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 Sciences.

PSO-2 Genome is the blue print of life to understand its intricate nature and gene analysis. 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 B.Sc. Genetics (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)	Skill Enhancement/Internship	Value-Added Courses (VAC) (F.A)*	Total Credits
I	24GENS401DS01 Introduction to Genetics 24GENS401DS02 Diversity of life forms-I (Plants)	MIC1 @ 4 credits Common Pool Life Science/Multidisciplinary	MDC1 @ 3 credits Common pool	AEC1 @ 2 credits Communication Skills from Common pool	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 (Animals)	MIC2 @ 4 credits Common Pool Life Science/Multidisciplinary	MDC2 @ 3 credits Common pool	AEC2 @ 2 credits Communication Skills from Common pool	SEC2@ 3 credits 24GENS402SE01 Cytogenetic Techniques <u>Optional:-</u> 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	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	<u>Optional:-</u> 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	----------	----------	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	----------	----------	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 **Human Genetics** 24GEN201DS03 **Molecular Cell Biology** 24GEN201DS04 **Developmental Genetics** 24GEN201DS05	**SEC4 @ 4 credits** **24GEN201SE01** **Techniques in Genetics**	----------	----------	----------	----------	**24**
VIII (4yr UG Hon.)	**Population and Evolutionary Genetics** 24GEN202DS01 **Molecular Genetics** 24GEN202DS02 **Immuno Genetics** 24GEN202DS03 **Medical Genomics** 24GEN202DS04 **Conservation of Genetic Resources** 24GEN202DS05	**SEC5 @ 4 credits** 24GEN202SE01 **Molecular Techniques in Genetics**	----------	----------	----------	----------	**24**
VIII (4yr UG Hon. with Research)	**Population and Evolutionary Genetics** 24GEN202DS01 **Molecular Genetics** 24GEN202DS02	**SEC5 @ 4 credits** 24GEN202SE01 **Molecular Techniques in Genetics**	----------	----------	**Research project/ Dissertation @ 12 credits** **24GENS408PD01**	---------- **TOTAL CREDITS**	**24** **184**

Scheme for Undergraduate Programmes B.Sc. Genetics (Single Major) USGEN4

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		
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 (Plants)	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 (Animals)	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
Resarch project/Dissertation @12 credits	Dissertation	24GENS408PD01	0	0	12	12	0	0	24	24	-	-	Internal 100	External 200	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 Examination	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 using permanent slides.
2. Study of ABO blood groups & Rh factor.
3.Demostration of inheritance pattern
4. Numerical based on monohybrid and dyhybrid crosses.

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 (Plants)	Course Code	24GENS401DS02
Hours per Week	05	Credits	3+0+1
Maximum Marks	100	Time of Examination	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 Plants.
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, 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 and 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. Familiarity with local flora and herbarium techniques.

Syllabi for Under Graduate Programme in Genetics.

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 Examination	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 from permanent slides.
2. Study of different stages of meiosis from permanent slides.
3. Study of structural chromosomal aberrations using permanent slides.
4. Study of numogical chromosomal aberrations using permanent slides.

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 (Animals)	Course Code	24GENS402DS02
Hours per Week	05	Credits	3+0+1
Maximum Marks	100	Time of Examination	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	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. DNA isolation from plants.
2. Numericals on gene frequencies
3. Numericals on gene interaction.
4. Study of ploidy using permanent slides.

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	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 RH-factor 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, sex linked pedigree.
3. Demonstration of plates/ photographs of sex chromosomes and autosomal chromosomal anomalies.
4. Study of Morphogenetics behavioural and serological traits.
5. Analysis of ABO & RH blood group of your own blood.

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 Examination	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- An 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. Multiple factor inheritance. Quantitative trait loci and their applications. Non-chromosomal genes and their inheritance.

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 Examination	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, quantitative genetics.

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 Examination	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 Examination	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, Biochemical Genetics inherited disorders of metabolism :- Alkaptonuria PKU, albinism Common numerical and structural chromosomal syndromes – Down syndrome, Turner syndrome, Klinefelter syndrome, Edward 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 in Prenatal diagnosis

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 gamic 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.

Syllabi for Under Graduate Programme in Genetics

Semester-V

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Behavioral Genetics	Course Code	26GENS405DS01
Hours per week	05	Credits	3 + 0 + 1
Maximum Marks	100	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:Concept of nature and nurture.
CLO 2:To understand role of genes in behaviour
CLO 3: Interaction of genes , environment & behaviour.

Unit I
Definition and scope of Behavior genetics, Importance of Behavior genetics in biology. Relationship between genes, environment and Behavior, Nature vs nurture concept, Heredity and Behavior, Family studies, Adoption studies, Twin studies, combination studies. Use of pedigree analysis in Behavior genetics, Limitations of Behavioral genetic studies.

Unit II
Estimating Genetic and Environmental Influences: Heritability, Interpreting Heritability, estimating heritability directly from DNA, Environmentality: Shared and Nonshared Environment, Linkage studies, Genome-Wide Association, Multivariate analysis, Twin Studies.

Unit III
Identifying genes: Genetic Control of Behavior, Single gene and polygenic control of Behavior, Behavioral variation within populations, Influence of environment on genetically controlled Behavior, Learning and Behavior:
General Cognitive disorders: Down Syndrome, XXX Syndrome; Phenylketonuria, Fragile X syndrome, Rett Syndrome

Unit IV
Psychiatric Genetics: Behavioral disorders with genetic influence, Schizophrenia,Anxiety Disorders: Panic Disorders, Phobias, posttraumatic stress disorder, Chronic fatigue, Depression, Autism.

References

1. Behavioral Genetics by Valerie S. Knopik, Jenae M. Neiderhiser, John C. Defries and Robert Plomin. 7th Edition.
2. Genetics: A Conceptual Approach by Benjamin A. Pierce
3. The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonald
4. Behavioral Genetics – Robert Plomin
5. Introduction to Genetic Analysis – Griffiths et al.

Practicals 0 + 0 + 1 Marks = 25
1. Twin studies
2. Case studies of Behavioral disorders with genetic influence
3. Numericals on heritability & linkage

Syllabi for Under Graduate Programme in Genetics

Semester-V

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Evolutionary Biology	Course Code	26GENS405DS02
Hours per Week	5	Credits	3+0+1
Maximum Marks	100	Time of Examination	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 of Evolution
CLO 2: Understanding of the mechanism natural selection & adaptation
CLO 3: To understand evolutionary significance

Unit 1: Introduction to Evolutionary Biology, Meaning and scope of evolutionary biology, Origin of life: brief overview, geological time scale era, epoch, Historical development of evolutionary ideas, Basic concepts of evolution, Contributions of Lamarck, Darwin, and Wallace.

Unit 2 Theories of Evolution; Lamarckism: principles and criticisms, Darwinism: theory of natural selection, Modern synthetic theory of evolution, Variation and heredity in evolution, Evidence supporting evolution.

Unit 3: Mechanisms of Evolution, Mutation as a source of variation, Role of recombination in evolution, Natural selection and adaptation, Genetic drift, Gene flow and isolation.

Unit 4: Evolutionary Patterns and Human Evolution, Adaptation and fitness, Types of natural selection: Directional, Stabilizing, Disruptive, Speciation: basic concept, Evolution of Horse, Evolution of humans: brief account

References

1. Evolution – Douglas J. Futuyma
2. Principles of Genetics – D. Peter Snustad & Michael J. Simmons
3. Genetics: A Conceptual Approach – Benjamin A. Pierce
4. Organic Evolution – Veer Bala Rastogi

Practicals 0 + 0 + 1 Marks = 25

1. To prepare a phylogenetic tree using given data using (H.W. equilibrium)
2. To estimate allele frequency in a population.
3. To study convergent and divergent evolution using examples.
4. To study geological time scale and major evolutionary events.
5. To study adaptive radiation using suitable examples.

Syllabi for Under Graduate Programme in Genetics

Semester-V

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Genes and Development	Course Code	26GENS405DS03
Hours per Week	5hrs	Credits	3+0+1
Maximum Marks	100	Time of Examination	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:** Understand the basic principles and mechanisms of developmental biology and gene regulation.
- **CLO 2:** Describe the role of genes and signaling in growth and development.
- **CLO 3:** Understand limb formation, regeneration, and metamorphosis.

Unit 1: Basic concepts of development: - Potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic determinants pattern formation, Cell fate and cell lineage;

Unit 2: 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.

Unit 3: 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:

Unit 4: Metamorphosis and Regeneration: (a) Molecular mechanism of ecdysone action cellular choice between apoptosis and differentiation (b) Molecular responses to thyroid hormone during metamorphosis (Amphibians) Genetic mechanisms Heterotopy, Heterochrony, Heterometry, Heterotypy

References

1. Gilbert, S. F. 2003. Developmental Biology. John Wiley Publishing.
2. Gilbert, S. F. Developmental Biology.2015. 11th edition. John Wiley Publishing.
3. Rao, V. 1994. Developmental Biology: A Modern Synthesis. Oxford and IBH. New Delhi.
4. Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick, 2014. Molecular Biology of Gene 7th Edition, Pearson Education RH Ltd. India.
   Link: https://share.google/Yny0D8aKSb8K086D0

Practicals 0 + 0 + 1 Marks = 25

1. Germ layers of frog
2. Observation of metamorphosis in frog.
3. Imaginal disc in drosophila
4. Metamorphosis in insects
5. Identification of developmental stages from charts and models.
6. To Study chick embryo development using permanent slides.

Syllabi for Under Graduate Programme in Genetics

Semester-V

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Genetic Engineering	Course Code	26GENS405DS04
Hours per Week	5	Credits	3+0+1
Maximum Marks	100	Time of Examination	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 understanding of principles and tools of genetic engineering
- **CLO 2:** Knowledge of recombinant DNA technology and gene manipulation strategies
- **CLO 3:** Ability to understand applications of genetic engineering in medicine, agriculture, and industry

Unit 1: Introduction to Genetic Engineering

Definition and scope of genetic engineering, Historical development of recombinant DNA technology, Central dogma revisited, Gene cloning concept, Basic strategies of gene manipulation, Ethical and biosafety considerations in genetic engineering.

Unit 2: Tools of Genetic Engineering

Restriction endonucleases (types and nomenclature), DNA ligases, DNA polymerases, Reverse transcriptase, Linkers and adapters, Vectors for gene cloning – plasmids, bacteriophages, cosmids, BACs and YACs, Host systems – *E. coli*, yeast, plant and animal cells.

Unit 3: Recombinant DNA Technology

Isolation and purification of DNA, Restriction digestion and ligation, Construction of recombinant DNA molecules, Introduction of recombinant DNA into host cells (transformation, transfection, electroporation), Screening and selection of recombinants – blue-white screening, colony PCR, Expression of recombinant proteins.

Unit 4: Applications of Genetic Engineering

Genetic engineering in medicine – insulin, vaccines, gene therapy, Genetic engineering in agriculture – transgenic plants, Bt crops, herbicide resistance, Genetic engineering in industry – enzymes and bio-products, CRISPR-Cas9 genome editing technology (overview), Future prospects and societal impact of genetic engineering

References

1. Brown, T.A. – Gene Cloning and DNA Analysis
2. Primrose, S.B. & Twyman, R.M. – Principles of Gene Manipulation and Genomics
3. Watson et al. – Molecular Biology of the Gene
4. Glick, B.R., Pasternak, J.J. & Patten, C.L. – Molecular Biotechnology
5. Lewin, B. – Genes

Practical 0+0+1 Marks External = 25

1. DNA isolation from peripheral blood.
2. Restriction digestion of isolated DNA.
3. PCR amplification of gene of interest from isolated genomic DNA.
4. Cloning of given gene in suitable vector and detection.

Syllabi for Under Graduate Programme in Genetics

Semester-VI

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Gene and Genomics	Course Code	26GENS406DS01
Hours per Week	05	Credits	3+0+1
Maximum Marks	100	Time of Examination	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 genetic material

CLO 2 Knowledge of genome architecture:.

CLO 3: Ability to understand genomic technologies and their biological applications

Unit 1: Concept of gene, Evolution of the gene concept, Structure of prokaryotic and eukaryotic genes, Coding and non-coding sequences, Exons and introns, Gene families, Pseudogenes, Regulatory elements Central Dogma of Molecular Biology, Model organisms for studying Molecular Biology.

Unit 2: Structure and functions of Nucleic acids: Nucleosides & Nucleotides, purines and pyrimidines. Watson and Crick model of DNA structure, A, B & Z forms of DNA, Supercoiled and relaxed DNA, denaturation and renaturation of DNA, melting temperature (Tm), hyperchromic effect.

Unit 3:. Genome size and complexity, Organization of prokaryotic and eukaryotic genomes, Repetitive DNA, Satellite DNA, Transposable elements, Chromatin organization, Euchromatin and heterochromatin, Epigenetic regulation – DNA methylation and histone modification.

Unit 4: Structural, functional and comparative genomics, Genome sequencing strategies, Overview of Human Genome Project, Gene annotation, Genome databases (NCBI, Ensembl, UCSC Genome Browser), Applications of genomics in medicine, agriculture and evolution

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. Brown T.A. – *Genomes*
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 External = 25

1. Extraction, Separation and Purification of nucleic acids.
2. Quantitation of Nucleic acids.
3. Gel Electrophoresis.
4. Melting temperature of DNA

Syllabi for Under Graduate Programme in Genetics

Semester-VI

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Gene Regulation	Course Code	26GENS406DS02
Hours per Week	05	Credits	3+0+1
Maximum Marks	100	Time of Examination	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 Gene expression and regulation
CLO 2: To understand the regulation of gene expression in prokaryotes and eukaryotes.
CLO 3:. Concept of epigenetics

Unit 1:. Concept and significance of gene regulation, Levels of gene regulation, Regulatory DNA elements, Features of DNA Replication, in Prokaryotes and Eukaryotes, Proof of semiconservative nature of DNA replication, Features of bidirectional DNA replication..

Unit 2: Regulation of Gene Expression in Prokaryotes : Operon model of gene regulation, Lac operon, Trp operon, Arabinose operon, Positive and negative regulation, Attenuation, Catabolite repression

Unit 3: Regulation of Gene Expression in Eukaryotes: Transcriptional regulation in eukaryotes, RNA polymerases and general transcription factors, Role of enhancers and mediators, Post-transcriptional regulation – RNA splicing, RNA editing, mRNA stability, Components of Protein synthesis machinery : Messenger RNA, tRNA structure and function, Charging of tRNA, aminoacyl tRNA synthetases, ribosome structure and assembly ,

Unit 4: Epigenetics – DNA methylation, histone modification, chromatin remodeling complexes, Genomic imprinting, X-chromosome inactivation, Regulatory RNAs – miRNA, siRNA, lncRNA, Role of gene regulation in development and disease.

References:

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.
2. Concepts of Genetics. Klug, WS., Cummins, MR., Spencer, C., Palladino, MA. 2020. 10th Edition. Pearsons Publication.
3. Genetics: A Conceptual approach.BenjaminA.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 External = 25

1. Isolation of protein from given sample.
2. SDS-PAGE
3. Quantification of given protein sample by Bradford method.

Syllabi for Under Graduate Programme in Genetics

Semester-VI

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Cancer Genetics	Course Code	26GENS406DS03
Hours per Week	3+2	Credits	3+0+1
Maximum Marks	100	Time of Examination	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 Cancer as a multifactorial disease
CLO 2: Understanding the genetics & mechanism of Cancer development
CLO 3: Overview of cancer treatment

Unit 1: Definition, characteristics and hallmarks of cancer., Types of tumors and stages of carcinogenesis. Cell transformation and tumorigenesis: Characteristics of normal cells, benign tumor cells, and malignant tumor cells, Concept of cancer as a genetic and multi-factorial disease Genetics and Cancer: Sporadic, familial, and hereditary cancers, Inherited Cancer syndromes, pedigree analysis - loss of heterozygosity - case study of retinal cancer (Rb)

Unit 2 Oncogenes, activation of proto-oncogenes, Tumor suppressor genes ; Major oncogenes such as Ras, Myc and Src. Tumor suppressor genes including p53, RB and BRCA. Cell cycle checkpoints, apoptosis and failure of regulatory mechanisms in cancer.

Unit 3: Types of mutations and accumulation of DNA damage in cancer. Genomic instability, microsatellite instability and defective DNA repair pathways. Mutagens and cancer. - Ames test DNA repair and cancer, - Case study of colon cancer (HNPCC) - UV light and xeroderma Familial cancer. - breast cancer case study Epigenetic changes including DNA methylation, histone modification and their impact on cancer gene expression.

Unit 4: Oncogenic viruses (HPV, HBV, HCV, EBV, HTLV) and viral-mediated transformation. Bacterial carcinogenesis with emphasis on *Helicobacter pylori*. Microbiome & cancer. Diagnostic tools; cytogenetics, tumor markers, PCR-based assays and use of NGS in cancer diagnosis. Overview of cancer treatment strategies including targeted therapy, hormonal therapy, immunotherapy and gene-based approaches.

References:

• Weinberg – The Biology of Cancer
• King – Cancer Biology
• Lodish – Molecular Cell Biology
• Vogelstein & Kinzler – The Genetic Basis of Human Cancer

Practical 0+0+1 Marks Internal 25
1.To differentiate between normal & malignant cell (immunohistochemistry)
2. Karyotyping of tumour cell
3.Tumour diagnosis (PCR , Elisa based detection)

Syllabi for Under Graduate Programme in Genetics

Semester-VI

Name of Program	B.Sc. Genetics	Program Code	USGEN4
Name of the Course	Pharmacogenetics	Course Code	26GENS406DS04
Hours per Week	5	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: Core understanding of pharmacogenetics and drug–gene interactions
CLO 2: Ability to explain genetic variability in drug metabolism and response
CLO 3: Knowledge of clinical application of pharmacogenetic testing in personalized medicine

Unit 1: Fundamentals of Pharmacogenetics: Historical development, definition and scope of pharmacogenetics and pharmacogenomics, Pharmacogenetic data base, Genetic polymorphisms and drug response variability.

Unit 2: Genes involved in Drug Metabolism and Transport**;** Phase-I & Phase-II Drug Metabolism pathways**;** Drug-metabolizing enzymes: Phase I enzymes (CYP450 family – CYP2C9, CYP2C19, CYP2D6, CYP3A4), Phase II enzymes (UGT, NAT, TPMT)

Unit 3: Clinical Pharmacogenetics: Pharmacogenetics of commonly prescribed drugs: Warfarin (VKORC1, CYP2C9), Clopidogrel (CYP2C19), Thiopurines (TPMT, NUDT15), Statins (SLCO1B1),Adverse drug reactions and toxicity prediction, Pharmacogenetics diseases (Maligram HP G-6 PD deficiency)

Unit 4: Pharmacogenetics in Personalized Medicine: Role of pharmacogenetics in precision medicine, Ethical, legal and social issues (ELSI), Overview of CPIC, FDA and PharmGKB guidelines

References:

1. Kalow W., Meyer U.A., Tyndale R.F. – Pharmacogenomics
2. Squassina A. et al. – Pharmacogenetics in Clinical Practice
3. Katzung B.G. – Basic & Clinical Pharmacology
4.

Practical 0+0+1 Marks Internal 25

1. Study and Exploration of Pharmacogenetic Databases for Drug–Gene Interaction Analysis
2. Identification and Matching of Pharmacogenetic Genes with Commonly Prescribed Drugs
3. Preparation of Flowcharts Illustrating Phase I and Phase II Drug Metabolism Pathways

Syllabi for Under Graduate Programme in Genetics

Semester-VII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Concepts of Genetics	Course Code	24GEN201DS01
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examinations	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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: Students will be having knowledge about the basic concepts that form the building block for understanding Genetics i.e life cycles of Model Organisms, basic genetic experiments, mutations , polyploidy,.QTL Blood groups
CLO 2: Acquaintance of students with organization of genome and specialized chromosomes, Chromosomal theory of Inheritance, linkage, crossing over and recombination, inheritance modesin nature, maternal inheritance
CLO 3: Students will learn navigation in DNA databases (Introductory Bioinformatics)

Unit 1: Brief introduction: **Life cycles** of Genetically important experimental organisms: *Neurospora crassa*, *Saccharomyces cerevisiae*: Baker's Yeast, *Arabidopsis thaliana*: A Fast-Growing Plant, *Drosophila melanogaster*: The fruit fly.

Mendelism: Mendel's experimental organism: the garden pea. Basic Principles of Inheritance: Monohybrid crosses (the principle of Segregation); Dihybrid crosses (the principle of independent Assortment); Applications of Mendel's Principles: The Punnett square method, Forked-line method, Probability method, Chisquare test.
Extensions of Mendelism: Incomplete Dominance and Co-dominance, Multiple Alleles, Testing gene mutations for allelism, Gene interactions: Complementation, Epistasis, Pleiotropy, Penetrance and Expressivity.

Unit 2: Chromosome Theory of Inheritance: Experimental evidence linking the inheritance of genes to chromosomes, Molecular organization of prokaryotic and eukaryotic chromosomes, chromomere, kinetochores, centromeres, telomeres, heterochromatin/ euchromatin; Linkage, Recombination and crossing over: Early evidence for linkage and genetic recombination, crossing over as the physical basis of recombination, cytological demonstration of crossing over, genetic recombination and construction of genetic maps, interference and coincidence.

Unit 3: Polyploidy and Aneuploidy in nature, tissue-specific polyploidy and polyteny (polytene and lampbrush chromosomes), Qualitative traits and Quantitative Traits and their inheritance, Polygenic inheritance, continuous discontinuous variation, Genetic variance, heritability & QTL mapping; Extra-nuclear Inheritance in nature: Mitochondrial and Chloroplast genes, maternal inheritance, Transposable elements/jumping genes. Mutation: definition, types, induction, detection, molecular basis and significance of mutations in nature, mutagenic agents (exogenous & endogenous).

Unit 4: Genetic Material: Prediction of DNA structure & chemistry, Alternative forms of DNA, negative and positive supercoiling; One DNA molecule per chromosome, DNA packaging, Nucleosome structure, DNA scaffolds & loops; Fine structure of gene, split genes, pseudogenes, overlapping genes & multigene families; c value paradox and central dogma; Introduction to Bioinformatics: Biological Databases: Primary, secondary & specialized databases. Types of databases- Nucleotide sequence database, EMBL, Genebank, Unigene, Genome biology, Protein dBase, 3D structure databases, Alignments using BLAST and FASTA.

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
4.http://highered.mcgrawhill.com/sites/007352526x/student_view0/genetic_portrait_chapters_

Syllabi for Under Graduate Programme in Genetics

Semester-VII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Microbial Genetics	Course Code	24GEN201DS02
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examinations	3 Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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: Students would be able to understand the basic principles of Genetics using simpler organisms.
CLO 2: Understanding concept & principles of genetic recombination in bacteria and bacteriophages
CLO 3: Students will be familiar with transformation , transduction , bacteriophage, plasmids
CLO 4: Understanding basic principles, working and applications of microscopy;

Unit 1: Bacteria as model systems in genetic analysis: Mutation, recombination, test of allelism, gene mapping; Methods of gene transfer in bacteria; Conjugation: Discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F', map of F plasmid, mechanism of chromosome transfer, molecular pathway of recombination; Chromosome transfer in other bacteria

Unit 2: Transformation: Natural transformation systems, Biology and mechanism of transformation, transformation and gene mapping, Chemical-mediated and electro transformation; Transduction: Discovery, generalized and specialized or restricted transduction, Phage P1 and P22-mediated transduction, mechanism of generalized transduction, abortive transduction. Temperate phage lambda and mechanism of specialized transduction, gene mapping, fine structure mapping.

Unit 3: Structure and classification of bacteriophage: Virulent phage (T4) and Temperate phage (lambda); Lytic and lysogenic cycles, phage-host relationship; immunity and repression, Site specific recombination (lambda and P1); Techniques for the study of bacteriophages. Transposable phage (phage Mu): Genetic organization, and transposition, Mu as a genetic tool; Plasmids: Types, detection, replication, incompatibility, partitioning, copy-number control and transfer; Properties of some known plasmids. Genetic rearrangements and their evolutionary significance: Phase variation in *Salmonella*

Unit 4: Microscopy: Light Microscopy-Introduction, Magnification and Resolution, Lens aberrations, Distortion of image and curvature of field;.Types of microscopes- Compound, Comparison, Fluorescence, Polarized, Stereo, Their basic principles, working and applications; Electron Microscopy- Introduction, Historical review, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Theory and basic principles, Instrumentation, applications

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
6. Genetics of Bacteria and Viruses Birge E. A., Springer
7. Molecular Genetics of Bacteria -Dale J.W. and Park S, Wiley

Syllabi for Under Graduate Programme in Genetics

Semester-VII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Human Genetics	Course Code	24GEN201DS03
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examinations	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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: Understanding of important hereditary diseases, their inheritance patterns ,Pedigree analysis &Human karyotyping
CLO 2: Knowledge of Genetics & molecular basis of diseases, their clinical impact leading to plantreatment.
CLO 3: Insight into Cancer genetics, Human genome project, human cloning, Numerical, structural & multifactorial human genetic disorders.
CLO 4: This will be first step towards a professional carrier in disease diagnostics, allied bio-medicalSciences & Genetic counselling.

Unit 1: Overview of historical milestones in Human genetics, Study tools in Human Genetics: pedigree-gathering family history symbols, construction of pedigree, pedigree analysis in monogenetic traits; Autosomal dominant and recessive inheritance; Sex linked dominant and recessive inheritance; Consanguinity and its effects; Sex Chromosomes and autosomes, Different sex determination systems in nature; Sex linked anomalies: Haemophilia, Colour blindness; Sex limited and sex influenced traits; Sex determination in Man, TDF & SRY, Testicular feminization syndrome; Lyon hypothesis, Single active X hypothesis, Sex chromatin and drum sticks, Genetic mosaics**.**

Unit 2: Human Karyotypes: Harvesting of cells for chromosome analysis, conventional and specialized staining protocols, Banding patterns, Nomenclature of aberrant karyotypes; Human genome mapping methods: Physical mapping, Introduction to physical map markers; Radiation hybrids; Fluorescence in situ hybridization; SKY, Comparative genome hybridization, long range restriction mapping; High resolution mapping-STS/RFLP/EST/MS/SNP/sequencing**.**

Unit 3: Human Health and Disease: Chromosomal numerical and structural alteration: Mechanisms of Deletion, Duplication, Translocation, Aneuploidy and Nullisomy; Common syndrome according to numerical and structural alteration; Genetics and clinical features of Syndromes (Klinefilter, Down's, Turner, Achondroplasia, Edwards, Polydactyly); Single gene and diseases: Beadle and tatum experiment; Inherited enzyme defects in man (PKU, Alkaptonuria, Albinism, Galactosemia); Haemoglobinopathies: ABO blood group system, Rh blood group, Thalassemia syndromes; Multifactorial disorders: Genetics factors in Diabetes, Schizophrenia, Huntington's disease, Alzheimer's disease.

Unit 4: Cancer genetics: Cancer cells, Oncogenes, Tumor suppressor genes ; Leukaemias, Lymphomes, myelomas; ; Human genome project: History and concepts, gateways, goals, role of sequencing, distribution of GC content, CPG islands, main conclusions, current activities; DNA finger printing ; Prenatal diagnosis; Human cloning and Eugenics; Ethical, legal and social issues in Human Genetics

References:

1. Human Genetics: Problems and Approaches - T Vogel F. and. Motulsky A. GT, Springer Verlag
2. Human Molecular Genetics . - Strachan T & Read A, Garland Science
3. An Introduction to Human Molecular Genetics - Mechanism of Inherited Diseases
Pasternak JFitzgerald, Science Press
4. Human Genetics - Cummings, M.R, Cehage Learning, USA.
5. Principles and branches of Medical Genetics, Emery and Rimoih, Churchill Livingstone, Newyork, Vol-1-3.
6. Human Cytogenetics-Constitutional analysis (Ed) D.E. Rooney, Oxford University Press.
7. Recombinant DNA - J.D. Watson Gillman, Scientific American books, W.H, freeman company N.Y.
8. Human Genetics - The molecular revolution McConkey, Edwin H, Jones & Bartlett publishers.

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Semester-VII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Molecular Cell Biology	Course Code	24GEN201DS04
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examinations	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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: Students will be able to understand structure, function of different cell organelles, biomolecules

CLO 2: Knowledge about the mechanism of cellular processes- cell cycle and regulation, cellular energetic,enzyme kinetics, transport across the cell membrane and cellular signal transduction

CLO 3: Students will be having knowledge of biophysical techniques (NMR,ESR ,X ray diffraction etc) for the analysis of biomolecules

Unit 1: Diversity of cell size and shape; Cell Theory; Structural organization and function of intracellular organelles: Cell wall, Nucleus, Mitochondria, Golgi bodies, lysosomes, Ribosome, Endoplasmic reticulum, Peroxisomes, plastids, Vacuoles, Chloroplast, Structure & function of cytoskeleton and its role in motility; Cell adhesion,gap junction, Extra cellular matrix. Endosymbiotic origin of mitochondria and chloroplast

Unit 2: Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, chromosomal movements and control of cell cycle; Membrane transport processes, transport molecules, inhibitors, ion gradient, proton pumps (in oxidative phosphorylation, in photosynthesis & in bacteria); Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of signaling pathways

Unit 3: Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids(DNA ,RNA:detail structure & types) and vitamins); Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds).

Unit 4: Bioenergetics, glycolysis, coupled reaction, group transfer, biological energy transducers; Enzyme kinetics: Factors affecting enzyme activity- pH, temperature, time of incubation, enzyme concentration and substrate concentration. Derivation of Michaelis-Menten equation, Kcat/Km and its significance, regulation of enzyme activity, allosteric enzymes ;Biophysical methods**:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy; Structure determination using X-ray diffraction and NMR analysis using light scattering; Different types of mass spectrometry and surface plasma resonance methods

References:

1. Lodish et al., Molecular Cell Biology Freeman and Company
2. Smith and Wood. Cell Biology, Chapman and Halls
3. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall, USA
4. Benjamin Lewin. Gene X, Jones and Barlett Publishers,
5. Lehninger Principles of Biochemistry 4th Ed By David L. Nelson and Michael M. Cox, WH Freeman andCompany.
6. Principles of Biochemistry (Hardcover) By Geoffrey Zubay. Publisher: McGraw Hill College.
7. Biochemistry By Lubert Stryer. WH Freeman and Co.

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Semester-VII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Developmental Genetics	Course Code	24GEN210DS05
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examinations	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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: Students will be enabled to understand the process of development in various animals

CLO 2: It will be helpful in knowing different gene expression patterns in development and the role of maternal environment on fetal development

CLO 3: To understand the environmental influences on development , factors responsible for ageing & programmed cell death

CLO 4: Understanding of the basic concept of assisted reproduction

Unit 1: Basic concepts of development: Potency, commitment, specification, induction, competence, determinationand differentiation; Morphogenetic gradients, pattern formation, cell fate and cell lineages; Mosaic versus regulative development; Genomic imprinting

Unit 2: Fertilization, Types of cleavage, Gastrulation; Cell movement and formation of germ layers in frog, Chick and mouse; Implantation and formation of the placenta in mammals; Gastrulation in mammals-formation of primitive streak, morphogenetic movements and induction; Organogenesis and foetal development; Formation of vulva in *C. elegans*

Unit 3: Drosophila: Embryonic development, Maternal genes and formation of body axes, Segmentation genes, and Homeotic genes function, Imaginal disc development, P-element and insertional mutagenesis; Pattern forming genes and expression in mammalian embryos, Axes formation and Hox genes; Development of mammalian brain-cerebral cortex-cell lineages; Limb development and regeneration in vertebrates; Lens development-fibre differentiation; Programmed morphogenetic histogenetic cell death (apoptosis); Erythropoesis, mylopoesis; Ageing

Unit 4: Embryonic stem cells and their applications; Clinical embryology: (Gametogenesis, Follicular development, egg release, fertilization implantation, Types of placenta), Brief account of hormonal control of reproduction; Gonadal malformation and their genetic basis; Reproductive failure and infertility; Assisted reproduction

References:

1. Developmental Biology (2003) - Gilbert S. F, Sinauer Asso.
2. Principles of Development (2002) - Wolpert L et al., Oxford University Press
3. The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
4. Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
5. Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge UniversityPress.

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Semester-VIII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Population and Evolutionary Genetics	Course Code	24GEN202DS01
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examination	3 Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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 having knowledge about natural selection, speciation, different theories of evolution and molecular evolution.

CLO2: They will be able to learn molecular evolution and quantitative genetics.

CLO3: Understanding of molecular tools in phylogeny, principle, procedure and applications of molecular biology techniques.

Unit 1: Population Genetics: Definition & Meaning; Microevolution in Mendelian population: Theory of Allele Frequencies; The Hardy-Weinberg Principle: Theory, exceptions and applications; Natural Selection: Concept of fitness, natural selection at the level of gene; factors affecting gene frequencies, genetic drift and mutation; Speciation: causes of reproductive isolation; Evidence for speciation; Mode of speciation: Allopatric, Parapatric, Sympatric; Co-speciation: sexual selection, Co-evolution and convergent evolution.

Unit 2: Populations in Genetic Equilibrium: Balancing Selection, Mutation–Selection Balance, Mutation–Drift Balance; Quantitative Genetics: Johannsen pure-line concept; Quantitative traits and their characteristics, threshold traits, multiple factor hypothesis, types of quantitative traits, determining gene number for a polygenic trait, components of phenotypic variation and genetic models for quantitative traits; Concept of heritability: Broad sense heritability and narrow sense heritability; Predicting phenotypes; Artificial selection.

Unit 3: Emergence of Evolutionary Theories: Lamarckism and Darwin's Theory of Evolution, Shortcomings of Lamarckism and Darwin's Theory; 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; Origin of prokaryotes and eukaryotes; Evolutionary time scale: eras, periods and epoch; major events in evolutionary time scale.

Unit 4: Molecular evolution: Concept of neutral theory of molecular evolution; Molecular divergence and molecular clocks; Genetic variation in natural populations; Molecular tools in phylogeny, classification and identification; Construction of phylogenetic tree by distance-based methods and character-based methods; Protein and nucleotide sequence analysis; Electrophoresis: principle, procedure and application of agarose, SDS-PAGE, pulse-field electrophoresis and isoelectric focusing.

References:

1. http://evolution.berkeley.edu/evolibrary/article/0_0_0/evo_01.
2. http://evolution.berkeley.edu/evolibrary/article/evo_44.
3. Principles of Genetics by D. Peter Snustad and Michael J Simmons.
4. Genetics: A Conceptual Approach by Benjamin A. Pierce.
5. The Science of Genetics by Alan G.Atherly, Jack R. Girton, John F. McDonal.
6. Genes in the Environment-Rosie S. Hails, Wiley-Blackwell Publications.

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Semester-VIII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Molecular Genetics	Course Code	24GEN202DS02
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examination	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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-1Knowledge about the molecular mechanisms of DNA, RNA.

CLO-2Understanding of DNA damage, repair, RNA transport, post and co transcriptional modifications, post translational modifications, RNA processing etc.

CLO-3Understanding about the mechanisms of gene expression regulation in prokaryotic and eukaryotic system.

Unit 1: DNA, RNA as genetic material; DNA replication, Repair and Recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication; DNA damage and repair mechanisms: nucleotide excision repair, base excision repair, SOS repair, recombination repair, Photo reactivation repair; Structure and function of different types of RNA, RNA transport; RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation.

Unit 2: Protein synthesis and processing: Ribosomes, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.

Unit 3: Gene regulation and levels of regulation, evidences and experimental designs/methodologies, role of genetic analysis in understanding gene function and regulation; Gene regulation in prokaryotes- lac, trp operon. Yeast- Gene regulation in a single celled eukaryote using a model case of gal gene.

Unit 4: Genetic regulation in eukaryotes; DNA alteration (Gene amplification, programmed DNA rearrangement, DNA methylation); Spatial and temporal control, Tubul in gene in plant, glob in genes in animals); Molecular control of transcription in eukaryotes (Enhancer, Silencer, enhancer trap mutagenesis, transcription factors, alternate promoters, alternate splicing, molecular organization of transcriptionally active DNA, Translational control.

References:

1. BenjaminLewin.GeneX,10th Edition, Jones and Barlett Publishers 2010.
2. J DWatsonetal., Biology of Gene,6thEdition,BenjaminCummingspublishers Inc.2007
3. Albertsetal., Molecular Biology of the Cell, Garland, 2002
4. PrimoseSB, Molecular Biotechnology, Panima, 2001.
5. Watsonet al. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003
6. Benjamin Lewin. GeneX, Jones and Barlett Publishers,2010.

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Semester-VIII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Immunogenetics	Course Code	24GEN202DS03
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examination	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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 Understanding of the immune system, its components, properties, role of immunity in human health & disease.

CLO-2 Knowledge of the genetic basis of the immune response and antibody diversity.

CLO-3 Enable to make a research carrier in identification of new therapeutic targets for immune diseases & will help to develop new strategies to harness the power of immunity to defeat various diseases including cancer.

CLO-4 Insight in the genetics of transplantation and tissue rejection, Autoimmunity and immune suppression that can be applied to the estimates of transplant compatibility and the likelihood finding suitable donors

Unit 1: Overview of immunity; General properties of immune system, Immunological memory, Specificity; Innate and Adaptive immunity;Cells and organs of immune system; Hematopoiesis; Antigens (Haptens, epitopes, adjuvants) ; Antibodies; Immunoglobulin classes; Cytokines, Interferon, Colony stimulating factor, Transforming growth factor; Complement pathways.

Unit 2: Immune response: MHC complex, Class I, II, III molecules; Genetic map of H-2 complex & HLA Complex; T cell receptor complex; Subtractive hybridization; Ig gene super family;Humoral & cell mediated immune response (antigen recognition, processing and presentation),Hypersensitivity reactions (I, II, III & IV types).

Unit 3: Immunogenetics: Organization of immuno globulin genes, Genetic control of light chains ((Lambda & Kappa), Genetic control of heavy chains; Genomic rearrangement during B lymphocyte differentiation, Somatic recombination events, Antibody class switching, Allelic exclusion, Somatic mutation; Genetic control of antibody diversity.

Unit 4: Immunity in health and disease: Disorders of immune system: Self tolerance & auto immunity, causative factors; Defects: Thyroiditis, IDDM, SLE, Rheumatoid arthritis; Immuno suppression: Severe combined immuno deficiency (SCID), AIDS; Tissue transplantation: Laws, types of grafts rejection, GVHR, alloantigens; Vaccines; Primary antigen, antibody reaction: Radio immunoassay, Enzyme linked immunosorbant assay; Secondary antigen antibody reaction: Precipitation, Agglutination & Immuno electrophoresis.

References:

1. Immunology - Kuby J. W. H., Freeman
2. Essentials of Immunology - Ivan M. Roitt, Wiley-Blackwell
3. Fundamentals of Immunology -William E. Paul Lippincott, Williams & Wilkins.
4. Immunology Understanding Immune system –Elgert K D, John Wiley and sons.

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Semester-VIII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Medical Genomics	Course Code	24GEN202DS04
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examination	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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):

CO-1 Students will be able to explain the technical and medical aspects of diagnostic and screening methods and reproductive options including associated risks, benefits, and limitations.
CO-2 Understanding of basic principles of genetic manipulation and gene therapy.
CO-3 Understanding the role that genetic testing plays in pharmacogenetics& its applicability.
CO-4 Concept of genetic counseling.

Unit 1: Growth and development of medical genetics, Role of genetics in medicine; Diagnostic genetics: Cytogenetics/Molecular Cytogenetics /Biochemical/Molecular methods; Screening for mutation/ chromosomal anomaly -Adult/Prenatal/Newborn screening; Preimplantation screening (Assisted reproductive technology- in-vitrofertilization and Embryo transfer); Organ banking, transplantation, Forensic testing - DNA fingerprinting, paternity testing, individual identification.

Unit 2: Treatment of genetic disorders: Recombinant Proteins, Gene therapy: Types, Criteria & technical aspects, Viral vectors, delivery methods and microinjection, germline therapy, gene therapy of (Thalassemia, Cystic fibrosis,DMD), Mitochondrial inheritance and its disorders (Mitochondrial myopathy,Maternally inherited diabetes mellitus and deafness, (MIMD), Leber's hereditary optic neuropathy (LHON))

Unit 3: Pharmacogenetics: History, Genes involved in pharmacokinetics and pharmacodynamics of drugs, Pharmacogenetic diseases (Hereditary disorders with altered drug response, Malignant hyperthermia, G-6-PDdeficiency), Role of SNPs in drug discovery and development, Stages in drug development, Personalized medicine: testing for susceptibility of complex diseases, Clinical implications of Pharmacogenomics

Unit 4: Genetic counseling: Definition and process, Diagnostic problems, decision making, risk assessment and role ofgenetic counsellors, Prenatal/adult diagnosis of genetic disorders; Psychosocial aspects of genetic counselling. Medical ethics; Risks and benefits; Informed consent and confidentiality Right of choice universalityof bioethics; Dilemmas faced by counsellors, Case studies; Genome ownership, Genetic insurance, Genetic privacy, genome Patenting.

References:

1. Human Molecular Genetics (2010) 4th ed. - Strachan T. & Read A., Garland Science
2. An introduction to Human Molecular Genetics (1999) - Mechanism of Inherited Diseases Pasternak J. Fitzgerald, Science Press
3. Thompson and Thompson Genetics in Medicine (2007) 7th ed. Robert et al., Saunders
4 Landmarks in Medical Genetics – (2002) Ed. Harper P. S., Oxford University Press
5.Chromosome Banding (1990) - Sumner A.T. Unwin, Hyman
6. Genes IX (2009) -Lewin B, Jones

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Semester-VIII

Name of Program	B.Sc. Genetics Single Major	Program Code	USGEN4
Name of the Course	Conservation of Genetic Resources	Course Code	24GEN202DS05
Hours per Week	4	Credits	4
Maximum Marks	100	Time of Examination	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

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: Students will be having knowledge about Ecosystems, Biomes and Bio-geographical zones, biodiversity and factors affecting biodiversity.
CLO-2: Appraisal of National and International organizations working for biodiversity, Conservation, IUCN Red Data book, different conservation Strategies, Project Tiger
CLO-3:Indian laws for Conservation, International agreements for conservation, Insight into Animals behavior.

Unit 1: Structure and function of ecosystem; energy flow in a ecosystem, primary production and decomposition; Some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Major terrestrial biomes; Biogeographical zones of India;Mega-centres of biodiversity; Biodiversity hot spots- Global and Indian; Measurement of biodiversity- species diversity.

Unit 2: Environmental pollution: Soil, water, air; Global climate change and its effects; Role of IPCC; Biodiversity status: monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches; Factors affecting biodiversity: Environmental pollution, Global climatic change; Invasive species eroding diversity;Assessing the loss of biodiversity- Floristic surveys/inventory; IUCN Red data book

Unit 3: *Conservation biology:* Strategies for conservation of biodiversity; *In situ* conservation- ecosystem approach; *In situ*-on farm conservation; *Ex situ* conservation- Whole plant conservation/maintenance, Conservation using cryobiology; Conservation using *in vitro* culture methods; Indian case study on conservation strategy (Project Tiger); International organization supporting conservation (PETA, WWF); Indian organizations supporting conservation (WPSI, Wildlife Trust of India); International agreement for conservation (CBD); *Indian laws forConservation*: The Indian Wildlife Protection Act 1972; The National Forest Policy of 1988

Unit 4: *Animal sexual behavior:* Monogamy, Polygamy with examples;*Social Behavior*: Living In Groups, Agonistic Behavior, Territories and Dominance Hierarchies, Altruism, Reciprocal Altruism, Kin Selection, Parental Care in birds, animals (lion, elephant); Habitat Selection and Optimality in Foraging, Specialists and Generalists organism; Migration in animals, birds, fishes and insects; Orientation And Navigation.

References:

1. Sharma PD (2011). Ecology and Environment. Rastogi Publications
2. Odum EP & Barret GW (2004). Fundamentals of ecology.Brooks/Cole
3. Millet GT &Spoolman S (2019). Essentials of ecology. Cengage Learning
4. Alcock J (2013). Animal Behavior: An Evolutionary Approach. OUP USA

http://en.wikibooks.org/wiki/Animal_Behavior