BHAVAN'S VIVEKANANDA COLLEGE OF SCIENCE, HUMANITIES AND COMMERCE, SAINIKPURI, SECUNDERABAD.
Autonomous College
Affiliated to Osmania University, Hyderabad.
(Accredited with 'A' grade by NAAC)
Department of Genetics and Biotechnology
Program Name: BSc MbGC & BtGC (w.e.f. 2020-'21)
Genetics (Optional)

Course Name: Transmission Genetics

Paper Code: GT132 | **No of Classes: 60**
Year/Semester: I/I | **No of Credits: 4**

Skill Development: Knowledge of Mendelian inheritance, linkage, gene mapping and Cytogenetic analysis of chromosomal aberrations will lay a strong foundation in the field of Genetics.

Course Objective: To demonstrate the concepts of Classical Genetics, chromosomal segregation during cell division, basics of recombination, gene mapping, and organization of chromatin.

Unit wise Course Objectives:

Cob1: To interpret the concepts of Mendelian Genetics.

Cob2: To develop the fundamentals of recombination and gene mapping.

Cob3: To explain the Genetics of cell division and chromosomal segregation.

Cob4: To distinguish different levels of organization of chromatin.

Unit- 1: Mendelian inheritance and its extensions **15 Hours**

1.1. Mendel's experiments; Law of segregation, monohybrid cross, reciprocal cross, back cross, test cross; Law of independent assortment, dihybrid cross; Chromosomal theory of Inheritance. (3)

1.2. Variations to dominance- Co dominance and Incomplete dominance; Lethal and Sub lethal genes, Penetrance and Expressivity; Pleiotropism; Multiple alleles- Eye colour in Drosophila, ABO blood groups in human; Rh Blood group incompatibility; Self incompatibility in plants. (3)

1.3. Gene interactions– types of epistasis (9:7; 9:3:4; 9:6:1; 12:3:1; 15:1). (2)

1.4. Multifactorial inheritance: Features of quantitative inheritance- additive effect, Kernel colour and size in wheat /maize, skin color in man. (2)

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1.5. Sex linked inheritance – X-linked and Y-linked traits – holandric genes, SRY gene; Sex limited and sex influenced traits; Sex determination –mechanisms of sex determination in Drosophila and Human. (3)

1.6. Non-Mendelian inheritance: Plastid inheritance – Variegation in Mirabilis jalapa; Maternal effects and inheritance – Shell coiling in snails, Poky mutants in Neurospora. (2)

Unit- 2: Linkage, Crossing over and Gene mapping **15 Hours**

2.1 Discovery of linkage – Phases of linkage. (1)

2.2 Chiasmata and Crossing over formation– Recombination. (2)

2.3 Cytological proof for crossing over – Curt Stern and McClintock experiments. (2)

2.4 Linkage analysis – Recombination frequencies, Two-point and Three-point crosses. (3)

2.5 Gene mapping – Coincidence and Interference, Determination of gene order. (3)

2.6 Gene mapping in Neurospora – Tetrad analysis; Mitotic recombination in Aspergillus and Drosophila. (3)

Unit- 3: Cell division and Chromosome segregation. **15 Hours**

3.1 Eukaryotic Cell cycle – Phases of cell cycle G0, G1, S and G2. (2)

3.2 Regulation of cell cycle cyclins, CDK proteins, role of p53 in cell cycle. (3)

3.3 Mitosis – Stages in mitotic cell division- significance of mitosis. (2)

3.4 Meiosis – Formation of Synaptonemal complex, crossing over, chiasma formation, significance of meiosis. (3)

3.5 Apoptosis – extrinsic & intrinsic pathways, & significance. (2)

3.6 Senescence, Necrosis –characteristics & mechanisms. (2)

Unit- 4: Chromosome structure, chromatin organization and variation **15 Hours**

4.1 Chromosome morphology- size and shape; Euchromatin and Heterochromatin- constitutive and facultative heterochromatin. (2)

4.2 Components of chromatin, histones &non-histones. (1)

4.3 Packing of DNA into chromatin – Nucleosome and higher order organization. (2)

4.4 Specialized Chromosomes – Lampbrush chromosomes, Polytene Chromosomes. (2)

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4.5 Structural chromosomal aberrations - duplications, deletions, inversions & translocations with examples, Genetic consequences. (4)

4.6 Numerical chromosomal aberrations – aneuploidy, euploidy auto-polyploidy and allo-polyploidy, Genetic consequences. (4)

Course Outcomes:

By the end of this course, student will be able to

GT132. CO1: Apply Mendelian laws and genetic notation for problem-solving.

GT132. CO2: Solve problems using gene mapping and recombination.

GT132. CO3: Examine the molecular mechanisms in cell cycle and chromosomal Segregation.

GT132. CO4: Identify chromosome structure and chromosomal aberrations.

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Paper I – Practicals

Paper Code: GT132 P **30 hrs (2 hrs/ week)**
Credits: 1

Skill Development: To comprehend and develop skills in maintaining and handling Drosophila and Cytogenetic analysis.

Objective: To acquire basic skills like handling the microscope, preparation of slides for microscopic observation and problem solving using Mendelian laws.

1. Identification of normal and mutant stocks of Drosophila.
2. Drosophila- monohybrid and dihybrid segregation.
3. Problems on Mendelian segregations- monohybrid, dihybrid and trihybrid crosses; multiple alleles, non-allelic interactions, multi-factorial inheritance; linkage and mapping of genes.
4. Neurospora – tetrad analysis.
5. Study of Mitosis in Onion root tips.
6. Study of Meiosis in Maize/Grasshopper.
7. Preparation of Drosophila salivary gland chromosomes – Polytene chromosomes.
8. Identification of structural and numerical aberrations.

Outcome: Students learn genetic annotations and develop analytical skills for problem solving.

Recommended Books

1. Genetics by Gardner
2. Theory and problems in Genetics by Stansfield
3. Introduction to Genetic Analysis by Suzuki, Griffith, Richard and Lewontin
4. Genetics by Strickberger
5. Genetics by Snustad & Simmons
6. Principles of Genetics by Tamarin
7. Cell & Molecular Biology – E.D.D. De Robertis And E.M.F. De Robertis
8. Molecular Biology of the Cell – Bruce Alberts

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Department of Genetics and Biotechnology
Program Name: BSc MbGC & BtGC (w.e.f. 2020-'21)
Genetics (Optional)
Course Name: Molecular Genetics and Genetic Engineering

Paper Code: GT232 | **No of Classes: 60**
Year/Semester: I/II | **No of Credits: 4**

Skill development: The theoretical and practical application of Molecular genetics and Genetic engineering help students to acquire skills in understanding and analyzing genomics, proteomics, genetic manipulation of microbes and their protein expression. .

Course Objective: To compare the structure of nucleic acids, mechanism of gene expression and regulation in Prokaryotes and Eukaryotes, methods of recombination in bacteria and Genetic Engineering.

Unit wise Course Objectives:

Cob1: To analyze the biochemical structure of nucleic acids and molecular mechanisms of mutation.

Cob2: To compare gene expression in Prokaryotes and Eukaryotes at the molecular level.

Cob3: To differentiate the different mechanisms of gene regulation in Prokaryotes and Eukaryotes.

Cob4: To examine different strategies used in Microbial Genetics and Genetic Engineering.

Unit-1: Nucleic acids, DNA replication & DNA repair **15 Hours**

1.1 DNA as the genetic material-Griffith's transformation experiment, Avery, MacLeod and McCarty's experiments and Hershey & Chase phage-labeling experiment; RNA as genetic material- tobacco mosaic virus. (3)

1.2 Chemistry of Nucleic acids- Nucleotides, Franklin's X-ray crystallography, Chargaff's rule, Watson-Crick model and forms of DNA (A, B & Z); types of RNA (rRNA, mRNA & tRNA). (2)

1.3 DNA replication-conservative, semi-conservative and dispersive models, Meselson– Stahl experiment; Mechanisms of DNA replication-linear, circular, rolling circle, D loop and θ- models. (2)

1.4 DNA replicative enzymes (DNA polymerases, helicase, primase, ligase, telomerase, nuclease & topoisomerases) and proteins (initiator protein & single strand binding proteins). (3)

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1.5 Mutations: types of mutations- transition, transversion, frame shift, silent, mis-sense and nonsense; Induced mutations- physical and chemical mutagens; spontaneous mutations 1.6 DNA damage and repair mechanisms - direct, excision and mismatch, SOS non homologous end joining(NHEJ). (5)

Unit-2: Gene expression in Prokaryotes & Eukaryotes **15 Hours**

2.1 Structure of prokaryotic gene; Structure of eukaryotic gene; structure and functions of RNA polymerase & it's subunits in prokaryotes. (2)

2.2 Transcriptional machinery in eukaryotes (RNA polymerases) and their structural and functional features. (1)

2.3 Genetic code-properties, deciphering of genetic code, wobble hypothesis. (2)

2.4 Transcription mechanism-initiation, elongation & proofreading, termination (rho independent & rho dependent). (4)

2.5 Transcription in eukaryotes-Initiation, elongation & termination factors. (3)

2.6 Translation mechanism- initiation, elongation and termination. (3)

Unit-3: Gene regulation in prokaryotes & eukaryotes **15 Hours**

3.1 Prokaryotic transcriptional regulation (inducible system) - Operon concept- lac operon & glucose effect. (3)

3.2 Prokaryotic transcriptional regulation (repressible system) – tryptophan operon. (3)

3.3 Post-transcriptional modifications- capping, poly- adenylation. (2)

3.4 Splicing and alternate splicing, rRNA and tRNA splicing. (2)

3.5 Post-translational modifications-glycosylation, lipidation, acetylation, ubiquitination and chaperones (3)

3.6 Gal locus regulation in yeast- regulation of mating type. (2)

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Unit-4: Microbial Genetics & Genetic Engineering **15 Hours**

4.1 Transformation- competence of bacterial cells; mechanism of transformation; gene mapping by transformation; Transduction: generalized transduction, co-transduction and linkage; Mapping by co transduction, Specialized transduction. (2)

4.2 Conjugation- unidirectional gene transfer- F+ and F- High frequency recombination, Gene mapping by conjugation (1)

4.3 Introduction to r-DNA technology; enzymes used in molecular cloning- restriction endonucleases, DNA modifying enzymes- methylases, polymerases, ligases and phosphatases. (3)

4.4 Vectors used in cloning: E Coli, plasmid vectors- pBR322, pUC vectors; cosmids; shuttle vectors- yeast vectors. (3)

4.5 Strategies for genomic libraries and cDNA libraries construction (2)

4.6 Screening for detection of cloned genes-antibiotic resistance, blue-white screening; Blotting techniques (Southern, Western & Northern), Applications of genetic engineering in agriculture and medicine. (4)

Course Outcomes :

By the end of this course, student will be able to

GT232.CO1: To distinguish structures of DNA and RNA.

GT232.CO2: Learn the fundamental aspects of gene expression such as transcription, translation and mRNA splicing.

GT232. CO3: Identify different mechanisms of gene regulation

GT232.CO4: Recognize the significance of rDNA technology in agriculture and medicine.

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Paper II – Practicals

Paper Code: GT232 P 30 hrs (2 hrs/ week)
Credits: 1

Skill Development: To acquire skills in Molecular and Biochemical techniques.

Objective: To give hands-on experience in basic techniques used in Molecular Biology.

1. Extraction of genomic DNA.
2. Quantification of DNA by spectrophotometer.
3. Agarose gel electrophoresis of DNA.
4. Estimation of DNA by DPA method.
5. Estimation of RNA by Orcinol method.
6. Effect of UV on bacterial growth.
7. Preparation of competent cells of bacteria.
8. Problems on restriction mapping.

Outcome: Students understand the underlying principle involved in extraction of DNA, estimation of DNA/RNA, basic techniques used in Microbial Genetics.

Recommended Books

1. Principles of Genetics- Irwin Herscowitz
2. Molecular Biology of the gene- Watson, Hopkins, Roberts, Steitz and Weiner
3. Genes- Benjamin Levin
4. General virology- Luria, Darnell, Baltimore and Campbell
5. Molecular Biology- David Frefielder
6. Practical Microbiology- Aneja
7. Microbial Genetics ByMaloy, Freifelder
8. Molecular Genetics By Gunther and Stent
9. Genetic Analysis By Griffith, Suzuki and others
10. Gene cloning and DNA analysis: an introduction - T.A. Brown

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Department of Genetics, Biotechnology and Botany
Subject: Genetics (Optional)
(BSc. Life Sciences)
W.e.f 2021-22 onwards
BSC GENETICS II YEAR

SEMESTER III PAPER III

DSC-IC BIOSTATISTICS AND BIOINFORMATICS

Code: GT332

Credits :4

No. of Hrs: 60 hrs

Skill development for employability in the field of Biostatistics and Bioinformatics.

Objectives:

Cob 1: To analyse the measures of central tendency, dispersion and principles of probability.

Cob 2: To apply statistical tests for testing of hypothesis and analysis of variance.

Cob 3: To implement bioinformatics tools and resources using biological databases.

Cob 4: To compare the various methods of sequence alignment.

Unit 1: Descriptive Biostatistics and Probability **15 hrs**

1.1. Introduction to biostatistics, kinds of data and variables- based on nature (numerical - discrete and continuous; categorical- ordinal and nominal) - based on source (primary and secondary data): sample size, sampling methods and sampling errors. (3)

1.2. Data tabulation and representation methods: Graphical methods- stem and leaf plot. line diagram, bar graphs, histogram, frequency polygon, frequency curves. Diagrammatic method- pie diagram. (2)

1.3. Measures of Central tendency: mean, median, mode; merits and demerits. (2)

1.4. Measures of Dispersion-range. variance, standard deviation, standard error and coefficient of variation: merits and demerits. (2)

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1.5. Concepts of probability: random experiment, events, probability of an event, probability rules (Addition and Multiplication rules), permutations and combinations, random variables (Discrete and Continuous). (3)

1.6. Probability Distributions: Binomial & Poisson distributions for discrete variables. Normal distribution for continuous variables. (3)

Unit 2: Applications of Biostatistics **15 hrs**

2.1. Hypothesis testing Steps in testing for statistical hypothesis, null and alternate hypothesis. level of significance: type-1 and type-2 errors(2)

2.2. Test of significance for small samples- Student's t-test (one sample and two samples).(2)

2.3. Test of significance for large samples- z-test of means and proportions. (2)

2.4. Chi-square test and its applications- goodness of fit, independence.(2)

2.5. Analysis of Variance (ANOVA) - one way analysis.(3)

2.6. Correlation- Definition. Simple and Linear analysis, Karl Pearson's correlation coefficient.(4)

Unit 3: Introduction to bioinformatics and biological databases **15 hrs**

3.1. Bioinformatics definition, history, scope and applications.(2)

3.2. Bioinformatics tools and resources- internet basics. Role of internet: free online tools downloading free softwares and installation.(3)

3.3. Bioinformatic web portals- NCBI, EBI and EXPASy(2)

3.4. Biological databases: Classification of databases- primary (GenBank), secondary (PIR) and tertiary or composite (KEGG) databases.(2)

3.5. DNA sequence databases (ENA & DDBJ).(3)

3.6. Protein sequence databases (Swissprot & PROSITE).(3)

Unit 4: Sequence Alignment **15 hrs**

4.1. Basics of sequence alignment - match, mismatch, gaps, gap penalties, scoring alignment.(3)

4.2. Types of sequence alignment - pairwise and multiple alignment, local and global alignment.(2)

4.3. Dot matrix comparison of sequences (2)

4.4. Scoring matrices - PAM and BLOSUM (3)

4.5. Pairwise sequence similarity search by BLAST and FASTA. (2)

4.6. Concepts of phylogenetic tree- character based (maximum likelihood & maximum parsimony method). (3)

By the end of the course, students will be able to

CO1: Apply the measures of central tendency, dispersion and principles of probability.

CO2: Implement statistical tests for testing of hypothesis and analysis of variance.

CO3: Interpret the tools of bioinformatics and resources for biological databases.

CO4: Investigate various methods of sequence alignment.

DSC-IC BIOSTATISTICS AND BIOINFORMATICS

PRACTICALS

W.e.f 2021-22 onwards

Code: GT332P

Credits:1

No. of Hours: 30hrs(2hrs/week)

Skill development to use the basic tools of Biostatistics and Bioinformatics.

Cob: To solve numericals in biostatistics and implement the tools of bioinformatics using biological databases.

1. Calculation of mean, median, mode, standard deviation, variance, standard error, coefficient of variation for a variable.

2. Construction of bar diagram, pie diagram, line diagram, histogram and box plot for data.

3. Problems on hypothesis testing using Z test, t-test and Chi-square test.

4. Problems of probability and probability distributions.

5. Exploring web portals-NCBI. EBI & ExPASY.

6. Literature search through PubMed and PubMed Central.

7. Sequence retrieval from GenBank, ENA and Swissprot.

8. Pairwise homology search by BLAST and FASTA.

CO: By the end of this course, students will be able to use various statistical tools and compare tools of bioinformatics.

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RECOMMENDED BOOKS

1. Khan & Khanum (2004), Fundamentals of Biostatistics, II Revised Edition. Ukaaz Publication

2. Bailey, N.T.J, Statistical methods in Biology, Cambridge Univ. Press

3. Fundamentals of Biostatistics, P Hanumantha Rao and K.Janardhan

4. Danial, W. W. Biostatistics, Wiley

5. Introduction to Bioinformatics by Aurther M lesk

6. Developing Bioinformatics Computer Skills By: Cynthia

7. Bioinformatics second edition By David M mount

8. Essential Bioinformatics by Jin Xiong

9. Bioinformatics Computing By Bryan Bergeron

10. Bioinformatics: Concepts, Skills & Applications by R.S. Rastogi

11. Queen. J. P., Quinn, G. P., & Keough. M. J. (2002). Experimental design and data analysis for biologists Cambridge University Press.

12. Mahajan. B. K. (2002). Methods in biostatistics Jaypee Brothers Publishers.

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Department of Genetics and Biotechnology

Skill Enhancement Course- Credits 2

Effective from 2023-'24 onwards

Title: Medicinal Plants-SE332

Skill Development: Students learn the powder analysis, histo chemical & specific chemical analysis of crude drugs like turmeric, ginger, cloves, cinnamon, and senna. They learn the basic concepts of Pharmacognosy.

Course Objective: To develop skill in analysis of crude drugs and examine the importance of medicinal plants in alternative systems of medicine like Ayurveda and Siddha.

Cob 1:To distinguish Rhizome, Bark, Leaf, Flower, Fruit drugs and analyse their medicinal properties by powder analysis.

Cob 2: To enhance identification skills by Herbarium preparation.

UNIT I: **(15 hours)**

1. History and Scope of Medicinal Botany with reference to Ayurveda and Siddha. (3)

2. Sources, Classification, Collection, Contamination and Preservation of Drugs. (5)

3. Medicinal Importance and identification of the following at the organoleptic level (5)

3.1 Rhizome drugs: Ginger and Curcuma

3.2 Bark drugs: Cinchona and Cinnamon

3.3 Leaf drugs: Senna and Datura

3.4 Flower drugs: Hibiscus

3.5 Fruit drugs: Strychnos, Emblica.

4. Medicinal principles and powder analysis of the following (2)

i) Cinnamomum ii) Cloves and iii) Curcuma

UNIT II- Practicals. **(15 hours)**

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1. Identification of the following crude drugs. (4)

i. Ginger ii. Curcuma iii. Cinnamomum iv. Datura v. Hibiscus vi. Strychnos

2. Powder analysis of the following drugs: (4)

i. Ginger ii. Curcuma iii. Cinnamomum iv. Senna v. Cloves

3. Histochemical and specific chemical test of the following drugs: (4)

i. Curcuma ii. Senna and iii. Cloves

4. Herbarium preparation of Medicinal Plants. (3)

Course Outcome: Students recognise the importance of medicinal plants and appreciate the significance of Medicinal Botany with reference to Siddha and Ayurveda systems of medicine.

CO 1: They collect and identify locally available medicinal plants in the form of a herbarium.

CO 2:They differentiate crude drugs by the technique of powder and histochemical analysis.

References:

1. C K Kokate, A P Purohit and S B Gokhale. 1990. *Pharmacognosy*. NiraliPrakashan
2. Chadha, K.L. and Gupta, R. 1995. *Advance in Horticulture*: Vol. II: *Medicinal and Aromatic Plants*. Malhotra Pub. House, New Delhi
3. Kameswara Rao, C.2000. *Database of medicinal plants*. KSCST, Bangalore
4. Nair, C.K.N. and Mohanan, N. *Medicinal Plants of India*. Nag Publishers, Delhi
5. Reddy, T.Y. and Reddy, G.H.S. 2005. *Principles of Agronomy*. Kalyani Publishers, New Delhi.
6. Dr S Vedavathy, Y Mrudula and A Sudhakar. 1997. *Tribal Medicine of Chittoor District, AP, India*. Published by Herbal Folklore Research Centre, Tirupati.
7. A S SAmmanna Sastry and A V Subbalakshmi. 1997. *A text book of Medical Botany*. Sri Vikas Publications.
8. Sivarajan, V.V. and Indira Balachandran. 1988. *Ayurvedic Drugs and Their Plant Sources*. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.

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Subject: Genetics (Optional)
(BSc. Life Sciences)
Semester –IV CBCS
W.e.f 2021-22 onwards
BSC GENETICS II YEAR

SEMESTER IV PAPER IV

DSC-ID POPULATION GENETICS & EVOLUTION

Code: GT432

Credits : 4

No. of Hours: 60

Basic Knowledge and skills for research in the field of Life Sciences, prepares students for a career in Evolutionary Biology.

Objectives:

Cob 1: To analyse the structure of populations and genetic equilibrium.

Cob 2: To explain mutation, migration and selection.

Cob 3: To evaluate the consequences of inbreeding in populations.

Cob 4: To demonstrate genome evolution at the molecular level.

Unit 1: Principles of Population genetics **15 Hrs**

1.1. Population structure, Random mating population, Concepts of a population (gene pool, deme and panmictic unit). (2)

1.2. Genetic and phenotypic variation in a population, allele frequencies and genotype frequencies at a locus. (2)

1.3. Hardy-Weinberg Law- assumptions and implications, establishment of Hardy Weinberg equilibrium for single gene locus.(3)

1.4. Extension of Hardy-Weinberg Law for multiple alleles.(2)

1.5. Establishment of Hardy-Weinberg Law for X-linked genes. (3)

1.6. Linkage disequilibrium haplotypes, coefficient of linkage disequilibrium, coupling gametes and repulsion gametes. (3)

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Unit 2: Selection, Mutation & Migration **15 Hrs**

2.1. Selection- fitness, patterns of natural selection, general selection equation, equilibrium under selection.(3)

2.2. Selection favouring heterozygotes: stable equilibrium, balanced polymorphism (sickle cell anaemia, heterozygote advantage). (3)

2.3. Selection against heterozygotes: unstable equilibrium (Rh incompatibility) complete elimination of recessive genes.(2)

2.4. Mutation influence of mutation on allele frequencies, balance between forward and backward mutation.(3)

2.5. Genetic load - mutational and segregational.(2)

2.6. Gene flow- Migration - Wahlund effect.(2)

Unit 3: Inbreeding, Genetic Drift and Quantitative inheritance **15 Hrs**

3.1. Inbreeding-non-random mating, Identity by descent, selfing. (2)

3.2. Construction of pedigrees- Raw & forked pedigrees - inbreeding coefficient.(3)

3.3. Effect of inbreeding on genotype frequencies and inbreeding depression(2)

3.4. Genetic Drift - Bottleneck effect. Founder effect.(2)

3.5. Effective population size, consequences of a decreasing population size.(3)

3.6. Quantitative vs qualitative traits- genetic and environmental values measures of variances. (3)

Unit 4:Genetic Variation and Molecular Evolution **15 Hrs**

4.1. The origin of genomes- Acquisition of new genes by gene duplication and from other species.(2)

4.2. Origin of non-coding DNA, transposable elements and introns.(3)

4.3.Molecular phylogenetics- DNA sequence and protein sequence phylogenetics.(3)

4.4. Molecular Evolution-neutral theory.(2)

4.5. Establishment of evolutionary relationship - molecular clock.(2)

4.6. Construction of molecular phylogenetic trees- UPGMA, NJ methods.(3)

By the end of the course, students will be able to

CO1: To demonstrate the concept of genetic equilibrium and recognise HWE.

CO2: To differentiate the effects of mutation, migration and selection.

CO3: Interpret the effects of inbreeding in populations through inbreeding coefficient.

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CO4: To judge evolutionary relationships between/among organisms.

Semester –IV CBCS

BSC GENETICS II YEAR

SEMESTER IV PAPER IV

DSC-ID POPULATION GENETICS & EVOLUTION

PRACTICALS

W.e.f 2021-22 onwards

Code : GT432P

Credits: 1

No. of hrs: 30 hrs (2hrs/week)

Skill development in mathematical analysis and reasoning for a career in research.

Cob : To solve numericals on HWE and construct pedigrees to deduce inbreeding coefficient.

1. Calculating allele and genotypic frequencies.
2. Testing of gene frequencies for Hardy-Weinberg equilibrium – monogenic.
3. Testing of gene frequencies for Hardy-Weinberg equilibrium -multiple alleles and sex linked linked loci.
4. Testing for deviation of HW equilibrium using chi-square test.
5. Estimation of mutation rates.
6. Calculation of gene frequencies under different types of selection.
7. Construction of pedigrees-raw and forked pedigrees.
8. Estimation of inbreeding coefficient using pedigrees.

CO: By the end of this course, students will be able to apply the concepts of HWE, Chi square test and inbreeding coefficient.

RECOMMENDED BOOKS

1. Hedrick P. W. -Jones & Bartlett. Genetics of Population
2. Hartl D. L. And Clark A. G., Principle of Population Genetics, Sinauer Associates
3. Falconer. D (1995) Introduction to Quantitative Genetics, 4th edition London
4. Stickberger, M. W (1990) Evolution, Jones and Bartlett, Boston
5. Population Genetics- C C Lee

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Department of Genetics and Biotechnology

Skill Enhancement Course- Credits 2

Effective from 2023-'24 onwards

Title:Genetic Counselling- SE432

Skill Development: Students learn risk assessment using principles of probability and Bayes theorem, they get hands-on training at the Institute of Genetics & Hospital for Genetic Diseases in Cell Biology (Cytogenetics), Clinical Genetics, Clinical Biochemistry, Molecular Biology and Environmental Toxicology laboratories.

Course Objectives: To evaluate the process of Genetic Counselling and its importance in prevention of genetic defects/disorders

Cob 1: To recognize the importance of prenatal diagnosis and molecular genetic techniques in the detection of genetic disorders.
Cob 2: To examine various strategies for the management/treatment of genetic disorders.

UNIT I: **15 Hours**

1. Basic aspects of Genetic Counselling: Types of genetic disorders and the need for Genetic Counselling (3)

2. Steps in Genetic Counselling (2)

3. Carrier detection (for recessive disorders) and risk prediction of genetic disorders. (Simple Probability and Bayesian calculation methods). (3)

4. Prenatal diagnosis and screening for congenital birth defects. (2)

5. Applications of molecular genetic techniques in detection of genetic disorders. (3)
6. Strategies for treatment of genetic disorders. (2)

UNIT II

Practical training program (Internship) at the Institute of Genetics and Hospital for Genetic Diseases, Begumpet, Hyderabad for a period of 4 weeks.

Course Outcome: Students distinguish the different aspects and steps involved in genetic counselling and value its importance in reducing the burden of genetic disease in populations.

Cob 1: They compare different methods of carrier detection and prenatal diagnosis.

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Cob 2:Hands-on practical training program at the Institute of Genetics and Hospital for Genetic Diseases, Hyderabad, helps students to improve their practical skills in Molecular Biology, Biochemistry and Cytogenetics.

References:

1. Emery's Elements of Medical Genetics, 2012, Elsevier, 14th edition.

2. Nussbaum, Genetics in Medicine, 2004, Elsevier, 2nd edition.

3. Harper, Practical Genetic Counselling, 2004, Arnold Publishers, 6th edition.

4. Emery and Rimoin, Principles and Practice of Medical Genetics (3 volumes), 2006, Churchill Livingston, 5th edition.

5. Mange and Mange, Basic Human Genetics, Sinauer Associates, Inc., 1999, 2nd edition.

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Department of Genetics and Biotechnology

Subject: Genetics

(BSc. Life Sciences)

Semester –V CBCS

W.e.f 2023-24 onwards

Paper V Theory

Title–ANIMAL GENETICS AND BIOTECHNOLOGY

Credits: 4
Paper Code: GT532
No of Hours: 60 (4hr/wk)

Employability: Knowledge of Genetics of lab animals like rabbits, mice etc, will be helpful in Industries working on vaccine development. Maintenance and cloning of lab animals will be useful to take up a career in Genetic Engineering and Genomics.

Course Objective: To examine the principles of Genetics in breeding systems for livestock, marker assisted selection, maintenance of laboratory animals, use of mice as models for human diseases, animal cell culture and production of transgenic animals

Cob 1: To discuss breeding systems for different livestock, use of DNA markers in artificial selection, and methods used for livestock improvement.

Cob 2: To examine the concepts of maintenance, mating methods and ethics for management and use of laboratory animals.

Cob 3: To compare the mouse and human genome and describe methods for development of transgenic mouse models to study human diseases.

Cob 4: To identify methods used in animal cell culture, importance of DNA based diagnostics and genetically engineered vaccines to protect livestock from diseases.

Unit 1: Livestock Genetics 15

1.1. Domestication of livestock, important breeds of livestock with economic importance (cattle, sheep, goat, poultry etc). 2

1.2. Mating systems for different livestock - genetic and phenotypic consequences and applications of inbreeding and outbreeding. 3

1.3. DNA markers (RAPD, SNPs), genotyping for identification, parentage verification, and determination of specific homozygous/heterozygous gene mutations in animals for diseases and physical traits-marker assisted selection. 3

1.4. Livestock improvement Role of Artificial Insemination/frozen semen/embryo transfer/ONBS/MOET in animal breeding; embryo sexing 3

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1.5. Animal genetic resources in India - evaluation and characterization of indigenous breeds of livestock, ex-situ and in situ conservation of genetic resources- cryogenic preservation of animal germplasm 4

Unit 2: Laboratory Animal Genetics **15**

2.1. Laboratory animal species-mice, rat, rabbit - chromosome number, genome size-major genes. 3

2.2. Physiological, nutritional and reproduction parameters of mice, rat and rabbit 3

2.3. Pedigree recording, planned mating, selection and mating methods, monogamous, polygamous 3

2.4. Ethics and legislation for management and use of laboratory animals; Institutional Animal Ethical committee guidelines 3

2.5. Importance of Laboratory Animal Genetics in health, genetic and environmental monitoring. 3

Unit 3: Mouse models for Human disease **15**

3.1. Mouse as model-advantages of mouse models - similarities and differences of mouse and human genomes 3

3.2. Nomenclature of strains, inbred lines in mice. 3

3.3. Methods of generating mouse models-non-targeted and targeted strategies-knock in and knock-out mouse 3

3.4. Transgenic mouse models in cancer-Oncomouse 3

3.5. Mouse models for human genetic diseases—Neurodegenerative disease (Alzheimer's & Parkinson's disease) 3

Unit 4: Animal Cell Culture & Biotechnology **15**

4.1. Animal cell culture types of animal cell culture, cell lines, culture media Applications of animal cell culture. 3

4.2. Stem cell-properties of stem cells, embryonic stem cells, adult stem cells, tissue engineering. 3

4.3. DNA based diagnostics and genetically engineered vaccines for animals - rabies virus-commercial DNA rabies vaccines, West Nile virus – commercially available WNV vaccines, Vaccines against bovine respiratory syncytial virus & Vaccines against bovine viral diarrhoea disease. 4

4.4. Cloning adult animals by somatic cell nuclear transfer-significance of Dolly experiment. 2

4.5. Transgenic animals-methods for producing transgenic animals, examples of transgenic animals Super fish, Glo fish and Enviro pig. Transgenesis in the

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improvement of production traits: growth and meat traits, wool production, milk composition. 3

Course Outcome: Students appraise the concepts of Animal Genetics in selection and breeding methods of livestock, maintenance of laboratory animals, applications of transgenic mouse models, animal cell culture and development of transgenic animals for improved traits.

CO1: They identify the importance of selection and breeding methods in animals and relate to modern methods of livestock improvement such as AI and embryo transfer technology.

CO2: They examine the importance of Animal Genetics in human health, genetics and environmental monitoring.

CO3: They interpret the role of transgenic mouse models in the study of human diseases like cancers and Alzheimer's disease.

CO4: They value the development of improved varieties of livestock using transgenic technology.

Paper V Practicals

Credits: 1
Paper Code: GT532P
No of Hours: 45 (3hr/wk)

Skill Development: The students will be able to maintain and manage lab animals like Utility Mice and rats. They will be able to prepare animal tissue culture media and maintain cell lines.

Course Objective: To appraise the guidelines for maintenance of laboratory animals, ethics and legislation regarding management and use of laboratory animals; to demonstrate the basic procedures used in animal cell culture.

1. Laboratory animal species maintenance and specific utility-mice and rat
2. Management and use of laboratory animals-ethics and legislation.
3. Strains and inbred lines-nomenclature
4. Preparation of animal cell culture media.
5. Sterilisation of cell culture media
6. Cell counting by microscopy

Course Outcome: Students value the contribution of laboratory animals to Bioscience research and examine the procedures used in animal cell culture.

REFERENCE BOOKS

1. Text book of Animal Biotechnology by BSingh. The Energy and Resources Institute (TERI)

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2. Genetics for Animal Sciences by WH Freeman, Van Vleck LD, Pollak EJ &Bltenacu EAB, 1987.
3. Cancer Cell Culture: Methods and Protocols: 731 (Methods in Molecular Biology) Humana: 2nd ed. 2011 edition (28 April 2011)
4. Genetic Engineering by V.K.Agarwal and P.S. Varma, S. Chand & Company Ltd. 2009

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Subject: Genetics

(BSc. Life Sciences)

Semester –V CBCS

W.e.f 2023-24 onwards

Paper VA Theory

Title–PLANT GENETICS & BIOTECHNOLOGY

Credits: 4
Paper Code: GT532A
No of Hours: 60 (4hr/wk)

Employability: Knowledge of Plant Tissue Culture will help in pursuing a career in Plant Biotechnology based Research Labs & Plant tissue culture companies. Knowledge of plant breeding will be useful in a career in Agriculture based companies like Nagarjuna Seeds, Syngenta to name a few.

Course Objective: To examine the principles of plant biotechnology in tissue culture, plant breeding methods and creation of genetically modified crops.

Cob 1: To analyse the basics of plant life cycle, Plant growth hormones and plant nuclear and organellar genome.

Cob 2: To apply the principles of plant tissue culture in callus induction, protoplast culture and somatic embryos.

Cob 3: To examine plant breeding methods in self-pollinating and cross-pollinating species and hybrid seed production.

Cob 4: To identify methods used in creation of transgenic plants.

Unit 1: Basics of Plant Life Cycle and Genetics 15

1.1. Overview of plant development and life cycle sporogenesis, gametogenesis, pollination, fertilisation, embryogenesis (development of monocot & dicot embryos) 2

1.2. Seed (monocot & dicot) development and seed germination 2

1.3. Meristems-root apical meristems & root development; shoot apical meristems & leaf development; flower and fruit development 2

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1.4. Plant hormones and their actions- auxins, cytokinins, gibberellins, abscisic acid. ethylene, brassinosteroids 3

1.5. Plant Nuclear Genome Organisations - General features, Variation of Genome size among plants, fine structure of plant gene 3

1.6 Plant Organellar Genome Organisation - Mitochondria, Chloroplast 3

Unit 2: Plant Tissue Culture **15**

2.1. Media and culture conditions, sterile technique. 2

2.2. Regeneration methods of plants in culture - organogenesis, somatic embryogenesis; Somaclonal variation 2

2.3. Induction of callus and cell suspension cultures. 3

2.4. Protoplast culture conditions, sterile technique 2

2.5. Anther/microspore culture - production of haploids and double haploids and their uses 3

2.6 Somatic embryo culture and production of synthetic seeds. 3

Unit 3: Plant breeding & Hybrid seed production **15**

3.1. Mating Systems - self-fertilization, Cross fertilization and Apomixis. 2

3.2. Methods of breeding in Self-pollinating species - pedigree breeding, single-seed descent, bulk breeding method. 3

3.3. Methods of breeding in Cross-pollinating species - mass selection, recurrent selection. 3

3.4. Hybrid seed production - genetic male sterility (procedure for hybrid seed production by using GMS) 3

3.5. Hybrid seed production based on cytoplasmic genetic male sterility (seed production of CMS lines (A), maintainer line (B), restorer line (R) 2

3.6 Hybrid seed production based on functional male sterility system - gametocides and their use in hybrid seed production. 2

Unit 4: Transgenic plants production and applications **15**

4.1. Transformation based transgenic plants production - Agrobacterium tumefaciens and viral vectors. 2

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4.2. Direct gene transfer based transgenic plants production - particle bombardment, electroporation, silicon carbide whiskers, sonication, laser micro puncture, nanofiber arrays, chemical methods. 3

4.3. Genetically modified crops for insect resistance - Bt crops, microbes and plant derived toxins. 3

4.4. Genetically modified crops for Virus resistance - coat protein mediated cross protection, antisense and sense mediated resistance, satellite RNA protection pathogen targeted protection. 2

4.5. Genetically modified crops for Disease resistance - pathogenesis related proteins, anti-microbial proteins, engineering toxin insensitivity, phytoalexins, manipulation of disease resistance genes. 3

4.6. Transgenic plants for product quality - improved storage, longer shelf life, nutritional quality (Golden Rice) 2.

Course Outcome: Students value the concepts of Plant Genetics and Biotechnology in tissue culture, plant breeding and creation of genetically modified crops.

CO1: They identify the importance of basics of plant life cycle, Plant growth hormones and plant nuclear and organellar genome.

CO2: They examine the importance of principles of plant tissue culture in callus induction, protoplast culture and somatic embryos.

CO3: They value the role of plant breeding methods in self-pollinating and cross-pollinating species and hybrid seed production.

CO4: They evaluate methods used in creation of transgenic plants.

Paper V A Practicals

Credits: 1
Paper Code: GT532AP
No of Hours: 45 (3hr/wk)

Skill Development: Students learn media preparation, callus induction, micropropagation and anther culture.

Course Objective: To design the methods used in plant tissue culture like callus induction, anther culture and production of artificial seeds.

1. Histological studies of embryos at different stages

2. Seed testing for germination

3 Introduction to Plant tissue culture laboratory-equipment

4. Sterilisation methods in plant tissue culture laboratory -aseptic technique

5. Preparation of stock solutions of MS basal medium and plant growth regulators

6 Isolation of explants, establishment and maintenance of callus

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7. Culture of anthers and establishment of haploid plants

8. Preparation of synthetic seeds

Course Outcome: Students are able to develop procedures for callus induction, anther culture and production of artificial seeds.

RECOMMENDED BOOKS

1. Principles of Plant Genetics and Breeding (2012) by George Acquaah, Second Edition Wiley-Blackwell Publishers.
2. Plant Tissue Culture: Techniques and Experiments (2013) by Roberta H. Smith, Academic Press, U.K
3. Plant Tissue Culture and Biotechnology: Emerging Trends (2003) P.B. KaviKishor, Universities Press
4. Plant Tissue Culture: Basic and Applied (2005) by Timir Baran Jha, Universities Press
5. Plant Biotechnology: Practical Manual (2007) by C. C. Giri, Archana Giri, I.K International Publishers
6. From Plant Genomics to Plant Biotechnology (2013) edited by PalmiroPoltronieri. NatalijaBurbulis, CorradoFogher, Woodhead Publishing Limited, New Delhi
7. Plant Genomics and Biotechnology (2016) Isabelle Nickel. Syrawood Publishing House
8. Plant Biotechnology and Agriculture: Prospects for the 21st Century (2012) edited by Arie Altman, Paul M. Hasegawa, Elsevier
9. PlantCell Biotechnology by Rudolf Endress, Springer-Verlag Berlin

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Department of Genetics and Biotechnology

Subject: Genetics

(BSc. Life Sciences)

Semester –VI CBCS

W.e.f 2023-24 onwards

Paper VI Theory

Title–Human Genome & Human Genetics

Credits: 4
Paper Code: GT632
No of Hours: 60 (4hr/wk.)

Employability: Knowledge of Human Genome and Human Genetics will be helpful in pursuing research/career in National institutes like CCMB & CDFD; Genetic testing & diagnostic laboratories like MedGenome, Mapmygenome, and GeneTech; Genetic Counselling in multi speciality hospitals such as Apollo & KIMS; and research labs that specialise in molecular medicine & gene therapy like Roche.

Course Objectives:To examine the basic concepts and developments in the field of Human Genetics with respect to the human genome organisation, the Human Genome Project, types of genetic diseases, prevention and management of genetic diseases including gene therapy.

Cob 1: To distinguish the important features of human genome organisation, gene families and the types of sequences.

Cob 2: To appraise the achievements of the Human Genome Project and the emergence of the 'omics' era (genomics, proteomics, transcriptomics, epigenomics and pharmacogenomics).

Cob 3: To differentiate types of human genetic disorders.

Cob 4: To recognize the importance of screening, prenatal diagnosis, genetic counselling and treatment strategies in the prevention and management of human genetic diseases

Unit 1: The Human Genome 15

1.1. Human nuclear genome organisation - gene size and density, organisation of protein coding genes 3

1.2. Gene families - globin gene family, histone gene family 2

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1.3. Non - coding RNA genes - rRNA, tRNA &micro-RNA 2

1.4. Repetitive elements - LINES, SINES, LTR elements, satellites, minisatellites, microsatellites, Transposons 3

1.5. Human Mitochondrial genome organisation 2

1.6 Human Genome Variation - DNA Sequence variants, genetic polymorphisms, gene duplication and evolution. 3

Unit 2: Human Genome Project - Applications **15**

2.1. Human genome project - Goals and achievements, Applications and Ethics 2

2.2. Comparative genomics - evolutionary constrained sequences, diversified sequences, G-valve paradox. 3

2.3. Transcriptomics - Transcriptome analysis - Microarrays, RNA sequencing (RNA-Seq), Gene expression profiling. 3

2.4. Epigenomics - Epigenetic modifications (DNA methylation, Histone Modifications); genomic imprinting. 3

2.5. Proteomics - Proteome analysis, Protein arrays and their applications. 2

2.6 Pharmacogenomics - role of SNP in drug response Ex. G6PD 2

Unit 3: Chromosomal & Genetic defects in Human **15**

3.1. Human chromosomal disorders - Disorders due to Autosomes and sex chromosomes: Abnormalities due to Chromosome Number and structure 3

3.2. Inborn errors of metabolism - Amino acid metabolism (Phenylketonuria), Protein metabolism (Duchenne muscular dystrophy) 2

3.3.Single gene disorders - Pattern of inheritance - Autosomal disorders: Dominant - Huntington's disease, Recessive-Haemophilia; X-linked disorders: dominant - Fragile X syndrome, Recessive - DMD. 3

3.4. Complex disorders - Multifactorial inheritance (Diabetes mellitus, Hypertension), threshold effect. 2

3.5. Genetics of cancer- Types of genes- proto-oncogenes, oncogenes, tumour suppressor genes - Breast and Colon cancers. 3

3.6 Mitochondrial inheritance and associated disorders - Leber's Hereditary Optic Neuropathy, Kearns-Sayers syndrome. 2

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Unit 4: Genetic counselling, testing and therapeutics 15

4.1. Genetic counselling and risk assessment for autosomal dominant, autosomal recessive, sex linked inherited diseases. 2

4.2. Prenatal diagnosis – invasive(Amniocentesis, Chorionic villus sampling) and non-invasive (Ultrasonography, fetoscopy) 2

4.3. New-born screening (PKU), Preclinical screening - Sickle cell anaemia. 3

4.4. Ethical, legal and Social Issues of genetic testing and screening 3

4.5. Traditional treatment modalities - PKU, ADA 2

4.6 Gene therapy: Types-somatic and germ line gene therapy; Gene therapy trials: ADA deficiency, Cystic Fibrosis. 3

Course Outcome:Students recognise the basic concepts and advancements in the field of Human Genetics and its role in human health and medicine.

CO1: They identify the important features of the human genome organisation, gene families and types of sequences in the human genome.

CO2: They interpret the advancements in Human Genetics as a consequence of the efforts and success of the Human Genome Project.

CO3: They differentiate the mechanisms involved in causing human genetic defects/diseases.

CO4: They value the role of genetic screening, genetic testing, prenatal diagnosis, genetic counselling, and various treatment strategies in reducing the burden of genetic disease in society.

Paper VI Practicals

Credits: 1
Paper Code: GT632P
No of Hours: 45(3hr/wk)

Skill Development: Students learn the method of karyotyping, identification of the mode of inheritance from pedigrees, risk estimation using the concept of probability & Bayes theorem and amplification of DNA using PCR.

Course Objective:To demonstrate the role of karyotyping in identification of chromosomal disorders, inactivation of one X chromosome in normal females, identification of mode of inheritance by pedigree analysis, risk estimation and use of PCR in disease diagnosis.

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1. Karyotyping (normal male/normal female)

2. Leucocyte culture and G-banding

3. Isolation of genomic DNA from blood sample.

4. Screening for Barr bodies

5. Construction of pedigrees and identification of mode of inheritance of a trait

6. Estimation of risk analysis using pedigrees

7. Diagnosis of diseases by PCR based methods

Course Outcome: Students examine karyotyping procedure, chromosomal abnormalities in Idiograms, different modes of inheritance of traits, risk estimation using rules of probability and disease diagnosis based on PCR.

RECOMMENDED BOOKS:

1. A.G. Motulsky and F. Vogel (1986) HumanGenetics

2. R. F. Mueller and LD Young (2001) Emery's Elements of Medical Genetics

3. Curt Stern (1960) Principles of Human Genetics

4. Gardner, A. and Davies, T. (2009) Human Genetics-Scion Publishing, 2nd ed.

5. Lewis, R.(2008) Human Genetics: Concepts and Applications, McGraw Hill Publishing. New York, 8th ed.

6. Lewis, R. (2011). Human Genetics-The Basics, Routledge, London

7. Mange. E.J. and Mange, A.P. (1999). Basic Human Genetics, Sinauer, Sunderland

8. Scriver, C.R.A.L. Beudit. W.S. Sty and D. Valle, Molecular Basis of Inherited Diseases. (6th Edition 1989) by EdsO McGrawHill, New York.

9. Tom Strachan and Andrew Read (1996) Human Molecular Genetics

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Department of Genetics and Biotechnology

Subject: Genetics (Optional)

(BSc. Life Sciences)

Semester –VI CBCS

W.e.f 2023-24 onwards

Paper VI A Theory

Title–Cellular & Molecular Immunology

Credits: 4
Paper Code: GT632A
No of Hours: 60 (4hr/wk)

Employability: Study of Cellular and Molecular Immunology helps students to pursue a career in vaccine producing companies like Indian Immunologicals, Bharat Biotech, Serum Institute of India, to name a few. They can also pursue research & career in immunology based laboratories such as National Institute of Virology, Pune, National Institute of Immunology, New Delhi etc.

Course Objectives:To differentiate innate and adaptive immunity, cellular and humoral, interpret the functioning of MHC, causes of hypersensitivity, auto immunity, immunodeficiency disorders and identify the uses of various immunological techniques.

Cob 1: To recognise basics concepts of the immune system and types of immunity.

Cob 2: To describe the humoral and Major Histocompatibility Complex (MHC) components of the immune system.

Cob 3: To distinguish cellular immune response, mechanisms involved in hypersensitivity, auto-immunity; immunodeficiency disorders and types of vaccines.

Cob 4: To examine the different techniques used in immunology.

Unit 1: Innate and Adaptive Immunity 15

1.1. Introduction to Immune System, types of immunity-innate and adaptive 2

1.2. Innate immunity - anatomical barriers and physiological barriers, phagocytic barrier 2

1.3. Cellular components of immunity - Lymphoid Cells (B cells, T cells and NK cells), Myeloid cells (Neutrophils, Eosinophils, basophils, mast cells, macrophages and dendritic cells) 3

1.4. Lymphoid organs- Primary lymphoid organs (Bone Marrow and thymus); secondary lymphoid organs (lymph node and spleen) 3

1.5. Antigens - Immunogens, epitopes 3

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1.6 Haptens and types of adjuvants 2

Unit 2: Humoral and MHC immune responses **15**

2.1. Basic structure of Immunoglobulin - Immunoglobulin domains- variable region and constant region domains; isotypes, allotypes, idiotypes 3

2.2. Immunoglobulin classes and its functions - IgG, IgM, IgA, IgD, IgE. 2

2.3. Polyclonal antibodies, Monoclonal antibodies - its production and applications. 2

2.4. Structure and organization of MHC class I and class II molecules. 3

2.5. MHC molecules - cellular distribution and immune responsiveness. 2

2.6. Types of grafts: Role of HLA typing in organ transplantation. 3

Unit 3: Cell mediated Immune response and Vaccines **15**

3.1. Cell mediated immunity: Structure and functions of T-cell receptors; Antigen presenting cells (APCs), ternary complex (TCR, peptide and MHC); Cytokines 3

3.2. Hypersensitivity - Types (I, II, III & IV) 2

3.3. Autoimmunity - mechanisms of autoimmunity and autoimmune diseases (thyroid and Rheumatoid arthritis) 2

3.4. Immunodeficiency disorders - primary immunodeficiency disorders (SCID), secondary immunodeficiency disorders (AIDS) 3

3.5. Vaccines - historical background and principle; passive and active immunisation, attributes of effective vaccines. 2

3.6 Types of vaccines - live attenuated and inactivated killed vaccines, subunit vaccines, DNA vaccines, edible vaccines.

2

3.7 Covid-19- Cause and Vaccine development strategies in India. 1

Unit 4: Immunological Techniques **15**

4.1. General features of ag-ab reactions - Agglutination, neutralisation, complement fixation, opsonization 3

4.2. Immunoprecipitation, immunoelectrophoresis, immunodiffusion tests 2

4.3. ELISA –Types(Sandwich, Indirect, Dot ELISA) - Principle and applications. 3

4.4. Immunofluorescence assays (direct and indirect) - Principle and Applications 3

4.5. Western blot - Principle, methodology and applications 2

4.6 Flow Cytometry - Principle, methodology and applications 2

Course Outcome: Students recognise the basic concepts of Immunology, mechanisms involved in hypersensitivity, auto immunity, immunodeficiency disorders, principles of immunology in vaccines development and importance of immunological techniques.

CO1: They distinguish innate and adaptive immunity and various components of the immune system.

CO2: They distinguish different types of immunoglobulins in terms of structure and function and relate the role of MHC/HLA in organ/tissue transplantation.

CO3: They interpret the role of the immune system in types of hypersensitivity, autoimmune disorders, immunodeficiency disorders and development of different types of vaccines.

CO4: They compare the principles and applications of different immunological techniques.

RECOMMENDED BOOKS

1. Essential Immunology by I. Roitt,Publ: Blackwell
2. Immunology by C. Reever&I. Todd,Publ: Blackwell
3. Immuno diagnostics by S.C.Rastogi, Publ: NewAge
4. Immunology by Richard A.Goldsby, Thomas J Kindt, Barbara Osborne, Janis Kuby
5, Fundamental immunology by William E. Paul
6. Basic Immunology by Bhoos Reddy G.L. and Wadher B. J.
7. Textbook of Immunology by Baruj Benacerraf
8. Immunology by Kuby. Publ:Freeman

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Paper VI A Practicals

Credits: 1
Paper Code: GT632AP
No of Hours: 45(3hr/wk)

Skill Development: Students learn the principle and working of important techniques used in immunology such as ELISA, SRID, Coomb's test and Western Blot.

Course Objective: To distinguish the principle and applications of commonly used immunological techniques.

1. ABO blood typing
2. Differential count of lymphocytes
3. Single Radial Immunodiffusion
4. ELISA
5. Agglutination
6. Haemagglutination test
7. Coomb's test
8. Western Blot

Course Outcome: Students evaluate the importance of different immunological techniques and relate to their applications.

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Department of Genetics and Biotechnology

Subject: Genetics

(BSc. Life Sciences)

Semester –V CBCS

W.e.f 2023-24 onwards

Generic Elective

Title– BASIC & APPLIED GENETICS

Credits: 4
Paper Code: GE532
No of Hours: 60 (4hrs/week)

Course Objectives:To analyse the concepts of basic Genetics with respect to Mendel's Laws of inheritance, Structure of Nucleic Acids, Cell structure, Cell division, Genetic Engineering and Genetic Diseases.

Cob 1: To examine the patterns of Mendelian Inheritance.

Cob 2: To analyse structure of Nucleic Acids, Cell Structure and Cell Division.

Cob 3: To evaluate the principles and applications of Genetic Engineering.

Cob 4: To interpret the mechanisms that cause various Human Genetic Diseases

Unit 1: Introduction to Genetics	**15**
1.1. Genotype & phenotype; homozygous & heterozygous; dominant & recessive; gene & allele	2
1.2. Mendelian genetics-Principle of dominance, Principle of segregation, Principle of Independent Assortment	3
1.3. Trait Inheritance ABO blood groups in human; eye colour in Drosophila	2
1.4. Polygenic Inheritance -Kernel colour in Maize, skin colour in man	3
1.5. Sex-linked Inheritance - haemophilia and colour blindness in man	2
1.6. Non-Mendelian inheritance-Maternal inheritance-Variegation in leaves of higher plants-Mirabilis Jalapa	3

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Unit 2: Cellular & Molecular basis of Inheritance:	15
2.1. DNA structure and its alternative forms (A, B & Z)	3
2.2. RNA-types of RNA (rRNA, mRNA & tRNA)	2
2.3. Ultra-structure of prokaryotic cell (cell membrane and plasmids, Nucleoid)	2
2.4. Ultra-structure of eukaryotic cell (nucleus, mitochondria, chloroplast, endoplasmic reticulum, golgi apparatus)	3
2.5. Chromosomes: Packaging of DNA into Chromosomes, structure(centromere and telomere), karyotype	3
2.6. Cell division stages of mitosis, meiosis I & II & fertilisation	2
Unit 3: Genomes & Genetic Engineering	15
3.1. Prokaryotic genomes-genome size & organisation	2
3.2. Eukaryotic genomes-features of eukaryotic nuclear and organellar genomes	2
3.3. Human genome project-goals and achievements	3
3.4. Genetic Engineering - Transgenic plants-Bt cotton, Golden rice	2
3.5. Genetic Engineering - Transgenic animals -Molecular pharming-Buffalo and Goat	3
3.6. Genetic Engineering: Environment- bioremediation	2
3.7 Vaccines- Indigenous Covid vaccines	1
Unit 4: Human Genetics	15
4.1. Human nuclear genome -general features, protein coding genes. RNA coding genes, non-coding DNA 2	
4.2. Human chromosome anomalies: Down's syndrome and Klinefelter's syndrome	2
4.3. Single gene disorders-Hemoglobinopathies(Sickle cell disease,Thalassemias)	2
4.4. Complex genetic diseases-Hypertension. Diabetes mellitus	3
4.5. Genetic testing: Prenatal screening (Invasive methods and non-invasive techniques). Neonatal screening (PKU), Preclinical screening (Alzheimer's)	3
4.6. Therapeutics: Conventional treatment modalities- PKU; Gene therapy: Types-somatic and germ line gene therapy, Gene therapy trials: ADA deficiency	3

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Course Outcome:Students distinguish the inheritance of different traits, types of nucleic acids, mitotic & meiotic cell division, types of genetic disorders and value the applications of Genetics to agriculture, animal husbandry, human health and medicine.

CO1: They recognize Mendel's laws of inheritance and different inheritance patterns.
CO2: They compare the structure and function of different types of nucleic acids, prokaryotic and eukaryotic cells, mitotic and meiotic cell division.
CO3: They appraise the importance of transgenic plants& transgenic animals in addressing global issues like food scarcity, nutrient deficiency etc. and bioremediation to reduce environmental pollution.
CO4: They identify different types of human genetic diseases, techniques of genetic testing and treatment strategies.

RECOMMENDED BOOKS

1. The Foundations of Genetics by F.A. I. Crew, Elsevier, 2014

2 Concepts of Genetics, 7/E by Klug, Pearson Education India, 2002

3 Genetics byKarvita B. Ahluwalia, New Age International, 2009

4. Genetics by M. Yadav, Discovery Publishing House, 2003

5. Human Genetics: The Basics byRicki Lewis Taylor & Francis, -2016

6. Essentials of Human Genetics by Bhatnagar, S.M. Orient Blackswan, 1999

7. DNA Technology: The Awesome Skill by I. Edward Alcamo, Gulf Professional

Publishing, 2001

8. Recombinant DNA Technologyby KeyaChaudhuri, The Energy and Resources Institute (TERI), 2013

9. Recombinant DNA Technology edited by Sardul Singh Sandhu, I.K. International Pvt.

Ltd, 2010

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Department of Genetics, Biotechnology and Botany

Subject: Genetics

Semester –VI

W.e.f 2023-24 onwards

Advanced Techniques in Genome Analysis

Credits: 4
Paper Code: GT632_O
No of Hours: 60(4hr/wk)

Employability: Students can pursue research/career in companies/institutes/University departments that deal with molecular biology techniques and genetic engineering of plants and animals such as Centre for Cellular & Molecular Biology (CCMB), Institute of Genomics and Integrative Biology (IGIB), and National Institute of Plant Genome Research (NIPGR) etc.

Course Objectives: To recognise the importance of biophysical techniques, genome analysis techniques, gene transfer techniques and their applications

Cob1: To examine biophysical techniques such as electrophoresis, hybridization, PCR etc.

Cob2: To discuss advanced genome analysis techniques like NGS and DNA Microarray.

Cob3: To describe gene transfer strategies for the development of Genetically Modified Organisms.

Cob4: To value the production of transgenic plants and animals.

Unit I: Biophysical Techniques. **15**

1.1. Chromatography – Principles and applications –Separation of peptides and amino acids. 3

1.2. Gel electrophoresis – Principles and applications. 2

1.3. Separation of proteins and nucleic acids- Agarose and PAGE. 3

1.4. Polymerase chain reaction (PCR) Principle and its applications. 3

1.5. Types of PCR- Reverse Transcription PCR, Inverse PCR, Anchored and site Directed PCR. 2

1.6. Autoradiography – Principles and Applications. 2

Unit II: Advanced techniques in genome analysis. **15**

1.1. Hybridization techniques – Southern, Northern, Western blotting techniques – FISH, Principles and Applications. DNA - Microarray technology. 3

1.2.DNA sequencing – Maxam Gilbert's method, Sanger's method and automated sequencing, Next Generation Sequencing. 3

1.3. Hybridoma technology and production of Monoclonal Antibodies. 2

1.4. Chromosome Banding - G-banding, C-banding, R-banding, Q-banding, NOR banding. 2

1.5. Flow cytometry – cell sorting & isolation of individual chromosomes. 2

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1.6. DNA Fingerprinting – RAPD technique, VNTRs.	3

Unit III: Techniques of gene transfer	**15**
1.1.Physical methods – Electroporation – Microprojectile bombardment.	3
1.2.Chemical methods – Liposome fusion, Calcium precipitation of DNA.	3
1.3.Gene transfer by Plant vectors –Ti vectors, CaMV and Gemini virus.	3
1.4.Gene transfer by Animal Vector- SV 40 and BPV.	2
1.5.Engineered embryonic stem cells – method.	2
1.6.Selection of engineered embryonic stem cells -positive, negative selection, PCR method.	2

Unit IV: Genetic engineering of Plants and Animals.	**15**
1.1.Transgenic plants – Need for developing transgenic plants.	1
1.2. Development of insect and herbicide resistant plants.	3
1.3. Development of stress tolerant plants.	2
1.4. Transgenic animals – Need for developing transgenic animals.	1
1.5. Nuclear transfer and cloning.	2
1.6. Developing transgenic animals – Cattle, Birds and Fish	3
1.7. Transgenic Mice – animal models for genetic diseases.	2
1.8 Gene Editing- CRISPR CAS 9	1

Outcomes: Students compare the principles and applications of various biophysical techniques, genome analysis techniques and gene transfer protocols

CO1: To value biophysical techniques such as electrophoresis, Hybridization techniques, PCR etc.
CO2: To appreciate advanced genome analysis techniques like NGS and DNA Microarray.
CO3: To differentiate gene transfer strategies for the development of Genetically Modified Organisms.
CO4:To appraise the uses of transgenic plants and animals.

Recommended Books

1. Molecular Biotechnology Principles and Applications of recombinant DNA — by BR Glick and JJ Pasternak
2. Next-Generation DNA Sequencing Informatics — by Stuart M. Brown
3. Biophysical Chemistry — by Upadhayay and Upadhayay
4. Recombinant DNA — by James D Watson

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5. Plant Biotechnology by H.S.Chawla

6. Gene Cloning by T. A. Brown

7. Principles of Gene Manipulation by Old & Primrose

Semester –VI

W.e.f 2022-'23 onwards

Advanced Techniques in Genome Analysis and Genetic Engineering (Practical))

Credits: 1
Paper Code: GT632_OP
No of hours: 45 hrs (3hr/ week)

Objectives: To implement techniques like chromatography, electrophoresis and leucocyte culture.

1.Identification of amino acids / proteins by chromatography.

2. Separation of proteins by electrophoresis.

3. Separation of nucleic acids by electrophoresis.

4.Restriction digestion analysis.

5. Leukocyte Culture

6.Karyotyping and G banding of Human chromosomes.

Outcomes: The students distinguish uses of cytogenetic techniques like Karyotyping and biophysical techniques like Agarose and Polyacrylamide gel electrophoresis.

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Department of Genetics and Biotechnology

Subject: Biotechnology

B.Sc Life Sciences

Semester–VI

CBCS

W.e.f 2023-24 onwards

PROJECT WORK

Credits: 4

Paper Code: BT632_PW
No of Hours: 60 (4hr/wk)

1. **Basic concepts of Project planning**

    a) **Selection of Project topic and defining objectives**
    b) **Planning of methods/approaches**

2. **Guidelines for Project writing**

- **Title of the project:**
- **Title page- Name of the Project, Name of the Student & the Supervisor**
- **Declaration by Student**
- **Declaration by Supervisor**
- **Introduction**
- **Objectives**
- **Review of Literature**
- **Methodology**
- **Results and Discussion**
- **Conclusion**
- **References**

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Course Objectives:

Cob 1: To develop practical and project writing skills.

Cob 2: To select a topic and execute the planned work using scientific analysis and logic.

1. **Project work will involve experimental work/data collection and it has to be completed in the stipulated time by the student.**

- Students will be asked their choice for Project work at the beginning of Semester VI and all formalities of topic and mentor selection will be completed. Project work will be offered as per the expertise and infrastructural facilities available in the department.

- Project work may be allotted to students as individual or as group project (not exceeding 4-5 students per group).

- The completed work and compiled data would be presented in the form of results and submitted in the form of a dissertation/project report.

- Final evaluation of the project work will be through a panel consisting of internal and external examiners.

- Guidelines provided for execution and evaluation of project work will be strictly adhered.

- The grading would be based on evaluation of punctuality, experimental work, record keeping, academic inputs, data presentation, interpretation etc.

Course Outcome:

At the end of the course, students will be able to

CO1: Plan and execute a project effectively in the stipulated time.

CO2: They develop analytical skills, statistical data handling skills, paper writing and oral presentation skills.

PROJECT WORK EVALUATION SCHEME

Presentation of Thesis Dissertation to External Examiner	-	**70 Marks (50 Presentation + 20 Dissertation)**
Continuous Evaluation by the Internal Examiner	-	**30 Marks**
Total	-	**100 Marks**

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Subject: Genetics
(BSc. Life Sciences)
Semester –VI CBCS
W.e.f 2023-24 onwards

Certificate Course - Basics of Biochemistry

Paper Code:
No of Hours: 30 (3hr/wk)

Skill Development: Fundamental concepts of biomolecules and basic practical skills will lay a strong foundation in the field of Biochemistry.

Course Objectives:

Cob 1: To distinguish biomolecules and analyze their structures including enzymes and enzyme action.

Cob 2: To provide hands on training in qualitative and quantitative assays of biomolecules

Unit I: Biomolecules **15 Hours**

1. Carbohydrates- Importance, classification, structure and functions of monosaccharides (glucose and fructose), disaccharides (sucrose, lactose and maltose) and polysaccharides - Homo (starch, glycogen, inulin) and hetero polysaccharides (hyaluronic acid and peptidoglycan). (4)
2. Amino acids- Importance, classification, structure, physical and chemical properties of amino acids, peptide bond formation. (3)
3. Proteins-importance, structure of proteins- primary, secondary, tertiary, and quaternary. (2)
4. Lipids- importance, classification-simple lipids (triacylglycerides and waxes), complex lipids (phospholipids and glycolipids), derived lipids (steroids, terpenes, and carotenoids). (3)
6. Enzymes – Importance, classification, and nomenclature, Michaelis- Menton Equation, factors influencing the enzyme reactions, enzyme inhibition (competitive, uncompetitive and mixed), co-enzymes (3)

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Unit II: Practical **15 Hours**

1. Preparation of Normal, Molar and Molal solutions
2. Preparation of Buffers (Acidic, Neutral and Alkaline Buffers)
3. Qualitative tests of sugars, amino acids and lipids.
4. Estimation of total sugars by Anthrone method.
5. Separation of amino acids by paper chromatography
6. Estimation of protein by Biuret method

Course Outcomes:

By the end of this course, student will be able to

CO1: To appreciate the structural and functional aspects of various biomolecules including enzymes.

CO2: Gain Expertise in qualitative and quantitative analysis of biomolecules

.RECOMMENDED BOOKS

Reference books:

1. Principles of Biochemistry by David L, Nelson and Cox
2. Biochemistry by Rex Montgomery
3. Harper's Biochemistry by Robert K. Murray
4. Enzymes by Trevor Palmer
5. Enzyme structure and mechanism by Alan Fersht
6. Principles of Biochemistry by Donald J. Voet, Judith G.Voet, Charlotte W.Pratt
7. Analytical Biochemistry by Cooper

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