

DETAILED SYLLABUS (SEMESTER WISE)

COURSE CONTENTS

The M.Sc. Programme is divided into two parts with each part consisting of two semesters (semester 1 to semester 4). Each course is adequately supported by practicals and/or tutorials in related areas. In semester 4 the students have to choose 3 elective courses out of the six being currently offered. The proposed syllabus for the current session is given below:

PART I: Semester-1

Gen 0701-CONCEPTS OF GENETICS

4Th-0T-3P = 6 credits

The science of Genetics has come to occupy a pivotal position in the entire field of Biology, as it is central to numerous aspects of human affairs. Deeply rooted in strong concepts, it has provided the unifying themes for all living organisms. While on one hand, the science centers around a phrase "like begets like", it also explains the inherent variability that differentiates one individual from the other. Though the discipline of Genetics has moved far ahead from simple inheritance of the characters, it is absolutely essential to have a clear understanding of the underlying concepts. This paper deals with these basic concepts that form the building block for any further understanding of Genetics.

Model systems in Genetic Analysis: Bacteriophage, E. coli, Neurospora crassa, yeast, Arabidopsis, maize, Drosophila, C. elegans, Zebra fish, Homo sapiens - General outline of life cycle, importance in Genetic analysis. [6]*

Laws of inheritance: Mendel's Laws, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance. [10]

Allelic and non-allelic interactions: Concept of alleles, types of dominance, lethal alleles, multiple alleles, test of allelism, complementation; Epistasis. [12]

Linkage: Concepts, recombination, gene mapping in prokaryotes and eukaryotes, fine structure mapping. [12]

Sex-linked inheritance: Conceptual basis, sex influenced traits, mechanism of sex determination. [4]

Quantitative inheritance – Concept, Genes and Environment - heritability, penetrance and expressivity. [4]

Cytoplasmic inheritance – Basis and mechanism, role of organellar genes. [4]

Mutation – Classification, mechanism, repair, role in genetic analysis and evolution. [6]

Changes in Chromosome number and structure: Polyploidy, aneuploidy, chromosomal rearrangements - deletion, duplication, inversion, and translocation. Meiotic consequences in structural heterozygotes, role in speciation and evolution. [6]

*Numbers in parenthesis indicates the proposed number of classes for respective topics

Suggested readings:

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 0702-CHROMOSOMES, GENES AND GENOMES

4Th-0T-3P = 6 credits

The students are expected to have basic knowledge of chromosome structure, genome organization and cell division. Therefore, the syllabus includes advanced aspects of chromosome biology, genome organization and genetics of cell cycle regulation. Emphasis would be given to explain the topics with the help of classical experimental strategies, examples from different model organisms and contemporary genetic approaches and methods.

Chromatin structure: Histones, DNA, nucleosome morphology and higher level organization; Functional states of chromatin and alterations in chromatin organization. [8]

Chromosome organization: Metaphase chromosomes: centromere and kinetochore, telomere and its maintenance; Holocentric chromosomes; Heterochromatin and euchromatin, position effect variegation; Chromosomal domains (matrix, loop domains) and their functional significance. [12]

Giant chromosomes: Polytene and lampbrush chromosomes. [2]

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. [10]

Chromosomal anomalies: Numerical and structural alterations, induced chromosomal aberrations in somatic cells. [6]

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. [8]

Genome organization in viruses, prokaryotes and eukaryotes: Organization of nuclear and organellar genomes; C-value paradox, Repetitive DNA-satellite DNAs and interspersed repeated DNAs, Transposable elements, LINES, SINES, Alu family and their application in genome mapping. [14]

Concept of gene: Conventional and modern views. Fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families. [2]

Genome mapping: Physical maps -an overview and approaches. [1]

Genome evolution [1]

Suggested readings:

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 0703 - BIostatISTICS AND POPULATION GENETICS

4TH-0T-3P = 6 credits

Biostatistics

Much of genetic analysis is based on quantitative data; statistical techniques are therefore used extensively. Some basic tools of statistics are essential in designing and analysis of data and in the interpretation of experimental results for dependable conclusion, essential to test a hypothesis.

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. Regression and correlation, Analysis of variance. [32]

Population Genetics

A thorough understanding of the population genetics is necessary to comprehend the evolutionary processes. This course will make the students familiar with different types of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics. It will also make them understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits.

General background [1]

Variation at the genetic level: DNA markers -VNTR, STR, microsatellite, SNP and their detection techniques - RFLP, genotyping, RAPD, AFLP etc. [7]

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). [10]

Linkage and linkage disequilibrium [2]

Sources responsible for changes in gene frequencies: Mutation, selection, migration and isolation; random genetic drift; insights into human migration, natural selection and evolution. [4]

Population substructure: Hierarchical population, Isolate breaking, Inbreeding, Assortative mating. [2]

Quantitative Genetics: Johanssen 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. [6]

Suggested readings:

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|----|---|---------------------------------|-----------------------|
| 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 0704 - CONCEPTS IN CELL AND MOLECULAR BIOLOGY

4Th-0T-3P = 6 credits

Life on this earth has evolved through a set of simple biochemical reactions, which has subsequently given rise to specific cell types. Cells are made out of some building blocks which when bonded together produce the various structural and functional constituents. From a geneticist's point of view, the understanding of informational molecules, such as DNA, RNA, and proteins is central as they provide information on life and its processes. This paper deals with the structural and informational molecules, and their role in information transfer. While tracing the origin of life and its subsequent evolution, special emphasis has been given to proteins as biocatalysts, in cellular reactions.

Origin of life: Origin of biomolecules, primitive life forms, RNA world, biological evolution. [8]

Tree of life: rRNA as a chronological marker, Woese's concept of molecular taxonomy. [4]

Cellular organization: An overview, endosymbiotic origin of mitochondria and chloroplast. [3]

Biomolecules: Chemical bonds, building blocks: carbohydrates, lipids, fats, proteins, nucleic acids. [8]

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. [14]

Enzymes: As biocatalysts, specificity and kinetics, assay and inhibition of enzyme activity, mechanism of action, regulation of enzyme activity; Allosteric enzymes. [11]

Cellular energetics: Energy rich compounds, ATP synthesis, thermodynamics of cellular reactions, metabolic networks-an overview. [8]

Cell cycle and its regulation [4]

Cell signaling [4]

Suggested readings:

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
6.	Molecular Biology of the Gene	Watson, J. et al.	Benjamin Cummings
7.	Molecular Cell Biology	Lodish,H. et al.	W. H. Freeman
8.	The World of the Cell	Becker, W.M. et al.	Benjamin Cummings

Gen 705- PRACTICAL

PART I: Semester-2

Gen 0801 - GENE EXPRESSION AND REGULATION

4TH-2T-0P = 6 CREDITS

These topics would be taught with emphasis on discoveries, examples and experimental designs for studies. After being introduced to the topics highlighting experiments leading to seminal discoveries the students will cover 'Gene expression: basic processes' mainly through self-study. The students are expected to read, research and discuss papers related to the topics.

Gene expression: Basic processes

Gene as a unit of function. [1]

Transcription (prokaryotic and eukaryotic) – RNA polymerase, DNA sequences, transcription factors, process of initiation, elongation and termination. [13]

Post transcriptional modifications – capping, poly-adenylation, splicing (*cis*- and *trans*-), editing. [9]

Translation – genetic code, ribosome structure, the process of translation. [6]

Gene regulation:

Introduction, levels of regulation, evidences and experimental designs/methodologies, role of genetic analysis in understanding gene function and regulation. [6]

Lessons from bacteria: regulation at lac (including reading of Jacob and Monod's seminal paper), trp and ara operons; control of lysis and lysogeny in λ phage. [18]

Yeast: Gene regulation in a single celled eukaryote using a model case of GAL gene. [4]

Regulation in higher eukaryotes:

- a. Perceiving signals. [2]
- b. Transcriptional control – Changes in chromatin structure, epigenetic controls. [14]
- c. Transcriptional control - DNA sequence elements and transcription factors. [6]
- d. Post-transcriptional regulation – Alternative RNA splicing, RNA editing, RNA transport and localization, RNA stability, Regulation of translation – RNA structure, control at initiation, codon usage, Post-translational modifications [13]
- e. RNA-mediated control of gene regulation. [4]

Suggested readings:

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|----|---|---------------------------------|----------------|
| 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. | Selected papers on gene function and regulation (a compilation) | | |

Gen 0802 - HUMAN GENETICS

4Th-0T-3P = 6 credits

Human Genetics is a very wide as well as a rapidly advancing subject and one which interests even a layman. Last two decades have revolutionized our early understanding of the basic concepts of Genetics, genome organization, gene structure and function. This introductory course attempts to walk the students through classical genetics and molecular genetics with a cautionary endnote on range of ethical, legal and social issues which are also the logical consequences of such unparalleled scientific progress. Beginning with constructing genetic hypothesis from pedigree data and population sampling, application of a variety of conventional and modern tools to test such hypothesis, constraints/ limitations of genetic methodology when applied to humans would be discussed in the early part of the paper. Application of mapping tools and cloning strategies culminating in the successful completion of the Human genome project and exciting, unimagined areas of research which have emerged in the post-sequencing era would be covered next. New/ current knowledge on genetic variations in health and disease across populations and their clinical/diagnostic implications would be dealt subsequently. Considering that purview of medical genetics is now all of medicine and involves ethical issues, this study will remain incomplete without serious discussion on these issues.

Introduction to Human Genetics: History; Early perception, development and documentation; Genome organization; Chromosome structure, function and implications for disease. [4]

Study tools in Human Genetics: Pedigree analysis- Mendelian inheritance and exceptions; Chromosomal analysis (*in vitro*, *in vivo*), Biochemical analysis; Somatic cell genetics (somatic cell hybrids, monochromosome hybrid panels, gene mapping); Molecular genetic analysis. [12]

Human genome mapping methods: Physical mapping: Introduction to physical map markers- Chromosomal, G/Q- banding, radiation hybrid, Fluorescence *in situ* hybridization, comparative

genome hybridization, long range restriction mapping, high resolution mapping- STS/EST/MS/SNP/sequencing; Genetic mapping: Linkage analysis (RFLP/MS/SNP); Applications of mapping in normal and disease genome analysis; Gene identification using positional and functional cloning approach. [16]

Human genome analysis: Conception, mapping, cloning and sequencing, Outcome- Generation of 'OMICS' era, significant leads. [8]

Genetic variation in health and disease: Human genetic diversity- Methods of study – Biochemical/molecular genetic markers; some examples. Tracing human migrations with autosomal, Y-chromosomal and mitochondrial markers. [4]

Diseases and disorders: Chromosomal disorders: Structural and numerical; Autosomal/sex chromosomal/sex reversal; Mechanisms – mitotic/meiotic non-disjunction/ chromosomal rearrangements; Some examples (Syndromes/Cancer/Infertility); Single gene and disease: Inborn errors of metabolism, Haemoglobinopathies; Multifactorial disorders: Introduction; Methods of study (Epidemiological, Twin/ adoption and Family studies); Etiology - genetic and non-genetic determinants; Common examples. Epigenetics and disease: Mechanisms (Imprinting/methylation; chromatin remodeling); Current understanding; examples. Mitochondrial myopathies. [10]

Ethical, legal and social issues in Human genetics: 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; Organ banking and transplantation; Research ethics; Medical ethics in India. [2]

Classical papers in Human genetics [8]

Suggested readings:

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|----|--|------------------------------|--------------------------|
| 1. | Human Genetics: Problems and Approaches | TVogel F. and Motulsky A. | Springer Verlag |
| 2. | Human Molecular Genetics | Strachan T & Read A | Garland Science |
| 3. | An Introduction to Human Molecular Genetics: Mechanism of Inherited Diseases | Pasternak J | Fitzgerald Science Press |
| 4. | Chromosome Structural analysis: A Practical Approach | (Ed.) W.A. Bickmore | Oxford University Press |
| 5. | The AGT Cytogenetics Lab Manual | Barch, Knutsen and Spurbeck, | Lippincott Raven publ |
| 6. | Human Cytogenetics: Constitutional analysis | (Ed) D.E. Rooney | Oxford University Press |

Gen 0803 - MOLECULAR PLANT BREEDING

4TH-0T-3P = 6 credits

This is a course on applied plant genetics. This course primarily deals with how to undertake plant genome analysis and gene mapping through the use of DNA markers and how this information could be utilized in bringing the efficiencies in selection methods of plant breeding and gene isolation through forward genetics approach.

Plant Breeding: History, genetic diversity in plant breeding. [4]

Natural breeding systems in plants and their application in plant breeding. [8]

Conventional breeding methods for self, cross-pollinated and vegetatively propagated crop plants. [6]

Heterosis breeding [4]

Polyploidy and haploids in plant breeding [2]

Cytogenetic tools in Plant breeding [4]

Seed production and variety development [2]

Molecular plant breeding: Introduction - molecular markers as new efficient tools in breeding. [4]

Molecular markers for genome mapping: Principles of genetic linkage, concept of genetic distance, development and choice of mapping populations, linkage map construction – relational, integrated and comparative maps. [10]

Dissection of quantitative traits: Principles and methods of QTL mapping, fine mapping of QTL. [6]

Marker assisted breeding: Gene tagging, marker aided selection – foreground and background selection, concept of graphical genotypes, elimination of linkage drags. [10]

Cloning plant genes: Comparative genomics and cloning, positional cloning. [4]

Suggested readings:

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|----|---|---|-------------------|
| 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 |

Gen 0804 – INTRODUCTION TO BIOINFORMATICS

4Th-0T-3P = 6 credits

Large scale genome sequencing projects are providing detailed information about gene content and organization in different species and even in different members of the same species. The information gleaned from genome sequencing created the field of genomics that branched out into structural, functional, and comparative genomics. The information generated from these projects are so monumental that it is virtually impossible to collate the information manually. The field of Bioinformatics that has allowed this information to be collected in the form of databases and to analyze this data for various purposes is one

of the most thriving branches of modern biology. This paper deals with various aspects of computer applications generating useful biological information on genome structure, function, and evolutionary relationships.

Introduction to computers and bioinformatics: Types of operating systems, concept of networking and remote login, basic fundamentals of working with unix. [4]

Biological databases: Overview, modes of database search, mode of data storage (Flat file format, db-tables), flat-file formats of GenBank, EMBL, DDBJ, PDB. [6]

Sequence alignment: Concept of local and global sequence alignment, Pairwise sequence alignment, scoring an alignment, substitutional matrices, multiple sequence alignment. [6]

Phylogenetic analysis: Basic concept of phylogenetic analysis, rooted/unrooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbor joining, Maximum parsimony, Maximum likelihood). [10].

Generation and analysis of high through-put sequence data – Assembly pipeline for clustering of HTGS data, format of ‘.ace’ file, quality assessment of genomic assemblies, International norms for sequence data quality, Clustering of EST sequences, concept of Unigene. [10]

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. [14]

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/’threading’, and *ab-initio* prediction. [14]

Suggested readings:

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

Gen 0805 -PRACTICAL

PART II: Semester-3

Gen 0901- STUDENTS’ SEMINARS

3 credits

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.

Gen 0902 - RECOMBINANT DNA TECHNOLOGY

4Th-0T-3P = 6 credits

Recombinant DNA technology is a set of molecular techniques for location, isolation, alteration and study of DNA segments or genes. Commonly called genetic engineering it encompasses ways to analyze, alter and recombine virtually any DNA sequences. Parting away from the classical gene-phenotype relationship, this technology provides information through direct reading of the nucleotide and/or protein sequences. This paper provides the details of the various techniques and tools used as well as its application in the generation of commercial products of myriad usage (Biotechnology). Looking at the vast implications, topics on Bioethics and Biosafety, implicit in such a technology will also be covered.

Basics of DNA cloning: Various ways of cloning. Cloning into different vectors – plasmids, phages, and phage-derived PACs, BACs and YACs, Selection and screening of clones. [6]

Methods of DNA and protein analysis: Electrophoretic techniques, Southern and Northern Blotting, Preparation of probes, Isolation and purification of DNA, RFLP analysis, DNA fingerprinting and its application, Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins, Western Blotting. [8]

Polymerase Chain Reaction (PCR): Concept of PCR, Various kinds of PCR, Real Time PCR, RAPD fingerprinting, Ligation Chain Reaction, Applications of PCR. [4]

Construction of DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries, Steps and enzymes involved, method of screening libraries, screening expression libraries, Positive selection and subtractive hybridization by identifying genes in complex genomes. [6]

Genome sequencing: DNA sequencing by Sanger's method, Physical mapping, Whole genome shotgun sequencing, Preparation of BAC/YAC library, Genome annotation at different levels, Comparative genome sequencing. [6]

Transcriptional analysis of gene expression and transcriptomics: Gene expression analysis by Northern Blotting, RT-PCR, EST analysis, Enzymatic and bioluminescent reporters, Reporters used in protein localization and trafficking studies, Promoters analysis, mapping transcriptional start sites, Transcriptome analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expression (SAGE). [8]

Overexpression of recombinant proteins: Overexpression and tagging of recombinant proteins in *E. coli*, Expression in *B. subtilis*, Overexpression systems. [4]

Analysis of protein-DNA and protein-protein interactions: Gel retardation assay, DNA footprinting, yeast one- two and three-hybrids assay, ChIP-chips split hybrids and reverse hybrids, Co-immunoprecipitations. Phage display. [6]

Protein engineering and proteome analysis: Insertional and deletion mutagenesis, Site-directed mutagenesis, Proteome analysis, Protein arrays and their applications. [6]

Pharmaceutical products of DNA technology: Human protein replacements, Human therapies, Vaccines. [4]

Transgenics and animal cloning: Creating transgenic animals and plants. Animal cloning, Biosafety and Bioethics. [6]

Suggested readings:

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|----|---|---|----------------------------------|
| 1. | Gene Cloning and DNA Analysis: An Introduction | Brown T. A. | Blackwell
Publishings |
| 2. | Gene Cloning and Manipulation | Howe C. | Cambridge
University
Press |
| 3. | Principles of Gene Manipulation and Genomics | Primrose S. B. & Twyman R. M. | Blackwell
Publishings |
| 4. | Principles of Gene Manipulation | Primrose, S. B. Twyman R. M. & Old R W. | Wiley-
Blackwell |
| 5. | Molecular Cloning: A Laboratory Manual (3-Volume Set) | Sambrook J. et al. | CSHL Press |
| 6. | Calculations for Molecular Biology and Biotechnology: | Stephenson F. H. | Academic
Press |

Gen 0903 - PLANT GENETIC ENGINEERING**4Th-0T-3P = 6 credits**

Human society is confronted with a multitude of challenges, including the rapid loss of phytodiversity, environmental perturbations, and the ever-increasing human population. Needless to highlight, food security for the ever-increasing population will be a major challenge in present and future times. In fact, it would be necessary to produce more and more in the coming years. Although conventional breeding has contributed its share, we need to adopt newer technologies, particularly biotechnological strategies to boost the yield and quality of our crop plants. The course is designed to provide students with specialized knowledge of the theory and practical skills of plant tissue culture, somatic cell genetics and genetic engineering relevant to crop improvement. It deals with the various cell and tissue culture systems and their applications, plant transformation vectors and methods, and potential applications of transgenic technology in agriculture and healthcare.

Plant tissue culture and somatic cell genetics: Historical developments; Nutrient media; Role of phytohormones in plant development in vitro; Plant regeneration pathways - Organogenesis and Somatic embryogenesis; Organ culture, Root culture, Embryo culture - Embryo rescue, Breakdown of seed dormancy; Endosperm culture and triploid production; Anther and pollen culture, and production of haploid and doubled haploid plants; Callus culture; Cell culture and production of secondary metabolites; Protoplast culture and fusion, Somatic hybrids; Organelle transfer and cybrids; In vitro fertilization for production of novel hybrids; Micropropagation, artificial seed and bioreactor technology, Virus-free plants by meristem culture; Use of somaclonal and gametoclonal variation for crop improvement; In vitro mutagenesis and mutant selection; Preservation of plant germplasm *in-vitro*. [26]

Plant transformation vectors and methods: Plant transformation vectors - T-DNA and viral vectors, direct gene transfer vectors; Selectable marker and reporter genes, Plant transformation by *Agrobacterium* sp., non-*Agrobacterium* sp., and in planta transformation, Molecular mechanism of T-DNA transfer; Direct gene transfer methods in plants - Gene gun and other methods; Chloroplast transformation; Transgene analysis, silencing and targeting; Marker-free and novel selection strategies; Multigene engineering; Gene knock-down by ribozymes, antisense RNA and RNA interference. [18]

Applications of plant transgenic technology: Transgenic crops for resistance against biotic and

abiotic stresses; Engineering crops for male sterility and modification of flower colour, flowering, fruit ripening and senescence; GM crops for nutritional quality and quantity; RNAi-mediated crop improvement; Molecular pharming; Metabolic engineering and hairy root culture for secondary plant products; Other applications; Global status and biosafety of transgenic plants. [20]

Suggested readings:

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

Gen 904(i)- PLANT-MICROBE INTERACTIONS

2TH -1T = 3 CREDITS

The course is designed to provide the genetic and molecular principles underlying plant- microbe interactions. Tutorials would be in form of discussion and student presentations based on recent reviews available for each topic, highlighting the advances made in the respective field.

History of Plant pathology and recent developments: Significance of plant diseases, and pathology, types of plant-microbe associations (pathogenic– bacteria, virus, fungi, and symbiotic). [3]

Beneficial Plant - Microbe interactions (molecular aspects): [5]

- a. Nitrogen fixing bacteria and blue green algae
- b. Mycorrhizal association
- c. Phytohormones and Biocontrol antibiotics

Parasitism and disease development: Pathogenecity, host range of pathogens, disease cycle and epidemics. [5]

Molecular biology of pathogenicity: Mechanisms of variability in pathogens, pathogenicity genes and mechanisms in pathogenic bacteria, biotrophic and necrotrophic fungi, Virus and Viroid genes involved in pathogenicity, *Agrobacterium* and plant interaction-a model system. [10]

Molecular genetics of plant disease susceptibility and resistance: Types of plant resistance to pathogens (R gene resistance, quantitative and monogenic), basal and induced defense mechanisms, pre-formed inhibitors of pathogens, gene for gene interaction in plant defense, Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Recognition

mechanism and signal transduction during plant - pathogen interaction. [10]

Suggested readings:

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|----|--|---------------|--------------------------|
| 1. | Plant Pathology | Agrios G. N. | Academic Press |
| 2. | Molecular Plant pathology | Dickinson M. | BIOS Scientific Press |
| 3. | Plant Pathogenesis and Resistance: Biochemistry and Physiology of Plant-Microbe Interactions | Jeng-Sheng H. | T Kluwer Academic Pubs.T |

Gen 904(ii)- MEDICAL GENOMICS

2Th-0T-1P = 3 credits

This era in time is the most exciting period in medical practice and research due to unprecedented technical advances in genetics and genomics research. An effective weaving together of previously separate strands of cytogenetics / biochemical genetics/ immunogenetics/ molecular genetics/ statistical, functional and population genetics is evident in this area. Conventional tools such as pedigree analysis still remain to be a powerful starting tool for new gene identification and study of inheritance genetics. Functional genomics and understanding mechanisms underlying genetic observations together with in- silico approaches to unravel nuances in genome architecture are the contemporary tools. Introduction to new methodologies to study genetics of single gene disorders as well as the enigmatic common complex traits; variety of tools to unravel the function of genes and their variants; and finally translation of this exciting new knowledge to medical practice by diagnostic and therapeutic innovations are the contents of this paper. Genetic counseling is emerging as an area of utmost importance in this translational research era and this would also be dealt with. A didactic approach and problem based tutorial exercises which seem to be the most effective method of introducing and training students in this branch of applied genetics would be followed.

Identification and Isolation of disease genes: Single gene disorders- conventional and contemporary methods: Pedigree analysis, Linkage mapping, Positional/structural and functional cloning; Bioinformatic analysis; Characterisation; Mutation detection, diagnosis and therapy (with examples from autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive and complex disease conditions); Multifactorial disorders: Familial forms- Linkage analysis, Candidate gene identification; Genetic polymorphism and disease susceptibility; Sporadic cases- Association studies- markers from candidate gene/pathways; whole genome association (Single nucleotide polymorphism, CNVs); Statistical methods used; Common examples. [16]

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, methods for generation of transgenic animals/ knock-in, knock-out models (microinjection, ES cell transformation); ENumutagenesis; RNAi approach; Some examples. [4]

Pharmacogenetics: History, Early evidence; Clinical determinants; Molecular insights (genes involved in pharmacokinetics and pharmacodynamics of drugs); Applications in pre-prescription testing. [2]

Diagnostic genetics: Cytogenetics/ Molecular Cytogenetics/Biochemical/Molecular methods; Screening for mutation/ chromosomal anomaly - Adult/Prenatal/Newborn screening; Pre-implantation screening (Assisted reproductive technology- *in vitro* fertilization and Embryo transfer); Forensic testing - DNA fingerprinting, paternity testing, individual identification. [6]

Treatment of genetic disorders: Methods of therapy - Drug (recombinant proteins); Diet; Gene (Viral vectors, delivery methods, efficacy); Some examples (Thalassemia, Phenylketonuria, Cystic fibrosis, DMD etc). [2]

Genetic counseling: Prenatal/adult diagnosis of genetic disorders; Risks and benefits; Informed consent; Right of choice; Dilemmas faced by counselors. Case studies. [2]

Suggested readings:

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

Gen 904(iii)- GENETIC VARIATION AND EVOLUTION

2Th-1T-0P = 3 credits

Mutation and recombination play a very important role in the creation of genetic variation, which is the raw material of evolution. Without genetic variation, a population cannot evolve in response to changing environmental variables, and as a result, may face an increased risk of extinction. This course covers the various sources and mechanisms of mutations and their role in generating genetic variation in populations; genotoxicity of environmental mutagens, role of mutations in human diseases, modern tools of mutagenesis and molecular basis of evolution. Role of mutations and recombination in genetic variation:

Categories of mutations; Mechanisms of spontaneous and induced mutations; Role of numerical and structural changes of chromosomes, gene mutations, recombination and transposable elements in genetic variation. [8]

Role of environmental mutagens in genetic variation: Categories and genotoxicity of atmospheric mutagens; Genotoxicity test systems. [3]

Mutations and human diseases [1]

Methods to induce genetic variation in single genes: Insertional mutagenesis - transposon and T-DNA mutagenesis; In vitro mutagenesis; Oligonucleotide- and PCR-mediated site-specific mutagenesis; TILLING; RNAi mutagenesis. [8]

Mechanisms of DNA damage repair: Proof reading activity of DNA polymerases, Direct reversal of damaged DNA, Post-replication repair, Error-prone repair, Repair of double-strand breaks. [4]

Molecular Evolution: Evolution of origin of species and theories of evolution; The basic force of evolution – Mutation, recombination and gene flow; Variation and divergence of populations; Molecular evolution of genes and proteins; Evolution of genomes; Phylogeny and systematics; Molecular clock. [8]

Suggested readings:

1.	Evolution	Morton Jenkins	McGraw-Hill.
2.	Biology	Campbell N. A. & Reece J. B.	Pearson Benjamin
3.	An Introduction to Genetic Analysis	Griffiths A. F. et al.	Freeman and Comapany.
4.	Genetics	Strickberger M. W.	Macmillan Publ.
5.	Discover Biology	Cain et al.	Sinauer
6.	Genetics: Analysis of Genes and Genomes	Hartl D. L. & Jones E. W.	Jones and Barlett Publishers

Gen 904(iv)- RNAi: BIOLOGY AND APPLICATIONS

2Th-1T-0P = 3 credits

In the postgenomic era, the elucidation of physiological function of genes is extremely important and RNAi has rapidly become one of the key methods used in functional genomics since its discovery in 1998. RNAi is also involved in defense and the regulation of chromatin structure and gene expression. In fact, this elegant and revolutionary reverse genetics approach has tremendous commercial promise with regard to developing new drugs and therapeutics for human diseases as well as the improvement of crop yield and quality. This course covers the basic aspects of RNAi biology, use of siRNA and microRNAs for gene silencing, RNAi vectors and generation of transgenic animals and plants expressing dsRNA. The current and potential applications of RNAi in healthcare and agriculture is also covered.

Discovery of RNA interference (RNAi): PTGS, RNAi and related phenomena. [2]

Categories of small non-coding RNAs: dsRNAs, siRNAs, shRNAs, piRNAs and miRNAs, Detection of small RNAs. [2]

Mechanism of RNAi: Different components of RNAi pathway and their evolutionary conservation and role in gene silencing, RNAi-like pathway in bacteria, Molecular basis of RNAi /siRNA /miRNA mediated gene silencing. RNAi in defense and the regulation of chromatin structure and gene expression; RNAi suppressors. [6]

Large-scale genetic analysis using RNAi: Genome-wide RNAi screens in *C. elegans*, and other systems, High-throughput small RNA profiling, RNAi microarrays. [4]

miRNAs and siRNAs: Pathways, expression and functions of microRNAs, 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. [8]

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; The 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. [10]

Suggested readings:

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|----|--|--------------------------|------------------------------|
| 1. | The RNA World | TEds. 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. | Ed. Gregory J. Hannon | CSHL Press |
| 4. | RNA Silencing: Methods and Protocols | Ed. Gordon G. Carmichael | CSHL Press |
| 5. | RNA Interference in Practice | Ed. Ute Schepers, | Wiley-VCH GmbH & Co. KGaA. |
| 6. | Genes IX. | Lewin B | Jones and Barlett Publishers |

Gen 904(v) - PRINCIPLES OF IMMUNOLOGY

2Th-1T-0P = 3 credits

The course provides a comprehensive overview of basic immunology beginning with the innate immune responses, followed by a study of the main aspects of acquired immunity. Specific interactions of target cells and T cells that are regulated by the MHC molecule and peptide antigens on the target cell and the antigen specific T cell receptor are discussed.

The generation and molecular structure of B and T cell antigen receptors, and signaling through immune receptors are covered in details. The development of antigen specific T and B cells, and specific roles of some cytokines/lymphokines are included. In addition, the course covers in-depth, information on T-and B cell-mediated immunity and topics of clinical relevance, such as microbial immunity, allergy, autoimmunity, tumor immunology, congenital and acquired immunodeficiencies, transplantation immunology, and immunotherapy. All the topics are studied through lectures and an in-depth review of selected articles.

Molecular Immunology: Basic principles and overview of immunity, antigens and antibody production, cellular interactions in the immune system, innate immunity, complement, antibody structure and antigen recognition, immunoglobulin genes, Ig/TCR gene rearrangement & generation of diversity, introduction to immunogenetics & the MHC, antigen recognition by T Cells, TCR, Co-Receptors and MHC structure, antigen processing and presentation. [12]

Mechanisms of host defense: Transmembrane signaling, antigen receptor signaling, hematopoiesis and B Lymphocyte development, B cell tolerance, central T cell tolerance, peripheral T cell tolerance, macrophage function, dendritic cell function, mucosal immunity, humoral immune response and Ab function revisited, APC regulation of the immune response, production of effector T cells, cytotoxic T cell effector mechanisms, immunological memory. [10]

Immunity in health and disease: Introduction to infectious disease, innate immunity to infection, adaptive immunity to infection, evasion of the immune response by pathogens, inherited immunodeficiency diseases, acquired immune deficiency syndrome, IgE and allergic reactions; hypersensitivity diseases, transplant rejection: responses to alloantigens, autoimmunity: responses to self antigens, tolerance and response to self and non-self, tumor immunology, manipulation of immune responses, vaccines, evolution of the immune system. [10]

Suggested readings:

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|----|--|-----------------|-------------------------------------|
| 1. | Immunobiology- The Immune System in Health and Disease | Janeway C. | Taylor & Francis |
| 2. | Immunology | Kuby J. | W. H. Freeman |
| 3. | Essentials of Immunology | Ivan M. Roitt | Wiley-Blackwell |
| 4. | Fundamentals of Immunology | William E. Paul | Lippincott
Williams &
Wilkins |

Gen 904(vi) - INDUSTRIAL MICROBIOLOGY

2T-1T-0P= 3 credits

Microorganisms possess a wide array of enzymatic activities that can be exploited to produce substances of commercial value. Underlying process is fermentation wherein a large number of parameters need to be optimized for successful application. This paper will deal with various aspects of industrial microbiology and the steps involved therein. The production aspects will be covered with some well known examples. The students will also be familiarized with recombinant product production as r-DNA technology has completely changed the scenario.

Introduction to industrial microbiology including sources of industrially important microbes, strain development, types of fermentation and fermenters, process optimization, and recent developments in fermentation technology. [10]

Downstream processing of microbial products [4]

Fermentation economics [4]

Production aspects (microbial strains, substrates, strain improvement, flow diagrams, product optimization, and applications) of industrial alcohol, amino acids (lysine, phenylalanine, tryptophan), antibiotics (cephalosporins, tetracyclines, polyenes), enzymes and immobilized enzymes, SCP, microbial polysters, biosurfactants, recombinant products (insulin, somatostatin, thaumatin). [14]

Suggested readings:

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|----|---|--|---------------------------|
| 1. | Biotechnology: A Text Book of Industrial Microbiology | Crueger W. &
Crueger A. | Panima Publ.
Corp. |
| 2. | Principles of Fermentation Technology | Stanbury, P.F.
Whitaker W. & Hall
S.J. | Butterworth-
Heinemann |
| 3. | Modern Industrial Microbiology & Biotechnology | Okafer N. | Science Publishers |

4	Fermentation Microbiology and Biotechnology	Mansi E. I & Bryce	CRC Press
5.	Fermentation Biotechnology	Ward O. P.	John Wiley & Sons
6.	Industrial Microbiology: An introduction	Waites, Morgan, Rockey & Highton	Wiley-Blackwell
7.	Biochemical Engineering and Biotechnology	Atkinson B. & Mavituna F.	The Nature Press
8.	Microbial Biotechnology: Fundamentals of Applied Microbiology	Glazer A. N. & Nikaido H.	Cambridge University Press

Gen 0905 - PRACTICAL

PART II: Semester-4

Gen 1001 - DEVELOPMENTAL BIOLOGY

4Th-0T-2P = 6 credits

There are proximal and ultimate explanations for development. Importantly, today for the first time one can begin to see how they might link up. These are based on molecular biology, genetics, biochemistry and mechanical properties of cells on the one hand, and evolutionary arguments on the other, with much of interplay between the two. Keeping this in mind, the course envisages giving an insight into how developmental patterns arise using examples from different model systems and highlighting regulatory networks involved in these processes. The students are however expected to have studied the basic processes of development (animal and plant embryology). The emphasis would be on experiments done which led to various concepts. The students are urged to read: "The art of the genes –How organisms make themselves by Enrico Coen".

Approaches to developmental biology: Anatomical, genetic, evolutionary, teratology, mathematical modeling and experimental approaches. [4]

Life cycles and evolution of developmental patterns. [2]

Introduction to model organisms: *Dictyostelium*, *Caenorhabditis elegans*, *Drosophila*, Zebrafish, Xenopus, Chick, Mouse, *Arabidopsis* and Rice. [8]

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. [6]

Fertilization and early development in animals: Cleavage, gastrulation, cell specification; axis and pattern formation with examples from *C. elegans*, *Drosophila*, amphibians, chick and mammals. [20]

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in *Dictyostelium*, formation of vulva in *C. elegans*, induction of development of compound eye in *Drosophila*, limb development and regeneration in vertebrates. [12]

Environmental regulation of animal development [4]

Developmental process in plants: Gametophyte development and fertilization, post-fertilization changes, organization of shoot and root apical meristem, shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and Rice. [12]

Developmental mechanisms of evolutionary change [2]

Suggested readings:

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|----|---|---------------------------|----------------------------|
| 1. | Developmental Biology | Gilbert S. F | Sinauer Asso. |
| 2. | Principles of Development | Wolpert L et al. | Oxford University Press |
| 3. | The Art of the Genes: How Organisms Make Themselves | Coen E. | Oxford University Press |
| 4. | Genetic Analysis of Animal Development | Wilkins A. S. | Wiley-Liss |
| 5. | Biological Physics of the Developing Embryo | Forgacs G. & Newman S. A. | Cambridge University Press |

Gen 1002 – DROSOPHILA GENETICS

4Th-0T-2P = 6 credits

The course has been designed to provide advanced understanding of Drosophila genetics. The teaching will include both knowledge-based sessions (to facilitate understanding of concepts) and skill-based sessions (application of knowledge and skills in practical activities).

Life cycle and advantages of *Drosophila* as a model organism for genetic analysis [4]

***Drosophila* development:** [12]

- (a) Embryonic development
- (b) Maternal genes and formation of body axes
- (c) Segmentation genes
- (d) Homeotic genes and their functions
- (e) Larval stages and tissue types
- (f) Imaginal discs: development and differentiation
- (g) Pupa and metamorphosis
- (h) Adult morphology and internal organs
- (i) Spermatogenesis and oogenesis
- (j) Stem cells in *Drosophila*

Polytene chromosome: Maps, puffing and utility. [4]

Basics of setting up *Drosophila* crosses [6]

Nomenclature of gene mutations, balancer chromosomes [3]

Mutagenesis and isolation of new variants: [7]

- (a) X-ray and chemical mutagenesis
- (b) P-element and insertional mutagenesis

- (c) Mapping of new mutations by recombination, deletion and complementation mapping

Generation of Transgenic *Drosophila*: [6]

- (a) Germ-line transformation and selection of vectors.
- (b) Application of P-element based vectors in transgenic generation

Advanced *Drosophila* genetics: [10]

- (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

***Drosophila* model for human genetic disorders** (e.g. Parkinson's, Huntington's, Alzheimer's diseases etc.). [6]

Overview of *Drosophila* genome project: Online databases and other resources for *Drosophila* genetics [6]

Suggested readings:

1.	Developmental Biology	Gilbert S. F.	Sinauer
2.	Development of <i>Drosophila melanogaster</i> (Vol I & II)	Bates and Arias	CSHL Press
3.	<i>Drosophila</i> Guide	Demerec and Kaufmann	Carnegie
4.	<i>D. melanogaste</i> : Practical Uses in Cell and Molecular Biology	Goldstein and Fyrberg	Academic
5.	The making of a fly: The genetics of animal design	Lawerence	Blackwell
6.	<i>Drosophila</i> : Methods and Protocols	TDahmann C.TTT	Humana
7.	Fly Pushing: The Theory and Practice of <i>Drosophila</i> Genetics	Greenspan R. J.	CSHL Press
8.	<i>Drosophila</i> : A Practical Approach	Roberts D. B.	CSHL Press
9.	Compiled reviews and research papers		

Gen 1003 - GENETICS OF BACTERIA AND THEIR VIRUSES

4Th-0T-3P = 6 credits

Though microorganisms have had a late entry in the field of genetics, once that happened, they quickly occupied the centre stage. Combining the structural simplicity with the unifying genetic basis, they offered immediate advantages in studying all the three aspects of heredity: the generation, expression, and transmission of biological variation. Bacteria and their viruses have been extensively exploited for genetic analyses providing important leads on gene function and gene manipulations. This paper deals with the strength of bacterial and phage genetics in terms of transmission of the genetic information, as the other two aspects are dealt with separately other courses. In phage

systems, their interaction with the host both under lytic and lysogenic as well as transpositional mode with the subsequent impact on the host are also included. Some topics of general interest where these systems have contributed significantly are also covered.

Bacteria as model systems in genetic analysis: Mutation, recombination, test of allelism, gene mapping. [6]

Methods of gene transfer in bacteria:

Conjugation: Discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F', map of F plasmid, mechanism of chromosome transfer, molecular pathway of recombination. Chromosome transfer in other bacteria. [12]

Transformation: Natural transformation systems, Biology and mechanism of transformation, transformation and gene mapping, Chemical-mediated and electrotransformation. [8]

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. [8]

Techniques for studying bacteriophages: Virulent phage (TB_{4B}) and Temperate phage (phage lambda). Important aspects of lytic cycle, phage-host relationships, immunity and repression. Site specific recombination (lambda and P1). [16]

Transposable phage (phage Mu): Genetic organization, and transposition, Mu as a genetic tool. [5]

Plasmids: Types, detection, replication, incompatibility, partitioning, copy-number control and transfer. Properties of some known plasmids. [6]

Genetic rearrangements and their evolutionary significance: Phase variation in *Salmonella*. [3]

Suggested readings:

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|----|--|--------------------------------------|--------------------|
| 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. | Others books on Genetics, Molecular biology, and Molecular Genetics. | | |
| 9. | Several Research papers, reviews, and Articles. | | |

Gen 1004 - FUNGAL GENETICS

4Th-0T-3P = 6 credits

The course is designed to provide some fundamental, theoretical principles on which to form an integrated view of various genetic and molecular processes using Fungi as model system. Tutorials would be in form of discussion based on recent reviews available related to each topic, highlighting the advances made in each field.

Overview of Fungal Biology: Fungal life cycle and various phases, Fungi in nature, fungi in biotechnology, and as experimental tools, Special fields of interest: metabolic studies and biotechnology, plant-pathogenic relationship. [6]

Fungi as model systems: Mutants and wild types: Isolation of various kinds of mutants, functional mutants (auxotrophs, conditional lethals, resistance mutants, reverse mutants) Characterization of mutants: complementation and functional allelism. [6]

Parasexual analysis: Parasexual cycle, heterokaryosis and protoplast fusion, haploidisation, mitotic crossover and recombination, genetic analysis. [6]

Meiotic Recombination: Methods of analysis, linkage: tetrad analysis, gene mapping gene conversion. [8]

Extra-chromosomal elements: Mitochondrial genome, mitochondrial plasmids, 2-micron plasmid, killer plasmid, linear plasmids. [4]

Epigenetic gene silencing in filamentous fungi: [16]

- a) RIP
- b) MIP
- c) Quelling
- d) Heterothallism and mating type switch

Transposable genetic elements in filamentous fungi retroposons, reterotransposons (transposon trapping) in fungi. [8]

Genetic transformation and vector development in fungi. [4]

Genetic engineering: Yeast 2-hybrid system and its variations - one-, and three- hybrid system in the study of nucleic acid-protein interaction. [8]

Suggested readings:

1.	Fungal Genetics: Principles and Practice	Bos C J.	CRC
2.	The Mycota	Ed. Esser K. & Lemke P. A.	Springer
3.	Essential Fungal Genetics	Moore D.& Frazer N.	Springer
4.	Fungal Genetics	Fincham	Springer

Other Information (if any) :

- Centre for Genetic Manipulation of Crop Plants (CGMCP), funded by the National Dairy Development Board (NDDB), New Delhi
- Centre for Excellence in Genome Sciences and Predictive Medicine, funded by the Department of Biotechnology, New Delhi (Govt. of India)
- Centre for Excellence in Genome Mapping and Molecular Breeding in Brassicas, funded by the Department of Biotechnology, New Delhi (Govt. of India)
- Department has established a small library and has procured some reputed international journals and books through UGC Special Assistance Programme

- Department has a Genetics Club, which regularly organizes seminars, which are given by the faculty, postdoctoral fellows and doctoral students