Telangana State Council of Higher Education,

Govt. of Telangana

B.Sc., CBCS

Common Core Syllabi for all Universities inTelangana

BScGENETICS

(*wef*2019-20)

Telangana State Council of Higher Education, Govt. of Telangana B.Sc.,
CBCS Common Core Syllabi for all Universities inTelangana
BScGENETICS(*wef*2019-20)

CODE	COURSE TITLE	COURSE TYPE	HPW	CREDITS
FIRST YEAR- SEMESTER I				
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 I- 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 I- **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	**Genetic Analysis& Model organisms**	SEC-I	2	2
BS 302	**Cytogenetics- Lab Processing and Analysis**	SEC-2	2	2
BS 303	English	CC-1C	3	3
BS 304	Second language	CC-2C	3	3
BS 305	Optional I- **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	**Analytical Techniques in Molecular Genetics**	SEC-3	2	2
BS402	**DNA technology in health care &Transgenics**	SEC-4	2	2
BS 403	English	CC-1D	3	3
BS 404	Second language	CC-2D	3	3
BS 405	Optional I- **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**

THIRD YEAR- 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	**Optional I- A/B** **A. Plant Genetics &Biotechnology** **(or)** **Animal Cell Technology & AnimalGenetics**	DSE -1E	4T+3P=7	4+1=5
BS 505	Optional- II **A/B**	DSE -2E	------	4+1=5
BS 506	Optional- III **A/B**	DSE -3E	-------	4+1=5
	TOTAL			**25**
THIRD YEAR- SEMESTER- VI				
BS 601	**Project in Genetics/Optional Paper**	Project work		4
BS 602	English	CC-1F	3	3
BS 603	Second language	CC-2F	3	3
BS 604	**Optional I- A/B** **A. Human Genome & HumanGenetics** **(or)** **Cellular & MolecularImmunology**	DSE-1F	4T+3P=7	4+1=5
BS 605	Optional- II **A/B**	DSE -2F	--------	4+1=5
BS 606	Optional- III **A/B**	DSE -3F	-------	4+1=5
	TOTAL			**25**
	TOTAL Credits			**150**

Total credits= 164-12 (AECC 4 + SEC 8) =15

AECC: Ability **E**nhancement **C**ompulsory **C**ourse
SEC: S*kill* ***E****nhancement* ***C****ourse*
DSC: D*iscipline* ***S****pecific* ***C****ourse*
DSE: D*iscipline* ***S****pecific* ***E****lective*
GE: G*eneric* ***E****lective*

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

Credit- 1: Mendelian inheritance and its extensions

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

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

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

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

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

1.6. Non-medelian inheritance: Plastid inheritance – Variegation in *Mirabilusjalapa;* Maternal effects and inheritance – Shell coiling in snails, Poky mutants in *Neurospora*.

Credit- 2: Linkage, Crossing over and Gene mapping

2.1 Discovery of linkage – Phases of linkage

2.2 Chiasmata and Crossing over formation– Recombination

2.3 Cytological proof for crossing over – Curt Stern and McClintock experiments

2.4 Linkage analysis – Recombination frequencies, Two-point and Three-point crosses

2.5 Gene mapping – Coincidence and Interference, Determination of gene order

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

Credit- 3: Cell division and Chromosome segregation.

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

3.2 Regulation of cell cycle cyclins, CDK proteins, role of p^{53} in cell cycle

3.3 Mitosis – Stages in mitotic cell division- significance ofmitosis

3.4 Meiosis – Formation of Synaptonemal complex, crossing over, chiasma formation, significance ofmeiosis

3.5 Apoptosis – extrinsic & intrinsic pathways, & significance

3.6 Senescence, Necrosis –characteristics & mechanisms

Credit- 4: Chromosome structure, chromatin organization and variation

4.1 Chromosome morphology- size and shape; Euchromatin and Heterochromatin-constitutive and facultativeheterochromatin

4.2 Components of chromatin, histones &non-histones

4.3 Packing of DNA into chromatin – Nucleosome and higher orderorganization

4.4 Specialized Chromosomes – Lampbrush chromosomes, Polytene Chromosomes

4.5 Strucrural chromosomal aberrations - duplications, deletions, inversions & translocations with examples, Geneticconsequences

4.6 Numerical chromosomal aberrations – aneuploidy, euploidy auto-polyploidy and allo-polyploidy, Geneticconsequences

Credit- 5: Practicals

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

Recommended Books

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

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

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

1.1 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 mosaicvirus

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)

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

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

1.5 Mutations: types of mutations- transition, transversion, frame shift, silent, mis-sense andnon-sense; Induced mutations- physical and chemicalmutagens; spontaneous mutations

1.6 DNA damage and repair mechanisms - direct, excision and mismatch, SOSnon-homologous end joining(NHEJ)

Credit-2: Gene expression in Prokaryotes & Eukaryotes

2.1 Structure of prokaryotic gene; Structure of eukaryotic gene; structure and functions of RNA polymerase & it'ssubunits in prokaryotes

2.2 Transcriptional machinery in eukaryotes (RNA polymerases) and their structural and functionalfeatures

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

2.4 Transcription mechanism-initiation, elongation & proof reading, termination (rho independent & rho dependent)

2.5 Transcription in eukaryotes-Initiation, elongation & termination factors

2.6 Translation mechanism- initiation, elongation andtermination

Credit-3: Gene regulation in prokaryotes & eukaryotes

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

3.2 Prokaryotic transcriptional regulation (repressible system) - tryptophanoperon

3.3 Post-transcriptional modifications- capping, poly- adenylation

3.4 Splicing and alternate splicing, rRNA andtRNA splicing

3.5 Post-translational modifications-glycosylation, lipidation, acetylation, ubiqutination andchaperones

3.6 Gal locus regulation in yeast- regulation of mating type

Credit-4: Microbial Genetics & Genetic Engineering

4.1 Transformation- competence of bacterial cells; mechanism of transformation; gene mapping bytransformation; Transduction: generalized transduction, co-transduction and linkage; Mapping byco-transduction, Specialized transduction
4.2 Conjugation- unidirectional gene transfer- F^+ andF^- High frequency recombination, Gene mapping byconjugation
4.3 Introduction to r-DNA technology; enzymes used in molecular cloning- restriction endonucleases, DNA modifying enzymes- methylases, polymerases, ligases andphosphatases
4.4 Vectors used in cloning: *E.Coli*, plasmid vectors- pBR322, pUC vectors; cosmids; shuttle vectors- yeastvectors
4.5 Strategies for genomic libraries and cDNA libraries construction
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.

Credit-5: Practicals

1. Extraction of genomic DNA
2. Quantification of DNA byspectrophotometer
3. Agarose gel electrophoresis ofDNA
4. Estimation of DNA by DPAmethod
5. Estimation of RNA by orcinolmethod
6. Effect of UV on bacterialgrowth
7. Preparation of competent cells of bacteria
8. Problems on restrictionmapping

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

QUESTION PAPER PATTERN
FACULTY OF SCIENCE
B.SC. GENETICS

Title of the Paper:
[Duration: 3 Hours] **[Max Marks=80M]**

SECTION-A

Short Answer type questions
Answer any EIGHT questions [8x4=32M]

1. **Unit - I**
2. **Unit – I**
3. **Unit – I**
4. **Unit – II**
5. **Unit - II**
6. **Unit - II**
7. **Unit - III**
8. **Unit - III**
9. **Unit - III**
10. **Unit - IV**
11. **Unit - IV**
12. **Unit – IV**

SECTION-B

Essay Answer type question **[4x12=48M]**
Answer all questions

13. **(a) Unit – I**
    OR
    (b) Unit – I

14. **(a) Unit –II**
    OR
    (b) Unit -II

15. **(a) Unit – III**
    OR
    (b) Unit – III

16. **(a) Unit- IV**
    OR
    (b) Unit-IV

1-20 Pages

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BS 204	Optional I- **Molecular Genetics & Genetic Engineering**	DSC-1B	4T+3P=7	4+1=5
BS 205	Optional II	DSC-2B	-----	4+1=5
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SECOND YEAR- SEMESTER III				
BS 301	**Cytogenetic Analysis**	SEC-1	2	2
BS 302		SEC-2	2	2
BS 303	English	CC-1C	3	3
BS 304	Second language	CC-2C	3	3
BS 305	Optional I- **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
BS402		SEC-4	2	2
BS 403	English	CC-1D	3	3
BS 404	Second language	CC-2D	3	3
BS 405	Optional I- **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
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THIRD YEAR- 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	**Optional I- A/B** **A. Plant Genetics &Biotechnology** **(or)** **Animal Genetics and Biotechnology**	DSE -1E	4T+3P=7	4+1=5
BS 505	Optional- II **A/B**	DSE -2E	------	4+1=5
BS 506	Optional- III **A/B**	DSE -3E	-------	4+1=5
	TOTAL			**25**
THIRD YEAR- SEMESTER- VI				
BS 601	**Project in Genetics**	Project work		4
BS 602	English	CC-1F	3	3
BS 603	Second language	CC-2F	3	3
BS 604	**Optional I- A/B** **A. Human Genome & Human Genetics** **(or)** **Cellular & Molecular Immunology**	DSE-1F	4T+3P=7	4+1=5
BS 605	Optional- II **A/B**	DSE -2F	--------	4+1=5
BS 606	Optional- III **A/B**	DSE -3F	-------	4+1=5
	TOTAL			**25**
	TOTAL Credits			**150**

Total credits= 164-12 (AECC 4 + SEC 8) =15

AECC: Ability Enhancement Compulsory Course
SEC: *Skill Enhancement Course*
DSC: *Discipline Specific Course*
DSE: *Discipline Specific Elective*
GE: *Generic Elective*

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BSC GENETICS II YEAR
SEMESTER III BS 301 SEC 1
CYTOGENETIC ANALYSIS

Unit 1: Preparation of Chromosomes

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

Unit 2: Chromosome Analysis

2.1. Microscopy – Bright-field microscopy, inverted and fluorescence microscopy
2.2. Chromosomal analysis - chromosome number, size & shape in humans; karyotyping chromosomes – ideogram
2.3. Chromosome abnormalities – Structural (breaks, gaps, deletions, insertions, duplications, inversions, translocations), numerical: aneuploidy (monosomy, trisomy&tetrasomy); polyploidy (triploidy, tetraploidy)
2.4. FISH&SKY – principle, applications and limitations
2.5. 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). PankajTalwar, Jaypee Brothers Medical Publishers (P) Ltd.
4. Clinical Biochemistry (2013) Gaw, Cowan, Murphy, Srivastava and O'Reilly, Elsevier

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BSC GENETICS II YEAR
SEMESTER III BS 305 DSC-IC
BIOSTATISTICS AND BIOINFORMATICS

Unit 1: Descriptive Biostatistics and Probability

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.

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

1.3. Measures of Central tendency – mean, median, mode; merits and demerits

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

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)

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

Unit 2: Applications of Biostatistics

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

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

2.3. Test of significance for large samples- Z-test of means and proportions

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

2.5. Analysis of Variance (ANOVA) – one way analysis

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

Unit 3: Introduction to bioinformatics and biological databases

3.1. Bioinformatics definition, history, scope and applications

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

3.3. Bioinformatic web portals – NCBI, EBI, ExPASy

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

3.5. DNA sequence databases (ENA &DDBJ)

3.6. Protein sequence databases (Swissprot& PROSITE)

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Unit 4: Sequence Alignment

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

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

4.3. Dot matrix comparison of sequences

4.4. Scoring matrices - PAM and BLOSUM

4.5. Pairwise sequence similarity search by BLAST and FASTA

4.6. 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 a data
3. Problems on hypothesis testing using Z test, t-test and Chi-squared 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 HanmanthRao 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.

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BSC GENETICS II YEAR
SEMESTER IV BS 305 SEC-3
BIOPHYSICAL AND MOLECULAR BIOLOGY TECHNIQUES

Unit 1: Biophysical techniques

1.1. Spectroscopy – principle, instrumentation, ultraviolet and visible light spectroscopy, applications

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

1.3. Centrifugation–principles of sedimentation, preparative centrifugation (differential centrifugation & density gradient centrifugation), applications

1.4. Electrophoretic techniques- types (Agarose gel electrophoresis,SDS PAGE), principle & applications

1.5. Mass spectrometry- principle & applications

1.6. Microscopy- principle & applications of Phase contrast microscope and confocal microscopy

2. **Unit 2: Molecular Biology techniques**

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

2.2. Quantitative Real Time PCR– principle and applications

2.3. DNA Sequencing – principle and applications

2.4. Microarray- DNA and protein arrays - principle and applications

2.5. Blotting techniques- Southern blot, Northern blot and Western blot- principle and applications

2.6. 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. Sharmal. 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 RajanKatoch Springer Science & Business Media, 2011

BSC GENETICS II YEAR
SEMESTER IV BS 405 DSC
POPULATION GENETICS & EVOLUTION

Unit 1: Principles of Population genetics

1.1. Population structure, Random mating population, Concepts of a population (gene pool, deme and panmictic unit)
1.2. Genetic and phenotypic variation in a population, allele frequencies and genotype frequencies at a locus
1.3. Hardy-Weinberg Law- assumptions and implications, establishment of Hardy-Weinberg equilibrium for single gene locus
1.4. Extension of Hardy-Weinberg Law for multiple alleles
1.5. Establishment of Hardy-Weinberg Law for X- linked genes
1.6. Linkage disequilibrium – haplotypes, coefficient of linkage disequilibrium, coupling gametes and repulsion gametes

Unit 2: Selection, Mutation & Migration

2.1. Selection– fitness, patterns of natural selection, general selection equation, equilibrium under selection
2.2. Selection favoring heterozygotes: stable equilibrium, balanced polymorphism (sickle cell anemia, heterozygote advantage)
2.3. Selection against heterozygotes: unstable equilibrium (Rh incompatibility); complete elimination of recessive genes
2.4. Mutation– influence of mutation on allele frequencies, balance between forward and backward mutation
2.5. Genetic load – mutational and segregational
2.6. Gene flow– Migration - Wahlund effect

Unit 3: Inbreeding, Genetic Drift and Quantitative inheritance

3.1. Inbreeding– non-random mating, Identity by descent, selfing
3.2. Construction of pedigrees- Raw & forked pedigrees - inbreeding coefficient
3.3. Effect of inbreeding on genotypic frequencies and inbreeding depression
3.4. Genetic Drift - Bottle neck effect, Founder effect
3.5. Effective population size, consequences of a decreasing population size
3.6. Quantitative vs qualitative traits – genetic and environmental values - measures of variances

Unit 4: Genetic Variation and Molecular Evolution

4.1. The origin of genomes- Acquisition of new genes by gene duplication and from other species
4.2. Origin of non-coding DNA, transposable elements and introns
4.3. Molecular phylogenetics- DNA sequence and protein sequence phylogenetics

4.4. Molecular Evolution–neutral theory
4.5. Establishment of evolutionary relationship - molecular clock
4.6. 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 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

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- C C Lee

BSC GENETICS III YEAR
SEMESTER V GE 502
BASIC& APPLIED GENETICS

Unit 1: Introduction to Genetics

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

Unit 2: Cellular & Molecular basis of Inheritance

2.1. DNA structure and its alternative forms (A, B & Z)
2.2. RNA - types of RNA (rRNA, mRNA &tRNA)
2.3. Ultra structure of prokaryotic cell (cell membrane and plasmids, Nucleoid)
2.4. Ultra structure of eukaryotic cell (nucleus, mitochondria, chloroplast, endoplasmic reticulum, golgi apparatus)
2.5. Chromosomes: Packaging of DNA in to Chromosomes, structure(centromere and telomere), karyotype
2.6. Cell division – stages of mitosis, meiosis I&II& fertilization

Unit 3: Genomes &Genetic Engineering

3.1. Prokaryotic genomes – genome size & organization
3.2. Eukaryotic genomes-features of eukaryotic nuclear and organellar genomes
3.3. Human genome project –goals and achievements
3.4. Genetic Engineering - Transgenic plants-Bt cotton, Golden rice
3.5. Genetic Engineering - Transgenic animals -Molecular pharming-Buffalo and Goat
3.6. Genetic Engineering: Environment- bioremediation

Unit 4: Human Genetics

4.1. Human nuclear genome –general features, protein coding genes, RNA coding genes, non-coding DNA
4.2. Human chromosome anomalies: Down's syndrome and Klinefelter's syndrome
4.3. Single gene disorders-Hemoglobinopathies(Sickle cell disease, Thalassemias)
4.4. Complex genetic diseases –Hypertension, Diabetes mellitus
4.5. Genetic testing: Prenatal screening (Invasive methods and Non- invasive techniques, Neonatal screening (PKU),Preclinical screening (Alzheimer's)
4.6. Therapeutics : Conventional treatment modalities- PKU; Gene therapy: Types- somatic and germ line gene therapy; Gene therapy trials: ADA deficiency

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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 ByKarvita B. Ahluwalia New Age International, 2009
4. Genetics byM. YadavDiscovery Publishing House, 2003 By M. Yadav
5. Human Genetics: The Basics ByRicki 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 TechnologyKeyaChaudhuri 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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BSC GENETICS III YEAR
SEMESTER V BS 504
ANIMAL GENETICS AND BIOTECHNOLOGY

Unit 1: Livestock Genetics

1.1. Domestication of livestock, important breeds of livestock with economic importance
1.2. Mating systems for different livestock - genetic and phenotypic consequences and applications of inbreeding and outbreeding
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.
1.4. Livestock improvement – Role of AI/frozen semen/embryo transfer/ONBS/MOET in animal breeding; embryo sexing
1.5. Animal genetic resources in India – evaluation and characterization of indigenous breeds of livestock, *ex-situ* and *insitu* conservation of genetic resources– cryogenic preservation of animal germplasm

Unit 2: Laboratory Animal Genetics

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

Unit 3: Mouse models for Human disease

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

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

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

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

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 synctitial virus & Vaccines against bovine viral diarrhea disease.

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

4.5. 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. Text book of Animal Biotechnology by B Singh. The Energy and Resources Institute (teri)
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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BSC GENETICS III YEAR
SEMESTER V BS 504
PLANTGENETICS & BIOTECHNOLOGY

Unit 1: Basics of Plant Life Cycle and Genetics

1.1. Overview of plant development and life cycle – sporogenesis, gametogenesis, pollination, fertilization, embryogenesis (development of monocot & dicot embryos)
1.2. Seed (monocot & dicot) development and seed germination
1.3. Meristems – root apical meristems & root development; shoot apical meristems & leaf development; flower and fruit development
1.4. Plant hormones and their actions - auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids
1.5. Plant Nuclear Genome Organization – General features, Variation of Genome size among plants, fine structure of plant gene
1.6. Plant Organellar Genome Organization – Mitochondria, Chloroplast

Unit 2: Plant Tissue culture

2.1. Media and culture conditions, sterile technique
2.2. Regeneration methods of plants in culture - organogenesis, somatic embryogenesis; Somaclonal variation
2.3. Induction of callus and cell suspension cultures
2.4. Protoplast culture techniques – production of somatic hybrids and cybrids
2.5. Anther/microspore culture - production of haploids and double haploids and their uses
2.6. Somatic embryo culture and production of synthetic seeds

Unit 3: Plant Breeding& Hybrid seed production

3.1. Mating systems – Self fertilization, Cross fertilization and Apomixis
3.2. Methods of breeding in Self-pollinating species – pedigree breeding, single-seed descent, bulk breeding method
3.3. Methods of breeding in Cross-pollinating species – mass selection, recurrent selection
3.4. Hybrid seed production – genetic male sterility(procedure for hybrid seed production by using GMS)
3.5. Hybrid seed production based on cytoplasmic genetic male sterility (seed production of CMS lines (A), maintainer line (B), restorer line (R)
3.6. 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**

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

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

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

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

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

4.6. Transgenic plants for product quality – improved storage, longer shelf life, nutritionalquality (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 – BlackwellPublishers
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. KaviKishor, Universities Press
4. Plant Tissue Culture: Basic and Applied (2005) by TimirBaranJha, Universities Press
5. Plant Biotechnology: Practical Manual (2007) by C. C. Giri, ArchanaGiri,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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BSC GENETICS III YEAR
SEMESTER VI BS 604
HUMAN GENOME & HUMAN GENETICS

Unit 1: The Human Genome

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

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

1.3. Non-coding RNA genes- rRNA, tRNA& microRNA

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

1.5. Human Mitochondrial genome organization

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

Unit 2: Human Genome Project – Applications

2.1. Human genome project – Goals and achievements, Applications & Ethics

2.2. Comparative genomics-evolutionary constrained sequences, diversified sequences, G –Valve paradox

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

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

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

2.6. Pharmacogenomics – role of SNP in drug response Ex. G6PD

Unit 3: Chromosomal & Genetic defects in Human

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

3.2. Inborn errors of metabolism- Amino acid metabolism (Phenyleketonuria), Protein metabolism (Duschenne muscular dystrophy)

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

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

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

3.6. Mitochondrial inheritance and associated disorders- Lebers Hereditary Optic Neuropathy, Kearns-sayersyndrome

Unit 4: Genetic counseling, testing and therapeutics

4.1. Genetic counseling and risk assessment for autosomal dominant, autosomal recessive, sexlinked inherited diseases

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

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

4.4. Ethical, legal and Social Issues of Genetic testing and screening

4.5. Traditional treatment modalities- PKU,ADA

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

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 – (Klienefelter's syndrome / Turner's syndrome)
4. Screening for Barrbodies
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) HumanGenetics
2. R. F. Mueller and I.D Yound (2001) Emery's Elements of MedicalGenetics
3. Curt Stern (1960) Principles of HumanGenetics
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 EdsOMcGrawHill, NewYork.
9. Tom Strachan and Andrew Read (1996) Human MolecularGenetics

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

Unit 1: Innate and Adaptive Immunity

1.1. Introduction to Immune System, types of immunity-innate and adaptive
1.2. Innate immunity – anatomical barriers & physiological barriers, phagocytic barrier
1.3. Cellular components of immunity – Lymphoid cells (B cells, T cells and NK cells), Myeliod cells (Neutrophils, Eosinophils, basophils, mast cells, macrophages and dendritic cells)
1.4. Lymphoid organs- Primary lymphoid organs (Bonemarrow&thymus); secondary lymphoid organs (lymph node andspleen)
1.5. Antigens- Immunogens, epitopes
1.6. Haptens and types of adjuvants

Unit 2: Humoral and MHC immune responses

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

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

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

Unit 4: Immunological techniques

4.1. General features of ag-ab reactions- Agglutination, neutralization, complement fixation,opsonisation

4.2. Immunoprecipitation, immunoelectrophoresis, immunodiffusion tests

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

4.4. Immuno fluorescence assays (direct & indirect)- Principle and applications

4.5. Western blot -Principle, procedure and applications

4.6. 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. Coomb's test
8. WesternBlot

RECOMMENDED BOOKS

1. Essential Immunology by I.Roitt,Publ:Blackwell
2. Immunology by G. Reever & I.Todd,Publ:Blackwell
3. Immuno diagnostics by S.C.Rastogi, Publ:NewAge
4. Immunology by Richard A.Golds by, Thomas J Kindt, Barbaraa. Osborne, Janiskuby
5. Fundamental immunology by WilliamE.Paul
6. Basic Immunology by Bhoosreddy G.L. and WadherB.J.
7. Text book of immunology by BarujBenacerraf
8. Immunology by Kuby:Publ:Freeman

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QUESTION PAPER PATTERN FACULTY OF SCIENCE
Title of the Paper: B.SC. GENETICS

[Duration: 3 Hours] [Max Marks=80M]

SECTION-A

Short Answer type questions
Answer any EIGHT questions (TWO FROM EACH PART) [8x4=32M]

PART A:
1. Unit - I
2. Unit –I
3. Unit –I

PART B:
4. Unit – II
5. Unit - II
6. Unit – II

PART C:
7. Unit -III
8. Unit -III
9. Unit – III

PART D:
10. Unit -IV
11. Unit -IV
12. Unit –IV

SECTION-B
Essay Answer type question [4x12=48M]
Answer all questions

13.
(a) Unit –I
OR
(b)Unit –I

14.
(a) Unit –II OR
(b)Unit-II

15.
(a) Unit – III OR
(b)Unit – III

16.
(a) Unit-IV
OR
(b)Unit- IV