201DS01 Microbial Genetics 24GEN201DS02	1a)SEC4 @ 4 credits 24GEN201SE01 Techniques in Genetics	----------	----------	----------	----------	24

	Human Genetics 24GEN201DS03 **Molecular Cell Biology** 24GEN201DS04 **Developmental Genetics** 24GEN201DS05						
VIII (4yr UG Hon.)	**Population and evolutionary Genetics** 24GEN202DS01 **Molecular Genetics** 24GEN202DS02 **Immuno Genetics** 24GEN202DS03 **Medical Genomics** 24GEN202DS04 **Conservation of Genetic Resources** 24GEN202DS05	**1a) SEC5 @ 4 credits** 24GEN202SE01 **Molecular Techniques in Genetics**	----------	----------	----------	----------	**24**
VIII (4yr UG Hon. with Research)	**Population and evolutionary Genetics** 24GEN202DS01 **Molecular Genetics** 24GEN202DS02	**1a) SEC5 @ 4 credits** 24GEN202SE01 **Molecular Techniques in Genetics**	----------	----------	**6b) Research project/ Dissertation @ 12 credits 24GENS408PD01**	---------- **TOTAL CREDITS**	**24** **184**

Note:

#Four credits of internship earned by a student during summer internship after 2nd semester or 4th semester will be counted in 5th semester of a student who pursue 3 year UG Programmes without taking exit option.

Note : -

1. **The skill enhancement courses should contain maximum of component and w.e.f. the Academic session 2026 – 2027, the pattern of Skill Enhancement Courses be revised as follows by the UTDS/Centres/Institutes in Scheme and Syllabi of UG/PG programs under NEP - 2020:**

For Four Credit SEC	For Three Credit SEC	For Two Credit SEC
L – T – P	L – T – P	L – T – P
0 – 0 – 4	0 – 0 – 3	0 – 0 – 2
1 – 0 – 3	1 – 0 – 2	----
2 – 0 – 2	---	----

2. The details of Formative Assessment in hard copy to submitted to Controller of Examinations within a week of uploading the marks on the portal and the relevant records alongwith the documents on the basis of which marks has been awarded and shall be maintained for a minimum period of two years in the Department/Centre/Institute/ affiliated colleges. The records may be verified/summoned by the Controller of Examinations.

Formative Assessment Models

1. For Skill Enhancement Courses

a) For four credits practical

	Marks distribution
Regular assessment through observation and class discussion	15
Lab work (practical file) / field work (report)/Portfolio	30
Case study / Mini project (2 X 15)	30
Assignment/Seminar / Presentation (2 X 10)	20
Attendance	05
Total	**100**

b) For three credits practical

	Marks distribution
Regular assessment through observation and class discussion	10
Lab work (practical file) / Field work (report)/Portfolio	30
Assignment/Case study / Mini project (2 X 10)	20
Seminar / Presentation	10
Attendance	05
Total	**75**

c) For two credits practical

	Marks distribution
Regular assessment through observation and class discussion	10
Lab work (practical file)/Field work (Report)/Mini project	20
Seminar/Presentation (2 X 7.5)	15
Attendance	05
Total	**50**

2. For Ability Enhancement Courses

For two credits theory

	Marks distribution
Written test (2 X 5)	10
Peer discussion / Debate / Extempore speech (2X 10)	20
Role play	05
Essay / Article / Report writing	10
Attendance	05
Total	**50**

3. For Value Added Courses

a) For two credits theory

	Marks distribution
Written test (2 X 10)	20
Class assignments / Case study / Mini project (2 X 5)	10
Quiz / seminar / Group discussion / Debate (2 X 7.5)	15
Attendance	05
Total	**50**

b)For two credits practical

	Marks distribution
Regular assessment through observation and class discussion	20
Field work (Report)/Mini project	15
Assignment (2 X 5)	10
Attendance	05
Total	**50**

c)For one credit theory and one credit practical

	Marks distribution
Written test (2 X 10)	20
Class Assignment (1 X 5)	05
Case study / Mini project (1 X 10)	10
Seminar / Presentation (1 X 10)	10
Attendance	05
Total	**50**

4. For Multidisciplinary Course

a)For three credits theory

	Marks distribution
Written test (2 X 10)	20
Class assignments / Case study / Mini project (2 X 10)	20
Book review / Essay / Seminar (1 X 10)	10
Quiz / Group discussion / Debate (2 X 10)	20
Attendance	05
Total	**75**

b)For two credits theory and one credit practical

	Marks distribution
Written test (2 X 10)	20
Lab work (practical file) / Field work (report)/Portfolio	20
Assignment/Case study / Mini project (2 X 10)	20
Seminar / Presentation	10
Attendance	05
Total	**75**

c)For three credits practical

	Marks distribution
Regular assessment through observation and class discussion	10
Lab work (practical file) / field work (report)/Portfolio	30
Assignment/Case study / Mini project (2 X 10)	20
Seminar / Presentation	10
Attendance	05
Total	**75**

[d)]For one credit theory and two credits practical

	Marks distribution
Written test (2 X 10)	20
Lab work (practical file) / Field work (report)/ Portfolio	20
Case study / Mini project (1 X 10)	10
Assignment/Seminar / Presentation (2 X 10)	20
Attendance	05
Total	**75**

5. For UG/PG Practical Courses
For four credits practical

	Marks distribution
Regular assessment through observation and class discussion	20
Lab work (practical file) / field work (report)/Portfolio	30
Assignment/Case study / Mini project (3 X 10)	30
Seminar / Presentation (2 X 7.5)	15
Attendance	05
Total	**100**

6. Internship Evaluation

After completion of internship, students need to prepare a comprehensive report highlighting their learning and takeaways during the internship period as per **MDUR Internship Regulations 2025**. The report shall be signed by the Internship Supervisor from respective UTD/Centre/College and Mentor from internship providing organizations. Evaluation of internship report and viva-voce will be jointly conducted by Internship Supervisor and Mentor on the time and date notified by the concerned HoDs/Directors/Principals. The mentor from host organization may participate in the evaluatation through online/offline mode. In case of non-availability of respective mentor, the available relevant mentor as decided by the concerned HOD/Director/Principal may be utilized for the purpose of evaluation.

6 a) Suggested distribution of marks will be as below:

<table>
<tr><th>S. No.</th><th>Components</th><th>Employability-Oriented Internship</th><th>Research-Oriented Internship</th></tr>
<tr><td>1</td><td>Assessment by Mentor
<table>
<tr><td>S.No.</td><td>Details</td><td>Marks</td></tr>
<tr><td>1</td><td>Skills learned</td><td>15</td></tr>
<tr><td>2</td><td>Regularity</td><td>10</td></tr>
<tr><td>3</td><td>Conduct</td><td>5</td></tr>
<tr><td></td><td>Total (30)</td><td></td></tr>
</table></td><td>30</td><td>30</td></tr>
<tr><td>2</td><td>Internship Report</td><td>40</td><td>40</td></tr>
<tr><td>3</td><td>Viva-Voce</td><td>30</td><td>30</td></tr>
</table>

6 b) EVALUATION OF PROJECT REPORT / DISSERTATION

In case of the Project reports/Dissertation/Research Project, the assessment shall be jointly carried out by the internal and external examiners. There shall be no Internal assessment component for Dissertation / Project Report. External examiners shall be invited from amongst the panel of examiners (ordinarily not below the rank of Associate Professor) recommended by the concerned Board of Studies.

Note : -

1. **The skill enhancement courses should contain maximum of component and w.e.f. the Academic session 2026 – 2027, the pattern of Skill Enhancement Courses be revised as follows by the UTDS/Centres/Institutes in Scheme and Syllabi of UG/PG programs under NEP - 2020:**

For Four Credit SEC	For Three Credit SEC	For Two Credit SEC
L – T – P	L – T – P	L – T – P
0 – 0 – 4	0 – 0 – 3	0 – 0 – 2
1 – 0 – 3	1 – 0 – 2	----
2 – 0 – 2	---	----

2. The details of Formative Assessment in hard copy to submitted to Controller of Examinations within a week of uploading the marks on the portal and the relevant records alongwith the documents on the basis of which marks has been awarded and shall be maintained for a minimum period of two years in the Department/Centre/Institute/ affiliated colleges. The records may be verified/summoned by the Controller of Examinations.

Discipline Specific Courses/ Major Course			Credits Distribution			Total Credits	Workload			Total Workload	Marks			
	Nomenclature of Course	Course Code	L	T	P		L	T	P		Theory		Practical	Total Marks
											Internal	External	F.A. as per University notification	
Semester I (Session 2024-25)														
DSC - A1 @ 4 credits	Introduction to Genetics	24GENS401DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A2 @ 4 credits	Diversity of life forms-I	24GENS401DS02	3	0	1	4	3	0	2	5	25	50	25	100
Semester II (Session 2024-25)														
DSC – A3 @ 4 credits	Cyto Genetics	24GENS402DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A4 @ 4 credits	Diversity of life forms-II	24GENS402DS02	3	0	1	4	3	0	2	5	25	50	25	100
Semester III (Session 2025-26)														
DSC – A5 @ 4 credits	Principal of Genetics	25GENS403DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A6 @ 4 credits	Basic Human Genetics	25GENS403DS02	3	0	1	4	3	0	2	5	25	50	25	100
Semester IV (Session 2025-26)														
DSC – A7 @ 4 credits	Animal Genetics	25GENS404DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A8 @ 4 credits	Plant Genetics	25GENS404DS02	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A9 @ 4 credits	Genetics & Microbes	25GENS404DS03	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A10 @ 4 credits	Medical Genetics	25GENS404DS04	3	0	1	4	3	0	2	5	25	50	25	100
Semester V (Session 2026-27)														
DSC – A11 @ 4 credits	Behavioral Genetics	26GENS405DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A12 @ 4 credits	Evolutionary Biology	26GENS405DS02	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A13 @ 4 credits	Genes and development	26GENS405DS03	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A14 @ 4 credits	Genetic engineering	26GENS405DS04	3	0	1	4	3	0	2	5	25	50	25	100
Semester VI (Session 2026-27)														
DSC – A15 @ 4 credits	Genes and Genomics	26GENS406DS01	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A16 @ 4 credits	Gene Regulation	26GENS406DS02	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A17 @ 4 credits	Cancer Genetics	26GENS406DS03	3	0	1	4	3	0	2	5	25	50	25	100
DSC – A18 @ 4 credits	Pharmaco Genetics	26GENS406DS04	3	0	1	4	3	0	2	5	25	50	25	100

Semester VII (Session 2027-28)														
DSC – H1 @ 4 credits	**Concept of Genetics**	24GEN201DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H2 @ 4 credits	**Microbial Genetics**	24GEN201DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H3 @ 4 credits	**Human Genetics**	24GEN201DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H4 @ 4 credits	**Molecular Cell Biology**	24GEN201DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H5 @ 4 credits	**Developmental Genetics**	24GEN201DS05	4	0	0	4	4	0	0	4	30	70	-	100
Semester VIII **(Option-1)** 4 Year U.G. Hons. (BSc. Genetics Hons.) (Session 2027-28)														
DSC – H6 @ 4 credits	**Population and evolutionary Genetics**	24GEN202DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H7 @ 4 credits	**Molecular Genetics**	24GEN202DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H8 @ 4 credits	**Immuno Genetics**	24GEN202DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H9 @ 4 credits	**Medical Genomics**	24GEN202DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H10 @ 4 credits	**Conservation of Genetic Resources**	24GEN202DS05	4	0	0	4	4	0	0	4	30	70	-	100
Semester VIII **(Option-2)** 4 Year U.G. Hons. with Research (BSc. Genetics Hons. with Research) (Session 2027-28)														
DSC – H6 @ 4 credits	**Population and evolutionary Genetics**	24GEN202DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC – H7 @ 4 credits	**Molecular Genetics**	24GEN202DS02	4	0	0	4	4	0	0	4	30	70	-	100
c)Research project/Dissertation @12 credits	**Dissertation**	24GENS408PD01	0	0	12	12	0	0	24	24	-	-	300	300

L: Lecture; T: Tutorial; P: Practical

Syllabi for Under Graduate Programme in Genetics

Semester-I

Name of Program	**B.Sc. Genetics Single Major**	**Program Code**	**USGEN4**
Name of the Course	**Introduction to Genetics**	**Course Code**	**24GENS401DS01**
Hours per Week	**05**	**Credits**	**3+0+1**
Maximum Marks	**100**	**Time of Examinations**	**3 Hrs**

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Knowledge of basic concepts in Genetics and inheritance.
CLO 2: Understanding of the role chromosomes and DNA in inheritance.
CLO 3: To understand the types of inheritance and their consequences.

Unit 1: Mendelian Genetics; basic principles of inheritance; monohybrid and dihybrid crosses; test cross and back cross; incomplete inheritance and co-dominance.

Unit 2: Multiples allelism: introduction, characterstics and examples in *Drosophila* and human; Blood group inheritance in human; antigen-antibody reaction; Rh factor and its inheritance; M-N blood group: its types and inheritance.

Unit 3: Polygenic inheritance; genetic variance; extra-nuclear inheritance in nature: plastid and mitochondrial inheritance; transposable elements; mutation and mutagenic agents.

Unit 4: Organization of prokaryotic and eukaryotic chromosomes, chromosome theory of linkage, recombination and crossing over; DNA structure and function; split genes; pseudogenes, overlapping genes; central dogma.

References:

1. Genetics. P. K. Gupta. 5th Revised Edition 2018. Rastogi Publications
2. Concepts of Genetics. Klug, WS., Cummins, MR., Spencer, C., Palladino, MA. 2020. 10th Edition. Pearsons Publication.
3. Genetics: A Conceptual approach Benjamin A.Pierce. 2000. 7th edition. McMillan Publication.
4. Genetics: Analysis of Genes and Genomes Daniel L. Hartl 2014. 5th Edition Jones and Bartlett Publishers. Inc.
5. Principles of Genetics. Snustad Simmons. 2008. 6th Edition. John Wiley Publication.

Practical 0+0+1 Marks Internal = 25

1. Study of polytene chromosomes and lampbrush chromosomes from permanent slides.
2. Study of ABO groups & Rh factor.
3.Demostration of inheritance pattern
4. Numerical based on monohybrid, dyhybrid cross.

Syllabi for Under Graduate Programme in Genetics.

Semester-I

Name of Program	B.Sc. Genetics Single Major	**Program Code**	USGEN4
Name of the Course	Diversity of Life Forms-I	**Course Code**	24GENS401DS02
Hours per Week	05	**Credits**	3+0+1
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: To understand the general characters & economic importance of microbes and Plantae

CLO 2: Familiarity with local flora and herbarium techniques

CLO3: To learn role of plants in environment, human welfare and industrial applications.

Unit 1: General account of Structure, reproduction and economic importance: Bacteria, Virus, Fungi, Algae and Lichens.

Unit 2: General characteristics, structure and reproduction and classification of Bryophytes and ecological and economic importance of bryophytes.

Unit 3: General characters, classification of Pteridophyta , structure and reproduction and Ecological and economic importance.

Unit 4: General characteristics, classification of Gymnosperms , morphology, anatomy and reproduction and economic importance; General account of paleobotany and Geological time scale.

References:

1. Bilgrami, K.S. and Saha, L.C., 2001, A Text Book of Algae, CBS Publishers, New Delhi.
2. Kumar, H.D. 1999. Introductory Phycology. East-west Press Pvt ltd., Delhi.
3. Alexopolous, C.J. , Mims, C.W. and Blackwell, M. (1996), Introductory Mycology, John Wiley and Sons, New York.
4. Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae.
5. Parihar, N.S. 1991. Bryophytes. Central Book Depot, Allahabad.
6. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
7. Bhatnager, S.P. and Moitra, A. (1996) Gymnospersm. New Age International (P) Ltd. Publishers, New Delhi.

Practical 0+0+1 Marks Internal = 25

Morphological studies through specimens, temporary mounts and permanent slides (Fresh material whichever available).

1. Fungi: Rhizopus, Aspergillus, Yeast, Puccinia, Agaricus
2. Algae: Volvox, Spirogyra, Chara, Vaucheria, Polysiphonia, Ectocarpus
3. Bryophytes: Riccia, Marchantia, Anthoceros, Funaria, Sphagnum
4. Pteridophytes: Lycopodium, Selaginella, Equisetum, Marsilea, Pteris
5. Gymnosperm: Cycas, Pinus, Ephedra, Thuja, Cedrus
6. Herbarium/museum specimens of the diseased plants: Black stem rust of Wheat, Late

blight of Potato, Red rot of Sugarcane, Green year of Bajra

7. Familiarity with local flora and herbarium techniques.

Semester-II

Name of Program	B.Sc. Genetics Single Major	**Program Code**	USGEN4
Name of the Course	CYTOGENETICS	**Course Code**	24GENS402DS01
Hours per Week	05	**Credits**	3+0+1
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1:To understand the Mendel's laws and its deviations.
CLO 2:To understand the chromosomal disorder.
CLO 3: To learn ploidy and its applications.

Unit 1: Chromosomes: Structure and morphology of chromosomes, chemical composition of a chromosome, Special Chromosomes: Polytene chromosomes, lampbrush chromosome, accessory or B-chromosomes, Brief account of Mitosis and Meiosis

Unit 2: Structural changes in chromosomes: Deletion, duplications, inversions and translocations; their consequences. Numerical changes in chromosomes: Aneuploidy, euploidy, their types and applications.

Unit 3: Linkage: History, coupling and repulsion hypothesis, chromosomal theory of linkage, complete and incomplete linkage, linkage groups and significance of linkage.

Unit 4: Crossing Over: Introduction, mechanism of crossing over, types of crossing over, interference and coincidence, theories regarding mechanism, factors affecting it and its significance.

References:

1. Cytogenetics, Plant Breeding and evolution by U.Sinha and Sunita Sinha , Vikas Publishing House Private, Limited, 1998.
2. Cytology, Genetics and Molecular Biology by P.K.Gupta (2002), Rastogi publications.
3. Gupta, P. K. (2010). Cytogenetics. Rastogi Publications, Meerut, India.
4. Singh, B. D. (Edition: 2). Genetics Cytogenetics Med tech Science Press Pranab, Genetics. Mahaveer Publications Gupta, P. K. (2022-2023). Cytogenetics. 2nd Ed Veer Bala Rastogi Publications, Meerut, India

Practical 0+0+1 Marks Internal = 25

1. Study of different stages of mitosis and meiosis from permanent slides.
2. Study of chromosomal aberrations from permanent slides.
3. Detection of Barr bodies.

Syllabi for Under Graduate Programme in Genetics.

Semester-II

Name of Program	B.Sc. Genetics Single Major	**Program Code**	USGEN4
Name of the Course	Diversity of Life Forms-II	**Course Code**	24GENS402DS02
Hours per Week	05	**Credits**	3+0+1
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Identification animal kingdom

CLO 2: To learn role of animals in environment, human welfare and industrial applications.

CLO 3:.To understand the animal behaviour in ecostystem.

Unit 1: General account, Principles of classification; Origin and Evolutionary tree, Protochordates, Urochordates, Cephalochordates.

Unit 2: General characters and classification upto order level, Pisces Amphibians, , Reptiles. Parental care in fishes, fish migration, Poisonous and non-poisonous snakes.

Unit 3: General characters and classification upto order level, Aves, Mammals. Migration in birds. Affinities of Prototheria, metatheria and eutheria.

Unit 4: Aquaculture, Pisciculture, Poultry, Sericulture, Apiculture

References:

1. Textbook of Invertebrates, R.L. Kotpal, Rastogi publications, Meerut
2. Invertebrate Zoology, Jordan and Verma, S.Chand& Company, Delhi
3. Integrated Principles of Zoology, C.P.Hickman,JR., L. S. Roberts , A.Larsed
4. Textbook of Animal Histology. A.K.Berry, Emkay Pub, New Delhi.
5. Economic Zoology, Sarkar, kundu& Chaki, New Central Book agency(P) Ltd. New Delhi
6. Economic Zoology (5th edition), G.S Shukla, V. B. Upadhyay, Rastogi Publications, Meerut, New Delhi
7. Applied Zoology, N. Arumugam, MuruganRajeswar& Prabhu, Saras Publication,Tamilnadu

Practical 0+0+1 Marks Internal = 25

1. Musem specimen of Protochordates, Urochordates, Cephalochordates.
2. Pisces: Scoliodon,Torpedo,Mystus,Labeo,Anabas,Flat fish,cattla,Pristis
3. Amphibia: Necturus, Proteus, Amphiuma, Salamandra, Amblystoma, Axolotie larva, Alytes, Bufo, Rana.
4. Reptilia: Hemidactylus, Calotes, Draco, Varanus, Phrynosoma, Chamaeleon, Typhops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Viper, Crocodilus, Gavialis, Chelone (Turtle) and Testudo (Tortoise).

5. Aves : Casuarius, Arden, Anas, Milvus, Pavo, Eudynamis, Tyto and Alcedo, Halcyon
6. Mammalia: Ornithorphynchus, Echidna, Didelphis, Macropus, Loris, Macaque, Hystrix, Funambulus, Telix, Panthera, Canis, Herpestes, Capra, Pteropus

Syllabi for Undergraduate Programme in Genetics

Semester-III

Name of Program	B.Sc. Genetics Single Major	**Program Code**	USGEN4
Name of the Course	Principles of Genetics	**Course Code**	25GENS403DS01
Hours per week	05	**Credits**	3 + 0 + 1
Maximum Marks	100 (75+ 25)	**Time of Examination**	3 hours

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)
Note:

Examiner will set nine questions, and the candidates will be required to attempt five questions in all. Question number one will be compulsory, containing short-answer type questions from all units. Further, the examiner will set two questions from each unit, and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1:To understand the basic laws of genetics.
CLO 2:To understand the concept of Gene Interaction.
CLO 3: To learn about the experiments leading to the discovery of DNA and genetic material.

Unit I - The Principle of Segregation, independent assortment, Dominance and recessivity, Use of Puneet square and Forked-line method, Expected and observed ratios, Testing Genetic hypotheses, Concept of haploid and diploid organisms, gene pool & gene frequencies, Hardy-Weinberg principle, factors affecting HW equilibrium.

Unit II - Chromosomal basis of inheritance, Haplodiploidy in honeybee, Environmental sex determination, continuous and discontinuous characters, multifactorial inheritance, environmental effects on genotype expression, quantitative traits, Concept of polyploidy, autopolyploidy and allopolyploidy, tissue-specific polyploidy.

Unit III - Gene interaction: Incomplete Dominance, Codominance, Non-Epistasis, Epistatic gene interactions: Complementary Genes, Supplementary Gene Interaction, Duplicate Gene Interaction, Polymeric Gene Interaction, Lethal Gene Interaction, additive and non-additive gene action.

Unit IV - The molecular basis of heredity: DNA as the source of genetic information, Bacterial transformation experiment (Griffith's Experiment), Discovery of the transforming principle (Oswald Avery's experiment), The Hershey-Chase experiment, Structure of DNA,RNA

References

1. Principles of Genetics by D. Peter Snustad and Michael J Simmons
2. Genetics: A Conceptual Approach by Benjamin A. Pierce
3. The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonald

Practical 0+0+1 Marks Internal = 25

1. Demonstration of DNA isolation from venous blood sample
2. Numericals on gene frequencies

Syllabi for Undergraduate Programme in Genetics

Semester-III

Name of Program	B.Sc. Genetics Single Major	**Program Code**	USGEN4
Name of the Course	Basic Human Genetics	**Course Code**	25GENS403DS02
Hours per week	05	**Credits**	3 + 0 + 1
Maximum Marks	100(75 +25)	**Time of Examination**	3 hours

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions, and the candidates will be required to attempt five questions in all. Question number one will be compulsory, containing short-answer type questions from all units. Further, the examiner will set two questions from each unit, and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: To understand the basic concepts of human genetics and pedigree.
CLO 2: To learn about various inherited human disorders.
CLO 3: To understand the transmission of sex-linked human disorders

Unit I - Brief introduction to Human Genetics: scope, history, and importance. Heredity and Inheritance of characters, various inheritance patterns: morphogenetic, behavioral, and serological traits. Family tree pedigree, symbols of pedigree and analysis.

Unit II - Multifactorial traits: multiple alleles definition,ABO bloodgroups and Rhfactor in humans. Mendelian and non-Mendelian inheritance patterns. Deviations from Mendelism (Incomplete inheritance and Co-dominance).

Unit III - Normal Human karyotype(Male and Female), Chromosomal theory of sex determination (XX/XY) in humans, Sex limited & sex influenced traits, Barr body, Dosage compensation,Clinical features and karyotypes of common sex disorders: Turner's Syndrome, Klinefelter Syndrome, and disorders of sex development (DSDs) like congenital adrenal hyperplasia, and androgen insensitivity syndrome.

Unit IV

Clinical and genetic features of common autosomal and metabolic defects in humans:Albinism,Galactosemia;Diabetes,Thalassemia, Hemophilia, Cystic fibrosis, Color blindness, achondroplasia, Cri-du- chats, Down's, Edward's, and Patau's, syndrome.

References

1. Principles of Genetics by D. Peter Snustad and Michael J Simmons
2. Human Genetics - Cummings, M.R, Cehage Learning, USA
3. The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonald

Practical 0+0+1 Marks Internal = 25

1. Preparation of Barr body from buccal smear

2. Pedigree symbols , analysis of autosomal, sexlinked pedigree
3. Demonstration of plates/ photographs of sex chromosomes and autosomal chromosomal anomalies.
4. Morphogenetics behavioural and serological traits

Syllabi for Under Graduate Programme in Genetics

Semester-IV

Name of Program	B.Sc. Genetics Single Major	**Program Code**	**USGEN4**
Name of the Course	Animal Genetics	**Course Code**	**25GENS404DS01**
Hours per Week	**05**	**Credits**	**3+0+1**
Maximum Marks	**100**	**Time of Examinations**	**3 Hrs**

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1- 1An understanding of basic and applied principles of animal genetics.
CLO 2-Explain chromosomal and molecular inheritance mechanisms.
CLO 3-Apply genetic and biotechnological tools in livestock improvement.
CLO 4-Evaluate breeding and conservation strategies of animal genetic resources

Unit 1: History of Genetics, Overview of Mendelian principles, Modified Mendelian inheritance, Pleiotropy, Penetrance and expressivity, Sex in relation to chromosomes and genes. Linkage and crossing over. Multiple factor inheritance. Quantitative trait loci and their applications. Non-chromosomal genes and their inheritance, Chromosomal aberrations and Genetic disorders.

Unit 2: DNA markers (RAPD, SNPs), genotyping for identification, parentage verification, and determination of specific homozygous/heterozygous gene mutations in animals for diseases and physical traits – marker assisted selection.

Unit 3: Types in livestock and poultry, Livestock improvement – Role of AI/frozen semen/embryo transfer/ONBS/MOET in animal breeding; Production of transgenic animals. Gene mixing for useful functions. Gene expression and its control. Artificial transmutation of genes. Gene modifiers.

Unit 4: Animal genetic resources in India – evaluation and characterization of indigenous breeds of livestock, ex-situ and in-situ conservation of genetic resources– cryogenic preservation of animal germplasm, Genetic and phenotypic consequences and applications of inbreeding and out- breeding. Genetic basis of heterosis and its use.

References:

1. Text book of Animal Biotechnology by B.D Singh. The Energy and Resources Institute (teri)
2. Genetic Engineering by V.K.Agarwal and P.S. Varma, S. Chand & Company Ltd, 2009
3. Nivsarkar AE, Vij RK and Tantia MS. 2000. Animal Genetic Resources of Indian Cattle and Buffaloes. ICAR.
4. Oldenbroek K. 2007. Utilisation and Conservation of Farm Animal Genetic Resources. WA Publishers.
5. Sahai R and Vij RK. 1997. Domestic Animal Diversity, Conservation and Sustainable Development. SI Publishers
6. Van Vleck LD, Pollak E and Bltenacu EAB. 1987. Genetics for Animal Sciences. WH Freeman.

Practical 0+0+1 Marks Internal = 25

1. Numerical problems on linkage and crossing over **(**recombination frequency, gene mapping).
2. Demonstration of genomic DNA isolation from animal blood/tissue.
3. Study and interpretation of DNA markers (RAPD, SNPs) using gel images/data sets.
4. Study of steps involved in production of transgenic animals (flow charts).

Syllabi for Under Graduate Programme in Genetics

Semester-IV

Name of Program	B.Sc. Genetics Single Major	**Program Code**	**USGEN4**
Name of the Course	**Plant Genetics**	**Course Code**	**25GENS404DS02**
Hours per Week	**05**	**Credits**	**3+0+1**
Maximum Marks	**100**	**Time of Examinations**	**3 Hrs**

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Fundamental of genetic principles governing inheritance in plants

CLO 2: Knowledge of chromosome behaviour, gene interactions, and cytoplasmic inheritance in plants

CLO 3: Ability to understand plant-specific genetic mechanisms and their applications in crop improvement

Unit 1: Introduction to genetics and its significance in plant biology, Historical background of plant genetics, Monohybrid, and dihybrid cross in plants, Test cross and back cross, Laws of segregation and independent assortment, Deviations from Mendelian ratios.

Unit 2: Chromosome structure and organization in plants, Chromosome mapping, Sex determination in plants, Structural and numerical chromosomal aberrations, Polyploidy and aneuploidy in plants and their evolutionary significance.

Unit 3: Cytoplasmic inheritance, Plastid and mitochondrial inheritance, Maternal effects, Male sterility in plants, Mutation and mutagenesis in plants (physical and chemical mutagens), Spontaneous and induced mutations.

Unit 4: Plant breeding and genetic improvement, Pure line selection, Hybridization and heterosis, Genetic basis of disease resistance, Introduction to molecular markers and their use in plant genetics.

References:

1. Singh, B.D.*Genetics.* 4th Edition. Kalyani Publishers, New Delhi. 2005.
2. Gupta, P.K.*Genetics.* 3rd Edition. Rastogi Publications, New Delhi. 2003.
3. Strick Berger, M.W.*Genetics.* 3rd Edition. Macmillan Publishing Company, New York. 1985.
4. Allard, R.W.*Principles of Plant Breeding.* 2nd Edition. John Wiley & Sons, New York. 1999.
5. Sinnott, Dunn & Dobzhansky.*Principles of Genetics.* 5th Edition. McGraw-Hill Book Company, New York. 1958.

Practical 0+0+1 Marks Internal = 25

1. Study and interpretation of monohybrid inheritance using plant-based examples (e.g., seed colour in pea) with demonstration of Punnett square and phenotypic and genotypic ratios.
2. Demonstration of dihybrid cross using genetic data sets to explain the Law of Independent Assortment.
3. Demonstration of common plant diseases such as tobacco mosaic disease, powdery mildew, or root knot disease with images or field observation
4. Identification of chromosomal aberrations (deletion, duplication, inversion, translocation) using prepared slides and charts.

Syllabi for Under Graduate Programme in Genetics

Semester-IV

Name of Program	B.Sc. Genetics Single Major	**Program Code**	**USGEN4**
Name of the Course	**Genetics & Microbes**	**Course Code**	25GENS404DS03
Hours per Week	**05**	**Credits**	**3+0+1**
Maximum Marks	**100**	**Time of Examinations**	**3 Hrs**

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Students will be able to understand basic concept of genetic in microbes.

CLO2: They will understand the genetic recombination in bacteria.

CLO3: Microbial strains may be utilized for various applications using genetic mechanisms,

Unit 1: Basic concepts of genetics in microorganisms: alleles, homozygous, heterozygous, dominants recessive, wild-type, and genetic markers; Extremophiles and environmental microbial communities; Overview of beneficial and pathogenic microbes.

Unit 2: Detailed bacterial cell structure: cell wall types, membranes, pili, and flagella; Environmental influences on growth of microorganisms; Sterilisation and control of microbial growth.

Unit 3: Organisation of microbial genomes including chromosomes, plasmids, and transposons. Mechanisms of genetic exchanges; conjugation, transformation and transduction in bacteria.

Unit 4: Mutation and its types; Development and spread of antibiotic resistance; Basic gene regulation mechanisms in microbes; Operon-based control relevant to microbial systems.

References:

1. Microbial Genetics - Maloy S., Cronan J., Freifelder D, Jones and Bertlett
2. Fundamental Bacterial Genetics - Trun N and Trempy J, Blackwell Publ.
3. Modern Microbial Genetics -Streips U. N. and Yasbin R.E., Wiley-Liss
4. Molecular Genetics of Bacteria -Sneider L. and Champness W. ASM Publishers
5. Genetics of Bacteria -Scaife J., Academic Press

Practical 0+0+1 Marks Internal = 25

1. Gram-staining of bacterial cells.
2. Isolation of DNA from bacteria.
3. To determine antibiotic resistance and sensitivity in bacterial cells.
4. UV mutagenesis in a given bacterial culture.

Syllabi for Under Graduate Programme in Genetics

Semester-IV

Name of Program	B.Sc. Genetics Single Major	**Program Code**	**USGEN4**
Name of the Course	Medical Genetics	**Course Code**	25GENS404DS04
Hours per Week	**05**	**Credits**	**3+0+1**
Maximum Marks	**100**	**Time of Examinations**	**3 Hrs**

Theory 3+0+0 Marks Internal =25 + External = 50 (75 Theory)

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Role of medical genetics and human hereditary disorders.

CLO2: Understanding of genetic mechanisms underlying disease development.

CLO3: Knowledge of clinical applications of medical genetics.

Unit 1: Definition and scope of medical genetics, Historical development, Human chromosomes and karyotype, Numerical chromosomal abnormalities (aneuploidy, polyploidy), Structural chromosomal abnormalities (deletions, duplications, inversions, translocations), Common chromosomal syndromes – Down syndrome, Turner syndrome, Klinefelter syndrome

Unit 2: Prenatal Screening and Diagnosis: Roles of 1st and 2nd trimester ultrasound andanalyte testing and the common indications, risks and benefits of chorionic villi sampling and amniocentesis.

Unit 3: Genetic Contribution to single gene disorders (Sickle cell anaemia, Thalassemia, Haemophilia, Cystic fibrosis), Inheritance patterns of multifactorial disorders (cleft lip/palate and Type1 diabetes.

Unit 4: Gene and Environment (Twins studies), Mechanisms of imprinting, Clinical features of imprinting disorder, Prader-willi and Angelman syndrome.

References:

1. Thompson & Thompson – Genetics in Medicine – Edited by Robert L. Nussbaum et al.; 9th edition; Elsevier, Philadelphia; published in 2016; ISBN: 978-0323188357.
2. Nussbaum, McInnes& Willard – Medical Genetics – Authors: Robert L. Nussbaum, Roderick R. McInnes, Huntington F. Willard; 8th edition; Elsevier, Philadelphia; published in 2016; ISBN: 978-0323188357.
3. Emery and Rimoin – Principles and Practice of Medical Genetics – Editors: David L. Rimoin, Robert E. Pyeritz, Bruce R. Korf; 7th edition; Academic Press (Elsevier), London; published in 2019; ISBN: 978-0128125359.

Practical 0+0+1 Marks Internal = 25

1. To observe metaphase chromosomes in prepared human karyotype slides.
2. To identify different types of structural chromosomal abnormalities using diagrams.
3. To analyze pedigrees of inherited disorders and determine their mode of inheritance
4. To study common chromosomal syndromes using karyotype charts.