



Solapur University, Solapur

M.Sc. Part- I Genetics

(Revised syllabus)

(w.e.f. June, 2013)

1) Title of the Course: M.Sc.-I Genetics (Revised Syllabus) -2013-14

2) Introduction: This course provides a broad overview of genetics and how it applies to the current research and various life science sectors. Major theoretical perspectives and concepts are presented, including Biochemistry and Molecular medicine which is an application oriented subject.

3) Objectives of the course:

- To learn and understand the basic as well as advanced part of the fundamental unit of life which is DNA.
- A course on genetics would be a totally specialized course focusing on the genetic aspect of not just humans but all living things in the ecosystem.
- A specialized course would enhance the knowledge of the students in one dimension and thus would have an edge of being specialized candidate when compared with the others for the job perspective.

4) Advantages of the Course:

- With the understand of the life, need for the more and more Geneticist is the need of the future
- After completing M.Sc. Genetics students can easily get into the research field as most of the research today is done at genetic level.
- Pharmaceutical Industries being more focused on the gene based drugs thus students have opportunity in such industries
- India being agriculture based country, Agriculture sector would seeks students of M.Sc. Genetics for incorporating the genetics knowledge in plant and animal breeding and creating a conducive breed.
- Apart from the usual life science industry students can also work as a genetic counsellor which is a need of future.

5) Eligibility of Course:

- For admission into Master's degree one should be graduate from a recognized University with any of the life science subject.

6) Duration:

- The duration for this program is of 2 years with semester pattern having a total of 4 Semesters.

7) Medium of Instruction: English

8) Structure of the Course:

- Structure of M.Sc. course in faculty of Science has total of 4 semesters for 2 years.
- M. Sc. I comprises of total two semesters. In each semester (I & II) four theory papers (Paper I, II, III, and IV) carrying 100 marks each and two practical papers (Paper I and II) carrying 100 marks each.
- M.Sc. II comprises four theory papers (Paper I,II,III, and IV) carrying 100 marks each and one practical paper (Paper I) carrying 100 marks and a compulsory final year project which would carry a 100 marks
- Each paper comprising of 5 units is distributed in total 45 lecture hours.
- Practical Papers are to be conducted at the end of their respective semester.
- Finally year project work should begin in 3rd semester and the complete thesis should be submitted during the practical exam of the 4th and the final semester
- Student would have to present his/her project work during the thesis submission which would be evaluated by the internal as well as the external examiner.

Syllabus for M.Sc. I Genetics

SEMESTER- I (THEORY)

Code	Title of the paper	Marks
GEN - 101	Concepts of Genetics	100
GEN - 102	Biostatistics and Population genetics	100
GEN - 103	Cytogenetics and Genome Organization	100
GEN - 104	Cellular and Molecular Biology	100

SEMESTER- I (PRACTICAL)

Code	Title of the paper	Marks
GEN PR- 105	Concepts of Genetics, Biostatistics and Population genetics	100
GEN PR - 106	Cytogenetics and Molecular/Cellular Biology	100

SEMESTER- II (THEORY)

Code	Title of the paper	Marks
GEN - 201	Regulation of gene expression and developmental genetics	100
GEN - 202	Concepts of Biochemistry	100
GEN - 203	Advanced microbial genetics	100
GEN - 204	Plant breeding and Tissue culture	100

SEMESTER- II (PRACTICAL)

Code	Title of the paper	Marks
GEN PR - 205	Gene expression, Developmental genetics and Concepts of Biochemistry	100
GEN PR - 206	Microbial genetics and Plant breeding and Tissue culture	100

9) Syllabus:

Semester – I

Paper - Gen 101: Concepts of Genetics

Total lectures: 45

UNIT 1

Introduction: Eukaryotic and prokaryotic Cell Organization, Evidence for DNA as genetic Material, Double helical structure of DNA. Cell Division – Mitosis and Meiosis. Adeno, TMV, Retro and T4 Virus and its genome.

Model systems in genetic analysis: General Outline of genome of *E.coli*, Life cycle of *S.cerevisiae*, *C.elegans*, *Zebra Fish*, *Arabidopsis Thaliana*, *Homo Sapiens*. (10)

UNIT 2

Laws of Inheritance: Mendel's Law of Dominance, segregation, and Independent assortment. Test cross, Back cross, Co-dominance, Incomplete dominance, Allelic Interaction, multiple allele

Linkage: Concept, Recombination, Crossing Over, Gene mapping in Prokaryotes and Eukaryotes, Complementation, Eukaryotic linkage. (10)

UNIT 3

Sex Chromosomes and Sex linked Inheritance: Complete and incompletely sex linked genes. Inheritance of XY linked genes, Y linked genes, X linked genes. Sex linkage in man. Sex limited influence. (6)

UNIT 4

Mutation: Types = Spontaneous and Induced Mutations, Chemical and Physical Mutagenic agents, Mechanism of Mutagenic agents, Transposon mediated mutagenesis.

Changes in Chromosome number and Structure: Polyploidy, Aneuploidy, Chromosomal aberrations – Intra and Inter chromosomal aberrations (9).

UNIT 5

DNA Repair: Base excision repair (BER), Nucleotide excision repair (NER), Mismatch repair (MMR), Homologous recombination (HR), Nonhomologous end joining (NHEJ), Photo reactivation and Dark repair (10)

Semester – I

Paper- Gen 102: BIOSTATISTICS AND POPULATION GENETICS

Total Lectures: 45

UNIT 1

Basic statistics- Samples and populations, Sampling Methods, Diagrammatic and Graphical representation.

Measures of Central Tendency, Measures of Dispersion – Standard deviation, Mean deviation, Variance, Skewness, Kurtosis. (10)

UNIT 2

Probability Distribution - Binomial, Poisson and Normal, Correlation (Carl-Pearson) and Regression.

Testing of Hypothesis – Chi square Test, T -Test, P- Test (10).

UNIT 3

Genetics polymorphism. Panmictic & Mendelian population, Hardy-Weinberg genetic Equilibrium with example. (8)

UNIT 4

Causes of changes in gene frequency (migration, selection, genetic drift, inbreeding and Mutations). (7)

UNIT 5

Natural and artificial selection, Heritability, Genetic load, Fisher's fundamental theorem, Co adapted gene complex, Linkage disequilibrium.

Evolution, Adaptation, Species, Modes of speciation, Pedigree Analysis (10)

Semester – I

Paper - Gen 103: CYTOGENETICS AND GENOME ORGANIZATION

Total Lectures: 45

UNIT 1

Chromosome structure, Organization: Chromatin structure, Nucleosomal and Higher order, Telomere and its maintenance. Mitotic and Meiotic Chromosomes
Special types of chromosomes – Polytene chromosome, Lamp-brush chromosome. B-chromosome, Sex chromosome (10)

UNIT 2

Chromosome Banding – (G, Q, C, R) and Painting, Karyotyping, *In-situ* hybridization (FISH and GISH), Somatic cell hybridization, Somaclonal Variation (6)

UNIT 3

Extra Nuclear inheritance - Maternal inheritance, Mitochondrial, and Chloroplast, P-element in *Drosophilla*. Plasmids: Types, detection, replication, incompatibility, partitioning, copy-number control and transfer. Properties of some known plasmids. (10)

UNIT 4

Genome organization in viruses, bacteria, animals and plants. Mechanisms of sex determination in plants, animals and *Drosophila* (Dosage compensation) (9)

UNIT 5

Genome mapping (Physical maps) and functional genomics; Repetitive DNA-satellite (minisatellite, microsatellite DNA).
Introduction to Transposable Elements in Prokaryotes and Eukaryotes, LINES, SINES, Alu family, Fine structure of gene, multigene families. (10)

Semester – I

Paper - Gen 104: Cellular and Molecular Biology

Total lectures: 45

UNIT 1

DNA replication in prokaryotes and eukaryotes. RNA Polymerase, Prokaryotic & Eukaryotic transcription (Constitutive and Inducible Genes) (9)

UNIT 2

Genetic code, deciphering the code, codon usage, Eukaryotic and Prokaryotic Translation. Membrane Trafficking: Vesicular transport from Endoplasmic reticulum to Golgi Apparatus, Endoplasmic reticulum and its function, Vesicular transport in Golgi apparatus. Golgi Complex and its function, (9)

UNIT 3

Antisense, of Co suppression, RNAi, Micro RNA - Mechanism and Examples, Ribozyme Tailor made for gene silencing. (8)

UNIT 4

Cytoplasmic Membrane: Chemical Composition of Membrane, Structure and function of Membrane proteins, Fluid Mosaic Model, Movement of substances across cell membrane – Diffusion, Active transport. Cell Cycle and Cell-Cell Adhesion: Cell Cycle Phases, Extracellular space, Desmosomes, Hemidesmosomes, Integrins, Selectins, Cadherins, Tight Junction, Gap Junction. (10)

UNIT 5

Signal Transduction: G protein coupled receptor, tyrosine Kinase receptor - Ras- MAP Kinase pathway, Hedgehog pathway, WNT signalling pathway, Notch Pathway, Nf- κ B Pathway. (9)

Practicals

Semester – I

GEN PR- 105 - Concepts of Genetics, Biostatistics and Population genetics

1. Study of mitosis
2. Study of meiosis.
3. Meiosis of complex translocation heterozytes.
4. To Study the effect of mutagens on germination, seedling growth and on mitosis.
5. Mendelism problem: one factor & two factor with examples.
6. Spontaneous mutation: Fluctuation test – StrR.
7. Spontaneous mutation: Replica plate method-StrR
8. Study of data presentation (any one method)
9. Study of measures of central tendency.
10. Study of measures of dispersion or spread.
11. Study of probability.
12. Examples based on pedigree analysis
- 13 Examples based on Hardy Weinberg Equilibrium

Practical

Semester – I

GEN PR – 106 - Cytogenetics and Molecular/Cellular Biology

1. Preparation of *Drosophila*/*Chironomas* polytene Chromosomes
2. *Drosophila* genetic crosses
3. Chromosome preparation from mouse bone marrow and human blood lymphocytes
4. Identification of inactivated X chromosome as Barr body
5. G-banding and karyotyping
6. Study of B chromosome in Maize/*Drimia*.
7. Quantitative analysis of DNA using DPA method
8. Qualitative analysis of DNA - Physical Property (T_m Melting Temperature)
9. Qualitative analysis of DNA – COT Curve
10. Quantitation of DNA by spectrophotometer
11. Size fractionation of total DNA using electrophoresis
12. Isolation of Nuclei from Bakers yeast
13. Isolation of Mitochondria.
14. Isolation of Chloroplast
15. Isolation of total Protein from Bakers Yeast (Translation)
16. Estimation of total Protein from Bakers Yeast (Translation)

Solapur University, Solapur
Semester – II

**Paper- Gen 201: REGULATION OF GENE EXPRESSION AND
DEVELOPMENTAL GENETICS**

Total lectures: 45

UNIT 1

Gene regulation in prokaryotes: Operon model of regulation (with examples of *lac*, *trp* and *ara*). Negative, positive and attenuation control in bacteria. Control of lysis and lysogeny in Lambda phage.

Gene regulation in eukaryotes: Overview of gene regulation in animals and plants using examples of galactose-utilization in yeast; heat shock gene expression; Signal integration in Human β -Interferon gene. (11)

UNIT 2

Transcriptional control – changes in chromatin structure, epigenetics controls, Post transcriptional regulation – alternative RNA splicing, RNA editing, RNA stability, Translational regulation – RNA structure, control at initiation, codon usage, Post Translational modification.

Regulation of SV40 and CaMV 35S viral promoters. Hormonal control of gene regulation in animals and plants. Regulation of Cell cycle (10)

UNIT 3

Introduction to developmental biology- Zygote development and differentiation in animals and plants. Model systems to study pattern formation- *Dictyostelium*: Life cycle, aggregation and slug formation, mechanism of cell differentiation in the slug and final body formation.

Caenorhabditis elegans: cell lineage and mosaic development; vulval cell formation. (9)

UNIT 4

Drosophila: Polarity determination of embryo by maternal genes, segmentation genes and formation of body segments.

Homeotic genes specifying segment identity; Vertebrate limb: specification of axis and limb field zone (10)

UNIT 5

Arabidopsis: Life cycle, Embryogenesis and seed development, genes involved in flower Development (5)

Semester – II

Paper- Gen 202: Concepts of Biochemistry

Total lectures: 45

UNIT 1

Laws of Thermodynamics: Concept of Free Energy, Standard free energy change and chemical equilibrium, Biological oxidation reduction reaction, Redox potential, ATP as energy-rich compound. (5)

UNIT 2

Protein classification according to its function. Amino Acids, Classification of amino acids. Peptides, The primary, secondary and tertiary and quaternary structure of proteins. Ramachandran Plot (9)

Enzymes as biocatalysts; enzyme classification, Properties of enzymes, Active site. Mechanism of enzyme action, Michaelis-Menten Equation, inhibition of enzymes. (9)

UNIT 3

Vitamins, Classification, Structure and biological role of - Thiamin, Riboflavin, Nicotinic Acid, Biotin, Folic acid, Ascorbic Acid, Vitamin A, D, E, K (5)

UNIT 4

Carbohydrate - Classification, structure, general properties and functions, Glycolysis, Gluconeogenesis, Cori Cycle, TCA, HMP Shunt, Oxidative phosphorylation, Structure of ATPase. Photosynthesis: Structure of Chloroplast, Light and Dark Reaction, Photophosphorylation, Calvin Cycle, HSK Pathway, CAM Pathway. (10)

UNIT 5

Lipids - Classification, structure, properties and functions of fatty acids; Storage lipids Phospholipids, sphingolipids, steroids, Biosynthesis of fatty acids, Beta oxidation of fatty acid Pathway, Reactions of amino acid metabolism – transamination, deamination, Transmethylation, Urea Cycle, Nucleotides, Purines and Pyrimidines, Nucleotide Biosynthesis – Salvage and De NOVO (12)

Semester – II

Paper- Gen 203: ADVANCED MICROBIAL GENETICS

Total lectures: 45

UNIT 1

Conjugation: Discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F', map of F plasmid, mechanism of chromosome transfer
Chromosome transfer in other bacteria. (9)

UNIT 2

Transformation: Natural transformation systems, Biology and mechanism of transformation, Chemical-mediated and electrotransformation. (9)

UNIT 3

Transduction: 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. (9)

UNIT 4

Techniques for studying bacteriophages: Virulent phage (T4) and Temperate phage (phage lambda). Important aspects of lytic cycle, phage-host relationships, immunity and repression.
Bacterial mutagenesis: Mutation, evidence of spontaneous nature of mutation, Fluctuation test, Methods of isolation of autotrophic mutants, drug resistant mutants and phage resistant mutants, analysis of mutation in biochemical pathways. (10)

UNIT 5

Overview of Fungal Biology: Fungal life cycle and various phases, Fungi in nature, fungi in biotechnology, and as experimental tools. Yeast Mating - Type Switching mechanism, (8)

Semester – II

Paper- Gen 204: PLANT BREEDING and TISSUE CULTURE

Total lecturers: 45

UNIT 1

History; Genetic resources- centers of diversity and origin of crop plants, Law of Homologous variation, genetic resources.

Plant breeding, Mode of reproduction and breeding strategies, Plant diseases and pests and defensive mechanisms. (9)

UNIT 2

Breeding of self and cross pollinated and vegetatively propagated crop plants, Heterosis breeding, Polyploidy and haploids in breeding, Wide hybridization.

Mutation breeding, breeding crops to contain useful and adaptive traits; seed production and variety development and its conservation. Marker assisted breeding using molecular probes. (9)

UNIT 3

Plant tissue culture and somatic cell genetics – role of growth regulators & Micropropagation. (9)

UNIT4

Artificial seeds, Germplasm storage *in vitro*; Embryo rescue, Haploids and triploids, Secondary products. (9)

UNIT 5

Protoplast culture and fusion, Cybrids, Somaclonal variation, Mutant selection *in vitro* and by transposon tagging. (9)

Practical

Gen Pr-205 Gene expression, Developmental genetics and Concepts of Biochemistry

1. Study of heat shock proteins.
2. Observation of homeotic mutants of *Drosophila*
3. Study of Chick embryo development (preparation of whole mounts & permanent slides)
4. Study of mouse embryonic developmental stages (Slides Demonstration)
5. Study of museum specimens of abnormal fetuses in local medical College (Demo/Visit/Photography)
6. Qualitative analysis of Carbohydrate,
7. Qualitative analysis of Amino acids
8. Qualitative analysis of Lipids
9. Quantitative estimation of Protein by Biurete method
10. Quantitative estimation of Protein by Lowry's method
11. Quantitative estimation of Glucose by DNSA method
12. Quantitative estimation of Total sugar by anthrone method
13. Quantitative estimation of Cholesterol from serum by Zacs method
14. Determination of acid value, Iodine number, and saponification of fat/oil
15. Isolation of casein from milk
16. Isolation of starch from potato
17. Induction and assay of β - galactosidase from *E.coli*
18. Immobilization of enzyme (Calcium chloride and Sodium alginate)
19. Assay of amylase by iodometric method

Practical

Semester – II

Gen Pr - 206 Microbial genetics and Plant breeding and Tissue culture

1. Isolation of Rhizobium from root nodule.
2. Seed dressing and inoculation with *Rhizobia*.
3. Perform experiment to study bacterial transduction.
4. Perform experiment to study bacterial Conjugation
5. Perform experiment to study bacterial Transformation
6. Detection and estimation of protease inhibitors from pulse seeds.
7. Isolation of vitamin B12 auxotrophic mutants.
8. Isolation and quantification of genomic DNA from bacteria.
9. Isolation of Plasmid DNA from bacteria.
10. Induction of polyploidy using colchicines. (Root Tip)
11. Cytological analysis of polyploidy plants. (Root Tip)
12. Study of Pollen fertility.
13. Isolation of genomic DNA from Plants.
14. Isolation of Ti Plasmid from Agrobacterium.
15. Media preparation, sterilization and callus culture.
16. Somatic embryogenesis and somaclonal variation, micro-propagation.
17. Cell suspension culture.
18. Isolation of protoplast by chemical and mechanical methods.
19. Synthetic seeds preparation.
15. Visit to commercial R & D green houses, agro based industries.

10) Bibliography / Reference Books

SEMESTER I

GEN – 101 Concepts of Genetics

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

GEN – 102 Biostatistics and Population genetics

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

GEN – 103 Cytogenetics and Genome Organization

1. Essential Cell Biology -Alberts B. et al. Garland
2. Molecular Biology of The Cell- Alberts B et al. Garland
3. The Eukaryotic Chromosome- TBostock C. J. & Summer A. T.T Elsevier
- 4 The Chromosome- Hamsew and Flavell Bios
5. Advanced Genetic Analysis- Hawley & Walker Blackwell
6. Structure & Function of Eukaryotic Chromosomes- Hennig Springer
7. Genes IX- Lewin B. Pearson
8. Molecular Cell Biology -Lodish, H. et al. Freeman
9. Cell and Molecular Biology- De Robertis & De Robertis Lippincott & Wilkins
10. Genome 3 -Brown T. A. Garland

GEN – 104 Cellular and Molecular Biology

1. Molecular Biology of the Gene- Watson, J. et al. Benjamin Cummings
2. Molecular Cell Biology -Lodish,H. et al. W. H. Freeman
3. The World of the Cell- Becker, W.M. et al. Benjamin Cummings
4. Essential Cell Biology- Alberts B. et al. Garland
5. Molecular Biology of The Cell -Alberts B et al. Garland

SEMESTER II

GEN – 201 Regulation of gene expression and developmental genetics

1. Genes and Signals- Mark Ptashne and Alexander Gann CSHL Press
2. A Genetic Switch- Mark Ptashne CSHL Press
3. Gene Regulation- David S Latchman Chapman & Hall
- 4 Genes- Benjamin Lewin Prentice Hall

5. Molecular Cell Biology- Lodish, H. et al. W. H. Freeman
6. Principles of Developmental Genetics, -Sally A. Moody Academic Press
7. Advances in Anatomy, Embryology and Cell Biology, -Korf, H.-W., Beck, F., Clascá, F., Haines, D.E., Hirokawa, N., Putz, R., Timmermans, J.-P. Springer
8. Developmental Biology- Gilbert S. F. Sinauer
9. Development of *Drosophila melanogaster* (Vol I & II)- Bates and Arias CSHL Press
10. *Drosophila* Guide- Demerec and Kaufmann Carnegie
11. *D. melanogaste*: Practical Uses in Cell and Molecular Biology Goldstein and Fyrberg Academic
12. The making of a fly: The genetics of animal design Lawrence Blackwell
13. *Drosophila*: Methods and Protocols TDahmann C.TTT Humana

GEN - 202 Concepts of Biochemistry

1. Principles of Biochemistry -Lehninger et al. Freeman
2. Biochemistry -Devlin, T.M. Wiley-Liss
3. Biochemical Calculation -Sehgal I. H. Wiley
- 4 Fundamentals of Enzymology -TPrice N. C. and Lewis S.T Oxford University Press
5. Biochemistry -TBerg, J. M. Tymoczko, J. L and Stryer L.T W. H. Freeman

GEN - 203 Advanced microbial genetics

1. Microbial Genetics -Maloy S., Cronan J., Freifelder D Jones and Bertlett
2. Fundamental Bacterial Genetics- Trun N and Trempey 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
8. Fungal Genetics: Principles and Practice Bos C J. CRC
9. The Mycota Ed. Esser K. & Lemke P. A. Springer
10. Essential Fungal Genetics-Moore D.& Frazer N. Springer
11. Fungal Genetics- Fincham Springer

GEN – 204 Plant breeding and Tissue culture

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. Principle of Crop Improvement -Simmonds N. W. & Smart J. Blackwell Science
- 4 Plant Cytogenetics- Singh R. J. CRC Press
5. Genome mapping in Plants- Paterson A. H. Academic Press
6. Molecular markers in Plant Genetics and Biotechnology -Vienne D. INRA
7. Quantitative Genetics, Genomics and Plant Breeding- Kang M. S. CABI Publishing
8. Plant Molecular Breeding- Newbury H. J. CRC press