DEPARTMENT OF GENETICS
(Choice Based Credit System)
Examination Scheme of M.Sc. Genetics (Semester system) w.e.f. the academic Session 2013-14

FIRST SEMESTER							
Paper No.	**Nomenclature of Paper**	**L**	**P**	**Credits**	**Max. Marks**	**Internal assessment**	**Total**
GENET-101	Concepts of Genetics	4	-	4	80	20	100
GENET-102	Chromosomes ,Genes and Genomics	4	-	4	80	20	100
GENET-103	Cell and Molecular Biology	4	-	4	80	20	100
GENET-104	Methods in Genetics	4	-	4	80	20	100
GENET-105(OE)	Biostatistics and Computers	4	-	4	80	20	100
GENET-106	Lab course-I	0	-	8	100	-	100
Total Credits for Semester-I				**28**			**600**

Open Elective (OE) - Biostatistics and Computers

There will be one common and compulsory paper for the students listed as Open Elective (OE).

SECOND SEMESTER							
Paper No.	**Nomenclature of Paper**	**L**	**P**	**Credits**	**Max. Marks**	**Internal assessment**	**Total**
GENET-201	Genetics of Bacteria and Viruses	4	-	4	80	20	100
GENET-202	Human Genetics	4	-	4	80	20	100
GENET-203	Biostatistics and Population Genetics	4	-	4	80	20	100
GENET-204	Recombinant DNA Technology	4	-	4	80	20	100
GENET-205PE (i) Or GENET-205PE(ii)	Medical Genomics or Plant Genetic Engineering	4	-	4	80	20	100
GENET-206	Lab course-II	0	-	10	100	-	100
Total Credits for Semester-II				**30**			**600**

THIRD SEMESTER							
Paper No.	**Nomenclature of Paper**	**L**	**P**	**Credits**	**Max. Marks**	**Internal assessment**	**Total**
GENET-301	Developmental Genetics	4	-	4	80	20	100
GENET-302	Conservation Biology	4	-	4	80	20	100
GENET-303	Gene Expression and Regulation	4	-	4	80	20	100
GENET-304	Immunogenetics	4	-	4	80	20	100
GENET-305 PE(iii) or GENET-305 PE(iv)	Medicinal and Aromatic Plants in Human Care or Advanced Human Molecular Genetics	4	-	4	80	20	100
GENET-306	Student Seminar	-	-	4	100	-	100
GENET-307	Lab course-III	-	-	10	100	-	100
Total Credits for Semester-III				**34**			**700**

Student Seminar:

Student would deliver a seminar on any general topic of Genetics. Evaluation of the seminar would be done by the concerned faculty members.

FOURTH SEMESTER							
Paper No.	**Nomenclature of Paper**	**L**	**P**	**Credits**	**Max. Marks**	**Internal assessment**	**Total**
GENET-401	Intellectual Property Right and Biosafety	4	-	4	80	20	100
GENET-402	Bioinformatics	4	-	4	80	20	100
GENET-403 PE (v) or GENET-403 PE (vi)	RNAi Biology and its Applications or Drosophila Genetics	4	-	4	80	20	100
GENET-404	Self Study Paper	-	-	-	-	-	-
GENET-405	Dissertation/Project Work	-	-	20	300	-	300
Total Credits for Semester-IV				**32**			**600**

Grand total of the credits for the all Semesters I (28) + II (30) +III (34) +IV (32) = 124;
Total Marks = (2500)

NOTE: Semester-IV

1. Self Study paper:

Student would also take a discipline centric elective paper to acquire knowledge as a supplement to the project work. Student would study this paper on his/her own with an advisory support by the concerned teacher.

2. M.Sc. Dissertation rules (From the session 2013-14)

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 3rd and 4th semesters. Scheme of chapters of dissertation is as follows-

Acknowledgement

Certificate by 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. Dissertations report will be evaluated on the basis of below given criteria.

Dissertation report will be evaluated on the basis of below given criteria:

Performance evaluation Parameter

Writing Quality

Novelty/Scientific significance of aim

Project design

Publication potential

Aim-results Concurrence

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.

SYLLABUS

M. Sc. Previous Genetics, Semester – I

GENET 101 CONCEPTS OF GENETICS

M. Marks: 80

Time-3 hours

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

Model systems in Genetic Analysis: Bacteriophage, *Escherichia coli*, *Neurospora crassa*, yeast, *Arabidopsis*, maize, *Drosophila*, *Caenorhabditis elegans,* zebra fish, homosapiens-General outline of life cycle, importance in genetic analysis. Laws of inheritance: Mendelôs Laws, concept of dominance, segregation, independent assortment; chromosome theory of inheritance.

Unit -II

Allelic and non-allelic interactions: Concept of alleles, types of dominance, lethal alleles, multiple alleles, test of allelism, Gene interaction: complementation, epistasis, pleiotropy.

Unit III

Linkage: Concepts, recombination, gene mapping in prokaryotes and eukaryotes, fine structure mapping. Sex-linked inheritance: Conceptual basis, sex influenced traits, mechanism of sex determination. Quantitative inheritance: Concept, genes and environment: heritability, penetrance and expressivity.

Unit IV

Cytoplasmic inheritance: Basis and mechanism, role of organellar genes. Mutation: Classification, mechanism, repair, role in genetic analysis and evolution. Changes in Chromosome number and structure: Polyploidy, aneuploidy, chromosomal rearrangements: deletion, duplication, inversion, and translocation. Meiotic consequences in structural heterozygote, role in speciation and evolution.

Suggested readings:

1. Concepts of Genetics (1999) - Klug W. S. and Cummings, M. R Prentice-Hall
2. Genetics (2008) -A Conceptual Approach, Pierce B. A., Freeman
3. Genetics- Analysis of Genes and Genomes (1998) - Hartl D. L. and Jones E. W, Jones & Bartlett
4. An Introduction to Genetic Analysis (2004) - Griffith A. F. et al, Freeman
5. Principles of Genetics (1997) -Snustad D. P. and Simmons M. J, John Wiley & Sons.
6. Genetics (2005) - Strickberger M. W., Prentice-Hall

M. Sc. Previous Genetics, Semester – I

GENET 102 CHROMOSOMES, GENES AND GENOMICS

M. Marks: 80

Time-3 hours

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

Chromatin structure: Histones, DNA, nucleosome morphology and higher level organization; functional states of chromatin and alterations in chromatin organization. Chromosome organization: metaphase chromosomes- centromere, kinetochore and telomere and its maintenance; holocentric chromosomes- heterochromatin and euchromatin, position effect; chromosomal domains (matrix, loop domains) and their functional significance.

Unit-II

Giant chromosomes: Polytene and lampbrush chromosomes. Cytogenetic aspects of cell division: Chromosome labeling and cell cycle analysis, overview of mitosis and meiosis, sister chromatid cohesion remodeling, regulation of exit from metaphase, chromosome movement at anaphase. Genetic control of meiosis with examples from yeast. Chromosomal anomalies: Numerical and structural alterations induced chromosomal aberrations in somatic cells.

Unit-III

Techniques in the study of chromosomes and their applications: Short term (lymphocyte) and long term (fibroblast) cultures, Chromosome preparations, karyotyping, banding, chromosome labeling, *in situ* hybridization, chromosome painting, comparative genome hybridization (CGH), somatic cell hybrids and gene mapping, premature chromosome condensation. Genome organization in viruses, prokaryotes and eukaryotes: Organization of nuclear and organellar genomes; C-value paradox, repetitive DNA-satellite and interspersed repeated DNAs, transposable elements, long interspersed elements (LINEs) and short interspersed

elements (SINEs), Alu (common SINEs in primates) family and their application in genome mapping.

Unit -IV

Concept of gene: Conventional and modern views. Fine structure of gene, gene families- split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families. Genome mapping: Physical maps- an overview and approaches.

Suggested readings:

1. Essential Cell Biology (2009) 3rd. ed. - Alberts B. *et al.,* Garland
2. Molecular Biology of the Cell (1994) - Alberts B *et al.,* Garland
3. The Eukaryotic Chromosome -TB stock C. J. & Summer A. T.T, Elsevier

4 The Chromosome (1993) - Hamsew and Flavell, Bios

5. Advanced Genetic Analysis (2003) - Hawley & Walker, Blackwell
6. Structure & Function of Eukaryotic Chromosomes (1987) - Hennig , Springer
7. Genes IX (2009) - Lewin B., Pearson
8. Molecular Cell Biology (2000) 4th ed. - Lodish, H. *et al.,* Freeman
9. Cell and Molecular Biology (1995) - De Robertis & De Robertis Lippincott & Wilkins

   Genome.Brown T. A. ,Garland

M. Sc. Previous Genetics, Semester – I

GENET 103 CELL AND MOLECULAR BIOLOGY

M. Marks: 80

Time-3 hours

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

Origin of life: Origin of biomolecules, primitive life forms, RNA world, biological evolution, Tree of life: rRNA as a chronological marker, Woese concept of molecular taxonomy.

Unit-II

Cellular organization: An overview, endosymbiotic origin of mitochondria and chloroplast. Biomolecular: Chemical bonds, building blocks- carbohydrates, lipids, fats, proteins, nucleic acids.

Unit-III

Informational molecules: DNA as genetic material, DNA structure and replication, RNA as genetic material, types of RNA, role of RNA in information transfer, concept of central dogma, genetic code, codon usage. Protein structure: primary, secondary and tertiary, processing, and transport; versatility of the proteins in biological processes.

Unit-IV

Enzymes: As biocatalysts, specificity and kinetics, assay and inhibition of enzyme activity, mechanism of action, regulation of enzyme activity, allosteric enzymes. Cellular energetics: Energy rich compounds, ATP synthesis, thermodynamics of cellular reactions, metabolic networks-an overview. Cell cycle and its regulation. Cell signaling.

Suggested readings:

1. Principles of Biochemistry (2005) - Lehninger *et al*., Freeman

2. Biochemistry (2002) - Devlin, T.M., Wiley-Liss

3. Biochemical Calculation (1976) 2nd ed. - Sehgal I. H., Wiley

4 Fundamentals of Enzymology (2002) - T Price N. C. and Lewis S.T, Oxford University Press

5. Biochemistry (2002) - T Berg, J. M. Tymoczko, J. L and Strider L.T W. H., Freeman

6. Molecular Biology of the Gene (2004) - Watson, J. *et al.,* Benjamin Cummings

7. Molecular Cell Biology (2000) 4th ed. - Lodish, H. *et al.,* W. H., Freeman

8. The World of the Cell (2010)-, Becker, W.M. *et al.,* Benjamin Cummings

M. Sc. Previous Genetics, Semester – I

GENET 104 METHODS IN GENETICS

M. Marks: 80

Time-3 hours

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

Principles and techniques of nucleic acid hybridization and cot curves; sequencing of nucleic acids; Southern, Northern and South -Western blotting techniques; polymerase chain reaction, Methods for measuring nucleic acid and protein interaction.

Unit - II

Biophysical methods**:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

Unit - III

Principle & application of gel filtration, ion exchange & affinity chromatography; thin layer chromatography ; gas chromatography; high pressure liquid chromatography (HPLC), electrophoresis (starch, agarose, PAGE), electrofocussing, ultracentrifugation (velocity and buoyant density).

Unit – IV

Radio labeling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines, computational methods- nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation.

Suggested readings:

1. Molecular cloning A Laboratory Manual 3rd edition Vol. 1, 2, 3- Sambrook and Russell, Churchill press, 2007
2. Principles and Techniques of Biochemistry and Molecular Biology (2010)- Edited by Keith Wilson and John Walker, Sixth Edition, Cambridge University Press.

M. Sc. Previous Genetics, Semester – I

GENET 105 (OE) BIOSTATISTICS & COMPUTERS

M. Marks: 80

Time-3 hours

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 of computer: Characteristics, classification of computer; block diagram of computer and overview of working, number system- non-positional vs. positional number, binary, octal, decimal, hexa-decimal conversion of number system.

Unit-II

Hardware and software: Input, output, and secondary storage devices, central processing unit; types of software; meaning, functions and types of operating system; computer languages, understanding computer networks: Types; topologies for local area network system (LANS), transmission media; analog and digital signals; network security.

Unit-III

Working with software packages: An introduction to PC-software packages; word processor-working with text, tables, checking spelling and grammar, printing a document; spreadsheet software- working with worksheet, formulas and functions, inserting charts; power point presentation- working with different views and designing presentation; window XP- working with files and folders, windows explorer.

Unit-IV

Methods of data collection, sampling and sampling methods, measurement of central tendency, mean, median, mode, standard deviation, standard error, variance. Correlation & regression analysis, analysis of variance (ANOVA), tests of significance, t-test, z-test.

Suggested readings:

- Elements of Biostatistics in Health Science (2005) 8th ed. - W. Daniell.
- Statistical Methods for Research- S. Singh et al (1988), Central Publishing Ludhiana.
- Fundamental of Statistics ï D. N. Enhance.
- Statistical Methods (1996) - S.P. Gupta. S. ,Chand Publication
- Fundamentals of Biostatistics- Khan and Khanna, Ukaz Publication

M. Sc. Previous Genetics, Semester – I

GENET 106 LAB COURSE 1

M. Marks: 100

Time-6 hours

GENET 106 Lab Course- I: PRACTICALS BASED ON THEORY PAPERS

1. Extraction of total nucleic acid (DNA, RNA) from plant tissues.
2. Determination of RNA concentration by orcinol method.
3. Quantitative determination of DNA and RNA by Spectrophotometric method.
4. Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis (SDS-PAGE) for protein profiling.
5. Protein quantification by Bradford method.
6. Separation of membrane and demonstration of permeability.
7. Isolation and demonstration of mitochondria activity.
8. Separation of pigments from leaves or flowers by adsorption chromatography.
9. Separation and identification of amino acids by thin layer chromatography.
10. Determination of molecular weight of a given protein by gel filtration chromatography.
11. Working knowledge of Microsoft Window programs.
12. Demonstration of on-line data-base search.
13. Similarity searching using BLAST/FASTA.
14. Demonstration for access to full text journals.
15. Operation of protein sequence database, data mining methods, motif analysis.
16. Preparation of slides for the study of mitosis in lymphocytes, recording structural changes in chromosomes during division cycle.
17. Isolation of mitochondria from plant tissue and determination of its enzymatic activity.
18. Study the mitotic complement of chromosomes in *Allium cepa*.
19. Karyotyping of mitotic metaphase chromosomes complements for cytological characterization of chromosomes in the genome.
20. Preparation of slides to study of meiosis in plant pollen mother cells recording structural changes in chromosomes during reduction division cycle.
21. Study chromosome associationsôconsequent to structural changes (*Tradescantia).*
22. Study meiotic chromosomes configurations in polyploid plants.
23. Study meiotic chromosomes configurations in hybrids.
24. Development of physical linkage maps.
25. To collect the *Drosophila* flies from its natural habitat.
26. To prepare the food for culture maintenance and to study the life history of *Drosophila melanogaster.*
27. Identification of male and female *Drosophila* flies.
28. Analysis of genetic variability in populations of insects, human etc.
29. Numericals on basic Genetics.
30. To prepare permanent slides of polytene chromosomes from salivary glands of *Drosophila*.
31. To demonstrate the results of genetic crosses for gene mapping.

32. To dissect the testes in males and ovaries in females of *Drosophila melanogaster.* Count the number of ovarioles in each lobe of ovary in case of females.
33. Numericals on Hardyï Weinberg Law.
34. To identify the different species and mutants of *Drosophila* by using standard keys.
35. To determine the density dependent selection in *Drosophila.*
36. To find the quantitative differences among three morphs of *Drosophila* for lipid contents (body lipids as well as surface lipids).
37. To demonstrate the results of genetic crosses for the linkage and crossing over.
38. Numericals on gene mapping.
39. To find the differential rate of water loss in *D. melanogaster*.
40. To demonstrate the results of genetic crosses for the process of independent assortment.
41. To estimate the energy metabolites in Drosophila:
    (a) Glycogen (b) Trehalose and (c) Lipids etc.
42. To study the metabolic rate variations in larvae of darker and lighter morphs of *Drosophila* from lowland and highland populations.
43. To demonstrate the results of genetic crosses for sex linkage.

M. Sc. Previous Genetics, Semester – II

GENET 201 GENETICS OF BACTERIA AND VIRUSES

M. Marks: 80

Time-3 hours

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, high frequency recombination (Hfr), Fertility factor F' (also known as the F factor, sex factor), 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

Techniques for studying bacteriophages**:** Virulent phage (TB4B) and temperate phage (phage lambda). Important aspects of lytic cycle, phage-host relationships, immunity and repression, site specific recombination (lambda and P1).

Unit-IV

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*.

Suggested readings:

1. Microbial Genetics (1994) - Maloy S., Cronan J., Freifelder D, Jones and Bertlett
2. Fundamental Bacterial Genetics (2004) - Trun N and Trempy J, Blackwell Publ.
3. Modern Microbial Genetics (2002)-Streips U. N. and Yasbin R.E., Wiley-Liss
4 Molecular Genetics of Bacteria (2003) -Sneider L. and Champness W. ASM Publishers
5. Genetics of Bacteria -Scaife J., Academic Press
6. Genetics of Bacteria and Viruses (2006)- Birge E. A., Springer
7. Molecular Genetics of Bacteria -Dale J.W. and Park S, Wiley

M. Sc. Previous Genetics, Semester – II

GENET 202 HUMAN GENETICS

M. Marks: 80

Time-3 hours

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 Human Genetics: Early perception, development and documentation; Study tools in human genetics : Pedigree symbols, construction of pedigree, pedigree analysis in monogenetic traits, autosomal dominant and autosomal recessive inheritance, sex linked dominant and sex linked recessive inheritance; Consanguinity and its effects; Sex linked anomalies (haemophilia, color blindness), sex linked and sex influenced traits, sex determination in man, testis determining factor (TDF) and sex-determining region Y (SRY), testicular feminization syndrome; Single active X hypothesis, sex chromatin and drum sticks, genetic mosaics.

UNIT-II

Human karyotypes: Banding patterns, nomenclature of aberrant karyotypes; Human genome mapping methods, physical mapping, introduction to physical map markers, chromosomal, Giemsa stain (G) and quinacrine stain (Q) banding, radiation hybrid; Fluorescence *in situ* hybridization; Comparative genome hybridization; Long range restriction mapping; High resolution mapping- sequence tagged sites (STS) / expressed sequence tags (EST) / molecular screening (MS)/ single nucleotide polymorphism **(**SNP**)** /sequencing.

UNIT III

Human health and disease: Chromosomal disorders : Structural and numerical chromosomal anomalies; Mechanisms of mitotic non-disjunction /meiotic non-disjunction/ chromosomal rearrangements; Some examples (Klinefilter syndrome, Downôs syndrome, Turner syndrome,

Achondroplasia); Single gene hypothesis : Beadle and Tatum experiment, inborn errors of metabolism (Phenylketonuria (PKU), Alkaptonuria, Albinism, Galactosemia); Haemoglobinopathies, ABO blood group system, Rhesus (Rh) blood group, Thalassemia syndromes; Multifactorial disorders- Diabetes, Schizophrenia, Huntington disease.

UNIT IV

Ethical, legal and social issues in human genetics: Human genome project: history and concepts, gateways, goals, role of sequencing, distribution of GC content, CPG islands, main conclusions, current activities; Prenatal/adult (individual/family/population) screening of mutation/risk factor for genetic diseases; Confidentiality/privacy, discrimination; Ethical dilemma, human rights, surrogate mothers; Human cloning and eugenics.

Suggested readings:

1. Human Genetics: Problems and Approaches (1997) - T Vogel F. and. Motulsky A. GT, Springer Verlag
2. Human Molecular Genetics (2003) 3rd ed. - Strachan T & Read A, Garland Science
3. An Introduction to Human Molecular Genetics (1999) - Mechanism of Inherited Diseases Pasternak J Fitzgerald, Science Press

4 Chromosome Structural analysis (1999) - A Practical Approach (Ed.) W.A. Bickmore, Oxford University Press

5. The AGT Cytogenetics Lab Manual (1997) 3rd ed. -, Barch, Knutsen and Spurbeck, Lippincott Raven publ
6. Human Cytogenetics-Constitutional analysis (1995) (Ed) D.E. Rooney, Oxford University Press.
7. Recombinant DNA (1992) - J.D. Watson Gillman, Scientific American books, W.H, freeman company N.Y.
8. Human Genetics (1993) - The molecular revolution McConkey, Edwin H, Jones & Bartlett publishers.

M. Sc. Previous Genetics, Semester – II

GENET 203 BIOSTATISTICS AND POPULATION GENETICS

M. Marks: 80

Time-3 hours

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

Principles and applications of statistical methods in biological research: Basic statistics: samples and populations, experimental design, data analysis, graphs, average. Coefficient distributions- chi-square, binomial, poisson and normal, tests of statistical significance- t-test, z-test, F-test, U-test and others. Analysis of variance and regression and correlation.

Unit-II

General background: Variation at the genetic level: DNA markers - Variable number tandem repeat (VNTR), Short tandem repeat (STR), microsatellite, SNP and their detection techniques - RFLP, genotyping, Random amplification of polymorphic DNA (RAPD), Amplified fragment length polymorphism (AFLP) etc. Organization and measure of genetic variation-random mating population, Hardy-Weinberg principle, complications of dominance, special cases of random mating- multiple alleles, different frequencies between sexes (autosomal and X-linked).

Unit- III

Linkage and linkage disequilibrium: Sources responsible for changes in gene frequencies, mutation, selection, migration and isolation; random genetic drift; insights into human migration, natural selection and evolution.

Unit-IV

Population substructure: Hierarchical population, isolate breaking, inbreeding, assortative mating. Quantitative Genetics- Johansen pure-line theory, multiple factor hypothesis, types of quantitative traits, components of phenotypic variation and genetic models for quantitative traits, concept of heritability, artificial selection and realized heritability.

Suggested readings:

1. DNA markers Protocols, applications and overviews (1997)-Anolles G. C. & Gresshoff P. M.,Wiley-Liss
2. Molecular markers in Plant Genetics and Biotechnology (2003) - Vienne De. D., Science Publishers
3. Genetics of Population (2000)- Hedrick P.W., Jones & Bartlett
4. Principles of Population Genetics (1989)-Hartl D. L. and Clark A.G. , Sinauer Associates
5. Biostatistics (2006) -Danial, W. W, Wiley
6. Statistical methods in Biology (1995) - Bailey, N.T.J, Cambridge Univ. Press

M. Sc. Previous Genetics, Semester – II

GENET 204 RECOMBINANT DNA TECHNOLOGY

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five questions. Question No. 1 will be compulsory and shall contain eight to ten answer type questions without any internal choice and it shall cover the entire syllabus. The remaining four 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 of gene cloning- 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

Polymerase chain reaction **(**PCR**)**: PCR- principle, methodology, types - reverse transcriptase (RT-PCR), RAPD, AFLP, inter simple sequence repeat (ISSR), inverse PCR and Real time PCR and their applications. DNA sequencing methods - Maxam and Gilbertôs method, Sangerôs 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 characterisation, DNA finger printing, 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 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

GENET 205 (I) **(PROGRAMME ELECTIVE)**

MEDICAL GENOMICS

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five 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 four 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

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: Methods of therapy, drug, recombinant proteins, diet; Gene therapy (criteria & technical aspects), viral vectors, delivery methods and microinjection, germline therapy, some examples (Thalassemia, Phenylketonuria, Cystic fibrosis, DMD etc).

Unit –III

Pharmacogenetics: History, early evidence; clinical determinants; Molecular insights (genes involved in pharmacokinetics and pharmacodynamics of drugs); Applications in pre-prescription testing.

Unit-IV

Genetic counseling: Prenatal/adult diagnosis of genetic disorders; Medical ethics, risks and benefits, informed consent, right of choice, dilemmas faced by counselors, case studies.

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 ï (2002) Ed. Harper P. S., Oxford University Press
5. Chromosome Banding (1990) - Sumner A.T. Unwin, Hyman
6. Human Genetics: Problems and Approaches (1997) - Vogel F. and Motulsky A. G., Springer Verlag.

M. Sc. Previous Genetics, Semester – II

GENET 205 (II) (PROGRAMME ELECTIVE)

PLANT GENETIC ENGINEERING

M. Marks: 80

Time-3 hours

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 tissue culture and somatic cell genetics: Historical Perspective; artificial nutritive media; role of growth-hormones in differentiation of *in vitro* plants; plant regeneration pathways- plant regeneration, somatic embryogenesis and organogenesis; organ culture- shoot, root, embryo; isolation and maintenance of callus and suspension culture; hardening of tissue culture raised plants.

Unit-II

Use of *in vitro* culture technology: Micro-propagation for multiplication; 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

Use of recombinant DNA technology through genetic transformation: Plant transformation vectors- T-DNA, viral vectors, transposon elements; genetic transformation methods: agro-bacterium system; direct DNA transfer by ballistic gun method, electroporation, microinjection; alternate in-planta 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

M. Sc. Previous Genetics, Semester – II

GENET 206 LAB COURSE 1I

M. Marks: 100

Time-6 hours

GENET 206 Lab Course- II: PRACTICALS BASED ON PAPERS VII to XI

1. To perform the simple staining of bacteria to compare the morphological shapes and arrangements of bacterial shapes.
2. To demonstrate Gram-staining of bacteria.
3. Preparation of media for fungus and bacteria culture.
4. Isolation of pure culture of microorganisms by streak plate and pour plate methods.
5. Growth curve for *E. coli*.
6. Isolation of different strains of bacteria from soil.
7. Pedigree, symbols, analysis, inheritance pattern in monogenic traits. Demonstration of bar body, genetic variability in human populations (morphogenetic, behavioral, serogenetic and PTC testing), hematological studies in humans, numerical based on HW equilibrium, gene frequency and probability.
8. PCR amplification, Northern, Western blotting chromatography and electrophoresis.
9. Fixing of slides for mitotic, meiotic analysis, demonstration of crossing over/ chaismata, Karyotype analysis, chromosome aberration, chromosome banding, image analysis.
10. Use of markers in clinical diagnosis.
11. Demonstration of drum sticks.
12. DNA fingerprinting.
13. Paternity testing.
14. Genetic Counseling.
15. Induction of polyploidy using colchicines
16. Induction of mutation using various physical and chemical mutagens
17. Preparation of culture medium (Murashige and Skoog Medium).
18. Culture of explants on MS medium.
19. Raising haploids by anther or pollen culture techniques.
20. Isolation of protoplasts from various plant tissues and testing their viability.
21. Screening of cell lines against salinity.
22. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface cultures.
23. Estimating percentage and average pollen tube length *in vitro.*
24. Role of transcription and translation inhibitors on pollen germination and pollen tube growth.
25. Listing of genetic transformation methods for development of transgenics with examples.
26. Facts and doubts about the concerns on transgenics with examples.
27. Isolation of DNA from bacteria by alkaline method.
28. Isolation of RNA from yeast.
29. Isolation of rhizobia from root nodules.

30. Determination of mean generation time of rhizobia.
31. Performing Gram-staining reaction with rhizobia.
32. To determine the Tm of given sample of DNA.
33. To calculate mean, median, mode within a sample and between samples.
34. Analysis of genetic variability in different populations.
35. Multiple comparisons and different types of t-test, Type 1, Type 11 errors during multiple comparisons.
36. To estimate dispersal frequency and central tendency in mean population size.
37. Linear regression or multiple regression analysis in order to correlate various traits or factors in wild populations.
38. Analysis of variance or covariance for between population or sample differences in filed populations.
39. Parametric and non-parametric distribution of different samples.
40. Chi-square test for fitness analysis.

M. Sc. Final Genetics, Semester – III

GENET 301 DEVELOPMENTAL GENETICS

M. Marks: 80

Time-3 hours

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 .

Unit-II

Fertilization: types of cleavage, gastrulation; cell movement and formation of germ layers in frog. chick and mouse, morphogenesis and organogenesis in animals, formation of vulva in *C. elegans*, induction of development of compound eye in *Drosophila*, limb development and regeneration in vertebrates.

Unit – III

Drosophila: Maternal genes and formation of body axes, segmentation genes, and homeotic genes function, imaginal disc development, genetic determination of sex in *Caenorhabditis*, *Drosophila* and mammals. Regeneration and senescence.

Unit - IV

Embryonic stem cells and their applications: Clinical embryology; Brief account of hormonal control of reproduction, differentiation of germ. Cells and gametogenesis, fertilization and implantation, 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..

M. Sc. Final Genetics, Semester – III

GENET 302 BIODIVERSITY AND CONSERVATION BIOLOGY

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five 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 four 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

Biodiversity: Structure and function of ecosystems; major terrestrial biomes; biogeographical zones- global and Indian; ecosystem diversity- global and Indian; terrestrial and aquatic biodiversity; mega-centres of biodiversity; biodiversity hot spots- global and Indian; measurement of biodiversity- species diversity; concept of centre of origin and crop diversity; agro-biodiversity- definition, global and Indian.

Unit II

Value and erosion of biodiversity: Biodiversity use: direct- for food, fuel, health, indirect- aesthetic, ethical, environmental services; assessing the value of biodiversity; factors driving the biodiversity- environmental pollution, global climatic change; invasive species eroding species diversity; factors affecting genetic erosion (crop species); 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 and inventory; International Union for Conservation of Nature (IUCN) guidelines for estimating the levels of threat.

Unit III

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; international organisation supporting conservation; Indian organisation supporting conservation; international treaties/agreements for conservation; Indian laws for conservation.

Unit –IV

Issues and legislation related with biodiversity and access to biodiversity: International conventions and agreements on biodiversity- Convention on Biological Diversity (CBD), Food and Agriculture Organization of the United Nations (FAO) Commission, Intergovernmental Panel on Climate Change **(**IPCC); International agreements and national legislation regulating access to biodiversity- CBD, Trade-related aspects of intellectual property rights (TRIPS), National Biodiversity Authority (NBA); International agreements and national legislation regulating access to genetic resources- Global crop diversity trust (GCDT), International treaty on plant genetic resources for food and agriculture (ITPGRFA), Protection of plant variety and farmersô rights (PPV & FR); *In situ* conservation and intellectual property rights (IPR); IPR and Farmersô Rights; Agencies enforcing IPR in biodiversity, International union for the protection of new varieties of plants (UPOV), ITPGRFA, NBA, PPV & FRA

References:

1) Krishnamurthy K. V. (2007). An Advanced Textbook on Biodiversity: Principles and Practice. Oxford & IHB Publishing Co. Pvt. Ltd. New Delhi.
2) Christian Leveque and Jean-Claude Mounolou (2003). Biodiversity. John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England.
3) Jeffries Michael J. (2006). Biodiversity and conservation, 2nd ed. Taylor and Francis Group, New York.
4) Arora RK 1991. Plant Diversity in the Indian Gene Centre. In: R.S. Paroda and R.K. Arora (eds) Plant Genetic Resources, Conservation and Management. Concept and Approaches, pp. 25-44, IBPGR, Regional Office for South and Southeast Asia, New Delhi.
5) Biodiversity Hot Spots (2005) 1919 M STREET, NW, SUITE 600, WASHINGTON, DC 20036 (202)912-1000 FAX (202)912- 1030 UPDATED 2/05 www.conservation.org.
6) Harlen, J.R. 1971. Agricultural origin: centres and non-centres. Science 174: 468-474.

7) Gadgil M and Meher-Homji VM. 1990. ñEcological diversityò In: Conservation in Developing Countries: Problems and Prospects. (eds. J.C. Daniel and J.S. Serrao), Bombay Natural History Society. Oxford University Press, Delhi. Pp.175-198.
8) Koshoo TN 1995. ñCensus of Indiaôs Biodiversity: task ahead. Curr. Sci. 69:14-17.
9) Ministry of Environment and Forest (1998). Implementation of article 6 of the Convention on Biological Diversity in India, National Report (interim).
10) Wilson, E.O. 1988. ñThe Current State of Biological Diversityò. In Biodiversity, (ed. E.O. Wilson) Washington DC: National Academy Press, p15.
11) Verma DD, Arora S and Rai RK (eds) 2006. Megadiverse Countries: Perspectives on Biodiversity- Vision for Megadiverse Countries, Ministry of Environment and Forests Government of India.

M. Sc. Final Genetics, Semester – III

GENET 303 GENE EXPRESSION AND REGULATION

M. Marks: 80

Time-3 hours

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: Basic processes, gene as a unit of function, transcription (prokaryotic and eukaryotic) ï RNA polymerase, DNA sequences, transcription factors, process of initiation, elongation and termination.

Unit- II

Post transcriptional modifications ï capping, poly-adenylation, splicing (*cis*- and *trans*-), editing, translation ï genetic code, ribosome structure, the process of translation.

Unit-III

Gene regulation: Introduction, levels of regulation, evidences and experimental designs/methodologies, role of genetic analysis in understanding gene function and regulation. Lessons from bacteria- regulation at lac (including reading of Jacob and Monodôs seminal paper), trp and ara operons; control of lysis and lysogeny in ¸ phage ,Yeast- Gene regulation in a single celled eukaryote using a model case of GAL gene.

Unit-IV

Regulation in higher eukaryotes: Perceiving signals, transcriptional control- changes in chromatin structure, epigenetic controls; DNA sequence elements and transcription factors. Post-transcriptional regulation- alternative RNA splicing, RNA editing, RNA transport and localization, RNA stability, regulation of translation ï RNA structure, control at initiation, codon usage, post-translational modifications. RNA-mediated control of gene regulation.

Suggested readings:

1. Genes and Signals (2002) - Mark Ptashne and Alexander Gann, CSHL Press
2. A Genetic Switch (2004) - Mark Ptashne, CSHL Press
3. Gene Regulation (1995) -David S Latchman, Chapman & Hall
4 Genes VII (2003) - Benjamin Lewin, Prentice Hall
5. Molecular Cell Biology (2000) -,Lodish, H. et al. W. H. Freeman

M. Sc. Final Genetics, Semester – III

GENET 304 IMMUNOGENETICS

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five 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 four 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

Molecular Immunology: Basic principles and overview of immunity, general properties of immune system, innate and adaptive immunity, immunological memory; 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: Major histocompatibility complex (MHC), class I, II, III molecules; Genetic map of H-2 complex and human leukocyte antigen (HLA) complex; Humoral & cell mediated immune response (antigen recognition, processing and presentation), Hypersensitivity reactions (I, II, III & IV types), T cell receptor complex, Subtractive hybridization; Ig gene super family.

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, genetic control of antibody diversity (different hypothesis), somatic recombination events, antibody class switching, allelic exclusion, somatic mutation;

Unit-IV

Immunity in health and disease: Disorders of immune system, self tolerance & auto immunity; Thyroiditis, Insulin-dependent diabetes mellitus (IDDM), Systemic lupus erythematosus (SLE), Rheumatoid arthritis; Immuno suppression, Severe combined immuno deficiency (SCID), Acquired immune deficiency syndrome (AIDS); Transplant rejection, alloantigen; Vaccines; Primary antigen antibody reaction (radio immunoassay, enzyme linked immunosorbant assay); Secondary antigen antibody reaction (precipitation, agglutination & immuno electrophoresis).

Suggested readings:

1. Immunology (2000) - Kuby J. W. H., Freeman
2. Essentials of Immunology (2001) - Ivan M. Roitt, Wiley-Blackwell
3. Fundamentals of Immunology (2008) -William E. Paul Lippincott, Williams & Wilkins.
4. Immunology Understanding Immune system (1996) ï Elgert K D, John Wiley and sons.

M. Sc. Final Genetics, Semester – III

GENET 305(III) PROGRAMME ELECTIVE

MEDICINAL AND AROMATIC PLANTS IN HUMAN HEALTH CARE

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five 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 four 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 and philosophies of herbal medicine: Ayurveda, Unani, and other traditional systems, relationship between people and plants; relevance of herbals as alternative source of medicine and health care; importance and need of cultivation of medicinal and aromatic plants for sustainable use, good agricultural practices (GAP) for cultivation of medicinal plants, precision farming, organic farming of medicinal and aromatic herbs; post harvest handling of aromatic plants, harvesting, drying, grading and storage of medicinal plants.

Unit II

Case study of 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

Active content dynamics *vis-a-vis* plant growth and post harvest processing for evaluation of chemical constituents; Phyto-chemicals (the chemical components of plants); phytochemical analyses- different methods for analysis of primary and secondary metabolites; traditional, analytical and preparative separation of natural products, use of thin layer chromatography for

extraction and purification of phyto-pharmaceuticals through conventional and column chromatographic techniques; different methods of extraction of essential oil and metabolites-preparation of active constituent enriched extracts.

Unit IV

Principles for assessment of biological activity of medicinal plants/essential compounds; bioassays for activity; the use of plant products by humans and risk associated with their use; Principle of clinical test for assessment: Application and dosage etc. Plant biotechnology for the production of natural compounds.

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 ï 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

M. Sc. Final Genetics, Semester – III

GENET 305(IV) PROGRAMME ELECTIVE

ADVANCED HUMAN MOLECULAR GENETICS

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five 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 four 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, protein coding genes, pseudogene; 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 (YAC), making YACs, mammalian artificial chromosomes (MACs) and satellite DNA's artificial chromosomes (SAT ACS).

Unit-II

Molecular explanation of dominance, recessiveness, incomplete peneterance and variable expressivity; Identifying the genetic basis of disease (Positional/structural and functional cloning); Bioinformatics analysis, characterisation; Mutation detection, diagnosis and therapy (with examples from autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive and complex disease conditions).

Unit –III

Multifactorial disorders: Familial forms, linkage analysis, candidate gene identification (Huntingtons, DMD, Cystic fibrosis); Genetic polymorphism and disease susceptibility; Sporadic cases, association studies- markers from candidate gene/pathways; Whole genome association (single nucleotide polymorphism, CNVs).

Unit-IV

Functional genomics and animal models in human disease: An overview, cDNA/gene, cloning; Site-directed mutagenesis; Mammalian tissue culture, cell line transfections, functional assays; Use of model organisms in human genetics research; Methods for generation of transgenic animals/ knock-in, knockout models (microinjection, ES cell transformation);ENumutagenesis; RNA interference (RNAi) approach; Studying whole genome, Pulsed field gel electrophoresis (PFGE), Automated DNA sequencing

Suggested readings:

1. Human Molecular Genetics (2011) 4thed - Strachan T. & Read A., Garland Science
2. An introduction to Human Molecular Genetics-Mechanism of Inherited Diseases (1999)- Pasternak J. Fitzgerald, Science Press
3. Genetics in Medicine 7th Ed (2007) - Thompson and Thompson, Saunders
4 Landmarks in Medical Genetics (2002) (Ed.) Harper P. S. Oxford University Press
5. Chromosome Banding (1990) -Sumner A.T., Unwin Hyman
6. Human Genetics: Problems and Approaches (1997)- Vogel F. and Motulsky A. G, Springer Verlag

M. Sc. Final Genetics, Semester – III

GENET 306 STUDENT SEMINAR

M. Marks: 100

Students will present a comprehensive seminar on topics of general interest. Topics will be selected under the guidance of the faculty members. They will also prepare a seminar report. The assessment will be based on presentation, content and the report

M. Sc. Final Genetics, Semester – III

GENET 307 LAB COURSE III

M. Marks: 100

Time-6 hours

GENET 307 Lab Course- III: PRACTICALS BASED ON PAPERS XIII to XVII

1. Use of thin layer chromatography during extraction and purification of phyto-phamaceuticals.
2. Preparation of active constituent enriched extracts.
3. Isolation and purification of phyto-pharmaceuticals through conventional and column chromatographic techniques.
4. Extraction of essential oils and their evaluation for quality parameters.
5. Preparation of concretes and absolutes from plants containing essentials oils.
6. Heamagglutination, precipitation reactions.
7. Estimation of total and differential leukocytes count.
8. Quantitative estimation of antigen/antibody (Enzyme-linked immunosorbent assay Ouchterlony double diffusion, Radial immuno diffusion, Immunoectrophoresis , quantitative precipitin analysis etc).
9. Linkage analysis.
10. Study of life cycle of model organism.
11. Pulse field gel electrophoresis.
12. Automated DNA sequencing.
13. Numerical based on autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive.
14. Numerical based on Gene mapping.
15. To study the physical characteristics of soil (temperature, colour and texture).
16. To study the chemical characteristics of soil (pH, water holding capacity, electrical conductivity, chemical composition- carbon, phosphorus, potassium, nitrate etc.).
17. Developing species area curve.
18. To study the community structure by quadrate method by determining frequency, density and abundance of different species present in the community.
19. Determination of species diversity index and importance value index in local vegetation.
20. Measuring biodiversity of a habitat.
21. Floristic surveys and inventory (landscape physical characteristics, wild species in nature reserves and crop species in traditional agro-ecosystems).
22. To study the development stages of frog.
23. To study the development stages of chick.
24. To study the development stages of mammals.
25. To study the Sex determination method in Caenorhabditis, *Drosophila* and mammals.

M. Sc. Final Genetics, Semester – IV

GENET 401 INTELLECTUAL PROPERTY RIGHTS AND BIOSAFETY

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five 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 four 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 Intellectual Property Rights (IPR): Types of IPRs- patents, trademarks, copyright and related rights, industrial design, traditional knowledge, geographical indications, protection of new genetically modified organisms (GMOs); international framework for the protection of IPR; IPR as a factor in research and development (R & D); IPRs of relevance to biotechnology and few case studies; introduction to history of General Agreement on Tariffs and Trade (GATT), world trade organization (WTO), world intellectual property organization (WIPO) and trade-related aspects of intellectual property rights (TRIPS).

Unit II

Development of global and Indian IPR systems and requirement for filling applications: International framework for protection of IPR in R & D; Development of GATT, WTO, WIPO, TRIPS; WIPO treaties; Budapest treaty; Indian Patent Act 1970- amendments; filing of patent application, precaution and preparation of application with disclosures and non-disclosures, fee structure, time frame; patent cooperation treaty (PCT) and implications and role of country patent office; procedure for filing a PCT application; International Patent requirements, procedure, cost, etc.; status of patenting in US and Europe; publication of patent-gazette of India; case studies and examples.

Unit-III

Bio-safety against infectious agents/microorganism: A Historical perspective of bio-safety; bio-safety levels for infectious agents and infected food/animals; introduction of biological safety cabinets; primary containment for biohazards; recommended bio-safety levels; bio-safety levels for specific microorganisms; bio-safety guidelines for safe food in Europe and USA, and India

Unit IV

Bio-safety issues related with GMOs: Historical perspective of bio-safety issues in GMOs; the risk of introducing genetically engineered organism to environment- ecological safety; Food safety; Socio-economic impact; Indian government bio-safety guidelines- Definitions; role of RCGM (review committee on genetic manipulation), role of GEAC (genetic engineering approval committee), role of IBSC (institute bio-safety committee) in research and development of GMOs (transgenics), in food and agriculture; guidelines for environmental release of GMOs; risk assessment, risk management; Cartagena protocol for safe movement and exchange of transgenic material/GMOs; restriction of GURT (Genetic Use Restriction Technology), using suitable probes/molecular markers.

Suggested Reading

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. Protection of Plant Varieties and FarmersôRight Act, Ministry of Agriculture, Government of India, 2001, page 127
5. http://ipindia.nic.in/ipr/patent/patents.htm
6. http://ipindia.nic.in/tmr_new/default.htm
7. http://copyright.gov.in/
8. http://ipindia.nic.in/girindia/
9. http://ipindia.nic.in/ipr/design/designs.htm

10. http://mit.gov.in/default.aspx?id=322
11. http://www.plantauthority.gov.in/
12. Saxena Sanjeev and Anurudh K Singh 2006. Legislations for Protecting Plant Varieties and Quality Seed. In: Megadiverse Countries. In: DD Verma, S Arora and RK Rai (eds) *Perspectives on Biodiversity- Vision for Megadiverse Countries*, Ministry of Environment and Forests Government of India. 64-78.

Important Links

http://www.w3.org/IPR/

http://www.wipo.int/portal/index.html.en

http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html

www.patentoffice.nic.in

www.iprlawindia.org/ - 31k - Cached - Similar page

http://www.cbd.int/biosafety/background.shtml

http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm

M. Sc. Final Genetics, Semester-IV

GENET 402 BIOINFORMATICS

M. Marks: 80

Time-3 hours

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 computers and bioinformatics: Types of operating systems, concept of networking and remote login, basic fundamentals of working with unix. Biological databases: Overview, modes of database search, mode of data storage (flat file format, db-tables), flat-file formats of Gene Bank, European Molecular Biology Laboratory **(**EMBL**),** DNA Data Bank of Japan (DDBJ), Protein Data Bank **(**PDB**).**

Unit-II

Sequence alignment: Concept of local and global sequence alignment, pair wise sequence alignment, scoring an alignment, substitution matrices and multiple sequence alignment. Phylogenetic analysis: Basic concept of phylogenetic analysis, rooted/unrooted trees, approaches for phylogenetic tree construction [Unweighted Pair Group Method with Arithmetic Mean (UPGMA), neighbour joining, maximum parsimony, maximum likelihood].

Unit-III

Generation and analysis of high through-put sequence data: Assembly pipeline for clustering of height throughput screening (HTS) data, format of ácaceô file (compressed archive file), quality assessment of genomic assemblies, international norms for sequence data quality, clustering of (expressed sequence tag) EST sequences, concept of unigene. Annotation procedures for high through-put sequence data: Identification of various genomic elements (protein coding genes,

repeat elements, strategies for annotation of whole genome, functional annotation of EST cluster, gene ontology (GO) consortium.

Unit-IV

Structure predictions for nucleic acids and proteins: Approaches for prediction of RNA secondary and tertiary predictions, energy minimization and base covariance models, basic approaches for protein structure predictions, comparative modeling, fold recognition/ôthreadingôand *ab-initio* prediction.

Suggested readings:

1. Bioinformatics (2001) - A Practical Guide to the Analysis of Genes and Proteins Baxevanis, A. D. and Ouellette, Wiley and Sons.
2. Bioinformatics Sequence and Genome Analysis (2004) 2nd ed. - Mount, D.W, CSHL Press
3. Introduction to Bioinformatics (1995) -Tramontano, A, Chapman & Hall
4. Understanding Bioinformatics (2008) - Zvelebil, M. and Baum, J.O, Taylor and Francis.

M. Sc. Final Genetics, Semester-IV

GENET 403 (V) PROGRAMME ELECTIVE

RNAi BIOLOGY AND ITS APPLICATION

M. Marks: 80

Time-3 hours

Instructions for paper setter

There will be a total of five 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 four 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 (RNAi): Post-transcriptional gene silencing **(**PTGS**),** RNAi and related phenomena. Categories of small non-coding RNAs: Double-stranded RNA (**dsRNA**), small interfering RNA (siRNA), short hairpin RNAs **(**shRNAs**),** piwi-interacting RNA **(**piRNA**)** and microRNA (miRNA), detection of small RNAs, mechanism of RNAi, different components of RNAi pathway and their evolutionary conservation and role in gene silencing, RNAi-like pathway in bacteria.

Unit-II

Molecular basis of RNAi /siRNA /miRNA mediated gene silencing, RNAi in defense and the regulation of chromatin structure and gene expression, RNAi suppressors, large-scale genetic analysis using RNAi- genome-wide RNAi screens in *C. elegans*, and other systems, high-throughput small RNA profiling, RNAi microarrays, miRNAs and siRNAs; pathways, expression and functions of microRNAs.

Unit-II

High-throughput analysis of miRNA gene expression; siRNA vectors, siRNA delivery *in vitro* and *in vivo*; RNA informatics - computational tools for miRNA discovery, siRNA and miRNA design.

Unit-IV

Expression of dsRNA in animals and plants, and its applications: RNAi vectors and generation of transgenic animals and plants, analysis of expression of dsRNA and gene silencing; use of RNAi in the prevention of diseases in animal models and crop improvement; RNAi therapy; future prospects of RNAi in biology, medicine and agriculture.

Suggested readings:

1. The RNA World ï (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 Publishers.

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GENET 403(VI) PROGRAMME ELECTIVE

DROSOPHILA GENETICS

M. Marks: 80

Time-3 hours

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

Life cycle and advantages of *Drosophila* as a model organism for genetic analysis, *Drosophila* development: Embryonic development, maternal genes and formation of body axes, segmentation genes, homeotic genes and their functions, larval stages and tissue types, imaginal discs- development and differentiation, pupa and metamorphosis, adult morphology and internal organs, spermatogenesis and oogenesis, stem cells in *Drosophila.*

Unit-II

Polytene chromosome: Maps, puffing and utility, basics of setting up *Drosophila* crosses, nomenclature of gene mutations, balancer chromosomes, mutagenesis and isolation of new variants**:** X-ray and chemical mutagenesis, P-element and insertional mutagenesis.

Unit-III

Generation of Transgenic *Drosophila*: (a) Germ-line transformation and selection of vectors, (b) application of P-element based vectors in transgenic generation, advanced *Drosophila* genetics: (a) mitotic recombination, (b) generation and analysis of somatic clones, (c) generation and analysis of 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.

Unit-IV

Drosophila model for human genetic disorders: **(**Parkinsonôs, Huntingtonôs, Alzheimerôs diseases etc.), overview of *Drosophila* genome project- Online databases and other resources for *Drosophila* genetics

Suggested readings:

1. Developmental Biology (2003) -Gilbert S. F., Sinauer
2. Development of *Drosophila melanogaster (1991)* - (Vol I & II) Bates and Arias, CSHL Press
3. *Drosophila* Guide (1996) 10th ed. - Demerec and Kaufmann, Carnegie
4. *D. melanogaster*- Practical Uses in Cell and Molecular Biology-(1994) Goldstein and Fyrberg Academic press.
5. The making of a fly-The genetics of animal design (1992)- Lawerence, Blackwell
6. *Drosophila*: Methods and Protocols -T Dahmann C.TTT Humana
7. Fly Pushing- The Theory and Practice of *Drosophila* Genetics (2004) Greenspan R. J., CSHL Press
8. *Drosophila (2000)*-A Practical Approach Roberts D. B., CSHL Press

M. Sc. Final Genetics, Semester-IV

GENET 404 SELF STUDY PAPER

M. Sc. Final Genetics, Semester-IV

GENET 405 DISSERTATION/PROJECT WORK

M. Marks: 300