MASTER OF SCIENCE IN GENETICS

TWO YEAR FULL TIME PROGRAMME

RULES, REGULATIONS, COURSE CONTENTS AND ENTRANCE FROM FOR SESSION 2011-12

Department of Genetics
FACULTY OF INTERDISCIPLINARY AND APPLIED SCIENCES
UNIVERSITY OF DELHI, SOUTH CAMPUS
NEW DELHI – 110 021
INDIA

DEPARTMENT OF GENETICS

The Department of Genetics was established in 1984, as a part of the Faculty of Inter-disciplinary & Applied Sciences at the University of Delhi South Campus. In its brief period of existence the department has developed into an advanced centre of study in Genetics recognized by the University Grants Commission (UGC) under their Special Assistance Programme (SAP-phaseII) and Department of Science & Technology under their FIST programme. Two of the faculties also have Centers of Excellence supported by Department of Biotechnology.

The department conducts a two year post-graduate programme in Genetics, a one year M.Phil. programme in Biotechnology and a Ph.D. programme. Through its interdisciplinary approaches involving interactions with different institutes and departments in the country, the department not only offers a unique opportunity to imbibe knowledge from experts in different fields but also helps maintain a high academic standard. Teaching in the department is also supported by research activities in frontline areas being pursued by the faculty of the department. M.Sc. students are encouraged to interact intensively with the faculty as well as research scholars of the department.

M.Sc. Programme – The Department offers a 2-year (based on four semesters) M.Sc. programme in Genetics. Students with Bachelor's degree in any area of Life Sciences / physical sciences / chemical sciences / mathematical sciences / medical sciences / pharmacology / any branch of biology / paramedical sciences with at least 60% marks in their main subject (for Hons. stream) or in aggregate (for B.Sc general) or other equivalent undergraduate degree are selected through a national level entrance test. The course consists of core areas in Molecular Genetics (microbial, *Drosophila,* plants and humans) as well as related areas like Biochemistry, Biostatistics, Developmental Biology, Recombinant DNA Technology and Bioinformatics. Apart from the core courses, students can select few courses of their choice from a bunch of elective courses. Some of the courses are offered by other departments. Class room seminars, discussions, written tests, project work and hands on practical training are integral components of the course. Students are continuously evaluated during the course. Various scholarships viz., Merit Scholarship, All India Post Graduate Scholarship and Monsanto Post Graduate Scholarship are also available for the M.Sc students. Students are encouraged to clear UGC/CSIR-NET while pursuing their M.Sc. course. Students passing M.Sc. Genetics and are registered for Ph.D in the Department can also apply for University Teaching Assistantship (conditions apply).

M.Phil (Biotechnology) Programme – The Department also offers an M. Phil programme in Biotechnology (one year duration), jointly with the Departments of Biochemistry, Biophysics and Microbiology. Candidates are selected through an open interview. This is a unique interdisciplinary programme jointly conducted by the four departments of the Faculty of Inter-disciplinary & Applied Sciences. M.Phil. students are required to take three courses followed by a dissertation in any one area.

Ph.D. Programme – Interdisciplinary research in the frontline areas of Microbial Genetics, Plant Genetics, Molecular Breeding and Biotechnology, Human Genetics, *Drosophila* Genetics, yeast Genetics, Plant-Microbe Interactions, RNAi technology, Developmental Genetics and Molecular Biology are carried out in the department. Students having fellowships instituted by the university and national and international agencies are registered provisionally under this programme. Students have to pass a course work (consisting of two courses) before confirmation of registration. The research facilities in the different laboratories are open to all the students. Six monthly periodical monitoring of work progress of Ph.D scholars is followed up and work record is maintained per student basis. Research emanating from these projects is regularly published in journals of national and international repute.

Financial Support - Financial support to the department is mainly accorded by UGC. The department has been recognized under UGC-SAP (2002-) and DST-FIST (2003) programmes. These two special grants have helped the Department to improve and strengthen the infrastructure facilities for both teaching and research. The Department has state of the art facilities that are open to all M.Sc., M.Phil. and Ph.D. students. All the labs and offices are provided with adequate computer facilities and are connected through campus-wide networking. Besides the Institutional grants, the faculty also attracts funding from national and international agencies as well as industrial houses to augment the research activities. A large number of research staff, post-docs as well as research scientists work under various projects. Many research scientists with independent funding from DBT, DST, ICMR, and CSIR are also associated with different labs. All this has helped in maintaining a high quality research profile in the Department.

Performance of Alumni – The information provided below may help the aspiring students to pursue their career in M.Sc. (Genetics) at the University of Delhi South Campus. After introduction of entrance examination for admission to M.Sc. (Genetics), fourteen batches of students have passed out from the Department and are currently employed as faculty members in Universities and research Institutions in India and abroad or working as post doctoral fellow or pursuing their Ph.D. at reputed research institutions in India and abroad.

Year of passing	No. of students passed out	No. of students cleared CSIR/UGC – JRF	Ph.D. placement
2002 – 03	4 (4)	4	1 – JNCASR, Bangalore 2 – NII, New Delhi 1 – ICGEB, New Delhi
2003 – 04	5 (5)	5	1 – Univ. of Florida, USA 2 – CCMB, Hyderabad 2 – UDSC, New Delhi
2004 – 05	5 (5)	4	1 – JNCASR, Bangalore 2 – NCBS, Bangalore 2 – UDSC, New Delhi
2005 – 06	5 (5)	5	1 – Michigan Univ. 1 – Zurich, Switzerland 1 – JNCASR, Bangalore 1 – UDSC, New Delhi 1 – Pune Univ.
2006 – 07	5(5)	5	3 - Foreign Universities 1 - NII, New Delhi 1 - BITS,Pilani
2007-08	5(5)	5	1- Basel, Switzerland 1 – Oxford, UK 2 – IISc, Bangalore 1 – TIFR, Mumbai
2008-2009	9(9)	8	2-Cambridge, UK 1-France 2-Australia 1-CCMB, Hyderabad 1-IGIB, New Delhi 1-ACBR, New Delhi
2009-10	11 (11)	11	4- Deptt. Of Genetics University of Delhi 1- Germany Max plank 1- UK Kings College 1- NII, New Delhi 1- ACTREC, Mumbai
2010-2011	Result awaited (12)		

Figure in the parenthesis indicates the number of students admitted.

MASTER OF SCIENCE (GENETICS)

TWO YEAR FULL TIME PROGRAMME

AFFILIATION

The proposed Programme shall be offered and governed by the Department of Genetics, Faculty of Interdisciplinary and Applied Sciences, University of Delhi South Campus, New Delhi – 110 021.

PROGRAMME STRUCTURE

The M.Sc. Programme is divided into two parts as under. Each part will consist of two semesters totaling to four semesters.

Each theory paper will be of 70 marks in the final examination and 30 marks are for internal assessment (25 marks for class tests / seminar / dissertation + 5 marks for attendance).

PART I: Semester – 1

Paper Gen 0701 -	**Concepts of Genetics**		**100**
Paper Gen 0702 -	**Chromosomes, Genes and Genomes**		**100**
Paper Gen 0703 -	**Biostatistics and Population Genetics**		**100**
Paper Gen 0704 -	**Concepts in Cell and Molecular Biology**		**100**
Paper Gen 0705 -	**Practical including continuous assessment**		**200**
Total Marks	**Theory**	**400**	
	Practical	**200**	
Grand Total			**600**

PART I: Semester – 2

Paper Gen 0801 -	**Gene Expression and Regulation**		**100**
Paper Gen 0802 -	**Human Genetics**		**100**
Paper Gen 0803 -	**Molecular Plant Breeding**		**100**
***Paper PMBB 0804 -**	**Introduction to Bioinformatics**		**100**
Paper Gen 0805 -	**Practical including continuous assessment**		**200**
Total Marks	**Theory**	**400**	
	Practical	**200**	
Grand Total			**600**

*** To be offered by Department of Plant Molecular Biology**

Note: Department will organize an add-on course on Techniques and Instrumentation

PART II: Semester – 3

Paper Gen 0901 -	**Students' seminar**		**50**
***Paper Microb 0902 -**	**Recombinant DNA Technology**		**100**
Paper Gen 0903 -	**Plant Genetic Engineering**		**100**
Paper Gen 0904 -	**Elective Courses (any three)**		**50x3**
Paper Gen 0905 -	**Practical including continuous assessment**		**200**
Total Marks	**Theory**	**400**	
	Practical	**200**	
Grand Total			**600**

*** To be offered by Department of Microbiology**

Elective Courses: Any three courses to be selected from the available electives

Paper Gen 904 (i)	**Plant-Microbe Interaction**	**50**
Paper Gen 904 (ii)	**Medical Genomics**	**50**
Paper Gen 904 (iii)	**Genetic Variation and Evolution**	**50**
Paper Gen 904 (iv)	**RNAi: Biology and Applications**	**50**
Paper Gen 904 (v)	**Basic Immunology**	**50**
Paper Gen 904 (vi)	**Industrial Microbiology**	**50**

PART II: Semester – 4

Compulsory Courses:

Paper Gen 1001 -	**Developmental Biology**		**100**
Paper Gen 1002 -	***Drosophila* Genetics**		**100**
Paper Gen 1003 -	**Genetics of Bacteria and Their Viruses**		**100**
Paper Gen 1004 -	**Fungal Genetics**		**100**
Paper Gen 1005 -	**Practical including continuous assessment**		**200**
Total Marks	**Theory**	**400**	
	Practical	**200**	
Grand Total			**600**

LIST OF ELECTIVE PAPERS

The Department will announce in the beginning of the respective semesters, the list of elective papers which will be offered during the semester depending upon the faculty members and the demand for electives.

Elective Courses: Any three courses to be selected from the available electives

Paper Gen 1004 (i)	**Plant-Microbe Interactions**	**50**
Paper Gen 1004 (ii)	**Medical Genomics**	**50**
Paper Gen 1004 (iii)	**Genetic Variation and Evolution**	**50**
Paper Gen 1004 (iv)	**RNAi: Biology and Applications**	**50**
Paper Gen 1004 (v)	**Basic Immunology**	**50**
Paper Gen 1004 (vi)	**Industrial Microbiology**	**50**

SCHEME OF EXAMINATIONS

1. English shall be the medium of instruction and examination.

2. Examinations shall be conducted at the end of each Semester as per the Academic Calendar notified by the University of Delhi.

3. The system of evaluation shall be as follows:

   Each theory course will carry 100 marks, which include 70 marks for semester end examination and 30 marks for internal assessment. Internal assessment is based on classroom participation, seminar, term papers, tests and attendance. The weightage given to each of these components shall be decided and announced at the beginning of the semester by the individual teacher responsible for the course. Any student who fails to participate in classes, seminars, term courses and tests will be debarred from appearing in the end-semester examination in the specific course and no internal assessment marks will be awarded. His/her internal assessment marks will be awarded as and when he/she attends regular classes in the courses in the next applicable semester. No special classes will be conducted for him/her during other semesters.

   The remaining 70 marks in each paper shall be awarded on the basis of a written examination at the end of each semester. The duration of written examination for each paper shall be three hours.

   As regards practical examination (Papers 0705, 0805, 0905, 1005), the scheme of evaluation shall be as follows:

   Practical work conducted during the semester shall be evaluated for a total of 200 marks.

   3.4.2. There shall be viva-voce at the end of the semester- during practical examination.

4. Examinations for courses shall be conducted only in the respective odd and even semesters as per the Scheme of Examinations.

PASS PERCENTAGE

Students are required to pass both in theory and practical examinations. Minimum marks for passing the examination in each semester shall be 45% in aggregate in theory courses, 45% in practical courses and 45% marks in dissertation (if applicable) with ay least 40% in each theory paper.

However, a candidate who has secured the minimum marks to pass in each paper but has not secured the minimum marks to pass in aggregate may reappear in any of the paper/s of his/her choice in the concerned semester in order to be able to secure the minimum marks prescribed to pass the semester in aggregate.

No student would be allowed to avail of more than 3 chances to pass any paper inclusive of the first attempt.

PROMOTION CRITERIA

SEMESTER TO SEMESTER: Within the same part, the candidate will be promoted from a Semester to the next Semester (Semester 1 to Semester 2 and Semester 3 to Semester 4), provided the candidate has passed at least two of the papers of the current semester by securing at least 40% marks in each paper.

Note:

1. A candidate will be permitted ONLY ADDITIONAL TWO CHANCES to pass a theory paper.
2. A candidate who does not appear in theory paper will be allowed ONLY ONE more attempt to pass the paper. No further attempts for improvement will be allowed.
3. A candidate will not be allowed to reappear (even if he/she in absent) in the practical examination)

PART I TO PART II: Admission to Part-II of the Programme shall be open to only those students who have fulfilled the following croteria:

1. Have scored at least 45% marks in the practical papers of both Semester 1 and 2 taken together,
2. Have passed at least 75% of the theory papers (6 papers) offered in the course of Part 1 comprising of Semester 1 and Semester 2 by securing at least 40% marks in each of these papers.
3. Have secured at least 45% in aggregate of all theory papers of Part 1.

Note: The candidate however will have to clear the remaining papers while studying in Part II of the programme.

AWARD OF DEGREE

A candidate will be awarded M.Sc. degree at the end of semester 4 provided he/she has:

1. passed all the theory papers of Part 1 (Semester I and II) and Part II (Semester III and IV) by securing at least 40% marks in each paper and has also obtained al least 45% in aggregate of Part I and Part III,
2. passed the practical examination by securing at least 45% in aggregate of Part I and Part II, separately and
3. passed dissertation (if applicable) by securing at least 45% of marks.

Candidates who have fulfilled criteria 2 and 3 (wherever applicable) but not criteria 1:

1. Can reappear for theory papers as per University riles.
2. A candidate must pass the M.Sc. examination within the span period.
3. No candidate shall be allowed to reappear for practical or dissertation.

SCOPE FOR IMPROVEMENT

As per University rule

DIVISION CRITERIA

Successful candidates will be classified on the basis of the combined results of Part-I and Part-II examinations.

Candidates securing 60% and above	:	I Division
Candidates securing between 50% and less than 60%	:	II Division
All others	:	Pass

SPAN PERIOD

No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of **Four years** from the date of admission to the Part-I/Semester 1 of the M.Sc. Programme.

ATTENDANCE REQUIREMENT

No student shall be considered to have pursued a regular to have pursued a regular course of study unless he/she is certified by the Head of the Department of Genetics, University of Delhi, to have attended 75% of the total number of lectures, tutorials and seminars conducted in each semester, during his/her course of study. Provided that he/she fulfils other conditions the Head, Department of Genetics may permit a student to the next Semester who falls short of the required percentage of attendance by not more than 10 per cent of the lectures, tutorials and seminars conducted during the semester.

COURSE CONTENT FOR EACH COURSE AND LIST OF READINGS:

Appendix 1

Appendix 1

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]

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*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: Johannsen 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:

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:

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:

1.	Human Genetics: Problems and Approaches	TVogel F. and. Motulsky A. GT	Springer Verlag
2.	Human Molecular Genetics	Strachan T & Read A	Garland Science
3.	An Introduction to Human Molecular Genetics: Mechanism of Inherited Diseases	Pasternak J	Fitzgerald Science Press
4	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:

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 teritiary 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:

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 libaries, Steps and enzymes involved, method of screening libraries,screening expression libraries, Positive selection and subtractive hybridyzation 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 Northen 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:

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:

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:

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-implatation

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:

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:

1.	The RNA World	TEds. TGesteland 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:

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

2Th-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. Microbial Biotechnology has thus become a thriving industry.

Introduction to industrial microbiology including sources of industrially important microbes, strain development, types of fermentation and fementers, 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 alchohol, amino acids (lysine, phenylalanine, tryptophan), antibiotics (cephalosporins, tetracyclines, polyenes), enzymes and immobilized enzymes, SCP, microbial polysters, biosurfactants, recombinant products (insulin, somatostasin, thaumatin). [14]

Suggested readings:

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:

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 *Drosophila melanogaster* (Vol I & II)	Bates and Arias	CSHL Press
3.	*Drosophila* Guide	Demerec and Kaufmann	Carnegie
4.	*D. melanogaste:* 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.	*Drosophila*: Methods and Protocols	TDahmann C.TTT	Humana
7.	Fly Pushing: The Theory and Practice of *Drosophila* Genetics	Greenspan R. J.	CSHL Press
8.	*Drosophila*: 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 in 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 (T_4) 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:

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

FACULTY

PROFESSORS:

Dr. Deepak Pental
Plant Biotechnology

Dr. Sheela Srivastava
Microbial Genetics and Biotechnology

Dr. Akshay K. Pradhan
Plant Genetics and Molecular Breeding

Dr. M. Venkat Rajam
Plant Genetic Engineering & RNAi

Dr. B.K. Thelma
Human Genetics

ASSOCIATE PROFESSOR:

Dr. P. K. Burma
Plant Biotechnology

ASSISTANT PROFESSORS:

Dr. Surajit Sarkar
Drosophila Genetics and Developmental Genetics

Dr. Jagreet Kaur
Plant Genetics and Plant-Microbe Interactions

Dr. Naorem Aruna Devi
Developmental Biology

Dr. Tapasya Srivastava
Cancer Genetics

Dr. Kaustuv Dutta
Yeast Mitochondrial Biology

RESEARCH PROFILE OF FACULTY

Prof. D. Pental, Prof. A.K. Pradhan

The major activity of the group is the genetic improvement of oilseed mustard (*Brassica juncea*) through conventional and biotechnological approaches. The major achievement in the form of tangible product is the development of the first ever hybrid in mustard, DMH-1, which gives 20-30% higher yield than pure line varieties. Another major area of activity is the molecular mapping and marker-assisted breeding of agronomically important traits in mustard. Some of the significant achievements are development of high-density molecular map of mustard, molecular tagging of many important quality traits such as, erucic acid by SNPs in the candidate genes, seed coat color by microsatellite markers and seed glucosinolates by both candidate genes and anonymous markers and QTL dissection of quantitative traits pertaining to yield. A comparative map of *B. juncea* consisting of *Arabidopsis thaliana* single copy gene sequences was developed which is being used for tagging agronomically important genes and candidate gene identification. The group is actively involved in marker-assisted introgression of quality traits in *B. juncea* through conventional plant breeding and through large scale application of doubled haploid (DH). Recently, a Centre of Excellence on genome mapping and molecular breeding in Brassica has been granted by the Department of Biotechnology, Government of India

Prof. Sheela Srivastava

Prof. Srivastava's group is engaged in research on heavy metal tolerance in microbial systems with emphasis on characterization of the genetic basis of resistance in soil bacteria isolated from polluted sites. Genes conferring resistance to zinc, copper and nickel have been cloned and functionally characterized and resistance mechanism has been worked out. Metal accumulating bacteria have been identified and their potential role in bioremediation and redistribution of metals has been studied. Additionally, the group is also actively engaged in studies on antimicrobial peptide antibiotics, bacteriocins from lactic acid bacteria for the development of effective broad-range biopreservatives. Some bacteriocins with novel properties have been purified and characterized looking at the features critical for their application. Genetic analysis is in progress. Major gene and its regulatory sequence in IAA biosynthesis pathway have been cloned and characterized from *Azosprillum brasilence*. Genetic/pathway manipulation has led to enhanced IAA production and superior bioinoculant strains. Biocontrol property of some rhizospheric isolates of *Pseudomonas flurescens* is being currently evaluated as part of the program on plant growth promoting rhizospheric bacteria. Interacion between different isolates, as sell as their rhizospheric competence is being checked and confirmed under *in vivo* conditions. Another major area of interest deals with metagenomic analysis for the identification of novel functions.

Prof. B.K. Thelma

Medical genomics and translational science occupies a pivotal position in contemporary biomedical research. As a Centre of excellence on "Genome Sciences and Predictive Medicine" multiple aspects of research are being pursued in the laboratory by employing an interdisciplinary approach- fostering synergy amongst geneticists, medical practitioners, biochemists, cell biologists, statisticians, computational biologists and bioinformaticians. Attempts to understand the biology of common as well as emerging complex diseases such as Rheumatoid arthritis and Ulcerative colitis respectively by genome wide search for genetic variants conferring disease susceptibility and identifying novel pathways therein; translation of this knowledge to develop novel drug molecules and generate predictive medicine tools are a major area of research focus in the lab and probably one of the very few of its kind in the country. Identification and functional analysis of critical genetic variants singly or in a haplotypic configuration for determination of phenotypes is a related area of work being pursued in the lab. Another exciting project is on genetics of brain disorders such as Mental retardation, Parkinson's disease and Schizophrenia where the emphasis is on novel gene identification

using the rich resource of familial forms of these disorders available in the country combined with powerful next generation sequencing technologies. Developing predictive algorithms to enable pre-prescription testing of commonly used drugs is the long term goal of the projects under Pharmacogenomics in the laboratory.

Prof. M.V. Rajam

My research uses transgenic and other molecular approaches like RNAi to address a wide range of fundamental questions in plant development and stress responses. We have developed several rice, eggplant and tomato transgenics, tolerant to abiotic and biotic stresses by over-expressing various stress-related genes, notably polyamine biosynthesis genes. We have also developed transgenic tomatoes for delayed fruit ripening for longer shelf-life and improved fruit quality by over-expressing polyamine biosynthetic genes during fruit development. These studies provide clues to basic molecular and cellular mechanisms underlying the plant development and stress responses, which we are actively persuing. Work is also undertaken to stack transgenes in transgenic eggplant and tomato for enhanced tolerance to abiotic and biotic stresses. For the past several years, I have been working on the molecular dissection of polyamine biosynthesis in crop plants, and also in a model organism *Chamydomonas reinhardti*i to decipher the roles of polyamines in various biological processes, and rigorous analysis of this important pathway has yeilded insights into the molecular and cellular basis for plant development processes and stress tolerance, and is opening new opportunities for the improvement of crop plants.

The current major research interests of my laboratory is to use RNAi technology to unravel the functions of polyamine biosynthesis genes in various developmental processes, including fruit ripening, male sterility, senescence and stress responses as well as to develop transgenic tomato, eggplant and cotton plants for disease, insect and nematode resistance through plant RNAi- mediated silencing of vital genes of the target pathogens and pests. Besides, virus resistant sweet orange transgenics, male sterility transgenic tomato and marker-free transgenic tomato are being produced by using RNAi and other approaches. Farther, we are also working on the control of cancer and human fungal pathogens by silencing some important genes by siRNAs. Silencing of vital gene of a fungal pathogen (*Aspergillus nidulans*) and insect pest (*Helicoverpa armigera*) by siRNAs for their control *in vitro*, development of marker-free and double transgenics of tomato for stress tolerance and slow ripening transgenic tomatoes are some of our recent significant achievements.

Dr. P.K. Burma

The introduction of insect resistant Bt cotton in India has led to the integration of genetically modified crops into agriculture. Although development of transgenic crops is being routinely done, the full potential of the transgenes used in these crops are not being realized as their expressions need to be properly optimized. The group is engaged in developing strategies to optimize transgene expression in plants by targeting transcriptional as well as post-transcriptional processes. Identifying and synthesizing novel promoters for both constitutive and tissue specific expression is one area being pursued. At the post-transcriptional level work on intron-mediated enhancements (IME) of gene expression and strategies to improve translational efficiency is being carried out.

The knowledge generated from the basic research is being utilized to develop transgenics in cotton. In the work on developing insect resistant cotton using Bt toxin genes, achieving appropriate levels of expression of the Bt gene without compromising the fitness of the plant was found to be a major bottle neck. Our work on cotton and tobacco demonstrated that accumulation of high levels of Cry1Ac protein was detrimental to plant regeneration and development. Such observations have been probably overlooked earlier as most of the studies were focused to identify a potential useful line. The work is currently being pursued to develop strategies to circumvent this problem. The second project on cotton is to develop a pollination control mechanism (using *barnase* and *barstar* genes) for production of hybrid seeds. The work on transgenic development is being carried out jointly with Prof. Deepak Pental.

Dr. Surajit Sarkar

Aging is a subject of interest to humans since the beginning of recorded history, yet, it remains largely, if not completely, mysterious. Aging is also associated with several neurodegenerative disorders. The major focus of our research is to understand the genetic and cellular basis of aging process and neurodegeneration, and to identify new genes involved. In addition, we are also characterizing developmental role of some stress genes and its possible role in progression of aging and neurodegeneration. To address these questions we utilize *Drosophila* as our model organism where we can take full advantage of a powerful array of genetic, molecular, and cellular approaches. Furthermore, availability *Drosophila* models of human neurodegenerative diseases providing an opportunity to study the normal function of disease proteins, as well as study of effects of familial mutations upon targeted expression of human mutant forms in the fly. By investigating these genes, it is expected to gain insights into the neurodegenerative disorders and aging phenomenon.

Dr. Jagreet Kaur

Plants are prone to attack by a variety of pathogens and plant diseases account for a significant role in yield losses in agriculture. Necrotrophs comprise the largest class of fungal plant pathogens and cause some of the most destructive of plant diseases. To study the plant-pathogen interaction, we are examining how the necrotrophic fungus, *Alternaria brassicae*, interacts with the model plant Arabidopsis as well as the closely related Brassica juncea. The major focus of our study is to understand how the plant recognizes the pathogen invasion and what kind of downstream resistance responses are activated in both resistant and susceptible plants. We are employing genetic and molecular approaches for identification and functional analysis of novel factors that determine plant susceptibility and/or resistance to *Alternaria* infection. Findings from our work will significantly advance the present level of understanding of host-necrotroph interactions and these results can be further extrapolated to improve durable resistance in crop plants using genetic engineering approaches.

Dr. Naorem Aruna Devi

The basic leucine zipper (bZIP) domain-containing proteins form one of the largest families of transcription factors in eukaryotic cells. These proteins dimerise to form homodimers and heterodimers with other bZIP proteins through their leucine repeats forming a coiled-coil with flanking α-helices that constitute the basic region for interacting with DNA bases. They play diverse roles in mediating cell proliferation, differentiation, inflammatory responses, metabolism, cellular transformation, oxidative stress response, multidrug resistance, oncogene-induced senescence and tumorogenesis etc.

Dictyostelium discoideum provides a good model system for studying morphogenesis and differentiation. One of its principal attractions is the distinct separation of its life cycle into a unicellular proliferative stage, during which a unicellular amoeba are distinguishable from one another, and a multicellular stage, during which a series of morphogenetic events involve amoeba with clearly different functional characteristics and are accompanied by extensive shifts in the enzyme patterns and metabolic contents of the cell.

Our main interest is in the area of transcription and its regulation. We are interested in elucidating the role of bZIP transcription factors and other proteins involved in differential expression of genes accompanying morphogenesis and cell differentiation in *D. discoideum*.

Dr. Tapasya Srivastava

My lab is interested in studying the various mechanisms which contribute to induction of genomic instability in primary tumors and in model systems which mimic the tumor microenvironment. We use hypoxia as a model of cellular stress and study its implications in stress induced molecular and

cellular changes in the tumor cell. Addressing this issue with reference to efficacy of small molecule modulators with/without genotoxic agents has tremendous implications in cancer therapy.

Dr. Kaustav Dutta

Mitochondria are the power house of the cell. Its proper biogenesis is critical as 1 in 5,000 humans suffers from a mitochondrial disease. *Saccharomyces cerevisae* is an attractive model system for studying mitochondrial biology due to its ability to survive without respiration, permitting the characterization of mutants that impair mitochondrial function. My lab is focused on using molecular, genetic and biochemical approaches in deciphering the role of a novel class of GTPases that are involved in mitochondrial ribosome biogenesis.

M.Sc. ENTRANCE EXAMINATION (2010)

The scheme of entrance test is as follows:

Eligibility: A student seeking admission to M.Sc. (Genetics) must have passed B.Sc. (General) or B.Sc (Hons.) or an equivalent undergraduate degree in any branch of life sciences / physical sciences / chemical sciences / mathematical sciences / medical sciences / pharmacology / any branch of biology / paramedical sciences with at least 60% marks in their main subject (for Hons. stream) or in aggregate (for B.Sc general) or other equivalent undergraduate degree. Those appearing for their final year exams can also appear for the entrance test, but they will have to produce the provisional certificate of results by the end of July of the concerned year. The applicant must be at least 20 years of age on first October of the year in which he or she seeks admission. Relaxation upto one year is permissible only with the approval of the Vice Chancellor.

Mode of Selection: Written Exam + Interview

Total Marks: 100 marks (Written paper = 80 marks; Interview = 20 marks)

Pattern of Written Exam:

Objective type (Multiple choice): Based on B.Sc. syllabus of Delhi University with an emphasis on Biology and Genetics

Candidates based on their merit in the written exam will be called for interview for final selection. The number of candidates to be called for interview will be approximately five times the intake capacity of the course.

No. of Seats	**12** (GEN 6; OBC 3; SC 2; ST 1)
Entrance Fee	**Rs.500/- (Rs.250/- for SC/ST candidates)** **(Only by DD)**
Application form available from	23rd May, 2011
Last Date for submission of Application	24th June, 2011
Date, Time & Duration of Exam	29th June 2011 10:00 A.M., 2 Hours Reporting time 9.00 A.M., Exam hall entry 9.30 A.M., Last entry 10.00A.M
Venue of Written Exam	Arts Faculty Building, University of Delhi South Campus New Delhi - 110 021
Names of qualified candidates for interview to be displayed on notice board of the department	30th June, 2011
Date of interview	1st and 2nd July, 2011
Declaration of final Result	4th July, 2011

The candidates should send their completed application along with photo copies of each of the marksheet of B.Sc. exam; and Matriculation / Secondary School Certificate bearing the date of birth, to **The Head, Department of Genetics, University of Delhi - South Campus, Benito Juarez Road, New Delhi – 110 021** (Tel: 011-24112761; 24113106 Ext- 179).

A bank draft for Rs.500/- (Rs.250/- for SC/ST candidates) on account of exam fee in favour of ***Director, University of Delhi South Campus*****,** payable at ***State Bank of India, South Campus Branch,*** must accompany the application form.

REGISTRATION-CUM_ADMISSION TICKET WOULD BE SENT BY POST TO THE CONTACT ADDRESS OF EACH APPLICANT. IN ADDITION, REGISTRATION NUMBERS (ROLL NUMBERS) WILL BE SENT THROUGH E.MAIL TO ALL OUTSTATION CANDIDATES. FOR ADDITIONAL HELP, PLEASE CONTACT udscgenetics@gmail.com OR TELEPHONICALLY ON 011-24112761.

UNIVERSITY OF DELHI
(SOUTH CAMPUS)

UDSC

Roll No. _____

Registration for entrance test for admission to **M.Sc. Course in GENETICS** for the Academic Year **2011-2012**

Demand Draft Details **: Entrance Fee GEN/OBC-Rs.500/- (Rs.250/- for SC/ST/PH)**

DD Number	DD date	Amount	Name & Address of Bank

ATTESTED RECENT PASSPORT SIZE PHOTOGRAPH OF THE CANDIDATE

1. Name of the Candidate (In Block Letters) : _____
2. Father's/Mother's Name & Occupation : _____
3. Date of Birth : _____
4. Whether General/SC/ST/OBC : _____
5. Whether Physically Handicapped/Blind/ Ward of University Employee/Sportsman : _____
6. Contact Address : _____

   _____
7. Telephone /Mobile No. : _____
8. E-mail Address : _____
9. DETAILS OF EXAMINATION PASSED

Examination Passed	**College/ University**	**Year of passing/ appeared**	**Percentage**	**Subjects**
AISSE (10th) or equivalent				
H.S.C. (12th) or equivalent				
B.Sc. (Hons./Gen.)			Part I:	Hons. :
			Part II:	Other subjects:
			Part III:	
			Aggregate:	

10. Tick Mark the pattern of education applicable to you

(**i**) 10+2+3 (**ii**) any other

If any other, please mention _____

11. Have you cleared all the papers at the last University Examination(s) (including I & II year) **YES/NO**

If No, the subject to be cleared _____

12. Have you joined any Master's programme in the previous year(s)? **YES/NO**

If yes, give complete details about discontinuation of the course _____

I have gone through the Bulletin of information published by the University and have verified that I fulfill the course requirements as prescribed for the subject. I also certify that the particulars given overleaf are correct. I enclose herewith attested copies of the following certificates:

(i) High School or Higher secondary/S.S.C. Examination certificate (for verification of age)
(ii) Marks sheets of Bachelor's examination
(iii) Certificate from a competent authority for belonging to SC/ST/OBC/PH (if applicable)
(iv) Entitlement Card from the Record officer if concession admissible to Children/Widows of Officers/ Jawans of Armed Forces killed or disabled in Action
(v) Bank Draft/Demand Draft

Dated:_____2011 Signature of the Applicant

The particulars and relevant certificates have been verified

Signature of Registration Assistant

***Note*:** 1. No original certificate(s) is to be attached

2. This is an Entrance Test Registration form only. Other formalities are to be completed by selected candidates only at a later date.

UNIVERSITY OF DELHI
(SOUTH CAMPUS)

UDSC

Registration Slip-cum-Admission ticket for Entrance test for Admission to M.Sc. Course in GENETICS

Academic Year 2011-2012

Roll No. _____

Name of the Candidate (In Block Letters) : _____

Father's Name & Occupation : _____

General / SC / ST / OBC/PH : _____

ATTESTED RECENT PASSPORT SIZE PHOTOGRAPH OF THE CANDIDATE

Signature of the Registration Assistant.

Note: Bring this acknowledge slip for Entrance Test. No one will be permitted to appear for the Entrance Test without this slip.

Things to remember:

Last Date for Submission of Application	24th June 2011
Date, Time & Duration of Exam	29th June 2011 10:00 A.M., 2 Hours Reporting time 9.00 A.M., Exam hall entry 9.30 A.M., Last entry 10.00A.M
Venue of Written Exam	Arts Faculty Building, University of Delhi, South Campus New Delhi - 110 021
Name of qualified candidates for interview to be displayed on notice board of the department	30th June, 2011
Date of interview	1st and 2nd July, 2011
Final Result	4th July, 2011

IMPORTANT

NO MOBILE PHONES ARE ALLOWED IN THE EXAMINATION HALL

ONLY SIMPLE (NON-STATISTICAL) CALCULATORS ARE ALLOWED

Candidates are advised to retain the registration slip. This must be produced at the time of collection of provisional admission slip, if selected for admission.

Please note that no intimation (by post) will be sent about selection for admission to the course. Candidate on their own interest are advised to see the list of selected candidates, which will be notified, on the Notice Board of the Department.

The Registration form No. will also be the Roll. No. of the candidate for the purpose of entrance test.

REGISTRATION-CUM_ADMISSION TICKET WOULD BE SENT BY POST TO THE CONTACT ADDRESS OF EACH APPLICANT. IN ADDITION, REGISTRATION NUMBERS (ROLL NUMBERS) WILL BE SENT THROUGH E.MAIL TO ALL OUTSTATION CANDIDATES. FOR ADDITIONAL HELP, PLEASE CONTACT udscgenetics@gmail.com OR TELEPHONICALLY ON 011-24112761.