PUNYASHLOK AHILYADEVI HOLKAR

SOLAPUR UNIVERSITY, SOLAPUR

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।

NAAC Accredited-2015
'B' Grade (CGPA 2.62)

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: GENETICS

Name of the Course: M.Sc. I (Sem– I & II)

(Draft Syllabus to be implemented from w.e.f. June 2020)

PAH Solapur University, Solapur

M.Sc. Part-I - GENETICS

Syllabus (RUSA - Choice Based Credit System Syllabus)

(w. e. f. June, 2020-21)

1) Course Title: M. Sc. Genetics

2) Introduction:

This course will provide the knowledge of genetics to understand genetic information of plants, animals and microorganisms also. It will discuss the basic concepts of genetics and focus how to identify genetics disorders by karyotyping analysis and inheritance related to normal and abnormal genes. Students will learn Mendelian genetics as well as advance genetics. This knowledge of genetics helps them for genetic counseling.

3) Objectives of the course:

- To equip the students with the requisite background in areas of modern biology (Genetics, biochemistry,cell biology, Biostatistics, bioinformatics and molecular biology)
- Become knowledgeable about the genetic inheritance and disease related karyotyping.
- To launch the students into core areas of Genetics like Mendelian genetics, advance genetics, Gene mapping, genetic disorders, study of animal and plant genome, Mutation study etc.
- To explore the students to applied areas of genetics like production of new plant variety by gene mutation, sequencing, karyotyping, genetics counseling etc.
- To provide practical experience to students by giving them an opportunity to pursue project work in an identified area of Genetics.
- Students should gain substantial competency in content, skills, and awareness within the field of Genetics.

4) Advantages of the course:

- Students will learn through applying the strategies and tools used in genetics to aware people about genetics disorders by proper counseling.
- A number of recent workforce studies have shown that there is a high current and unmet demand for people trained to various levels of expertise in genetics.
- The emergence of new plant breeding technologies, gene mapping, DNA sequence analysis, Phylogenetic analysis in closely related as well as endangered species, Karyotyping analysis has enabled genetics to address the biological problems from several different angles. It is this change in paradigm that has led to the development of genetics as a separate skill oriented discipline.
- This course provides scope for employment opportunities in various industries in the applied aspects Biotechnology, Microbiology, Molecular biology, various research institution and academics.

5) Eligibility of the Course

Candidates who have passed (a) 10+2 with Science and (b) Bachelor's degree in Science / Technology/ Agriculture / Medicine / Veterinary Science / Pharmaceutics from recognized University and as per the eligibility criteria lay down by Punyasholk Ahilyadevi Holakar Solapur University; Solapur will be eligible for admission to M.Sc. course in genetics.

6) Duration: The course will be of two years duration and shall be completed in four semesters.

7) Medium of instruction: English

8) Structure of the Course:

- Structure of M.Sc. course in faculty of Science has total of 4 semesters for 2 years.
- M. Sc. I comprise of total two semesters and M. Sc. II comprises of total two semesters.
- Semester I includes four theory papers (3 Hard Core and 1 Soft Core) and practical course as per theory papers.
- Semester II & III includes four theory papers (2 Hard Core, 1 Soft Core and 1 Open Elective) and practical course as per theory papers.
- Semester IV includes four theory papers (3 Hard Core and 1 Soft Core) and a Major project substituting the practical course.
- Each theory paper comprising of 5 units which are distributed in total 60 Lecture hours having weightage of 4 credits.
- Practical papers are to be conducted at the end of their respective semester.
- Final year Major project work should begin in III semester and the complete thesis should be submitted at the end of the IV semester.
- Student would have to present his/her project work during the project report submission which would be evaluated by the internal as well as the external examiner.
- As per the credit system, the assessment of Theory paper of 100 marks weightage will be as: 80 marks theory assessment by University examination (UA) and 20 marks internal assessment by the college (CA). For internal assessment of candidate, periodical tests/seminars/ viva/oral / quiz etc. may be suitably adopted.
- As per the credit system, the assessment of practical paper of 50 marks weightage will be as: 40 marks theory assessment by University examination (UA) and 10 marks internal assessment by the college (CA).
- In each semester student has to compulsorily give Seminar/Tutorial/ Industrial Visit/ Field Tour which has weightage of 25 marks.

Syllabus (RUSA - Choice Based Credit System Syllabus)
(w. e. f. June, 2020-21)

Semester	Code	Title of the Paper	Semester Examination			L	T	P	Credits
			Theory	IA	Total				
Sem-I		**Hard Core**							
	HCT1.1	Concepts of Genetics	80	20	100	4	--	--	4
	HCT1.2	Biostatistics and Population genetics	80	20	100	4	--	--	4
	HCT1.3	Cytogenetics and Genome Organization	80	20	100	4	--	--	4
		Soft Core (Any one)							
	SCT1.1	Cellular and Molecular Biology	80	20	100	4	--	--	4
	SCT1.2	Clinical Bioinformatics	80	20	100	4	--	--	4
		Seminar/Tutorial/ Industrial Visit/ Field Tour	---	25	25	--	1	--	1
	HCP1.1	**Practical Course HCP 1.1**	40	10	50	--	--	03	2
	HCP1.2	**Practical Course HCP 1.2**	40	10	50	--	--	03	2
	HCP1.3	**Practical Course HCP 1.3**	40	10	50	--	--	03	2
	SCP 1.1/1.2	**Practical Course SCP 1.1/ Practical Course SCP 1.2**	40	10	50	--	--	03	2
	Total for Semester-I		**480**	**145**	**625**	**--**	**--**	**--**	**25**
Sem-II		**Hard Core**							
	HCT2.1	Regulation of gene expression and developmental genetics	80	20	100	4	--	--	4
	HCT2.2	Concepts of Biochemistry	80	20	100	4	--	--	4
		Soft Core (Any one)							
	SCT2.1	Advanced microbial genetics	80	20	100	4	--	--	4
	SCT2.2	Industrial and Environmental Biotechnology	80	20	100	4	--	--	4
		Open Elective(Any one)							
	OET2.1	Plant breeding and Tissue culture	80	20	100	4	--	--	4
	OET2.2	Computational Structure Biology and Drug designing	80	20	100	4	--	--	4
		Seminar/Tutorial/ Industrial Visit/ Field Tour	---	25	25	--	1	--	1
	HCP2.1	**Practical Course HCP 2.1**	40	10	50	--	--	03	2
	HCP2.2	**Practical Course HCP 2.2**	40	10	50	--	--	03	2
	SCP2.1/2.2	**Practical Course SCP 2.1/2.2**	40	10	50	--	--	03	2
	OEP2.1/2.2	**Practical Course OEP 2.1/2.2**	40	10	50	--	--	03	2
	Total for Semester-II		**480**	**145**	**625**	**--**	**--**	**--**	**25**

L = Lecture T = Tutorials P = Practical IA=Internal Assessment

UA= University Assessment
4 Credits of Theory = 4 Hours of teaching per week
2 Credits of Practical = 4 hours per week
HCT = Hard core theory
SCT = Soft core theory
HCP = Hard core practical
SCP = Soft core practical
OET = Open elective theory
OEP = Open elective practical
MP = Major project

SEM- I
Hard Core
GEN HCT 1.1 Concepts of Genetics

Learning Outcome:

This subject helps in understanding fundamental ideas of genetics, while exploring modern techniques and recent applications of genetic analysis. It will also provide explanation of complex analytical topics covering the areas of ethics towards society and case study.

Total lectures: 60
Total Credit : 04

UNIT I:[12]

Genetic Counseling:History taking, Examination, Genetic Counseling in Clinical Genetics, Determining Recurrence Risks, Population Screening for Genetic Diseases, Reproductive decision making

Model systems in genetic analysis: General Outline of genome of *E.coli*, *Neurosporacrassa*, *Arabidopsis thaliana*, Drosophila; Life cycle of *S.cerevisiae, C.elegans,*, maize.

UNIT II: [12]

Laws of Inheritance: Mendel's Law of Dominance, segregation and Independent assortment. Test cross, Back cross, Co-dominance, Incomplete dominance, Allelic Interaction, multiple allele, Linkage and Crossing Over with suitable examples, Gene mapping in Prokaryotes and Eukaryotes, Complementation test.

UNIT III: [12]

Structure of Sex Chromosomes, Sex linked Inheritance: Complete and incompletely sex linked genes. Inheritance of XY linked genes, Y linked genes, X linked genes, Sex limited and Sex influence gene. Quantitative inheritance: Concept, Genes and Environment: heritability, Penetrance and expressivity.

UNIT IV: [12]

DNA Damage:Mutation; Types - Spontaneous and Induced Mutations, Chemical and Physical Mutagenic agents, Mechanism of action of Mutagenic agents, Transposon mediated mutagenesis. Changes in Chromosome number and Structure.

UNIT V: [12]

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

Recommended Text Books:

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
7. Genetics - B.D.Singh
8. Genetics - Verma&Agrawal
9. Genetics - P.K.Gupta
10. Peter Snustad and Michael J Simmons (2009). Principles of Human Genetics.

Fifth Edition. John Wiley & Sons, Inc.
11. Strachan T and Read A 2010 Human Molecular Genetics, Fourth Edition. Taylor and Francis
12. Ricki Lewis (2009) Human Genetics-Concepts and Application. Ninth Edition.
McGraw-Hill College Publishers

GEN HCT 1.2 Biostatistics and Population genetics

Learning Outcome:

Students will also be able to define biostatistics and its relation with other subjects, restate the principal concepts about biostatistics. Data analysis becomes very easy by studying biostatistics. The students will explain difference between microevolution & macroevolution. They will be able to calculate genotypic allelic frequencies, factors that lead to microevolution, sources of new alleles within any populations.

Total Lectures: 60
Total Credit : 04

UNIT I: [15]

Basic terms, measures of central tendency and dispersion: Population, Sample, sampling method, variable, parameter, classification of data, Frequency distribution, tabulation, graphic and diagrammatic representation. Mean, median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis **Probability and distributions**: Definition of probability (frequency approach), independent events. conditional probability, Examples of Bernoulli, Binomial, Poisson and Normal distributions. Coefficient of distribution, Use of these distributions to describe in biological models.

UNIT II: [10]

Bivariate data: Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination**. Hypothesis Testing**: Hypothesis, critical region, and error probabilities. Z-test, 't'-test, Chi-square test for independence. P-value of the statistic. Confidence limits, Introduction to analysis of variance.

UNIT III: [10]

Introduction: Overview of history and evolutionary theories with more emphasis on synthetic theory of evolution, Genetics polymorphism, Hardy-Weinberg genetic Equilibrium with example, Forces affecting the Hardy-Weinberg Genetic equilibrium. Causes of changes in allele frequency through natural selection/artificial selection.

UNIT IV: [15]

Heritability and measurement of variability.Genetic load – overview and causes. Co-adapted gene complex – Traits controlled by two loci, three loci and multi-loci. Isolating mechanisms: Classification – (a) Geographic isolation (b) Reproductive isolation – (i) Premating isolation – Climatic, Seasonal, Habitat, Ethological (ii) Post mating isolation – gametic mortality, zygotic mortality, Hybrid inviability, Hybrid sterility, Hybrid breakdown (c) Origin of reproduction isolation – Muller's view, Dobzhansky view. Speciation: (a) Species types (b) Species categories (c) Concepts of species (d) Models of speciation (e) Hybridization and speciation (f) Phyletic gradualism and punctuated equilibrium (g) Molecular aspect of speciation -speciation genes.

UNIT V: [10]

QTL mapping strategies; Statistical methods for mapping QTL in experimental cross populations (experimental design, linkage map construction, single-marker analysis, interval mapping and multiple interval mapping), Estimation of breeding values and genetic variances in general

pedigrees, association mapping, genomic selection, direct and associative models of general group and kin selection, genotype by environment interaction models.

Recommended Text Books:

1. DNA markers Protocols, applications and overviews- Anolles G. C. &Gresshoff P. 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
7. Statistical Genetics: Linkage, Mapping and QTL analysis, Ben Hui Liu – CRC Press
8. Statistical Genetics: Gene Mapping Through Linkage and Association, ed. By B Neale, M Ferreira, S Medland, D Posthuma – Taylor Francis
9. The Fundamentals of Modern Statistical Genetics NM Lairdand, C Lange - Springer
10. Computational Molecular Evolution, Z Yang, 2006, Oxford University Press.

GEN HCT 1.3 Cytogenetics and Genome Organization

Learning Outcome:

Students are expected to have basic knowledge regarding structure, function and organization of chromosome and methods of cell division. This subject includes advanced aspect of organization and regulation covering classical experimental strategies using different organisms as model and its genetic approaches.

Total Lectures: 60
Total Credit :04

UNIT I: [14]

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

UNIT II: [10]

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

UNIT III: [12]

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

UNIT IV: [12]

Genome organization in viruses, bacteria, animals and plants. Mechanisms of sex determinationin plants, animals and *Drosophila* (Dosage compensation), Organization of nuclear and
organellar genomes.

UNIT V: [12]

Genome mapping (Physical maps) and functional genomics; Repetitive DNA-satellite(minisatellite, microsatellite DNA). Introduction to Transposable Elements in Prokaryotes andEukaryotes, C-value paradox, LINES, SINES, Alu family, Fine structure of gene, multigenefamilies.

Recommended Text Books:

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

Soft Core (Any one)

GEN SCT 1.1 Cellular and Molecular Biology

Learning Outcome:

It gives in depth knowledge of biological and/or medicinal processes through the investigation of the underlying processes that occur in and between cells and able to explain processes and their meaning for the characteristics of living organisms. Students will gain insight into the most significant molecular and cell based methods used today to expand understanding of biology.

Total lectures: 60
Total Credit : 04

UNIT I: [14]

Types of replication, DNA replication in prokaryotes and eukaryotes - i) Initiation of replicationprocess: Origin of replication ii) Elongation: coordinatedsynthesis of Leading and Lagging strands. iii) Termination: End of replication. Types of DNA Polymerases,
Mechanism of Transcriptionin Prokaryote and Eukaryotes -Initiation, Elongation and Termination, Types of RNAPolymerasesin prokaryotes.

UNIT II: [13]

Genetic code- deciphering the code, codon usage, Eukaryotic and Prokaryotic Translation.
Antisense, RNAi, Micro RNA - Mechanism and Examples, Ribozyme Tailor made for genesilencing.
Membrane Trafficking: Vesicular transport from Endoplasmic reticulum to Golgi Apparatus,Endoplasmic reticulum and its function, Vesicular transport in Golgi apparatus. Golgi Complexand its function

UNIT III: [07]

Cytoskeletal proteins: Microtubules, microfilaments and intermediate filaments, structure of cilia and flagella, Motor proteins, Inhibitors and activators of cytoskeleton, Cytoplasmic streaming and transport.

UNIT IV: [14]

Cytoplasmic Membrane: Chemical Composition of Membrane, Structure and function ofMembrane proteins, Models of Plasma membrane, Movement of substances across cell membrane –Passive transport and Active transport. Cell Cycle: Cell Cycle Phases, Cell-Cell

Adhesion: Extracellularspace, Desmosomes, Hemidesmosomes, Integrins, Selectins, Cadherins, Tight Junction, GapJunction.

UNIT V: [12]
Signal Transduction: G protein coupled receptor, tyrosine Kinase receptor - Ras- MAP Kinasepathway, Hedgehog pathway, WNT signaling pathway, Notch Pathway, Nf-κB Pathway. Signal transduction in plants: With respect to light and phytohormones

Recommended Text Books:
1. Molecular Biology of the Gene- Watson, J. et al. Benjamin Cummings
2. Molecular Cell Biology -Lodish,H. et al. W. H. Freeman
3. The World of the Cell- Becker, W.M. et al. Benjamin Cummings
4. Essential Cell Biology- Alberts B. et al. Garland
5. Molecular Biology of The Cell -Alberts B et al. Garland
6. Cell & Molecular Biology by Karp
7. Genetics by B.D.Singh
8. Genetics by Verma&Agrawal
9. Genetics by P.K.Gupta
10. Cell and Molecular Biology by P.K.Gupta

GEN SCT 1.2 Clinical Bioinformatics

Learning Outcome:

This subject will help students to provide knowledge and explain how clinical bioinformatics will create a bridge between research of genomic medicine and practical approaches. Students will identify the type of tools & technologies used to filter and clarify the information from human genome. It will help to explore stages of the clinical bioinformatics workflow. This will help the students to understand the role of clinical bioinformatics in healthcare and how their work helps to realize the genomics revolution.

Total lectures: 60
Total Credit : 04

UNIT I: (13)
Next Generation Sequencing; Introduction, Process, Application, NGS Platforms &Techniques, NGS Tools: Data & Data Formats, introduction to R scripting and QC toolsPrinSek, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOT, NGS Methods:Reference Based Genome Assembly, De Novo Genome Assembly, Transcriptomics,Epigenomics, Genome Mapping, Microarray Data Analysis, RNA Sequence Analysis and NGSData Annotation.

UNIT II: (13)
Medical Bioinformatics: Basic understanding, causes and available treatmentstrategies for bacterial and viral and parasitic diseases, Neurodegenerative disorders, Disease ofcirculatory system and respiratory system, Cancer, Genetic diseases. Introduction to pathologyinformatics, study of pathogen genomes (bacteria, fungi and viruses), databases, computationalstudy of host–pathogen interactions (Animals and Plants).

UNIT III: (10)

Clinical Data Analysis: Introduction to Medical coding, International Classification ofDisease-10, Pharmacoviglance, Tools for Clinical trial data analysis and management.

UNIT IV: (12)
System and Functional Biology: Pharmacogenomic: Introduction, History,Application and Challenges. System Biology, System structures, system dynamicsMetabolomics: Introduction to Metabolome, Metabolites, Metabonomics, Analyticaltechnologies, applications.

UNIT V: (12)
Genome sequencing projects and applications: human Genome Project Introduction,Applications, Challenges of HGP, Introduction to various genome sequencing projects and theirimplications in human health and diseases, Comparative genome analysis Genome datavisualization using Ensemble and Mapviewer.

Recommended Text Books:
1. EijaKorpelainen, JarnoTuimala, PanuSomervuo, Mikael Huss, Garry Wong 2014: RNA-seq Data Analysis: A Practical Approach by Chapman & Hall/CRC Mathematical and Computational Biology
2. Robert Gentleman: 2008 R Programming for Bioinformatics by Chapman and Hall/CRC
3. Shui Qing Ye 2015: Big Data Analysis for Bioinformatics and Biomedical Discoveries by Chapman and Hall/CRC
4. Bentley DR, Balasubramanian S, Swerdlow HP, et al. Accurate whole human genome sequencing using reversible terminator chemistry. Nature. 2008; 456:53-59

Practicals

Hard Core

Practical Course HCP 1.1Concepts of Genetics
1. Interspecific study of mitosis in *Alliumcepa* and *Alliumsativum*
2. Interspecific study of meiosis.
3. To Study the effect of mutagens on germination, seedling growth and on mitosis.
4. Mendelism problem: one factor & two factor with examples.
5. Problems on non-Mendelian genetics.
6. Problem on gene mapping.
7. Problems on Linkage and crossing over.
8. Study of adaptation in *Drosophila* by biotic/abiotic effect.
9. Spontaneous mutation: Fluctuation test – StrR.
10. Spontaneous mutation: Replica plate method-StrR

Practical Course HCP 1.2 Biostatistics and Population genetics
1. Study of data presentation-graphical.

2. Study of data presentation-diagrammatic.
3. Study of measures of central tendency.
4. Study of measures of dispersion.
5. Study of correlation and regression.
6. Study of probability.
7. Examples on student‘t’ test.
8. Examples based on pedigree analysis.
9. Examples based on Hardy Weinberg Equilibrium.

Practical Course HCP 1.3 Cytogenetics, Genome organization,

1. Preparation of *Drosophila*/*Chironomas*polytene Chromosomes
2. *Drosophila* genetic crosses.
3. Study of different morphology of nucleus.
4. Chromosome preparation from human blood lymphocytes.
5. Identification of inactivated X chromosome as Barr body.
6. G-banding /O-banding and
7. Karyotype analysis
8. Problems on extrachromosal inheritance.
9. Quantitative analysis of DNA using DPA method.
10. Qualitative analysis of DNA - Physical Property (Tm Melting Temperature).

Soft Core (Any one)

Practical Course SCP 1.1 Cellular and Molecular Biology

1. Isolation and estimation of RNA from Bacteria.
2. DNA isolation from plants.
3. Quantitative estimation ofDNA by spectrophotometer.
4. Restriction digestion of DNA and its verification by using electrophoresis.
5. Ligation ofrestricted DNA and observe using electrophoresis.
6. Isolation of Mitochondria.
7. Isolation of Chloroplast.
8. Isolation of organelle DNA.
9. Isolation of total Protein from Bakers Yeast (Translation).
10. Estimation of total Protein from Bakers Yeast (Translation) .

Practical Course SCP 1.2Clinical Bioinformatics

1. Practical’s based on R language.
2. Study online Next Generation sequencing resources and databases.
3. Study of PrinSek, BAMStats FASTX Toolkit FastQC, HTQC, Pyrocleaner and QPLOTtools.
4. Study of Microarray Data Analysis tools and databases.
5. Introduction of International Classification of Disease-10 codes.
6. Study of Human genome project database and genome analysis tools

Semester II

Hard Core

GEN HCT 2.1 Regulation of gene expression and developmental genetics

Learning Outcome:

Knowledge of this subject helps students to describe two main strategies that cells used to control metabolism, able to explainadaptive advantage of bacterial genes grouped into an operon. Students were able to distinguish between positive and negative control. Also able to explain differential gene expression, the characters of organism which make organism as ideal for developmental study and also able to explain developmental stages.

Total lectures: 60
Total Credit : 04

UNIT I: [13]

Gene regulation in prokaryotes: Operon model of regulation (with examples of *lac*, *trp*and*ara*). Negative, positive and attenuation control in bacteria. Control of lysis and lysogeny inLambda phage. Gene regulation in eukaryotes: Overview of gene regulation using examplesofgalactose-utilization in yeast; heat shock gene expression; Signal integration in Human β-Interferon gene.

UNIT II: [13]

Transcriptional control – changes in chromatin structure, epigenetics controls, Posttranscriptional regulation – alternative RNA splicing, RNA editing, RNA stability,Translational regulation – RNA structure, control at initiation, codon usage, PostTranslational modification.Regulation of SV40 and CaMV 35S viral promoters. Hormonalcontrol of gene regulation in animals (thyroxine and insulin) and plants (cytokinin&gibberellins). Regulation of Cell cycle.

UNIT III: [13]

Basic concepts in development: Potency, commitment, specification, induction, competence,determination and differentiation; Production of gametes, cell surface molecules in spermeggrecognition in animals; zygote formation, cleavage, blastula formation, embryonic fields,gastrulation and formation of germ layers in animals; embryo sac development and doublefertilization in plants; embryogenesis, establishment of symmetry in plants; seed formationand germination.

UNIT IV: [13]

Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in*Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditiselegans;* eye lens induction, limb development and regeneration in vertebrates; differentiationof neurons, post embryonic development-larval formation, metamorphosis; environmentalregulation of normal development; sex determination.

UNIT V: [08]

Organization of shoot and root apical meristem; shoot and root development; leafdevelopment and phyllotaxy; transition to flowering, floral meristems and floral developmentin*Arabidopsis* and *Antirrhinum.*

Recommended Text Books:

1. Genes and Signals- Mark Ptashne and Alexander Gann CSHL Press
2. A Genetic Switch- Mark Ptashne CSHL Press

3. Gene Regulation- David S Latchman Chapman & Hall
4. Genes- Benjamin Lewin Prentice Hall
5. Molecular Cell Biology- Lodish, H. et al. W. H. Freeman
6. Principles of Developmental Genetics, -Sally A. Moody Academic Press
7. Advances in Anatomy, Embryology and Cell Biology, -Korf, H.-W., Beck, F., Clascá, F., Haines, D.E., Hirokawa, N., Putz, R., Timmermans, J.-P. Springer
8. Developmental Biology- Gilbert S. F. Sinauer
9. Development of *Drosophila melanogaster* (Vol I & II)- Bates and Arias CSHL Press
10. Developmental Biology, 1992 3rd edition, Browder L.W. Erickson C.A. &Williams, R.J. Saunders College, Publications, London.
11. Developmental Biology; Patterns/Principles/Problems, 1982, Saunders J. W. Collier MacMillan, Publishers, London.

GEN HCT 2.2 Concepts of Biochemistry

Learning Outcome:

Knowledge of this subject helps students to the synthesis of biomolecules such as proteins, lipids, carbohydrate and nucleic acid and their role in the metabolic pathways along with their regulation at the epigenetic, transcriptional & posttranslational level. Students will analyze structural and functional relationships of genes and proteins.

Total lectures: 60
Total Credit : 04

UNIT I: [10]

Laws of Thermodynamics: Concept of Free Energy, Standard free energy change andchemical equilibrium, Biological oxidation reduction reaction, Redox potential, ATP asenergy-rich compound.

UNIT II: [15]

Protein - classification according to its function. Amino Acids, Classification of amino acids.Peptides, The primary, secondary and tertiary and quaternary structure of proteins.Ramachandran Plot. Enzymes as biocatalysts; enzyme classification, Properties of enzymes,Active site. Mechanism of enzyme action, Michaelis-Menten Equation, Linewever-Burk plot, Eadie-Hofstee plot, inhibition ofenzymes.

UNIT III: [07]

Vitamins - Classification, Structure and biological role of - Thiamin, Riboflavin, Nicotinicacid, Biotin, Folic acid , Ascorbic Acid, Vitamin A, D ,E, K.

UNIT IV: [13]

Carbohydrate - Classification, structure, general properties and functions, Glycolysis,Gluconeogenesis, Cori Cycle, TCA, HMP Shunt, Glycogen metabolism, Oxidativephosphorylation, Structure of ATPase. Photosynthesis: Structure of Chloroplast, Light andDark Reaction, Photophosphorylation, Calvin Cycle, HSK Pathway, CAM Pathway.

UNIT V: [15]

Lipids - Classification, structure, properties and functions of fatty acids; Storage lipidsPhospholipids, sphingolipids, steroids, Biosynthesis of fatty acids, Beta oxidation of fattyacid, Reactions of amino acid metabolism – transamination, deamination, decarboxylation,Urea Cycle, Nucleotides, Purines and Pyrimidines, Nucleotide Biosynthesis – Salvage and DeNOVO.

Recommended Text Books:

1. Principles of Biochemistry -Lehninger et al. Freeman
2. Biochemistry -Devlin, T.M. Wiley-Liss
3. Biochemical Calculation -Sehgal I. H. Wiley
4. 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

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Soft Core(Any one)

GEN SCT 2.1 Advanced microbial genetics

Learning Outcome:

This subject presents logic and methods used in the genetics of complex biological processes in bacteria. The course subject will cover various genetic approaches to study bacterial mechanisms of metabolism, development and pathogenesis. It also covers the study of bacteriophages and their modes of infection during the gene transfer mechanisms. The students will learn regarding various methods of genetic recombination with help of horizontal gene transfer mechanisms and their mapping techniques. Also they can get the knowledge of industrial applications and the products obtained from microorganism.

Total lectures: 60
Total Credit : 04

UNIT I: (12L)

Conjugation: Discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F, map of F plasmid, mechanism of chromosome transfer in bacteria. Transformation: Natural transformation systems, Biology and mechanism of transformation, Competency, regulation of competency in *B. subtilis*, artificial induced competency- calcium ion induction and electroporation.

Transduction: Generalized and specialized or restricted transduction, Phage P1 and P22-mediated transduction, mechanism of generalized transduction, abortive transduction. Temperate phage lambda and mechanism of specialized transduction.

UNIT II: (12L)

Phage Genetics:Virulent phage (lambda) and temperate phage (phage lambda). Important aspects of lytic and lysogenic cycle, phage-host relationships, immunity and repression. Site specific recombination (lambda and P1). Role of regulator proteins, lysogenic induction and repression, Genetic mapping of viruses. Concept of phage typing and its applications.

Phage therapy: History, commercial production of phages, phages as therapeutic agents (with examples),Advantages and disadvantages.

UNIT III: (12L)

Overview of Fungal Biology: Fungal life cycle and various phases, Genetic Recombination in Fungi: Mating systems, outcrossing, nonoutcrossingparaserual cycle, fungi in biotechnology, and as experimental tools. Yeast Mating - Type Switching mechanism, Bacterial mutagenesis: Mutation, evidence of spontaneous nature of mutation, Fluctuation test, Methods of isolation of autotrophic mutants, drug resistant mutants and phage resistant mutants, analysis of mutation in biochemical pathways.

Unit IV:(12L)

Agricultural and environmental applications: Genetics and molecular Biology of plant-microbes interactions (PGPB, mycorrhizal symbiosis). Microbial association for plant stress tolerance, rhizoremediation. Production and role of microbial genetics in crop improvement: bio-fertilizers, bio-insecticides, bio-pesticides with example. Genetically engineered bacteria for bioremediation and bioaugmentation with example.

UNIT V:(12L)
Industrial and pharmaceutical applications:
Genetic improvement of strains for industrial applications:methods of strain improvement,mutation and selection, protoplast fusion, conventional breeding,recombinant DNA technology. Genetics and industrial production of lysine, glutamic acid.
Genetics and molecular basis of pathogenesis in bacteria (Mycobactetrium tuberculosis),Virus(Influenza), Fungi (Candida) and Protozoa (Malaria).Pharmaceuticals and biologicaldrugs: gene products, secondary metabolites in drug.

References:
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. Fungal Genetics: Principles and Practice Bos C J. CRC
9. The Mycota Ed. Esser K. &. Lemke P. A. Springer
10. Essential Fungal Genetics-Moore D.& Frazer N. Springer
11. Fungal Genetics- Fincham Springer

GEN SCT 2.2 Industrial and Environmental Biotechnology

Learning Outcome:
This subject will provide knowledge regarding understanding of designs and operation methods of life science based processes with good quality product recovery and sustainability. Students will acquire skills for maintaining and optimizing the quality work with respect to different cell components like enzymes, biofuels, biomaterial and their applications in development of a sustainable society. Various approaches are covered in environmental biotechnology so as to conserve and embrace the value of natural resources.

Total lectures: 60
Total Credit : 04

UNIT I: [15]
Introduction to bioprocess engineering, bioreactors, isolation,preservation and maintenance of industrial microorganisms, microbialgrowth kinetics, media formulation for industrial fermentation, Air andmedia sterilization. Designing of a fermenter/bioreactor. Types offermentation process batch, fed batch and continuous, biotransformation,analysis of mixed microbial populations, specialized bioreactors (pulsed,fluidized, photo bioreactors etc.) Measurement and control of bioprocessparameters.

UNIT II: [12]

Upstream Process:Industrial production of chemicals: alcohols, acids(citric, acetic and gluconic), solvents (glycerols, acetone, butanol),antibiotics (penicillin, streptomycin, tetracycline) amino acids (lysine,glutamic acid), single cell proteins, single cell oil, dairy products, wine,beer and other alcoholic Beverages.

UNIT III: [09]

Downstream process:introduction, removal of microbial cells and solidmatters, foam separation, filtration, centrifugation, cell disruption,precipitation, liquid-liquid extraction, chromatography, membrane process,drying and crystallization, effluent treatment.

UNIT IV: [12]

Scope of Biotechnology-in Environmental protection. Nonconventionalenergy sources. Environment protection Act: Environmental laws,Environmental policies, Environmental ethics.UN declaration.Environmental protection and conservation. Environmental ImpactAssessment, Ecoplanning and Sustainable Development

UNIT V: [12]

Bioremediation-Biotechnology for clean environment, Biomaterials assubstitutes for non-degradable materials, Metal microbe interactions:Heavy Metal Pollution and impact on environment, Microbial Systems forHeavy Metal Accumulation, Biosorption, molecular mechanisms of heavymetal tolerance. Bioindicators and biosensors for detection of pollution, Hazardous Waste Management, Xenobiotics, Biological Detoxification ofPAH, Air Pollution Control, Solid Waste Management.

Recommended Text Books:

1. Sullia S. B &Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Glaser A.N &Nilaido. H (1995) Microbial Biotechnology,W.H Freeman & Co.
3. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers& Distributors.
4. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Crueger W. &Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology.,Aditya Books (P) Ltd. S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House
7. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology
8. Dash : Concepts of Ecology
9. Chattergy : Environmental Biotechnology
10. Varma&Agarwal : Environmental Biology
11. B.K. Sharma : Environmental Chemistry
12. Peavy&Rowe : Environmental Pollution
13. Asthana&Asthana : Environment Problems & Solutions

Open Elective(Anyone)

GEN OET 2.1 Plant breeding and Tissue culture

Learning Outcome:

Knowledge of this subject helps students to identify characteristics of self and cross pollinated plants. Students were able to identify sources of genetic variation to conduct a breeding programme, determine breeding methodology appropriate for plants with different mating systems. Able to conduct basic statistitical analyses related to plant breeding. Students get practical knowledge of plant tissue culture, learn how to set up a laboratory and able to describe various protocols and apply plant tissue culture technology for clonal propagation, assisting plant breeding and plant improvement.

Total lectures: 60
Total Credit : 04

UNIT I: [10]

History; Genetic resources- centers of diversity and origin of crop plants, Law ofHomologous variation, genetic resources. Component, recombinational and transgressivebreeding. Single seed descent. Populations, their improvement methods and maintenance,Hybrid breeding and genetic basis of heterosis.Ideotype breeding.Mutation breeding.

UNIT II: [20]

Objectives of plant breeding, Principles of plant breeding, Methods of plant breeding-Introduction and acclimatization, selection- natural selection, artificial selection- mass selection, pure line selection and clonal selection, Hybridization; Breeding in self and cross pollinated crops, Plant Breeding for Stress Resistance and Nutritional Quality: Genetic basis and breeding forresistance to diseases and insect-pests. Breeding for vertical and horizontal resistance todiseases. Genetic and physiological basis of abiotic stress tolerance. Breeding for resistanceto heat, frost, flood, drought and soil stresses. Important quality parameters in various crops,their genetic basis and breeding for these traits. Role of molecular markers in stress resistancebreeding: MAS, MARS and MABB.

UNIT III: [10]

Plant regeneration pathways - Organogenesis and Somatic embryogenesis; Endospermculture and triploid production; Anther and pollen culture, and production of haploid anddoubled haploid plants; Protoplast culture and fusion, Somatic hybrids; Organelle transferandcybrids; Micropropagation, Artificial seed and bioreactor technology, Virus-free plants bymeristem culture; Use of somaclonal and gametoclonal variation for crop improvement; Invitro mutagenesis and mutant selection; Preservation of plant germ plasm*in-vitro*.

UNITIV: [10]

Cryopreservation -Principle and types. Biosynthesis- batch, continuous cultures, immobilized plant cell, Biotransformation of precursors by cell culturing, metabolic engineering forproduction of secondary metabolites, Hairy root culture, elicitation.

UNIT V: [10]

Transgenic crops for resistance against biotic and abiotic stresses; Transgenic plants-Edible vaccine, Golden rice; 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; Other applications; Global statusand biosafety of transgenic plants.

Recommended Text Books:

1. Principles of Plant Breeding, Allard RW – Wiley

2. Plant Breeding Theory and Practice, Stoskopf NC, Tomes DT and Christie BR – Westview Press
3. Quantitative Genetics, Genomics and Plant Breeding, Kang MS – CABI Publishing
4. Plant Molecular Breeding, Newbury HJ – CRC Press
5. Plant Cells in liquid culture (1991), Payne Shuler Hanser Publishers.
6. Introduction to plant tissue culture- M.K. Razdan
7. Plant tissue culture-Theory & practice-S.S.Bhojwani& M.K. Razdan
8. Plant tissue culture-KalyankumarDey
9. Biotechnology- H.S. Chawla

GEN OET 2.2 Computational Structure Biology and Drug designing

Learning outcome:

This subject helps in establishing bimolecular sequence-structure-function relations using fundamental principles of physical sciences in theoretical models and simulations of structure and dynamics; also it improves understanding the origin and mechanisms of biological interactions, and designing/controlling function in students. Different tool for efficient identification of structure and dynamics can be studied along with applications. students will gain knowledge regarding the interactions between protein-protein, protein-ligand and protein-DNA interactions and their functional implications.

Total lectures: 60
Total Credit : 04

UNIT I: [15]

Introduction to Structural and Pathway Databases: structural data, exploring thestructural databases such as Protein Data Bank (PDB) at RCSB, Catalytic Site Atlas (CSA),Homology Derived Structures of Proteins (HSSP), Protein Data Bank Europe (PDBe),PDBeChem, PDBeFold, PDBeMotiff, PDBeNMR, PDBSum, SCOP and CATH. Introduction tobiological Pathway Databases.

UNIT II: [10]

Structure Prediction Methods: Statistical methods of Chou-Fasman, Garnier-Osguthorpe-Robson method, Neural network method, Position specific scoring matrices, Motifsand domains, folds and protein folding.

UNIT III:[10]

Homology Modeling: Introduction to homology modeling, Fold recognition andThreading, RNA structure prediction, architectures and topologies of protein and DNA usingmolecular visualization software, Structure validation.

UNIT IV: [10]

Molecular interaction: Molecular interaction; protein-protein, protein-DNA, Protein-Lipid, Protein- Ligand, Protein-Carbohydrate, DNA-Drug interaction, Metalloproteins, Pi … Piinteractions, C-H…Pi interactions.

UNIT V: [15]

Drug Discovery and Drug designing: Natural products, drugs, principles of drugdevelopment, Drug discovery, mutation in drug targets, automated drug design, structure basedand ligand based drug design methods, combinatorial chemistry, high throughput screening(HTS), *in silico*ADMET properties, QSAR, developing lead library, DOCKING; introduction todocking method to generate new structure, tools and molecular docking programs-AUTODOCK, HEX

and VLifeMD suite, virtual screening, Drug metabolism; Cytochrome p450,pharmacodynamics and pharmacokinetics, clinical trials, FDA approval.

Recommended Text Books:

1. Wilkins, M.R., Williams, K.L., Appel, R.D., Hochstrasser, D.F. (Editors) 1997
2. Proteome Research: New Frontiers in Functional Genomics. Springer Verlag Berlin Heidelberg.
3. Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.Second Edition, Wiley.
4. Graur, D. and Li, W-H. 2000 Fundamentals of Molecular Evolution.SinauerAss.,USA.
5. Essential Bioinformatics, Jin Xiong
6. Rastogi S. C., Mendiratta. N., Rastogi. P. 2005 Bioinformatics methods and application, Genomics, Proteomics, and Drug Discovery.

Practicals

Practical Course GEN HCP 2.1Regulation of gene expression and developmental genetics

1. Induction and assay of β- galactosidase from *E.coli*.
2. Observation of homeotic mutants of *Drosophila*
3. Study of Chick embryo development (preparation of whole mounts & permanent slides)
4. Study of different types of sperms by smear technique- Frog, Hen, Rat and Human
5. Study of Cleavage, Blastula and Gastrula –Frog and Hen (Slide/ICT)
6. Study Teratogenic effect on development of Frog / Chick embryo
7. Study of developmental phases in human (By ICT)
8. To study types of ovules and male gametophytes (by permanent slides)
9. Study of floral patterning in any suitable flower

Practical Course GEN HCP 2.2 Concepts of Biochemistry

1. Quantitative estimation of Protein by Lowry's method.
2. Quantitative estimation of Protein by Biurete method
3. Quantitative estimation of Glucose by DNSA method.
4. Quantitative estimation of Total sugar by anthrone method.
5. Quantitative estimation of Cholesterol from serum by Zacs method.
6. Determination of acid value, Iodine number, and saponification of fat/oil.
7. Isolation of casein from milk.
8. Isolation of starch from potato.
9. Immobilization of enzyme (Calcium chloride and Sodium alginate).
10. Assay of amylase by iodometric method.
11. Qualitative analysis of Carbohydrate/lipid/amino acids.

Soft Core(Any one)

Practical Course GEN SCP 2.1 Advanced microbial genetics

1.Isolation of Rhizobium from root nodule.
2. Seed dressing and inoculation with Rhizobia.
3. Perform experiment to study bacterial transduction.
4. Perform experiment to study bacterial Conjugation
5. Perform experiment to study bacterial Transformation
6.Ames test for detecting chemical carcinogen.
7. Isolation of vitamin B12 auxotrophic mutants.
8. Isolation and quantification of genomic DNA from bacteria.
9. Isolation of Plasmid DNA from bacteria.
10. Isolation of coliphages.
11. One step growth curve.

Practical Course GEN SCP 2.2 Industrial and Environmental Biotechnology

1. Fermentative production of Organic solvents: - Ethanol/Acetone/ Butanol.
2. Alcoholic beverages: Beer/ Wine
3. Bioassay of antibiotic/ vitamin
4. Fermentative production of Amino Acid: L-glutamic acid/Phenylalanine/ L-lysine & Vitamins: Vitamin B12.
5. To study the BOD levels of different water systems.
6. To study the COD levels of different water systems.
7. Bacteriological analysis of water by presumptive, confirmatory and completed tests
8. Isolation of xenobiotic degrading microorganisms
9. Visit to commercial industry.

Open Elective(Anyone)

Practical Course GEN OEP 2.1Plant breeding and Tissue culture

1. Induction of polyploidy using colchicines. (Root Tip)
2. Cytological analysis of polyploidy plants. (Root Tip)
3. Study of Pollen fertility.
4. Isolation of Ti Plasmid from Agrobacterium.
5. Media preparation, sterilization and callus culture.
6. Induction of callus.
7. Cell suspension culture.
8. Isolation of protoplast by chemical and mechanical methods.
9. Synthetic seeds preparation.
10. Breeding in Malvaceae, Poacae,
11. Breeding in Brassicacae and Fabaceae

Practical Course GEN OEP 2.2Computational Structure Biology and Drug designing

1. Accessing to Structural Databases and Data retrieval using RCSB PDB, CSA, PDBe, PDBeChem, PDBeFold, PDBeMotif, PdbSum.
2. Structural classification using CATH, SCOP resources.
3. Secondary structure prediction using SOPMA and GOR.
4. Homology modeling by SWISSMODEL, and Modeller 9V2 and
5. Model Validation using RAMPAGE or PROCHECK,
6. Prediction of protein-protein, protein-DNA, protein-ligand interactions andDrugbank and Chembank databases and Design of ligands using ACD lab andChemsketch

7. Development of lead library and high throughput screening using *in silico*ADMETProperties.
8. Docking studies using AUTODOCK and HEX.