

B.Sc.GeneticsSyllabus

Under Choice Based Credit System

w.e.f

2019-20



DEPARTMENT OF GENETICS
NIZAM COLLEGE (AUTONOMOUS)
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Telangana State Council of Higher Education, Govt. of Telangana B.Sc., CBCS
Common Core Syllabi for all Universities in Telangana
BSc GENETICS (wef 2019-20)

FIRST YEAR-SEMESTER I				
CODE	COURSE TITLE	COURSE TYPE	HPW	CREDITS
BS 101	Environmental Science/Basic Computer Skills	AECC-1	2	2
BS 102	English	CC-1A	4	4
BS 103	Second language	CC-2A	4	4
BS 104	Optional II-Transmission Genetics	DSC-1A	4T+3P=7	4+1=5
BS 105	Optional II	DSC-2A	-----	4+1=5
BS 106	Optional III	DSC-3A	-----	4+1=5
	TOTAL			25
FIRST YEAR-SEMESTER II				
BS 201	Gender Sensitization	AECC-2	2	2
BS 202	English	CC-1B	4	4
BS 203	Second language	CC-2B	4	4
BS 204	Optional II-Molecular Genetics & Genetic Engineering	DSC-1B	4T+3P=7	4+1=5
BS 205	Optional II	DSC-2B	-----	4+1=5
BS 206	Optional III	DSC-3B	-----	4+1=5
	TOTAL			25
SECOND YEAR-SEMESTER III				
BS 301	Cytogenetic Analysis	SEC-I	2	2
BS 302	Genetic Analysis in Model Organisms	SEC-2	2	2
BS 303	English	CC-1C	3	3
BS 304	Second language	CC-2C	3	3
BS 305	Optional II-Biostatistics & Bioinformatics	DSC-1C	4T+3P=7	4+1=5
BS 306	Optional II	DSC-2C	-----	4+1=5
BS 307	Optional III	DSC-3C	-----	4+1=5
	TOTAL			25
SECOND YEAR-SEMESTER IV				
BS 401	Biophysical and Molecular Biology techniques	SEC-3	2	2
BS 402	DNA Technology in Health Care and Transgenics	SEC-4	2	2
BS 403	English	CC-1D	3	3
BS 404	Second language	CC-2D	3	3
BS 405	Optional II-Population Genetics & Evolution	DSC-1D	4T+3P=7	4+1=5
BS 406	Optional II	DSC-2D	-----	4+1=5
BS 407	Optional III	DSC-3D	-----	4+1=5
	TOTAL			25

THIRDYEAR-SEMESTER-V

CODE	COURSE TITLE	COURSE TYPE	HPW	CREDITS
BS 501	English	CC-1E	3	3
BS 502	Second language	CC-2E	3	3
BS 503	Basic & Applied Genetics	GE	4	4
BS 504	OptionalI- A/B A.PlantGenetics &Biotechnology (or) AnimalGeneticsandBiotechnology	DSE-1E	4T+3P=7	4+1=5
BS 505	Optional-IIA/B	DSE-2E	-----	4+1=5
BS 506	Optional-IIIA/B	DSE-3E	-----	4+1=5
	TOTAL			25

THIRDYEAR-SEMESTER-VI

BS 601	ProjectinGenetics	Projectwork		4
BS 602	English	CC-1F	3	3
BS 603	Second language	CC-2F	3	3
BS 604	OptionalI- A/B A.HumanGenome&HumanGenetics (or) Cellular&MolecularImmunology	DSE-1F	4T+3P=7	4+1=5
BS 605	Optional-IIA/B	DSE-2F	-----	4+1=5
BS 606	Optional-IIIA/B	DSE-3F	-----	4+1=5
	TOTAL			25
	TOTAL Credits			150

Total credits= 164-12 (AECC 4 + SEC 8) =152

AECC: Ability Enhancement Compulsory Course

SEC: Skill Enhancement Course

DSC: Discipline Specific Course

DSE: Discipline Specific Elective

GE: Generic Elective

BSC GENETICS I
YEAR SEMESTER-I
DSC-Paper-I: TRANSMISSION GENETICS

Unit-1: Mendelian inheritance and its extensions

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

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.

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

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

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

Unit-2: Linkage, Crossing over and Gene mapping

Discovery of linkage – Phases of linkage

Chiasmata and Crossing over formation – Recombination

Cytological proof for crossing over – Curt Stern and McClintock experiments

Linkage analysis – Recombination frequencies, Two-point and Three-point crosses Gene mapping – Coincidence and Interference, Determination of gene order

Gene mapping in *Neurospora* – Tetrad analysis; Mitotic recombination in *Aspergillus* and *Drosophila*

Unit-3: Cell division and Chromosome segregation.

Eukaryotic Cell cycle – Phases of cell cycle G₀, G₁, S, G₂.

Regulation of cell cycle cyclins, CDK proteins, role of p⁵³ in cell cycle. Mitosis –

Stages in mitotic cell division- significance of mitosis.

Meiosis – Formation of Synaptonemal complex, crossing over, chiasma formation, significance of meiosis.

Apoptosis – extrinsic & intrinsic pathways, & significance. Senescence,

Necrosis – characteristics & mechanisms

Unit-4:Chromosomestructure, chromatinorganizationandvariation

Chromosomemorphology-sizeandshape; EuchromatinandHeterochromatin-constitutive and facultative heterochromatin

Componentsofchromatin,histones &non-histones

Packing of DNA into chromatin – Nucleosome and higher order organization

SpecializedChromosomes–Lampbrushchromosomes,PolyteneChromosomes

Structuralchromosomalaberrations-duplications, deletions, inversions& translocations with examples, Genetic consequences

Numericalchromosomalaberrations–aneuploidy,euploidyauto-polyploidyandallo-polyploidy, Genetic consequences

PRACTICALS

1. IdentificationofnormalandmutantstocksofDrosophila
2. Drosophila-monoybrid anddihybrid segregation
3. ProblemsonMendeliansegregations-monoybrid,dihybridandtrihybridcrosses;multiple alleles, non-allelic interactions, multi-factorial inheritance; linkage and mapping of genes.
4. Neurospora–tetradanalysis
5. Studyof MitosisinOnion roottips
6. Studyof Meiosis inMaize/Grasshopper
7. PreparationofDrosophilasalivaryglandchromosomes –Polytenechromosomes
8. Identificationofstructuralandnumericalaberrations

RECOMMENDED BOOKS

1. GeneticsbyGardener
2. TheoryandproblemsinGeneticsby Stansfield
3. IntroductiontoGenetic AnalysisbySuzuki,Griffith,RichardandLewontin
4. GeneticsbyStrickburger
5. GeneticsbySnustad&Simmonds
6. PrinciplesofGeneticsbyTamarin
7. Cell&MolecularBiology–E.D.D. DeRobertis& E.M.F.DeRobertis
8. MolecularBiologyoftheCell–BruceAlberts

BSC GENETICS I Year SEMESTER-II
DSC-Paper II: MOLECULAR GENETICS & GENETIC ENGINEERING

Unit-1: Nucleic acids, DNA replication & DNA repair

DNA as the genetic material-Griffiths transformation experiment, Avery, MacLeod and McCarty's experiments and Hershey & Chase phage-labelling experiment; RNA as genetic material- tobacco mosaic virus

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 (r RNA, mRNA & t RNA)

DNA replication-conservative, semi-conservative and dispersive models, Meselson- Stahl experiment; Mechanisms of DNA replication-linear, circular, rolling circle, D-loop and θ -models

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

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

Unit-2: Gene expression in Prokaryotes & Eukaryotes

Structure of prokaryotic gene; Structure of eukaryotic gene; structure and functions of RNA polymerase & its sub units in prokaryotes

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

Genetic code-properties, deciphering of genetic code, Wobble hypothesis

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

Transcription in eukaryotes-Initiation, elongation & termination factors

Translation mechanism- initiation, elongation and termination

Unit-3: Gene regulation in prokaryotes & eukaryotes

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

Prokaryotic transcriptional regulation (repressible system)-tryptophan Operon

Post-transcriptional modifications- capping, poly-adenylation

Splicing and alternative splicing, rRNA and tRNA splicing

Post-translational modifications-glycosylation, lipidation, acetylation, ubiquitination and chaperones

Gal locus regulation in yeast-regulation of mating type

Unit-4:MicrobialGenetics&GeneticEngineering

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

Conjugation- unidirectional gene transfer- F⁺ and F⁻ High frequency recombination, Gene mapping by conjugation

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

Vectors used in cloning: *E.Coli*, plasmid vectors- pBR322, pUC vectors; cosmids; shuttle vectors- yeast vectors

Strategiesfor genomiclibrariesandcDNAlibraries construction

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

PRACTICALS

1. ExtractionofgenomicDNA
2. QuantificationofDNA byspectrophotometer
3. Agarosegelelectrophoresis ofDNA
4. Estimation of DNAby DPAMethod
5. EstimationofRNA byorcinol method
6. EffectofUVonbacterialgrowth
7. Preparationofcompetent cellsof bacteria
8. Problemsonrestriction mapping

RECOMMENDED BOOKS

1. PrinciplesofGenetics- IrwinHerscowitz
2. MolecularBiologyofthe gene-Watson,Hopkins,Roberts, SteitzandWeiner
3. Genes-BenjaminLevin
4. Generalvirology-Luria,Darnell,Baltimoreand Campbell
5. MolecularBiology-DavidFreifelder
6. PracticalMicrobiology-Aneja
7. MicrobialGeneticsByMaloy, Freifelder
8. MolecularGeneticsBy GuntherandStent
9. GeneticAnalysisByGriffith,Suzukiand others
10. GenecloningandDNAanalysis:anintroduction/T.A.Brown

**BSC GENETICS II YEAR
SEMESTER I IBS301 SEC1
CYTOGENETIC ANALYSIS**

Unit 1: Preparation of Chromosomes

Cell culture – sterilizing techniques, growth media, variables affecting cell growth, contamination in tissue culture, preservation of cells
Sample collection and handling – peripheral blood, bone marrow, amniotic fluid, solid tissues
Culture initiation; harvesting, hypotonic treatment, slide preparation
Chromosome staining and banding - G-banding, Q-banding, R-banding, C-banding
Karyotyping – metaphase spread, counting of chromosomes

Unit 2: Chromosome Analysis

Microscopy – Bright-field microscopy, inverted and fluorescence microscopy
Chromosomal analysis - chromosome number, size & shape in humans; karyotyping
chromosomes – ideogram
Chromosome abnormalities – Structural (breaks, gaps, deletions, insertions, duplications, inversions, translocations), numerical: aneuploidy (monosomy, trisomy & tetrasomy); polyploidy (triploidy, tetraploidy)
FISH & SKY – principle, applications and limitations
Screening Analysis - amniotic fluid sampling, chorionic villi sampling, bone marrow aspiration & biopsy analysis

RECOMMENDED BOOKS

1. AGT cytogenetics Laboratory Manual (2017) Arsham, Barch & Lawce, Wiley Blackwell publications
2. Human cytogenetics - A practical approach (2001) Rooney, Oxford University press
3. Manual of cytogenetics in Reproductive Biology (2014). Pankaj Talwar, Jaypee Brothers Medical Publishers (P) Ltd.
4. Clinical Biochemistry (2013) Gaw, Cowan, Murphy, Srivastava and O'Reilly, Elsevier

BSC GENETICS II YEAR

SEMESTER III IBS302 SEC2

GENETIC ANALYSIS IN MODEL ORGANISMS

Unit 1 - Lower Model Organisms

E. coli - life cycle - *E. coli* genome – *E. coli* plasmids - Advantages of *E. coli* as model organism - pathogenic *E. coli* – *E. coli* data bases *E. coli* biotechnology applications.

Yeast - life cycle - mating and homothallic sporulation and meiosis tetrad analysis - dominance complementation test - yeast as model system -non- mendelian segregation - yeast resources

Neurospora crassa – life cycle - fine structure genetic analysis - *N. crassa* as model organism

Chlamydomonas - lifecycle – reproduction - *Chlamydomonas* as model organism

Non-traditional model organisms – reasons for non-traditional models - examples

Unit 2 - Higher Model Organisms

Caenorhabditis elegans- life cycle , anatomy, development - reproduction - chromosomes – Genome of *C. elegans* - *C. elegans* as model organisms

Drosophila – life cycle – reproduction - genetic markers - classic genetic mutations, genome similarities to humans - development - sex determination - drosophila genetic resources

Maize - life cycle and physiology - maize genome - maize as a model organism for plant biology - maize as crop plant - maize genetic resources

Zebra fish - reproduction and developmental biology - zebra fish as model organism

Role of genetic model organisms in human diseases - cancer, neurological disorders , heart diseases , ageing and age related diseases

RECOMMENDED BOOKS

1. R.H. Tamarin, principles of genetics, McGraw Hill publication
2. Alberts. B, et al, Molecular Biology of the cell, J.D. Garland publishers, Oxford
3. David. T. Suzuki et al, Introduction to Genetic Analysis, W.H. Freeman publication, seventh edition.
4. Geoffrey M Cooper, The Cell A Molecular Approach, Sunderland publication, eighth edition.
5. Redei, Genetics, McMillan publication

BSC GENETICS II YEAR
SEMESTER III BBS305 DSC-IC
BIOSTATISTICS AND BIOINFORMATICS

Unit 1: Descriptive Biostatistics and Probability

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.

Data tabulation and representation methods: Graphical methods- stem and leaf plot, line diagram, bar graphs, histogram, frequency polygon, frequency curves; Diagrammatic method- pie diagram

Measures of Central tendency—mean, median, mode; merits and demerits

Measures of Dispersion-range, variance, standard deviation, standard error and coefficient of variation; merits and demerits

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

Probability Distributions: Binomial & Poisson distributions for discrete variables, Normal distribution for continuous variables

Unit 2: Applications of Biostatistics

Hypothesis testing- Steps in testing for statistical hypothesis, null and alternative hypothesis, level of significance- type-1 and type-2 errors

Tests of significance for small samples- Student's t-test (one sample and two sample) Test of significance for large samples- Z-test of means and proportions

Chi-square test and its applications- goodness of fit, independence

Analysis of Variance (ANOVA) – one way analysis

Correlation- Definition, Simple and Linear analysis, Karl Pearson's correlation coefficient

Unit 3: Introduction to bioinformatics and biological databases

Bioinformatics definition, history, scope and applications

Bioinformatic tools and resources- internet basics, role of internet, free online tools, downloading free softwares and installation.

Bioinformatic web portals—NCBI, EBI, ExPASy

Biological databases: Classification of databases—primary (GenBank), secondary (PIR) and tertiary or composite (KEGG) databases

DNA sequencedatabases (ENA & DDBJ)

Protein sequencedatabases (Swissprot & PROSITE)

Unit4:Sequence Alignment

Basics of sequence alignment-match, mismatch, gaps, gap penalties, scoring alignment
Types of sequence alignment-pairwise and multiple alignment, local and global alignment
Dot matrix comparison of sequences
Scoring matrices-PAM and BLOSUM
Pairwise sequence similarity search by BLAST and FASTA
Concepts of phylogenetic tree-character based (maximum likelihood & maximum parsimony method)

PRACTICALS

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 on 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, Swissprot
8. Pairwise homology search by BLAST and FASTA

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. Hanmanth 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 Gibas, Per Jambeck
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.

BSC GENETICS II YEAR
SEMESTER IV BS401 SEC-3
BIOPHYSICAL AND MOLECULAR BIOLOGY TECHNIQUES

Unit 1: Biophysical techniques

Spectroscopy—principle, instrumentation, ultraviolet and visible light spectroscopy, applications

Chromatography— types of chromatographic techniques (paper, ion exchange chromatography, size exclusion chromatography)- principle & applications

Centrifugation—principles of sedimentation, preparative centrifugation (differential centrifugation & density gradient centrifugation), applications

Electrophoretic techniques—types (Agarose gel electrophoresis, SDS PAGE), principle & applications

Mass spectrometry—principle & applications

Microscopy—principle & applications of Phase contrast microscope and confocal microscopy

Unit 2: Molecular Biology techniques

PCR—Types (Allele-Specific PCR, ARMS PCR, Reverse Transcriptase PCR)- principle and applications.

Quantitative Real Time PCR—principle and applications. DNA

Sequencing – principle and applications.

Microarray—DNA and protein arrays—principle and applications.

Blotting techniques—Southern blot, Northern blot and Western blot—principle and applications.

Fluorescence & Chemiluminescence Imaging—principle and applications

RECOMMENDED BOOKS

1. Principles and Techniques of Biochemistry and Molecular Biology edited by Keith Wilson, John Walker Cambridge University Press, -2010
2. Basic Techniques in Biochemistry and Molecular Biology by R. K. Sharma I. K. International Pvt Ltd, 2008
3. Techniques in Molecular Biology. Textbook Student Edition; Agrawal S. International Book Distributing Company, 2008
4. Analytical Techniques in Biochemistry and Molecular Biology; By Rajan Katoch Springer Science & Business Media, 2011

**BSC GENETICS II YEAR
SEMESTER-IVBS402SEC4
DNA TECHNOLOGY IN HEALTH CARE AND TRANSGENICS**

Unit 1: DNA Technology in Health care

Methods of DNA analysis – DNA probes, PCR, signal amplification, DNA chip, RFLP analysis, DNA fingerprinting.

Diagnosing infectious diseases – AIDS, tuberculosis.

Identifying genetic disease – DMD, Huntington's disease. Gene therapy- ADA deficiency and Cystic fibrosis.

Pharmaceutical products of DNA technology – Recombinant insulin, recombinant growth hormone, recombinant vaccines- Hepatitis-B

Unit 2: Applications of Transgenic Technology

Custom Made Animals – Human mouse, Oncomouse, Alzheimer's mouse, Knockout mouse; Diagnosing infectious disease – AIDS and tuberculosis.

Animal bioreactors- Pharm Animals.

Enhancing resistance in plants – ice-minus experiments, resistance to biological agents, and resistance to herbicides. Coat protein-mediated protection against virus infections, genetic engineering of crops for insect resistance using genes of plant origin.

Bioengineered foods – Vegetable vaccines, GM foods.

Energy applications – biohydrogen, bioethanol, biomethanol, biobutanol

RECOMMENDED BOOKS

1. DNA Technology: The Awesome Skill By I. Edward Alcamo Gulf Professional Publishing, 2001.
2. Recombinant DNA Technology Keya Chaudhuri The Energy and Resources Institute (TERI), 2013.
3. Recombinant DNA Technology edited by Sardul Singh Sandhu I.K. International Pvt Ltd, 2010.
4. From Genes to Genomes: Concepts and Applications of DNA Technology By Jeremy W. Dale, Malcolm von Schantz, John Wiley & Sons, 2011

BSC GENETICS II YEAR
SEMESTER IV BS405 DSC
POPULATION GENETICS & EVOLUTION

Unit 1: Principles of Population genetics

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

Genetic and phenotypic variation in a population, allele frequencies and genotype frequencies at a locus

Hardy-Weinberg Law - assumptions and implications, establishment of Hardy-Weinberg equilibrium for single gene locus

Extension of Hardy-Weinberg Law for multiple alleles

Establishment of Hardy-Weinberg Law for X-linked genes

Linkage disequilibrium - haplotypes, coefficient of linkage disequilibrium, coupling gametes and repulsion gametes

Unit 2: Selection, Mutation & Migration

Selection - fitness, patterns of natural selection, general selection equation, equilibrium under selection

Selection favoring heterozygotes: stable equilibrium, balanced polymorphism (sickle cell anemia, heterozygote advantage)

Selection against heterozygotes: unstable equilibrium (Rh incompatibility); complete elimination of recessive genes

Mutation - influence of mutation on allele frequencies, balance between forward and backward mutation

Genetic load - mutational and segregational

Gene flow - Migration - Wahlund effect

Unit 3: Inbreeding, Genetic Drift and Quantitative inheritance

Inbreeding - non-random mating, Identity by descent, selfing

Construction of pedigrees - Raw & forked pedigrees - inbreeding coefficient Effect of inbreeding on genotypic frequencies and inbreeding depression Genetic Drift - Bottleneck effect, Founder effect

Effective population size, consequences of a decreasing population size

Quantitative vs qualitative traits - genetic and environmental values - measures of variances

Unit4: Genetic Variation and Molecular Evolution

The origin of genomes- Acquisition of new genes by gene duplication and from other species. Origin of non-coding DNA, transposable elements and introns. Molecular phylogenetics- DNA sequence and protein sequence phylogenetics. Molecular Evolution- neutral theory. Establishment of evolutionary relationship – molecular clock. Construction of molecular phylogenetic trees – UPGMA, NJ methods.

PRACTICALS

1. Calculating allele and genotypic frequencies
2. Testing of gene frequencies for Hardy-Weinberg equilibrium – monogenic alleles
3. Testing of gene frequencies for Hardy-Weinberg equilibrium – multiple alleles and X-linked loci
4. Testing for deviation of HWE 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

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, Longman, London
4. Stickberger, M.W (1990) Evolution, Jones and Bartlett, Boston
5. Population Genetics-CCL

BSC GENETICS III YEAR
SEMESTER V GE
502BASIC&APPLIEDGENETI
CS

Unit1:Introductionto Genetics

Genotype&phenotype;homozygous&heterozygous;dominant& recessive;gene&allele
Mendeliangenetics–Principleofdominance,Principleofsegregation,Principle of
Independent Assortment
TraitInheritance–ABObloodgroupsinhuman;eyecolorinDrosophila
Polygenic Inheritance –KernelcolourinMaize, skin colour in manSex-
linked Inheritance – haemophilia andcolourblindnessinman
Non-Mendelianinheritance-Maternalinheritance-Variegationinleavesofhigher
plants-Mirabilis Jalapa

Unit 2: Cellular & Molecular basis of Inheritance

DNAstructureanditsalternativeforms(A,B&Z) RNA -
types of RNA (rRNA, mRNA &tRNA)
Ultrastructureof prokaryoticcell (cellmembraneandplasmids,Nucleoid)
Ultrastructureofeukaryoticcell(nucleus,mitochondria,chloroplast,endoplasmic
reticulum, golgi apparatus)
Chromosomes:PackagingofDNAintoChromosomes,structure(centromereand
telomere), karyotype
Celldivision–stagesofmitosis,meiosisI&II&fertilization

Unit3:Genomes&Genetic Engineering

Prokaryoticgenomes –genomesize& organization
Eukaryoticgenomes-featuresofeukaryoticnuclearandorganellargenomes Human
genome project –goals and achievements
GeneticEngineering -Transgenicplants-Bt cotton,Golden rice
GeneticEngineering-Transgenicanimals-Molecularpharming-BuffaloandGoat Genetic
Engineering: Environment- bioremediation

Unit 4: Human Genetics

Human nuclear genome – general features, protein coding genes, RNA coding genes, non-coding DNA

Human chromosome anomalies: Down's syndrome and Klinefelter's syndrome

Single gene disorders - Hemoglobinopathies (Sickle cell disease, Thalassemias)

Complex genetic diseases – Hypertension, Diabetes mellitus

Genetic testing: Prenatal screening (Invasive methods and Non-invasive techniques, Neonatal screening (PKU), Preclinical screening (Alzheimer's)

Therapeutics: Conventional treatment modalities - PKU; Gene therapy: Somatic and germ line gene therapy; Gene therapy trials: ADA deficiency

RECOMMENDED BOOKS

1. The Foundations of Genetics By F. A. E. Crew Elsevier, 2014
2. Concepts of Genetics, 7/E By Klug Pearson Education India, 2002
3. Genetics By Karvita B. Ahluwalia New Age International, 2009
4. Genetics by M. Yadav Discovery Publishing House, 2003 By M. Yadav
5. Human Genetics: The Basics By Ricki Lewis Taylor & Francis, -2016
6. Essentials of Human Genetics (Rev) By Bhatnagar, S. M. Orient Blackswan, 1999
7. DNA Technology: The Awesome Skill By I. Edward Alcamo Gulf Professional Publishing, 2001
8. Recombinant DNA Technology Keya Chaudhuri The Energy and Resources Institute (TERI), 2013
9. Recombinant DNA Technology edited by Sardul Singh Sandhu I. K. International Pvt Ltd, 2010

BSC GENETICS III YEAR SEMESTER
V BS 504
ANIMAL GENETICS AND BIOTECHNOLOGY

Unit 1: Livestock Genetics

Domestication of livestock, important breeds of livestock with economic importance
Mating systems for different livestock- genetic and phenotypic consequences and applications of inbreeding and outbreeding
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.
Livestock improvement – Role of AI/frozen semen/embryo transfer/ONBS/MOET in animal breeding; embryo sexing
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

Unit 2: Laboratory Animal Genetics

Laboratory animal species – mice, rat, rabbit – chromosome number – genome size – major genes
Physiological, nutritional and reproduction parameters of mice, rat and rabbit
Pedigree recording, planned mating, selection and mating methods, monogamous, polygamous
Ethics and legislation for management and use of laboratory animals; Institutional Animal Ethical committee guidelines
Importance of Laboratory Animal Genetics in health, genetic and environmental monitoring

Unit 3: Mouse models for Human disease

Mouse as model – advantages of mouse models - similarities and differences of mouse and human genomes
Nomenclature of strains, inbred lines in mice
Methods of generating mouse models – non-targeted and targeted strategies – knock-in and knock-out mouse
Transgenic Mouse models in cancer – onco mouse
Mouse models for human genetic diseases – Neurodegenerative disease (Alzheimer's & Parkinson's disease)

4. Unit4: Animal Cell Culture & Biotechnology

Animal cell culture - types of animal cell culture, cell lines, culture media Applications of animal cell culture

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

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.

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

Transgenic animals - methods for producing transgenic animals, examples of

transgenic animals - Super fish, Glo fish, Enviro pig, ANDi; Transgenesis in the

improvement of production traits - growth and meat traits, wool production, milk composition

PRACTICALS

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. Sterilization of cell culture media
6. Cell counting by microscopy

REFERENCE BOOKS

1. Textbook of Animal Biotechnology by B.Singh. The Energy and Resources Institute (teri)
2. Genetics for Animal Sciences by W.H.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

BSC GENETICS III YEAR SEMESTER
V BS 504
PLANT GENETICS & BIOTECHNOLOGY

Unit 1: Basics of Plant Life Cycle and Genetics

Overview of plant development and life cycle – sporogenesis, gametogenesis, pollination, fertilization, embryogenesis (development of monocot & dicot embryos) Seed (monocot & dicot) development and seed germination

Meristems – root apical meristems & root development; shoot apical meristems & leaf development; flower and fruit development

Plant hormones and their actions – auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids

Plant Nuclear Genome Organization – General features, Variation of Genome size among plants, fine structure of plant genome

Plant Organellar Genome Organization – Mitochondria, Chloroplast

Unit 2: Plant Tissue Culture

Media and culture conditions, sterile technique

Regeneration methods of plants in culture – organogenesis, somatic embryogenesis; Somaclonal variation

Induction of callus and cell suspension cultures

Protoplast culture techniques – production of somatic hybrids and cybrids

Anther/microspore culture – production of haploids and double haploids and their uses

Somatic embryo culture and production of synthetic seeds

Unit 3: Plant Breeding & Hybrid seed production

Mating systems – Self-fertilization, Cross-fertilization and Apomixis

Methods of breeding in Self-pollinating species – pedigree breeding, single-seed descent, bulk breeding method

Methods of breeding in Cross-pollinating species – mass selection, recurrent selection

Hybrid seed production – genetic male sterility (procedure for hybrid seed production by using GMS)

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

Hybrid seed production based on functional male sterility system – gametocides and their use in hybrid seed production

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

Transformation based transgenic plants production – *Agrobacterium tumefaciens* and viral vectors

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

Genetically modified crops for insect resistance - Bt crops, microbes & plant derived toxins

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

Genetically modified crops for Disease resistance – pathogenesis related proteins, antimicrobial proteins, engineering toxin insensitivity, phytoalexins, manipulation of disease resistance genes

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

PRACTICALS

1. Histological studies of embryos at different stages
2. Seed testing for germination
3. Introduction to Plant tissue culture laboratory-equipment
4. Sterilization 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
7. Culture of anthers and establishment of haploid plants
8. Preparation of synthetic 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) by P.B. Kavi Kishor, 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 Palmiro Poltronieri, Natalija Burbulis, Corrado Fogher, 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. Plant Cell Biotechnology by Rudolf Endress, Springer-Verlag Berlin.

BSC GENETICS III YEAR SEMESTER
VI BS 604
HUMAN GENOME & HUMAN GENETICS

Unit 1: The Human Genome

Human nuclear genome organisation - genome size and density, organisation of protein coding genes

Gene families - globin gene family, histone gene family

Non-coding RNA genes - rRNA, tRNA & microRNA

Repetitive elements - LINEs, SINEs, LTR elements, satellites, minisatellites, microsatellites, Transposons

Human Mitochondrial genome organization

Human Genome variation - DNA sequence variants, genetic polymorphisms, gene duplication and evolution

Unit 2: Human Genome Project – Applications

Human genome project – Goals and achievements, Applications & Ethics

Comparative genomics - evolutionary conserved sequences, diversified sequences, G – Value paradox

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

Epigenomics - Epigenetic modifications (DNA methylation, Histone modifications); genomic imprinting

Proteomics - Proteome analysis, Protein arrays and their applications. Pharmacogenomics – role of SNP in drug response Ex. G6PD

Unit 3: Chromosomal & Genetic defects in Human

Human chromosomal disorders - Disorders due to Autosomes and sex chromosomes: Abnormalities due to Chromosome number and structure

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

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

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

Genetics of cancer - Types of genes - proto-oncogenes, oncogenes, tumor suppressor genes - Breast and Colon cancers
Mitochondrial inheritance and associated disorders - Lebers
Hereditary Optic Neuropathy, Kearns-sayers syndrome

Unit 4: Genetic counseling, testing and therapeutics

Genetic counseling and risk assessment for autosomal dominant, autosomal recessive, sex linked inherited diseases

Prenatal diagnosis - invasive (Amniocentesis, Chorionic villus sampling) and non-invasive (Ultrasonography, fetoscopy)

New born screening (PKU), Pre-clinical screening - Sickle cell anemia

Ethical, legal and Social Issues of Genetic testing and screening

Traditional treatment modalities - PKU, ADA

Gene therapy: Types - somatic and germline gene therapy; Gene therapy trials : ADA deficiency, Cystic fibrosis

PRACTICALS

1. Karyotyping (normal male/normal female)
2. Identification of chromosome anomalies using Idiograms - Autosomal disorders (Down Syndrome / Edward's syndrome)
3. Identification of chromosome anomalies using Idiograms - X-linked disorders - (Klinefelter's syndrome / Turner's syndrome)
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

RECOMMENDED BOOKS

1. A.G. Motulsky and F. Vogel (1986) Human Genetics
2. R.F. Mueller and I. D. Yound (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. Beaudet, W. S. Sly and D. Valle, Molecular Basis of Inherited Diseases, (6th Edition 1989) by Eds O McGraw Hill, New York.
9. Tom Strachan and Andrew Read (1996) Human Molecular Genetics.

BSC GENETICS III YEAR SEMESTER
VI BS 604
CELLULAR & MOLECULAR IMMUNOLOGY

Unit 1: Innate and Adaptive Immunity

Introduction to Immune System, types of immunity - innate and adaptive
Innate immunity – anatomical barriers & physiological barriers, phagocytic barrier
Cellular components of immunity – Lymphoid cells (B cells, T cells and NK cells), Myeloid cells (Neutrophils, Eosinophils, basophils, mast cells, macrophages and dendritic cells)
Lymphoid organs - Primary lymphoid organs (Bone marrow & thymus); secondary lymphoid organs (lymph node and spleen)
Antigens - Immunogens, epitopes Haptens
and types of adjuvants

Unit 2: Humoral and MHC immune responses

Basic structure of Immunoglobulin - Immunoglobulin domains - variable region and constant region domains; isotypes, allotypes, idiotypes
Immunoglobulin classes and its functions - IgG, IgM, IgA, IgD, IgE
Polyclonal antibodies, Monoclonal antibodies - its production and applications
Structure and organization of MHC class I and class II molecules. MHC molecules - cellular distribution & immune responsiveness
Types of grafts: Role of HLA typing in organ transplantation

3. Unit 3: Cell-mediated Immune responses and vaccines

Cell mediated immunity: Structure and functions of T-cell receptors; Antigen presenting cells (APCs), ternary complex (TCR, peptide and MHC); Cytokines
Hypersensitivity - Types (I, II, III & IV)
Autoimmunity - mechanisms of autoimmunity and autoimmune diseases (thyroid and Rheumatoid arthritis)
Immunodeficiency disorders - primary immunodeficiency disorders (SCID), secondary immunodeficiency disorders (AIDS)
Vaccines - historical background and principle; passive & active immunization, attributes of effective vaccines
Types of vaccines - live attenuated and inactivated killed vaccines, sub-unit vaccines, DNA vaccines, edible vaccines

Unit4: Immunological techniques

General features of antigen-antibody reactions- Agglutination, neutralization, complement fixation, opsonisation

Immunoprecipitation, immunoelectrophoresis, immunodiffusion tests

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

Immunofluorescence assays (direct & indirect)-Principle and applications

Western blot-Principle, procedure and applications

Flow cytometry-Principle, methodology and applications

PRACTICALS

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

RECOMMENDED BOOKS

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

QUESTIONPAPERPATTERNFACULTYOFSCIENCE

Title of the Paper: B.SC. GENETICS

[Duration:3Hours][MaxMarks=80M]

SECTION-A

ShortAnswertypequestions

AnsweranyEIGHTquestions(TWOFROMEACH PART)

[8x4=32M]

PART A:

1. Unit-I
2. Unit-I
3. Unit-IPART B:
4. Unit-II
5. Unit-II
6. Unit-IIPARTC:
7. Unit-III
8. Unit-III
9. Unit-IIIPARTD:
10. Unit-IV
11. Unit-IV
12. Unit-IV

SECTION-B

EssayAnswertypequestion

Answerall questions

[4x12=48M]

13.
(a) Unit-I
OR
(b) Unit-I
14.
(a) Unit-IIOR
(b) Unit-II
15.
(a) Unit- III OR
(b) Unit-III
16.
(a) Unit-IV
OR
(b) Unit- IV