DEPARTMENT OF GENETICS
FACULTY OF INTERDISCIPINARY & APPLIED SCIENCES
UNIVERSITY OF DELHI SOUTH CAMPUS

Syllabus for Ph.D course work (July, 2021 onward)

The department offers the following seven papers (one compulsory and six optional papers) for the Ph. D course work.

Paper code	Course	Credits
	Compulsory Course	
PGEN001:	Research Methodology	4 credits
	Optional Courses (any two courses to be selected)	
PGEN002:	Genetic Toolkits to Study Genes, Development and Diseases	2 credits
PGEN003:	Introduction to *Dictyostelium discoideum*	2 credits
PGEN004:	Introductory Course on Cancer Research	2 credits
PGEN005:	Mitochondrial Physiology and its Consequences on Cellular Fitness: *S. cerevisiae* a model system	2 credits
PGEN006:	Plant –Microbe Interactions	2 credits
PGEN007:	Reviewing Regulation of Gene Expression	2 credits

The department will be offering the above listed courses/ papers as Ph.D course work to the Ph.D scholars. Students will have to select minimum 8 credits courses from the above list of papers (4 credit compulsory paper + any two courses from the optional papers with 2 credits each). Students will be encouraged to choose one optional course of the immediate relevance to their research work/ lab and another course from the allied areas. These courses are also open for the Ph.D students of other departments. The students of the department of genetics are also free to choose papers from Ph.D courses offered by other departments. A Ph.D student has to qualify all three opted papers (minimum 8 credits) as specified above in one year (two semesters) to have successfully completed the Ph.D. course work.

Evaluation: All the courses will have components of end semester examination and continuing evaluation. The total marks for the compulsory research methodology course will be 100, and

50 marks each for the optional papers. A Ph.D student has to score minimum 50% marks to qualify a paper. The course-wise distribution of marks is as follows:

Paper	End semester examination	Continuing assessment	Total marks
PGEN001: Research Methodology	70	30	**100**
PGEN002: Genetic Toolkits to Study Genes, Development and Diseases	35	15	**50**
PGEN003: Introduction to *Dictyostelium discoideum*	35	15	**50**
PGEN004: Introductory Course on Cancer Research	35	15	**50**
PGEN005: Mitochondrial Physiology and its Consequences on Cellular Fitness: *S. cerevisiae* a model system	35	15	**50**
PGEN006: Plant –Microbe Interactions	35	15	**50**
PGEN007: Reviewing Regulation of Gene Expression	35	15	**50**

All seven courses will be offered in the July to December semester.

Brief preamble of each courses/ papers have been provided below:

PGEN001- Research Methodology (4 credits): This course is aimed at teaching the essentials to fresh Ph.D students to train them in the appropriate research methods that they should inculcate early on in their scientific pursuit. This course also revisit the concepts which are important for genetic analysis. It is proposed to teach this course in an interactive mode and offering in-house examples.

PGEN002- Genetic Toolkits to Study Genes, Development and Diseases (2 credits): This course has been designed to provide a brief overview of the available genetic toolkits to study genes, development and diseases. This course not only provides a notion about the dynamic nature of chromosome and its influence on cellular functioning but also offers an outline of the concepts on the flow of genetic information, development and Evo-Devo with especial

emphasis on *Drosophila* based genetic tools to perform human disease modelling, drug screening, behavioral studies and aging.

PGEN003: Introduction to *Dictyostelium discoideum* (2 credits): The course is designed to provide some fundamental principles to form an integrated view of various genetic and molecular processes in *Dictyostelium discoideum* and to highlight it as a powerful model system. Tutorials would be in the form of assignments, discussions on research and review papers related to each topic, highlighting the advances made in the field.

PGEN004: Introductory Course in Cancer Research (2 credits): This course aims to build a foundation in the basic understanding of cancer research peppered with seminal work from the past and critical advances in the field. Case studies and examples from bench-to-bedside-to-bench will help in understanding the progression of basic cancer research to therapy. We look beyond the basic cancer research and discuss our role as educated and scientifically empowered individuals in the society.

PGEN005- Mitochondrial physiology and its consequences on cellular fitness (2 credits): This is designed to provide some fundamental principles on which to form an integrated view of various genetic and molecular processes using yeast as a model system for studying molecular mechanisms governing mitochondrial function. Tutorials would be in the form of discussion based on primary literature available related to each topic, highlighting the advances in each filed.

PGEN005- Plant-Microbe interactions (2 credits): This course is designed to provide the students insights into the genetic and molecular principles underlying immunity in plants and microbial pathogenesis. The interactions between microbes and plants provide fascinating examples of biological communication. The course design explores the molecular intricacies underlying the host-pathogen relationships, the virulence factors that promote colonization and survival of infecting microorganisms and virulence attributes that damage the host.

PGEN007- Reviewing Regulation of Gene Expression (2 credits): This course while revisiting the different strategies used for regulating the expression of a gene, would emphasize on the various approaches to analyze the strategies and how this knowledge can be used in biotechnological approaches.

Paper- PGEN001

Research Methodology

(4 credits)

Duration: 60 hrs. **Marks:** 100

This paper aims to introduce different aspects of research methodology and also to revisit the concepts which are important for genetic analysis.

Revisiting concepts for genetic analysis: variations, segregation, independent assortment, gene interactions, linkage, recombination and genetic maps [10]

Identifying a broad research area: Basic versus applied; Narrowing down to a sub-area [2]

Relevant scientific literature search: Importance and methods (including choice of key words); Learning to distinguish between original work, repetitive work and validation study [2]

Framing a research question: Identification of lacunae in the research area of interest; Hypothesis generation; defining the aims/objectives; Revising objectives at a later date [2]

Designing a realistic research strategy including alternate strategy; Study design, Importance of - inclusion of negative and positive experimental controls, biological and technical replicates, single and double blind studies, coding/anonymisation of samples, statistics based sample size determination prior to finalization of study design [6]

Recording observations: Importance; Methods of transparent and systematic record keeping; Maintenance of laboratory work books – hard and soft copies; Storage of data including taking regular backups [4]

Organization and analysis of observational/experimental data: Hypothesis testing, hypothesis generation, unbiased analysis, importance of looking beyond the obvious, serendipitous findings, independent cross-validation of data; Interpretation of data [6]

Presentation of data: Raw and analyzed data; Methods- Graphic, pictorial, tabular, oral, poster [10]

Scientific writing: Abstract, synopsis, concept note, full length research proposal, research paper, research thesis; Importance and styles of citing references [12]

Safety in research: Handling of biohazardous substances, disposal of biohazardous waste; Biosafety issues- Chemical, radiation, recombinant DNA, biological material [2]

Debatable issues in applied research: Genetically modified foods; Ethical, legal and social issues in biomedical research [2]

IPR issues in research [2]

Paper- PGEN002

Genetic Toolkits to Study Genes, Development and Diseases

(2 credits)

Course Instructor: *Dr. Surajit Sarkar*

Duration: 30 hrs. **Marks:** 50

This course has been designed to provide a brief overview of the available genetic toolkits to study genes, development and diseases. This course provides a notion about the dynamic nature of chromosome and its influence on cellular functioning. Along with, the students will get an outline of the concepts on the flow of genetic information, development and Evo-Devo. This course also provides an advanced understanding about contemporary Drosophila genetics and related areas. Students are expected to not only develop an inclusive concept on classical and contemporary fly-based genetic toolkits but also study the relevance of Drosophila in human disease modelling, drug screening, behavioral studies and aging.

Concept of chromosomes, genes and genome: A brief history and present status. [4]

The flow of genetic information: Brief overview of rules and regulations. [2]

Concept of development: The complexities and unexpected insights. [2]

Evo-Devo: Discovery of diverse mechanisms regulating development. [2]

***Drosophila* - a century old model system to comprehend genes, development and diseases:** life history; imaginal discs, overview of gametogenesis, classical and contemporary tools (P-element, FRT/FLP; UAS/Gal4/Gal80; CRISPR-Cas9 etc.) to study genes and development; Somatic and germline stem cells, Modeling of human neurodegenerative disorders (i.e. Parkinson's, Huntington's, Alzheimer's diseases etc.), cancer, mitochondrial dysfunction etc. Screening and identification of modifier genes, drug targets and drug molecules. Usages of *Drosophila* in behavioural genetics and aging research. [16]

Discussion on some breakthrough research papers. [4]

Paper- PGEN003

Introduction to *Dictyostelium discoideum*

(2 credits)

Course Instructor: *Dr. Aruna Naorem*

Duration: 30 hrs. **Marks:** 50

The course is designed to provide some fundamental principles to form an integrated view of various genetic and molecular processes in Dictyostelium discoideum and to highlight it as a powerful model system. Tutorials would be in the form of assignments, discussions on research and review papers related to each topic, highlighting the advances made in the field

Brief introduction: An overview; *Dictyostelium discoideum* and its life cycle - unicellular and multicellular phases. [2]

History of research on *D. discoideum*: Classical experiments of Kenneth Raper; Chemotaxis and aggregation; Molecular techniques. [4]

Multicellular development: Transition from growth to development, detection of starvation, events after starvation, Cellular and molecular mechanisms; Factors controlling early development, Cell adhesion molecules, cell-cell contact and gene expression; Cell recognition in the sexual development, Cell differentiation and Pattern formation, coordinated cell movement and Morphogenesis, Cell fate determination. [10]

Signal transduction: Diffusible molecules; cAMP signaling, cAMP oscillation and signal relay, control of aggregation, cell sorting, coordinated cell movement during multicellular morphogenesis; Prespore gene expression; Peptide signaling; Spore and Stalk differentiation. [8]

***D. discoideum*:** a model system for biomedical research. [6]

Paper- PGEN004

Introductory Course in Cancer Research

(2 credits)

Course Instructor: *Prof. Tapasya Srivastava*

Duration: 30 hrs. **Marks:** 50

This course aims to build a foundation in the basic understanding of cancer research peppered with seminal work from the past and critical advances in the field. Case studies and examples from bench-to-bedside-to-bench will help in understanding the progression of basic cancer research to therapy. We look beyond the basic cancer research and discuss our role as educated and scientifically empowered individuals in the society.

Basic cancer biology - Cellular changes in tumour onset and progression; Frequently used nomenclature in cancer research [4]

Genetic basis of cancer onset and progression - Experiments that explained genomic instability, the role of tumour suppressor genes, oncogenes and repair pathways and epigenetic changes associated with cancer onset [10]

Advances in cancer research - Understanding various disease models used for cancer research; Commonly used experiments in research for cancer therapy; Examples of lab-to-clinic work in cancer research; An invited lecture on related topic [6]

Current trends in cancer research - Recent path-breaking advances and on-going research updates [6]

Cancer and society - Understanding roles of various care-giver; Our role as educated citizens; Entrepreneurial opportunities in cancer research [4]

Paper- PGEN005

Mitochondrial physiology and its consequences on cellular fitness

(2 credits)

Course Instructor: *Dr. Kaustuv Datta*

Duration: 30 hrs. **Marks:** 50

The course is designed to provide some fundamental principles on which to form an integrated view of various genetic and molecular processes using yeast as a model system for studying molecular mechanisms governing mitochondrial function. Tutorials would be in the form of discussion based on primary literature available related to each topic, highlighting the advances in each filed.The detailed contents of the course would vary depending upon the background of the students taking this course and their specific requirements in doctoral work.

Saccharomyces cerevisiae as a hotbed for discovery of basic biological process: Life with 6000 genes; post-genomic era - genome-wide microarrays, proteomics, genome-wide protein localization; Synthetic gene array analysis, SC2.0 [4]

Mitochondrial Physiology: Mitochondrial dynamics; Mitochondrial control by nuclear genome: Mitochondrial retrograde signaling: Mitochondrial gene expression: links to cellular life span. [6]

Transcriptional and translational control by nutrition: Amino acid starvation and TOR signaling, glucose repression and de-repression. Control of mitochondrial gene expression. [6]

Metabolic switching and adaptation: principles governing cellular heterogeneity; concepts of bet-hedging; contribution of mitochondria to these events; connection between *Saccharomyces cerevisi*ae and pathogenic cell state. [10]

Saccharomyces cerevisiae as a model for pathogenic yeast: similarities and differences; unique features of mitochondrial system in pathogenic organisms. [4]

Paper- PGEN006

Plant-Microbe interactions

(2 credits)

Course Instructor: *Prof. Jagreet Kaur*

Duration: 30 hrs. **Marks:** 50

Pathogenic microbes are a global threat not only to human health but also to food production and quality. With the ever-increasing demand to improve agricultural yields to keep up with the global food demand this area of host – microbe interaction is becoming more and more important for sustainable agriculture. This advanced course is designed to provide the students insights into the genetic and molecular principles underlying immunity in plants and microbial pathogenesis. The interactions between microbes and plants provide fascinating examples of biological communication. The course design explores the molecular intricacies underlying the host-pathogen relationships, the virulence factors that promote colonization and survival of infecting microorganisms and virulence attributes that damage the host.

Introduction: A historical perspective, significance of plant health, current challenges to sustainable crop production and introduction to central concepts underlying host-microbe interactions, molecular Koch's Postulates**.** Studying the infection processes and specificity of pathogens and their host range, Disease cycle and epidemics. [4]

Model pathosystems used in plant pathology: Arabidopsis – *Pseudomona syringae*, - Potato –*Phytophthora infestans* [2]

Research tools used to study host- microbe interaction Genomic tools, molecular and cellular genetics, imaging for bacteria, fungi and oomycetes. [6]

Molecular basis of Microbial pathogenesis: Strategies deployed for pathogenesis, symbiosis, commensalisms and mutualism; Virulence factors, Gene for gene Model, molecular Koch's Postulates; Repertoire of effectors and their actions in pathogenesis; generation of variability. [8]

Molecular and cellular basis of plant defense: Non-host resistance, Plant innate immunity, Pre-formed inhibitors of pathogen invasion, Types of plant resistance – vertical and horizontal, R genes (quantitative and monogenic resistance); molecular mechanisms underlying basal and induced defense responses and systemic acquired resistance. [8]

Disease resistance in agricultural contexts
Translational research advances and potentials**:** Biotechnological approaches. [2]

Paper- PGEN007

Reviewing Regulation of Gene Expression

(2 credits)

Course Instructor: *Prof. Pradeep Kumar Burma*

Duration: 30 hrs. **Marks:** 50

This course builds on the foundation laid at the Master's level. The course while revisiting the different strategies used for regulating the expression of a gene, would emphasize on the various approaches to analyze the strategies and how this knowledge can be used in biotechnological approaches. The detailed contents of the course would vary depending upon the background of the students taking this course and their specific requirements in doctoral work.

Levels of regulation of gene expression; epigenetic, transcriptional, post-transcriptional, translational, post-translational etc. – A recap. [4]

Building constitutive, inducible and repressible gene expression systems using positive and negative regulators. [6]

Gene regulatory networks. [4]

Strategies to analyze different components of regulation. [10]

Approaches to achieve optimal levels of expression of heterologous genes in prokaryotic and eukaryotic systems. [6]