MAHARSHI DAYANAND UNIVERSITY, ROHTAK-124001, INDIA

(NAAC Accredited 'A' Grade State University established under Haryana Act No. XXV of 1975)

SCHEME & SYLLABUS

M. Sc . Genetics
(2 Year Programme)

Choice Based Credit System (CBCS)
(w.e.f. Academic Session 2016-17)

DEPARTMENT OF GENETICS

Web site: http://www.mdurohtak.ac.in

http://mdurohtak.ac.in/info/acad_fac_lifescien_genetics.html

Credit Matrix for M. Sc . Genetics Program w.e.f. 2016-17

SEMESTER	CORE PAPER (INCLUDING PRACTICAL)	DISCIPLINE SPECIFIC ELECTIVE (INCLUDING PRACTICAL)	FOUNDATION COURSE	OPEN ELECTIVE (INTERDISCIPLINARY)	PROJECT WORK/DISSERTATION	TOTAL
I	28	-	-	-	-	28
II	16	8	2	3	-	29
III	12	12	-	3	-	27
IV	8	-	-	-	20	28
TOTAL	64	20	2	6	20	112

REQUIRED CREDITS FOR M. SC GENETICS TWO YEAR COURSE : TOTAL=112

CORE PAPER = 64
DISCIPLINE SPECIFIC ELECTIVE = 20
OPEN ELECTIVE COURSE = 6
FOUDATION COURSE = 2
DISSERTATION = 20

INSTRUCTION FOR THE STUDENTS

Course Types:

- **Core Paper (C):-** There are Core Papers in every semester. These are to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in the said discipline/ Course of study.
- **Discipline Specific Elective (D):-** These are Elective papers which can be chosen from a pool of papers given by the department. It will be supportive to the discipline of study & mandatory as per course curriculum.
- **Foundation Course (F)**:- The Foundation Course is based upon the content that leads to Knowledge enhancement/proficiency/skill development. It is mandatory as per course curriculum & to be taken from pool provided by M.D. University Rohtak.
- **Open Elective (O)**:-Open elective course may be from an unrelated discipline. It is Interdisciplinary/Open Elective & mandatory as per course curriculum. Choice may be from any other Subject/Department of M.D. University campus Rohtak/pool provided by M.D. University Rohtak. .
- **Dissertation/ Field work/Project -Dissertation/**Project /Field work/ is discipline centric & mandatory as per course curriculum. Student has to study with an advisory support by concerned teacher

SCHEME OF EXAMINATION

M. SC . GENETICS - CHOICE BASED CREDIT SYSTEM (W.E.F. ACADEMIC SESSION 2016-17)

	SEMESTER –I						
Paper No.	**Nomenclature**	**Course structure**			**Internal assessment M.M**	**External M.M**	**Total Marks**
		L+T+P	**Total Credits**	**Hrs./week**			
Core Paper							
16GEN21C1	Concepts of Genetics	4+0+0	4	4	20	80	100
16GEN21C2	Microbial Genetics	4+0+0	4	4	20	80	100
16GEN21C3	Human Genetics	4+0+0	4	4	20	80	100
16GEN21C4	Molecular Cell Biology	4+0+0	4	4	20	80	100
16GEN21C5	Developmental Genetics	4+0+0	4	4	20	80	100
16GEN21L1	Lab course-I **(**Based on 1C1&1C2 papers**)**	0+0+4	4	8	-	-	100
16GEN21CL2	Lab course-II**(**Based on 1C3,1C4&1C5 papers**)**	0+0+4	4	8	-	-	100

Total Credits=28

SEMESTER –II

Student will opt any **one** of the given four **Discipline specific** elective course (D1 to D4) along with respective Lab Course(-D5)

The students are required to take **one** paper of **Foundation course (F)** of their choice from pool provided by M.D. University Rohtak. The students are also required to take **one** paper **Open Elective**(O) of their choice from any other Subject/Department of M.D. University campus Rohtak/pool provided by M.D. University Rohtak. .

Paper No.	**Nomenclature**	**Course structure**			**Internal Assesment (M.M)**	**External (M.M)**	**Total Marks**
		L+T+P	**Total Credits**	**Hrs./ week**			
Core Paper							
16GEN22C1	Molecular Genetics	4+0+0	4	4	20	80	100
16GEN22C2	Immunogenetics	4+0+0	4	4	20	80	100
16GEN22C3	Plant Genetics	4+0+0	4	4	20	80	100
16GEN22CL	Lab course-I**II (**Based on 2C1,2C2&2C3 papers)	0+0+4	4	8	-	-	100
Discipline specific(Elective)							
16GEN22DA1	Conservation Biology	4+0+0	4	4	20	80	100
16GEN22DA2	Bioinformatics and Biostatistics	4+0+0	4	4	20	80	100
16GEN22DA3	Medical Genomics	4+0+0	4	4	20	80	100
16GEN22DA4	Genetics of Medicinal Plants	4+0+0	4	4	20	80	100
16GEN22DL	Lab course-IV(for respective discipline specific elective courses)	0+0+4	4	8	-	-	100
Foundation course							
	To be chosen by the student from common pool of the university	0+0+2	2	2	10	40	50
Open Elective course							
	To be chosen by the student from common pool of the university	0+0+3	3	3	20	80	100

Total Credits=29

SEMESTER –III

Student will opt **any one** of the Discipline specific elective course (DA1 to DA3) and any one of the Discipline specific elective course (DB1 to DB3) along with respective Lab Course (DL)**.** The students are also required to take **one** paper **Open Elective(O**) of their choice from any other Subject/Department of M.D. University campus Rohtak/pool provided by M.D. University Rohtak. .

Paper No.	**Nomenclature**	**Course structure**			**Internal Assessment M.M**	**External**	**Total Marks**
		L+T+P	**Total Credits**	**Hrs./ week.**			
Core Paper							
17GEN23C1	Recombinant DNA Technology	4+0+0	4	4	20	80	100
17GEN23C2	Population and Evolutionary Genetics	4+0+0	4	4	20	80	100
17GEN23CL	Lab course-V**(**Based on 3C1&3C2 papers)	0+0+4	4	8	-	-	100
Discipline specific(Elective)							
17GEN23DA1	Human Molecular Genetics	4+0+0	4	4	20	80	100
17GEN23DA2	Drosophila Genetics	4+0+0	4	4	20	80	100
17GEN23DA3	Somatic Cell Genetics	4+0+0	4	4	20	80	100
17GEN23DB1	Plant molecular Genetics	4+0+0	4	4	20	80	100
17GEN23DB2	Microbial Technology	4+0+0	4	4	20	80	100
17GEN23DB3	RNAi technology	4+0+0	4	4	20	80	100
17GEN23DL	Lab course-VI(for two respective discipline specific elective course)	0+0+4	4	8	-	-	100
	Open Elective course (To be chosen by the student from common pool of the university)	0+0+3	3	3	20	80	100

Total Credits=27

	SEMESTER –IV						
Paper No.	**Nomenclature**	**Course structure**			**Internal Assessment (M.M)**	**External (M.M)**	**Total Marks**
		L+T+P	**Total Credits**	**Hrs./week.**			
Core Paper							
17GEN24C1	Social, Ethical Issues in Genetics	4+0+0	4	4	20	80	100
17GEN24C2	Lab Design and Bio safety	4+0+0	4	4	20	80	100
17GEN24C3	Dissertation/Project Work/Seminar	0+0+20	20	40			300

Total Credits=28

Grand Total Credits=112

INTERNAL ASSESMENT

The distribution of the weightage of marks will be as under:-

Internal Assessment	**20% or 20 marks**
Sessional Test	10% or 10 marks
Assignment/Presentation	5% or 5 marks
Attendance*	5 marks

*Distribution of marks for attendance is as under:-

Attendance Classification:

(a)	65% to 70%	=	2 marks
(b)	71% to 75%	=	3 marks
(c)	76% to 80%	=	4 marks
(d)	81% onwards	=	5 marks

DEPARTMENT OF GENETICS

M. Sc . (Genetics)

Program Specific Outcome (PSO)

PSO-1 The degree in M. Sc . Genetics offers 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 The course provides suitable platform to understand the genetic tools for improvement of plant and animal varieties.

PSO-4 By understanding principals of genetics & practical exposure one can have designer crops with agronomic traits of interest or go for molecular farming for production of therapeutic proteins, industrial enzymes, antibodies or vaccines, etc

PSO-5 Understanding of the human genetic disorders can be translated to the improvement of diagnosis and treatment of diseases .Focus is to promote health by understanding the genetic basis of common diseases and early detection of potentially treatable genetic conditions. The awareness in the society about these problems is necessary for improving human health.

PSO -6 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.

SEMESTER-I
(Core Paper)
CONCEPTS OF GENETICS
Paper Code: 16GEN21C1

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome (CO)

CO-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.

CO-2 Acquaintance of students with organization of genome and specialized chromosomes, Chromosomal theory of Inheritance, linkage, crossing over and recombination, inheritance modes in nature, maternal inheritance,

CO-3 Students will learn navigation in DNA databases (Introductory Bioinformatics)

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

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, Chi square 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.

Suggested Readings:

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.mcgraw-hill.com/sites/007352526x/student_view0/genetic_portrait_chapters_

SEMESTER-I
(Core Paper)
MICROBIAL GENETICS
Paper Code: 16GEN21C2

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Students would be able to understand the basic principles of Genetics using simpler organisms.
CO-2 Understanding concept & principles of genetic recombination in bacteria and bacteriophages
CO-3 Students will be familiar with transformation , transduction , bacteriophage, plasmids
CO-4 Understanding basic principles, working and applications of microscopy;

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

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-II

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-III

Structure and classification of bacteriophage: Virulent phage (T_4) 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-IV

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

Suggested readings:

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.

SEMESTER-I
(Core Paper)
HUMAN GENETICS
Paper Code: 16GEN21C3

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Understanding of important hereditary diseases, their inheritance patterns ,Pedigree analysis & Human karyotyping,

CO-2 Knowledge of Genetics & molecular basis of diseases, their clinical impact leading to plan treatment.

CO-3 Insight into Cancer genetics, Human genome project, human cloning, Numerical, structural & multifactorial human genetic disorders

CO-4 This will be first step towards a professional carrier in disease diagnostics, allied bio-medical Sciences & Genetic counselling.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

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-II

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-III

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-IV

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

Suggested readings:

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 J Fitzgerald, 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.

SEMESTER-I
(Core Paper)
MOLECULAR CELL BIOLOGY
Paper Code: 16GEN21C4

Time: 3 Hours **Credits: 4**

Course Outcome

CO-1 Students will be able to understand structure, function of different cell organelles, biomolecules,
CO-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.
CO-3 Students will be having knowledge of biophysical techniques (NMR,ESR ,X ray diffraction etc) for the analysis of biomolecules.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

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-II

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-III

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-IV

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.

Suggested Readings

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 and Company.
6. Principles of Biochemistry (Hardcover) By Geoffrey Zubay. Publisher: McGraw Hill College.
7. Biochemistry By Lubert Stryer. WH Freeman and Co.

SEMESTER-I
(Core Paper)
DEVELOPMENTAL GENETICS
Paper Code: 16GEN21C5

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Students will be enabled to understand the process of development in various animals.
CO-2 It will be helpful in knowing different gene expression patterns in development.
and the role of maternal environment on fetal development.
CO-3 To understand the environmental influences on development , factors responsible for ageing & programmed cell death.
CO-4 Understanding of the basic concept of assisted reproduction.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

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

Unit-II

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 – III

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 - IV

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.

Suggested readings:

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 University Press.

SEMESTER-I
(Core Paper)

Paper Code: 16GEN21CL1 **LAB COURSE-I** **Credits: 4**

Time: 8 Hours **(Based on 1C1& 1C2 papers)** **Max. Marks: 100**

Lab Course Outcome

CO-I Student will be able to identify model organism (Drosophila flies) , sex of the fly and different stages of its life cycle

CO-2 Make slides of cell division (mitosis).

CO-3Start navigating in the nucleotide databases, blast given DNA sequence.

CO-4 To perform various identification and isolation process for microbial culture ,familiar with growth conditions, and handling of microorganisms.

CO-5 Students will get familiarity with basic tools and techniques for the study of bacterial genetics

SEMESTER-I
(Core paper)

Paper Code: **LAB COURSE-II** **Credits: 4**
16GEN21CL2

Time: 8 Hours **(Based on1C3,1C4&1C5 papers)** **Max. Marks: 100**

Lab Course Outcome:

CO-1 Enable to study& calculate the gene frequency of various human morphogenetic ,behavioural & serogenetic traits; dermatoglyphics of fingers and palm; To draw& understand pedigree of different inheritance patterns, Karyotyping; hematological techniques ;Barr body in neutrophils

CO-2 Conversant of various numerical problems based on H.W equilibrium ,blood grouping, probability & gene mapping

CO-3 To understand cell cycle stages by mitosis and meiosis slides.

CO-4 Qualitative &quantitative analysis of DNA, RNA & protein

CO-5 Understand the basic features of developmental stages of various animals & lifecycles of organisms.

SEMESTER-II

(Core Paper)
MOLECULAR GENETICS
Paper Code: 16GEN22C1

Time: 3 Hours **Credits: 4**
Max. Marks: 80.

Course Outcome

CO-1 Knowledge about the molecular mechanisms of DNA, RNA.
CO-2 Understanding of DNA damage, repair, RNA transport, post and co-transcriptional modifications, post translational modifications, RNA processing etc
CO-3 Students will be having knowledge about the mechanisms of gene expression regulation in prokaryotic and eukaryotic system.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit -I

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, Photoreactivation 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- II

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. Computation methods; Nucleic method and protein sequence databases, data mining method for sequence searches, motif analysis and prediction.

Unit-III

Structure of genes in eukaryotes: Split genes-exons and introns; different kinds of introns and junction sequences; origin of introns (exon early intron early hypothesis); coding potential and overlapping genes; pseudogenes-their origin and function; cryptic genes- their origin and function; gene transfer between nucleus and other organelles.

Gene regulation and levels of regulation, evidences and experimental designs/methodologies, role of genetic analysis in understanding gene function and regulation; Yeast- Gene regulation in a single celled eukaryote using a model case of GAL gene.

Unit-IV

Genetic regulation in eukaryotes; DNA alteration (Gene amplification, programmed DNA rearrangement, DNA methylation); Spatial and temporal control, Tubulin gene in plant, globin genes in animals); Molecular control of transcription in eukaryotes (Enhancer, Silencer, enhancer trap mutagenesis, transcription factors, alternate promoters, alternate splicing, molecular organization of transcriptionaally active DNA); Induction of transcriptional activity by environmental and horizontal factors; Translational control.

Suggested readings:

1. Benjamin Lewin. Gene X, 10th Edition, Jones and Barlett Publishers 2010.
2. J D Watson et al., Biology of Gene, 6th Edition, Benjamin Cummings publishers Inc. 2007
3. Alberts et al., Molecular Biology of the Cell, Garland, 2002
4. Primose SB, Molecular Biotechnology, Panima, 2001.
5. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003
6. Benjamin Lewin. Gene X, Jones and Barlett Publishers, 2010.

SEMESTER-II
(Core Paper)
IMMUNOGENETICS
Paper Code: 16GEN22C2

Time: 3 Hours **Credits: 4**
Max. Marks: 80.

Course Outcome

CO-1 Understanding of the immune system, its components, properties ,antigen, antibody & various Cytokines, role of immunity in human health & disease
CO-2 Knowledge of the genetic basis of the immune response,antibody diversity & interrelation between immunity to disease
CO-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
CO-4 Insight in the genetics of transplantation and tissue rejection, Autoimmunity and immunosuppression that can be applied to the estimates of transplant compatibility and the likelihood finding suitable donors

Instructions for paper setter
There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I
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-II
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-III
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-IV
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.

Suggested readings:

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.

SEMESTER-II
(Core Paper)
PLANT GENETICS
Paper Code: 16GEN22C3

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Students would be able to understand the basic principles of plant inheritance, & various molecular markers for gene mapping

CO-2 Insight into plant breeding, Heterosis breeding and their role in plant breeding so that cultivation varieties may be improved.

CO-3 Learning of principal of the various cytogenetic techniques, plant tissue culture.

CO-4 Enable students about the principles and functioning of various molecular techniques i.e. gel filtration, TLC, GLC, HPLC, FPLC & ultracentrifugation.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all

Unit I

Plant Genetics: Introduction; Problems related to higher plants, including polyploidy inheritance, self-incompatibility, cytoplasmic inheritance, mutable alleles; complex loci, genome analysis, recombination and mutagenesis; cytological aspects of hybridity and apomixes; chromosomes as they affect breeding behaviour.

Unit 1I

Plant Breeding: History of plant breeding; Principles of plant breeding; Breeding methods for self and cross pollinated crops; Heterosis breeding; Polyploidy and haploids in plant breeding; Cytogenetic tools in Plant breeding; Limitations of conventional breeding.

Unit III

Plant Tissue Culture: History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; In vitro differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration; Molecular basis of plant organ differentiation.

Unit IV

Molecular markers for genome mapping: Principles of genetic linkage, concept of genetic distance, development and choice of mapping populations, linkage map construction – relational, integrated and comparative maps; Principles and methods of QTL mapping; Principle and applications of gel filtration, ion exchange & affinity chromatography; Thin layer chromatography; Gas chromatography; GLC; High pressure liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC); Ultracentrifugation (Velocity and buoyant density).

Suggested Readings

1. Principles of Plant Breeding, Allard R. W. Wiley & Sons
2. Plant Breeding Theory and Practice, Stoskopf N. C., Tomes D. T. & Christie, B. R. Westview Press
3. Genome mapping in Plants, Paterson A. H. Academic Press
4. Molecular markers in Plant Genetics and Biotechnology, Vienne D. INRA
5. Quantitative Genetics, Genomics and Plant Breeding, Kang M. S. CABI Publishing
6. Plant Molecular Breeding , Newbury H. J. CRC press
7. Bhojwani SS. Plant Tissue Culture: Theory and Practice . Elsevier.
8. Dixon RA. Plant Cell Culture. IRL Press.

SEMESTER-II

(Core paper)

Paper Code: 16GEN22CL **LAB COURSE-III** **Credits: 4**

Time: 8 Hours **(Based on 2C1, 2C2 & 2C3 papers)** **Max. Marks: 100**

Lab course outcome

CO-1 Students will learn the concept of gene expression regulation in bacterial system and in-vitro transcription Process.

CO-2 Appraisal of the students with various Immunological techniques and their applications.

CO-3 Learning techniques of W.B.C & D.L.C counting

CO-4 Understanding basic principles of plant inheritance and tissue culture.

CO- 5 Learning cytogenetic techniques and tissue culture techniques for the improvement of plant varieties.

SEMESTER-II

DISCIPLINE SPECIFIC (ELECTIVE)

Student will opt any **one** of the given four Discipline specific elective (**2DA1 to 2DA4)** along with respective **Lab Course-IV (2DL).**

SEMESTER-II
(Discipline Specific Elective Paper)
CONSERVATION BIOLOGY
Paper Code: 16GEN22DA1

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Students will be having knowledge about Ecosystems, Biomes, sustainable development, Bio-geographical zones, biodiversity and factors affecting biodiversity.

CO-2 Appraisal of National and International organizations working for biodiversity Conservation, IUCN Red Data book, different conservation Strategies , (cryobiology, Project Tiger, Biosphere reserves) PETA, Indian laws for Conservation.

CO-3 Insight into Animals behavior.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all

Unit 1

Structure and function of ecosystems; Energy flow and mineral cycling (C,N,P), primary production and decomposition; Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine); Major terrestrial biomes, biogeographical zones of India; Mega-centres of biodiversity; Biodiversity hot spots- Global and Indian; Measurement of biodiversity- species diversity; Concept of centre of origin and crop diversity.

Unit 2

Environmental pollution: Soil, water, air; global climate/environmental change, Role of IPCC; Biodiversity: status, monitoring and documentation, major drivers of biodiversity change, biodiversity management approaches; Factors affecting biodiversity, Global climatic change; Invasive species eroding species diversity; Estimation of genetic diversity, population biology, concept of minimum viable population; Population viability and population genetics to facilitate conservation, Assessing the loss of biodiversity- Floristic surveys/inventory; IUCN Red data book.

Unit 3

Strategies for conservation of biodiversity: *In situ* conservation- Ecosystem approach, Habitat approach, Gene management zones; *In situ*-on farm conservation; *Ex situ* conservation- Whole plant conservation/maintenance, conservation through storage of orthodox seeds at low temperatures; Conservation using *in vitro* culture methods; Conservation using cryobiology; Conservation using storage of DNA molecule; Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves); International organization supporting conservation (PETA); Indian organization supporting conservation; International treaties/agreements for conservation; Indian laws for Conservation

Unit 4

Animal Sexual behavior: Monogamy, Polygamy with examples; Learning Behavior: Habituation, Classical Conditioning, Instrumental Conditioning, Latent Learning, Insight Learning; Communication: visual, acoustic, tactile and chemical communication; Social Behavior: Living In Groups, Agonistic Behavior, Aggressive behavior Territories and Dominance Hierarchies, Altruism, Reciprocal Altruism, Kin Selection, Parental Care in humans, birds, animals (lion, elephant); Habitat Selection and Optimality in Foraging, Specialists and Generalists; Migration, Orientation And Navigation.

Suggested readings

1. Ecology and Environment by P D Sharma
2. Fundamentals of ecology by E P Odum
3. Essentials of ecology by G T Miller
4. Animal Behavior: An Evolutionary Approach, Tenth Edition by John Alcock
5. http://en.wikibooks.org/wiki/Animal_Behavior
6. http://en.wikipedia.org/wiki/Drosophila_melanogaster

SEMESTER-II

(Discipline Specific Elective Paper)
BIOINFORMATICS &BIOSTATISTICS
Paper Code: 16GEN22DA2

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Students will be having knowledge of bioinformatics, biological databases & their application in biological system.

CO-2 Sequence retrieval, primer designing for PCR, sequence alignment, multiple sequence alignment and applications of alignment, phylogenetics and protein 3D structure prediction based upon different methods.

CO-3 Students will be able to understand biostatistical methods to measure the central tendency by using different statistical tests.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

Introduction to Bioinformatics, Biological Databases: Primary, secondary & specialized databases. Types of databases- Nucleotide sequence database, EMBL, Genebank, Unigene, Genome biology, Protein dBase (Swiss-prot & Trembl and Motif) and 3D structure databases (PDB, SCOP, Cath, Genecards, SRS & Entrez) and various specialized databases like TIGR, Hovergen, TAIR, PlasmoDB, ECDC etc. Sequence retrieval, primer designing for PCR.

Unit-II

Basics of sequence analysis- Dot matrix method, Needleman–Wunsch Algorithm and Smith-Waterman algorithm, Alignments using BLAST and FASTA, Multiple Sequence Alignment (CLUSTAL-X and CLUSTAL-W), Application of multiple sequence alignment (PSSM and Markov/Hidden Markov models. Phylogenetic tree construction by distance based methods, character based methods. Protein Structure Prediction - Ab initio based methods, Homology based methods and comparative modelling, Phylogenetic analysis: Application of phylip.

Unit-III

Methods of data collection, sampling and sampling methods, Sample size estimation and designing of experiments, case-control studies, randomization, replication local control, completely randomized and randomized block design.

Unit-IV

Types of data, tabular and graphical presentation of data; Measurement of central tendency, mean, median, mode, standard deviation, standard error and variance. Analysis of variance (ANOVA), Correlation & regression analysis, tests of significance, t-test, z-test, chi-square test.

Suggested Readings:

1. David W. Mount Bioinformatics: Sequence and Genome Analysis CSHL Press, 2004
2. A. Baxevanis and FBF Ouellette, Bioinformatics: A practical guid to the analysis of genes and proteins 2nd eds. John Wiley 2001

3. Jonathan Pevsner Bioinformatics and functional genomics Ist Ed. Wiley Liss 2003
4. P E Bourne and H. Weissig Structural Bioinformatics Wiley 2003. Statistical Analysis of Non normal data, : J.V. Deshpande, A.P. Gore, A. Shanubhogue, New Age International Publishers Ltd.
5. Introduction to Bioinformatics; T K Attword and DJ Parrysmith (2002) Pearson education.
6. Statistical methods in Animal Sciences, By : V.N. Amble, Indian Society Agricultural Statistics (New Delhi)
7. Statistical Procedure for Agricultural Research : Kwanchai A Gomes Arturo A.Gomez, John Wiley and Sons.
8. A text book of Agricultural Statistics. By: R. Rangaswamy, New Age International Pvt. Ltd.
9. Statistics for Agricultural Sciences. By: G. Nageswar Rao,Oxford and IBH Publishing Co.
10. SP Gupta, Statistical Methods S Chand and Sons 2004.
11. B L Agarwal, Basic Statistics, New Age. 2003

SEMESTER-II

(Discipline Specific Elective Paper)
MEDICAL GENOMICS
Paper Code: 16GEN22DA3

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course outcome:

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.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain short answer eight to ten type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

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 vitro* fertilization and Embryo transfer); Organ banking, transplantation, Forensic testing - DNA fingerprinting, paternity testing, individual identification.

Unit-II

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 disorders (Mitochondrial myopathy, Retinitis pigmentosa,Diabetes mellitus).

Unit -III

Pharmacogenetics: History, Genes involved in pharmacokinetics and pharmacodynamics of drugs, Pharmacogenetic diseases (Hereditary disorders with altered drug response, Malignant hyperthermia, G-6-PD deficiency), Role of functional genomics in new drug discovery and drugable genome, Role of SNPs in drug discovery and development.

Unit-IV

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

Suggested readings:

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 and Barlett Publishers

SEMESTER-II
(Discipline Specific Elective Paper)
GENETICS OF MEDICINAL PLANTS
Paper Code: 16GEN22DA4

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course outcome:

CO-1 Acquaintance with our traditional knowledge, cultivation and processing of medicinal plants.

CO-2 Knowledge of constituents and medicinal uses of different medicinal plants & to understand the role of molecular pathway for enhancement of plant natural products.

CO-3 Able to isolate and purify the active constituents of phytochemicals for therapeutic purposes

. CO-4 Able to use of plant biotechnology for enhancement of secondary metabolites

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit I

History & philosophics of herbal medicine (Ayurveda, Unani), Importance and need of cultivation of medicinal and aromatic plants; Harvesting, drying, grading and storage of medicinal plants; Organic cultivation of medicinal plants; Good agricultural practices in medicinal plants.

Unit II

Active constituents and uses of important medicinal and aromatic plants: *Asparagus racemosus, Stevia rebaudiana, Aloevera, Withania somnifera, Solanum nigrumi Cassia angustifolia, Rosa damacena, Tagetes minuta, Salvadora species,Cassia tora,Cassia occidentalis,Boerhavia diffusa,Achyranthes aspera,Ncytanthus arborytis,Balanites aegyptiaca,Tridex procumbens* or any other species specific to the region.

Unit III

Molecular biology of plant natural products: Genes involved in biosynthetic pathways of plants, Families of metabolic genes and their evolution (Gene families & their evolution, cytochrome, P450 genes):Expression of metabolism genes; Molecular biology tools used in natural products research; Application of molecular biology approaches to natural products.

Unit IV

Separation and purification of phytopharmaceuticals through thin layer chromatography and column chromatographic techniques; Extraction of essential oils and their evaluation for quality parameters; Natural products and plant biodiversity; Plant cell biotechnology for the production of secondary metabolities, Metabolic engineering of plant secondary metabolism; Molecular farming, Transferring genes from plants to rhizophere microbes and vice-versa.

Suggested Reading

1. Farooqi, A.A. and B.S. Sreeramu (2001). Cultivation of Medicinal and Aromatic Crops. Universities Press (India) Ltd. 3-5-819, Hyderguda, Hyderabad – 29.
2. Handa, S.S. and M.K. Kaul. (1987). Cultivation and Utilization of Medicinal Plants. RRL, Jammu.
3. Kumar, N., J.B. Md. Abdul Khadar, P. Rangaswamy and I. Irulappan. (1982).
4. Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

SEMESTER-II

Paper Code: 16GEN22DL **LAB COURSE-IV** **Credits: 4**

(FOR RESPECTIVE DISCIPLINE SPECIFIC ELECTIVE PAPER)

Time: 8 Hours **Max. Marks: 100**

Laboratory Course Outcome

Conservation Biology:

CO-1 Student will be able to Measure biodiversity of a given area;
CO-2 Differentiate between insitu and exsitu methods of conservation;
CO-3 Know the importance of Biodiversity conservation for sustainable development.

Bioinformatics and Biostatistics

CO-1 Students will be familiar with bioinformatics tools e.g., BLAST,
CO-2 Phylogenetic tree construction and Homology modeling
CO-3 Biostatistics methods of measure of central tendency.

Medical Genomics

CO-1 To be conversant about genetics, medical, and technical information & management of genetic Conditions and/or birth defects
CO-2 Education of various programs on awareness of human genetics, patient care
CO-3 Apprise of genetic counseling issues.

Genetics of Medicinal plants

CO-1 Knowledge of medicinal plants & natural products.
CO-2 To access antimicrobial and antioxidant activity of medicinal plants.
CO-3 Learning of technique of preparing nanoparticles of isolated compounds.

SEMESTER-II

(FOUNDATION COURSE)

(For **Common Pool** offered by the Department of Genetics)

The students are required to take one paper of Foundation elective course of their choice from the pool of papers offered by different Departments of M.D. University campus Rohtak

Paper Code: to be written as per student option/ chosen Foundation elective

Time: 2 Hours **Credits: 2**

Max. Marks: 50

Department of Genetics is running Foundation course entitled **Moral Education.**

SEMESTER-II
INTERDISCIPLINARY/OPEN ELECTIVE COURSE

(FOR COMMON POOL OOFERED BY THE DEPARTMENT OF GENETICS)

The students are required to take one paper (Interdisciplinary/Open Elective) of their choice from any other Subject/Department of M.D. University campus Rohtak/ from pool of papers provided by the university

(Offered by Department of Genetics for common pool of the university**)**

SEMESTER-II

INTERDISCIPLINARY/OPEN ELECTIVE COURSE

Genetics &Society

Paper Code: 16GEN2O

Time: 3 Hours **Credits: 3**

Max. Marks: 80

Course Outcome

CO-1 The syllabus is designed in such a way so that students would be aware of basic principles of Genetics and its role for the betterment of society.

CO-2 Students would be able to understand the genetic disorders, method of testing and get awareness about genetic counselling & Eugenics.

CO-3 This course offers great advantage to students across discipline to learn about green revolution, genetically modified plants(GMO) and animals(transgenic) and their consequences as well as benefit for human health, agriculture and environment.

CO-4 Understanding Microbial innovations in pharmaceutical, health, agricultural and industrial Sectors.

Instructions for paper setter

There will be a total of seven questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining six questions will include two questions from each unit. The students will be required to attempt one question from each of the three units. The students will attempt four questions in all.

Unit I

Human Health and Disease: Chromosomes and genes, pedigree- gathering family history, symbols, inheritance of characters, Consanguinity and its effects; Sex linked anomalies: Haemophilia, Color blindness; Sex limited and sex influenced traits. Common syndrome according to numerical and structural alteration: Klinefilter, Down's, Turner, Achondroplasia; Inherited enzyme defects in man: Albinism, Galactosemia; Multifactorial disorders: Diabetes, Schizophrenia, Huntington's disease, Alzheimer's disease; Methods of genetic testing, Prenatal diagnosis, New born screening; DNA fingerprinting: Paternity testing, Individual Identification.

Unit II

GM World: Green revolution, Application r-DNA technology in agriculture: Transgenic crops, Gene gun, GM foods, Ht, Bt and others, Concerns about bio-safety of genetically modified organism (GMO) (Allergen, toxicity, impact on biodiversity etc.); Indian regulatory system for testing of GMOs in laboratory, field trials and commercial release of transgenic ;potential benefits of GMOs.

Unit III

Microbial innovations in pharmaceutical, health, agricultural and industrial sectors; Strategies for selection and improvement of industrial strains of microorganisms; Stem cell research, Cloning designer babies, Organ banking, Transgenic animals, Creating transgenic animals, In vitro fertilization, Genetic counseling and reproductive decisions ,Eugenics; Role of Genetics for the improvement of Health,Agriculture and environment.

Suggested books:

1 Principles of Genetics by D. Peter Snustad and Michael J Simmons

2 Genes in the Environment- Rosie S. Hails, Wiley-Blackwell Publications

3 The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonald

4 Principles and branches of Medical Genetics, Emery and Rimoih, Churchill Livingstone, Newyork, Vol-1-3.
5 Industrial Microbiology, G. Reed (editor), CBS Publishers (A VI Publishing Company).
6 Modern Microbial Genetics (2002)-Streips U. N. and Yasbin R.E., Wiley-Liss
7 Plant Biotechnology (2006) - B. D. Singh, Kalyani Publishers
8 Plant Biotechnology-The Genetic Manipulation of Plants (2003) Slater A. Scott N. & Fowler M., Oxford University Press Inc Nigel Jen,
9 Animal Cell Biotechnology:Methods and protocols, Humana Press.
10 Genetics in Medicine 7th Ed (2007) - Thompson and Thompson, Saunders
11 . Primose SB, Molecular Biotechnology, Panima, 2001

SEMESTER-III
(Core Paper)
RECOMBINANT DNA TECHNOLOGY
Paper Code: 17GEN23C1

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course outcome:

CO-1 Students will be having knowledge of various components & techniques of genetic engineering & microarray..

CO-2 Students will be able use the recombinant technology in agriculture and human health; and know about the post translation modification of proteins.

CO-3 They will be able to understand the structure, behavior and activity of genes and how developments in gene manipulation have revolutionized medicine, agriculture and health

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain short answer eight to ten short type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

Principles of Genetic Engineering: Historical account, Components– Nucleic acids, DNA modifying enzymes, Cloning vectors and Cloning hosts, Gene transfer and cloning methods, Gene Screening and isolation - Strategies, DNA libraries, Probe Selection and gene screening.

UNIT II

PCR and DNA sequencing: PCR – Principle, Methodology, Types - RT-PCR, RAPD, AFLP, ISSR, inverse PCR and Real time PCR and their applications,;Sequencing of nucleic acids, DNA sequencing methods - Maxam and Gilbert's method, Sanger's method, Automated DNA sequencing method, Capillary gel electrophoresis for DNA sequencing.

UNIT III

Molecular markers: Type of molecular markers; Application of molecular markers in discerning polymorphism, germplasm characterization, Gene tagging; Disease diagnostics; Marker aided selection in crop improvement. DNA Engineering techniques: Gel electrophoresis of nucleic acids, Methods of labeling of DNA, Blotting of macromolecules: Southern, Northern and Western blotting techniques and hybridization, Oligonucleotide synthesis, Promoter characterization, DNA fingerprinting, Microarray technology, *In vitro* translation.

UNIT IV

Application r-DNA technology: (Production of recombinant protein, Vaccine and pharmaceutical compounds; application in agriculture, Fluorescence in situ hybridization (FISH), Proteomics: Tools techniques, study of protein- protein interaction, protein analysis for gene identification, post translation modification.

Suggested readings:

1. Gene Cloning and DNA Analysis,-An Introduction (2001) Brown T. A., Blackwell

Publishing.
2. Gene Cloning and Manipulation- Howe C., Cambridge University Press.
3. Principles of Gene Manipulation and Genomics (2001) - Primrose S. B. & Twyman R. M, Blackwell Publishing.
4. Molecular Cloning (2001) - A Laboratory Manual (3-Volume Set) Sambrook J. et al., CSHL Press
5. Calculations for Molecular Biology and Biotechnology (2003) -Stephenson F. H., Academic Press

SEMESTER-III
(Core Paper)
POPULATION AND EVOLUTIONARY GENETICS
Paper Code: 17GEN23C2

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Students will be having knowledge about Natural selection, Speciation, different theories of evolution of life and molecular evolution.
CO-2 Knowledge of Quantitative genetics and its uses.
CO-3 Understanding of Molecular tools in phylogeny , Principle, procedure and application of molecular biology techniques.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-1

Population genetics: Definition & Meaning, Microevolution in Mendelian population: Theory of Allele Frequencies, The Hardy–Weinberg Principle, Applications of The Hardy–Weinberg Principle, Exceptions to Hardy–Weinberg Principle (non-random mating, unequal survival, population sub-division, migration); Natural Selection: Concept of fitness, Natural Selection at the level of gene; Factors affecting gene frequencies: natural selection, genetic drift, 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 Theory: 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. Bioinformatics- Phylogenetic tree construction by distance based methods, character based methods. Phylogenetic analysis: Application of phylip.

Unit-4

Molecular evolution; concept of neutral theory of molecular evolution; Molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification electrophoresis: Principle, procedure and application of- Agarose, PAGE, SDS-PAGE, Pulse field electrophoresis, Paper cellulose acetate and High voltage electrophoresis; Isoelectric focusing (IEF).Genetic Variation in natural populations; Chromosomal and allozyme polymorphism, Balanced polymorphism and heterosis; Protein and nucleotide sequence analysis; Origin of new genes and proteins; gene duplication and divergence.

Suggested Readings:

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,

SEMESTER-III

Student will opt **any one** of the Discipline specific elective course (3DA1 to 3DA3) and any one of the Discipline specific elective course (3DB1 to 3DB3) along with respective **Lab Course (3DL).** The students are also required to take **one** paper **Open Elective (O**) of their choice from any other Subject/Department of M.D. University campus Rohtak/pool provided by M.D. University Rohtak.

SEMESTER-III
(Discipline specific Elective Paper)
HUMAN MOLECULAR GENETICS
Paper Code: 17GEN23DA1

Time: 3 Hours **Credits: 4**

Max. Marks: 80

Course outcome

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

CO-1 Describe the approaches used to identify the genetic basis of inherited diseases.

CO-2 Understand the role of copy number repeat and SNP in genetic susceptibility study.

CO-3 Understand the mechanisms of genotoxicity, DNA damage.

CO-4 Know about Functional genomics and understanding mechanisms together with in- silico approaches to unravel genome architecture.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

Organization of genome in humans: General features of chromosomes, reiterated sequences and their detection: LINE, SINE, Alu family, transposable elements; Gene mapping: Gene mapping by somatic cell hybridization, top down approach to molecular mapping, restriction maps and contig construction (the bottom up approach);Engineering chromosomes : Yeast artificial chromosome, making YACs, MACs (mammalian artificial chromosomes) and satellite DNA's, artificial chromosomes (SAT ACS).

Unit –II

Molecular explanation of dominance & recessiveness, incomplete penetrance & expressivity; Identification of genetic basis of disease: Positional analysis, structural and functional cloning; Bioinformatic analysis; Characterization, Mutation detection, diagnosis and therapy (with examples from autosomal Dominant, autosomal recessive, X-linked dominant, X-linked recessive and complex disease Conditions); Identification of specific disease gene in Huntington's disease, DMD (Duchenne muscular dystrophy) and Cystic fibrosis.

Unit-III

Genetic susceptibility to common diseases: Types and mechanisms of susceptibility; Genetic approaches to common diseases (Diabetes mellitus, Hypertension, Coronary artery diseases, Schizophrenia, Alzheimer's disease); Whole genome association (Single nucleotide polymorphism, CNVs).

Unit-IV

Genetic toxicology: Genotoxicity- classification of genotoxic agents, genotoxic test systems, mutagenicity, teratogenecity; DNA damage & genome instability: endogenous metabolism & DNA damage, exogenous factors (irradiation & carcinogens); Functional genomics: cDNA/gene, cloning; site-directed mutagenesis; Mammalian tissue culture,Methods for generation of transgenic animals/ knock-in, knockout models (microinjection, ES cell transformation); E Numutagenesis; PFGE, Automated DNA sequencing.

Suggested readings:

1. Human Molecular Genetics 4thed - Strachan T. & Read A., Garland Science
2. An introduction to Human Molecular Genetics-Mechanism of Inherited Diseases
Pasternak J. Fitzgerald, Science Press
3. Genetics in Medicine 7th Ed - Thompson and Thompson, Saunders
4 Landmarks in Medical Genetics (Ed.) Harper P. S. Oxford University Press
5. Chromosome Banding -Sumner A.T., Unwin Hyman
6. Human Genetics: Problems and Approaches - Vogel F. and Motulsky A. G, Springer Verlag

SEMESTER-III
(Discipline specific Elective Paper)
DROSOPHILA GENETICS
Paper Code: 17GEN23DA2

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course outcome

Students will be having knowledge about

CO-1 Drosophila genetics its importance as model for human genetic disorders,
CO-2 Mutagenesis & isolation of new variants
CO-3 Drosophila Genome Project and Databases.

Instruction for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit.
Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

Drosophila as an model organism, Methods for collection from natural sites, Life cycle of *Drosophila* with characteristic features of each stage, Mechanism of sex determination in *Drosophila m.*; mating behavior in *Drosophila,* Basic requirements for setting up *Drosophila* laboratory; Nonallelic and allelic interactions in *Drosophila,* Linkage study, mutants in *Drosophila,* sex lethals in *Drosophila*.

Unit-II

Mutagenesis and isolation of new variants**:** X-ray and chemical mutagenesis, P-element and insertional mutagenesis *Drosophila* development: Embryonic development, Maternal effect genes and formation of body axes, Segmentation genes, Homeotic genes and their functions, Imaginal discs and their types, Pupa and metamorphosis; Induction and development of compound eye in *Drosophila*. Polytene chromosome: Maps, puffing and utility; Chromosomes of *Drosophila*, Balancer chromosomes,

Unit-III

Stem cells in *Drosophila,* Oogenesis in *Drosophila*, Ectopic expression, Generation of Transgenic *Drosophila*: (a) Germ-line transformation, (b) Application of P-element based vectors in transgenic generation; Advancement in *Drosophila* genetics: (a) Mitotic recombination, (b) Somatic clones, (c) Germ-line clones, (d) Conditional and /or targeted expression/ablation of genes/transcripts (e.g. UAS/GAL4 system), (e) RNAi based screening of gene functions in *Drosophila.*

Unit-IV

Drosophila model for human genetic disorders like Parkinson's, Huntington's, Alzheimer's diseases etc.; Brief overview of *Drosophila* genome project: Online databases and other resources for *Drosophila* genetics.

Suggested Readings

1.Principles of Genetics by D. Peter Snustad and Michael J Simmons

2. Genetics: A Conceptual Approach by Benjamin A. Pierce

3. The Development of *Drosophila Melanogaster* Vol. 1 by Cold Spring Harbor Press

4. Matthew C. LaFave, Jeff Sekelsky. Mitotic Recombination: Why? When? How? Where? PLoS Genetics March 2009 | Volume 5 | Issue 3 | e1000411

5. David A. Elliott and Andrea H. Brand. The GAL4 System: *A Versatile System for the Expression of Genes* from Methods in Molecular Biology: Drosophila: Methods and Protocols

SEMESTER-III
(Discipline specific Elective Paper)
SOMATIC CELL GENETICS
Paper Code: 17GEN23DA3

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course outcome

CO-1 They will be familiar with animal cell culture technology, equipments and various requirements of animal cell culture, different types of cell culture and its application.

CO-2 Students will understand the basics of processes and their application to cell culture and generate the products.

CO-3 Knowledge of techniques like hybridoma technology, transformation, transgenesis, Stem cell therapy and cloning

Instruction for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

Structure and organization of animal cell; Equipments and materials for cell culture technology; Introduction to the balanced salt solution and simple growth medium, Role of carbon dioxide, Role of serum and supplements, Serum & protein free defined media and their application.

Unit- II

Primary culture, secondary culture, serum free culture and established cell line cultures; Measurement of viability and cytotoxicity; Biology and characterization of the cultured cells, measuring parameters of growth, Basic techniques of mammalian cell culture *in vitro*, disaggregation of tissue, maintenance of cell culture, cell separation, cell synchronization, Scaling-up of animal cell culture; Organ and histotypic cultures.

Unit-III

Biology and genetics of stem cells- definition & characteristics of stem cell; Sources and origin of stem cell, types of Stem cells, nature of pleuripotent cells, division; Hematopoitic stem cells, Neural stem cells, Adult & embryonic stem cell, Cancer stem cell; Cell based therapy, Therapeutic cloning, Bone marrow transplantation versus Stem cell transplantation and GVHD; Epidermis & its renewal by stem cell.

Unit-IV

Somatic cell fusion and somatic cell genetics; Tissue and organ culture - advantages and limitations; medical/pharmaceutical products of animal cell culture; Monoclonal antibodies, Cell culture based vaccines, Hybridoma technology etc., Genetic engineering of animal cells and their applications; Artificial life.

Suggested readings

1. Freshney I. Culture of Animal Cells: A Manual of Basic Technique, 5th Edition Publisher: Wiley-Liss, 2005 ISBN: 0471453293.
2. Nigel Jen, Animal Cell Biotechnology:Methods and protocols, Humana Press.
3. R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology. (2009), Elsevier Academic press.
4. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual. Wiley-Blackwell; 1 edition (January 4, 2011).
5. Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells (v. 1).Academic Press (September 28, 2004)

SEMESTER-III
(Discipline specific Elective Paper)
PLANT MOLECULAR GENETICS
Paper Code: 17GEN23DB1

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

CO-1 Students will be having knowledge about gene structure and function in plant system, mitochondrial and chloroplast genome and Arabidopsis genome and applications of GM plants.
CO-2 Students will be having knowledge about the mechanism of plant genetic transformation,
CO-3 Concern of bio safety, regulatory norms at national and international levels about genetically modified crops.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

Gene expression in plants:Gene structure ,expression and regulation in plants- an overview of nuclear & organelle gene structure, function and expression with emphasis on aspects that are unique to plants genes; Development of Arabidopsis as a model for molecular genetic studies in plant biology.

Unit-II

Use of *in vitro* culture technology: Micro-propagation for multiplicaion; Embryo rescue for production of hybrids; Production of haploid through anther or pollen culture; Culture and manipulation of protoplast-Somatic Hybrids, Organelle transfer and cybrids; *In vitro* screening and selection of desirable cell lines; Creation of soma-clonal variation and selection of desirable genotypes in genetic improvement; *In vitro* mutagenesis; Callus and cell culture for production secondary metabolites; Production of synthetic seed; Germplasm conservation.

Unit-III

Genetic Transformation: Plant transformation vectors- T-DNA, viral vectors, transposon elements; Genetic transformation methods: Agro-bacterium system; Direct DNA transfer by ballistic gun method, electro-proration, microinjection; Alternate in-plant methods, floral dip, silicon carbide, pollen tube pathway etc.; Marker-free and novel selection strategies; Gene silencing; RNA interference (RNAi) system; Gene knockdown.

Unit-IV

Application of technology and bio-safety; Targeted transfer of genes conferring resistance to biotic and abiotic stresses, nutritional quality, and other desirable traits, like male sterility, flowering, fruiting, ripening etc. (case study); Concerns about bio-safety of genetically modified organism (GMO) (Allergen, toxicity, impact on biodiversity etc.); Indian regulatory system for testing of GMOs in laboratory, field trials and commercial release of transgenic; Bio-confinement strategies for cultivated crops; bio-safety and ethics in generating GMOs;
potential benefits of GMOs.

Suggested readings:

1. Plant Tissue Culture- Theory and Practice (1996) Bhojwani S. S. & Razdan M. K., Elsevier
2. Plant Biotechnology-The Genetic Manipulation of Plants (2003) Slater A. Scott N. & Fowler M., Oxford University Press Inc.
3. Plants, Genes and Crop Biotechnology (2003) - Chrispeels M. J. & Sadava D. E., Jones and Barlett Publishers
4 Principles of Gene Manipulation and Genomics (2001) -Primrose S. B. &Twyman R M, Blackwell Publishing.
5. Plant Cell, Tissue and Organ Culture- Fundamental Methods (1995) (Eds). Gamborg O. L & Phillips G. C. Springer-Verlag.
6. Plant Biotechnology (2006) - B. D. Singh, Kalyani Publishers.
7. Plant Cell Culture- A practical approach - (1985) Dixon RA (ed.) IRL Press, Oxford, Washington, DC

SEMESTER-III
(Discipline specific Elective Paper)
MICROBIAL TECHNOLOGY
Paper Code: 17GEN23DB2

Time: 3 Hours **Credits: 4**
Max. Marks: 80

. **Course Outcome**

CO-1 Students would be able to understand the importance of microbial products for various industrial application.

CO-2 Students will learn purification techniques such as different chromatography, HPLC, SDS-PAGE etc.

CO-3 Students would be able to correlate the genetic basis of production of proteins and other biomolecules.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit -I

Microbial innovations in pharmaceutical, health, agricultural and industrial sectors; Strategies for selection and improvement of industrial strains of microorganisms; Metagenomics of the isolation of genes for novel compounds; Measurement and control of bioprocess parameters; Genetic and Environmental Control of metabolic pathways.

Unit- II

Process Development: optimization of bio-process development, classical and statistical methods of optimization, different matrices, whole cell and enzyme immobilization, scale up of bioprocess, general concepts of fermenter. batch, fed and continuous fermentation.

Unit -III

Downstream process, purification and characterization of industrially important microbial products; Primary and secondary metabolites; Industrial production of antibiotics, biofuel, steroids and single cell proteins; Peptide antibiotics of bacteria and its role to combat antimicrobial resistance.

Unit- IV

Microbial overproduction of recombinant molecules: Selection of suitable promoter sequences, ribosome binding sites, fusion protein tags, purification tags, protease cleavage sites and enzymes, inducible expression system, limitations of metabolic engineering. Metabolic engineering of antibiotics. Maintenance and containment of recombinant molecules.

Suggested readings:

1. Biotechnological Innovations in Chemical Synthesis: BIOTOL, Butterworth - Heinemann.
2. Industrial Microbiology, G. Reed (editor), CBS Publishers (A VI Publishing Company).
3. Genetics and Biotechnology of Industrial Microorganisms. C.L. I-le'-shnergev, S.W. Queener and Q Hege^n. American Society of Microbiology.
4. Protein Expression A Practical Approach: Edited by S.J. Higgins and B.D. Hames (OUP).

SEMESTER-III
(Discipline specific Elective Paper)
RNAi AND ITS APPLICATIONS
Paper Code: 17GEN23DB3

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course outcome

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

CO-1 Learn about RNA interference and its importance in molecular biology
CO-2 Identify and predict tools and biogenesis of miRNA and siRNA
CO-3 To know the current and potential applications of RNAi in healthcare as well as the improvement of crop yield and quality.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit-I

Discovery of RNA interference, Categories of small non-coding RNAs: dsRNAs, siRNAs, shRNAs, piRNAs and miRNAs, Different components of gene silencing (Dicer,Guide RNA and RNA- induced silencing complex, Translation initiation factor, RNA dependent RNA polymerase,Transmembrane protein), Mechanism of RNA interference (Processing of dsRNA in to siRNAs, amplication of siRNAs, degradation of mRNA). Bacterial vectors for RNAi delivery.

Unit-II

Micro-RNA: Identification and biogenesis, Apoptosis-related micro-RNA, kinship of si RNA and Micro-RNA related pathways, functional classifications ,Large-scale genetic analysis using RNAi: Genome-wide RNAi screens in *C. elegans*, and other systems. , siRNA vectors, siRNA delivery *in vitro* and *in vivo*; RNAi in mammalian cells: Searching for right siRNA, getting siRNA into cells and verification for specificity.

Unit-III

RNAi to gene function: (Signal transduction, cell cycle regulation, development, cell motility, cell death, viral invasion/replication) ,RNAi interactomics and therapeutics informatics – RNAi libraries, discovering RNAi genes and role of bioinformatics, interactomics of RNAi, database and prediction tools of miRNA, siRNA.

Unit-IV

Expression of dsRNA in animals and plants and its applications: RNAi microarrays (Loss of function genetics in mammalian cells);Recent developments and applications in agriculture, Applications of , RNAi therapy: RNAi and therapeutics,(cancer, infectious diseases, cardiovascular and cerebrovascular diseases, neurogenerative disorder, Future of RNAi in biology and medicine.

Suggested readings:

1. The RNA World – (2006) 3rd Eds. T Gesteland et al., CSHL Press
2. RNA Interference Technology- From Basic Science to Drug Development. Eds. Fire et. al. Cambridge University Press,
3. RNAi: A Guide to Gene Silencing (2003).-Ed. Gregory J. Hannon, CSHL Press
4 RNA Silencing: Methods and Protocols (2005) --Ed. Gordon G. Carmichael, CSHL Press
5. RNA Interference in Practice (2005) - Ed. Ute Schepers, Wiley-VCH GmbH & Co. KGaA.
6. Genes IX (2009) -Lewin B, Jones and Barlett Publisher.

SEMESTER III

Paper Code: 17GEN23CL **LAB COURSE-V** **Credits: 4**

(BASED ON CORE PAPERS(3CI) &(3C2

Time: 8 Hours **Max. Marks: 100**

Lab Course Outcome

CO-I Student will be able to isolate plant genomic DNA & plasmid DNA by various techniques.
CO-2 Enable to perform PCR
CO-3 Learn to solve numericals based on conjugation, R.E & Transformation
CO-4 Students will get familiarity with basic statistics i.e mean, mode ,mean deviation, Standard deviation & coefficient of variation.
CO-5 Numericals on Heritability & Genetic variation.

SEMESTER III

Paper Code: 17GEN23DL **LAB COURSE-VI (FOR RESPECTIVE TWO DISCIPLINE SPECIFIC ELECTIVE PAPERS)** **Credits: 4**

Time: 3 Hours **Max. Marks: 100**

Lab Course Outcome

Human molecular genetics

CO-1 Conversant of various methods of diagnosis and detection of diseases i.e PCR, RFLP etc.
CO-2 Understand the role of copy number repeat and SNP in genetic susceptibility study.
CO-3 Knowledge of all related techniques of DNA RNA quantification ,checking purity, melting temp.& sequencing of DNA.

Drosophila Genetics

CO-1Prepare Drosophila handling kits, culture Drosophila flies in the lab.
CO-2 Differentiate b/w anterior & posterior side from other life stages i.e egg, larva and pupa.
CO-3 Dissect out the salivary gland and imaginal disc from drosophila larva.
CO-4 Make polytene slides from salivary gland of insect larva.

Somatic Cell Genetics

. CO-1 Knowledge of Equipments and materials for animal cell culture technology; Introduction to the balanced salt solution and simple growth medium, supplements, Serum & protein free defined media and their application.
CO-2 Students will learn basic techniques of animal tissue culturing.
CO-3 Measurement of viability and cytotoxicity;

Plant Molecular Genetics

CO-1 Media prepration for tissue culture
CO-2 Conversant of various steps of plant tissue culture
CO-3 Knowledge of all related techniques of plant DNA extraction & purification

Microbial Technology

CO-1 Students would be able to learn purification techniques of microbial cell culture technology;
CO-2 Students will learn characterization of microbial products with industrial and therapeutic applications .
CO-3 Assessment of industrially important microbial molecules.

RNAi technology

CO-1 Helpful in identification and prediction tools of miRNA and siRNA
CO-2 Students will be able to explain the expression of ds RNA in animals and plants.
CO-3 Knowledge of all related techniques & applications of miRNA and siRNA in different fields.

SEMESTER III

INTERDISCIPLINARY/OPEN ELECTIVE COURSE

(FROM COMMON POOL)

The students are required to take one paper (Interdisciplinary/Open Elective) of their choice from any other Subject/Department of M.D. University campus Rohtak/ from pool of papers provided by the university

Paper Code: to be written as per student option/ choosen I.D paper
Time: 3 Hours

Credits:3
Max. Marks: 80

SEMESTER-IV
(Core Paper)
SOCIAL, ETHICAL ISSUES IN GENETICS
Paper Code: 17GEN24C1

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course Outcome

Students will be having knowledge about

CO-1 Intellectual properties, cases regarding IP, Ethical and Religious considerations in stem cell research,

CO-2 International ethical guidelines for biomedical research involving human subjects (CIOMS-WHO).

CO-3 Reprogenetics, Consumer genetics, Personal genomics, Public health genetics, Community genetics & Various acts.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit- I

Concept of IPR, Protection of intellectual property, World organizations, forms of protection- Copyright, Trademark; Geographical indications, trade secrets, Layout design of integrated circuits; Human genome and IPR, Issues on IPR in Public-Private partnership. Intellectual property rights and biotechnology

Unit- II

Patent: Criteria and procedure of patenting, patenting biological material; Patent procedure in India; Patenting basmati rice in USA, revocation of turmeric and Neem patent; Patenting of biological material with example and case studies. Patentability of life forms with special reference to microorganisms, pharmaceutical industries, biodiversity, naturally occurring substances; Availabilities of Patent facilitating funds, Substantive Patent Law Treaty (SPLT) and World patent, European Patent

Unit -III

Ethical decision making, ethical dilemmas, professional ethics- professional conduct; Somatic and germ line gene therapy, clinical trials, the right to information; International ethical guidelines for biomedical research involving human subjects (CI0MS-WHO) ethics committee function; Social and ethical issues in human stem cell research. Religious considerations in stem cell therapy/research; Genetic discrimination: insurance and employment.

Unit -IV

Planning, Organizing, Leading & Controlling; Concepts and characteristics of information; Importance of Management Information System (MIS); Overview of Reprogenetics, Consumer genetics, Personal genomics, Public health genetics, Community genetics, Regenerative medicine; Drugs & Cosmetics Act, The Patents Act, The Medical Termination of Pregnancy Act, The Preconception & Prenatal Diagnostic Techniques Act, The Transplantation of Human Organs Act, Human Cloning.

Suggested Readings:

1. Biological Diversity Act, 2002 and Biological Diversity Rules, National Biodiversity Authority, Chennai, 2004, pages 57.
2. Gautam PL and Singh AK 1998 Agrobiodiversity and Intellectual Property Rights (IPR) related issues. *Indian J. Pl. Genet. Resources* 11:129-153.
3. Khetarpal PL 2004. A critical appraisal of seed health certification and transboundary movements of seeds under WTO regime. *Indian Phytopathology* 57:408-427.
4. Plant Biotechnology, Dr. Chawla, for IPR.
5. Department of Biotechnology, Ministry of Science & Technology, Government of India, Ethical policies on Human Genome, Genetic Research and Services (www.dbtindia.nic).

SEMESTER-IV
(Core Paper)
LAB DESIGN AND BIOSAFETY
Paper Code: 17GEN24C2

Time: 3 Hours **Credits: 4**
Max. Marks: 80

Course outcome

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

CO-1 Understand laboratories of BSL-2 and BSL-3,4 facilities.
CO-2 Conversant wih Lab Equipments and Precautions.
CO-3 Outline a Medical surveillance program.
CO-4 Understand risk assessment and biological risk management for field research.

Instructions for paper setter

There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Unit 1

Introduction, trends, risk classification of laboratory, design & safety guidelines for biosafety level I, II, III and IV laboratories, Laboratory animal facility. Laboratory space planning; Engineering Considerations: Electrical (Emergency power, power requirements, lighting), Mechanical (Heating, Ventilating, and Air Conditioning); Plumbing, Energy Conservation in lab.; Concerns Specific To Research Facilities: Finishes, Doors and hardware, Furniture, Glassware washers and Dryers, Reagent Grade Water Systems; Preparation rooms and storage, The greenhouse and animal house; Security, Life management: Eye wash and related facilities, Fire prevention and control measures.

Unit 2

Handling & Storing of hazardous chemicals, Chemical incompatibility, Chemical Storage Locations , Material safety data sheet and its significance; Disposal of chemical waste: Restrictions, Waste containers, Labels, Storage of waste chemicals, Scheduling of waste collection, Segregation of incompatible chemical wastes; Disposal of biological waste: Sharps, culture stocks and labware, animal body parts, animal solid waste, animal liquid waste etc; Radioactive waste management.

Unit 3

A Historical perspective of bio-safety; Definition, requirement, biosafety containment facilities, biohazards colour coding; Biosafety Requirements: Registration for the Use of Biological Materials, Human pathogens, Human Blood, Body Fluids, Tissue and Other Potentially Infectious Materials.

Lab Equipments and Precautions for using: HEPA filters, Biological Safety Cabinets (BSCs), Use & care of pipettes, pipetteguards, syringes and needles, Centrifuges, Oven, Incubators, Sonicators, and Cell Disruption Equipment, Microtome/cryostat, Microincinerators, Miscellaneous Equipment (Waterbaths, Cold Storage, Shakers); Lab animals; Decontamination and Disposal Procedures; Transportation of Infectious Substances.

Unit 4

Risk Assessment and Risk Management; Routes of Exposures, Exposure incidents and their types; Emergency Procedures for Exposure Incidents, Emergency procedure for fire & chemical exposure, safety check list.

Medical Surveillance Program and their significance: Tuberculosis (TB) Screening and Immunizations; Medical Restrictions: Pregnancy, Reproductive Biological Hazards, Other Restrictions; Objectives of Housekeeping in laboratory; Bio-safety levels for different infectious agents and infected food/animals, routes of transmission & protection measures; Laboratory Practices for different biosafety levels, Biosafety training programs.

Suggested Readings:

1. **Biosafety in Microbiological and Biomedical Laboratories** 5th edition by U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institutes of Health
2. **Biological Safety Manual** by Yale University
3. **RESEARCH LABORATORY Design Guide** by Department of Veterans Affairs, United States of America
4. **Laboratory Safety Manual** – the University of North Carolina at Chapel Hill
5. **WHO (2003)- Laboratory biosafety manual** WHO, Geneva.

SEMESTER-IV

(Core Paper)

Paper Code:17GEN24C3 **Dissertation*/Project */Field work*** **Credits: 20**

Time: 6 Hours **Max. Marks: 300**

Course outcome

CO-1 Students will be having sufficient experience and proficiency in the research methodology.
CO-2 Enabled to carry out independent research as per individual's interest.
CO-3 Initial training to write & execute a research plan.

***M. Sc . Dissertation rules**

Distribution/Allotment of Students to be done at department level in the 3rd semester
The dissertation to be innovative work based on small piece of research with duration in 4th semester.
Scheme of chapters of dissertation is as follows-
Acknowledgement
Certificate by candidate& countersigned by allotted Supervisor

i) Introduction with objectives
ii) Review of literature(Brief)
iii) Material & Methods
iv) Results
v) Discussion
vi) Summary
vii) Bibliography

Pattern of References/typing/figures as per Ph. D Thesis. Last date of submission will be 30th June. Evaluation of dissertation will be done by external examiner from panel approved by PGBOS and internal examiner. Final marks will be mean of internal + external.
The written part of dissertation report shall account for 250 of marks and the viva-voce will be conducted by a duly constituted Board of Examiners for the remaining 50 of marks.

No. of copies of Dissertations will be for Deptt. Record, one copy of guide record, one copy for candidate and soft copy to library. Any patent/IPR based on Dissertation will be in the name of MDU student & Guide as inventer.Publication based on dissertation will be under control of Guide.