

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Syllabus of M. Sc. Genetics Semester-wise

O-821 Eligibility Criteria

Graduate in any Life Science (Genetics, Biotechnology, Botany, Zoology, Biochemistry, Microbiology, Agri. Biotechnology, and Agriculture) with minimum of 50% mark for open category and 45% for Reserve category.

R.1190 For each batch the following infrastructure must be created before starting the course

- a. Well established 2 classroom
- b. Laboratory with basic equipments

Simple and compound microscope (at list ten), Centrifuge cooling high speed, Deep freeze(-20,-86⁰ C), Incubator, oven, PCR. Stereo-microscope, Inverted Microscope, Bench top multiple rotors centrifuge, Gel-Doc, ELISA, Sonicator/ Homogenizer, Autoclave, heating block, water bath, dry bath, orbital shaker, biosafety hood (For Animal cell culture, plant tissue culture and general purpose), Digital Microbalance, Cryotome, UV Spectrophotometer, Plant tissue culture Lab, Animal cell culture lab and 2 student lab.

- c. Computer lab with at least 10 computers, having internet connection.
- d. Library should contain at least five copies of each recommended books.

R.1191 College must have following facilities and non teaching staffs in the department.

- a. The Head/Coordinator should be full time and qualification should be as per the

UGC rules and as per the university guidelines.

b. All teachers are appointed as per the University procedure and the UGC guide lines.

c. One lab assistance (B.Sc.) and one lab attendant for each laboratory.

d. A clerk cum typist to assist the Head for maintenance of the office record/work.

R.1192 Standard of Passing and Award of Division

1. Minimum marks for passing in each paper/practical shall be 40% of the maximum marks prescribed for the paper /practical.
2. A candidate who secures 45 % or more but less than 50% of the aggregate marks prescribed for I, II, III, IV semesters taken together shall be awarded a Pass division.
3. A candidate who secures 50% marks or more but less than 60% of the aggregate marks prescribed for I, II, III, IV semesters taken together shall be awarded a Second division.
4. A candidate who secures 60% marks or more than aggregate marks prescribed for I, II, III, IV semesters taken together shall be awarded a First division.
5. A candidate who secures 75% marks or more than aggregate marks prescribed for I, II, III, IV semesters taken together shall be awarded as Distinction.

R. 1193 Course Structure

Semester	Course	Course Title	Hrs/Week		Exam Hrs	Marks		Total
			T	P		T	P	

I	P-11 BMS	Biomathematics and Biostatistics	4	6	3	50	25	75
	P-12 BOG	Basics of Genetics	4	6	3	50	25	75
	P-13 BIT	Biotechniques	4	6	3	50	25	75
	P-14 BBC	Biochemistry & Biochemical Genetics	4	6	3	50	25	75
	Total						200	100
II	P-21 MCB	Molecular Cell Biology	4	6	3	50	25	75
	P-22 MIG	Microbial Genetics	4	6	3	50	25	75
	P-23 PEG	Population and Evolution Genetics	4	6	3	50	25	75
	P-24 HUG	Human Genetics	4	6	3	50	25	75
Total						200	100	300

T—Theory

A-Assignment

P-Practical

Course Number definition

Example: P-11BMS

P-Paper **11**--semester and paper no **BMS**—Subject Name

Semester 1st

P-11BMS BIOMATHEMATICS & BIOSTATISTICS Total 75 (50+25)

Unit I Introduction to statistics

Introduction to Biostatistics: Basic definitions, notations and applications.

Sampling: Representative sample, sample size, sampling techniques.

Data collection and presentation: Types of data, methods of collection of primary and secondary data, Data presentation (Histogram, polygon, ogive curves and Pie diagram).

Unit II Statistical Measures

Measures of Central Tendency: Mean, Mode, Median.

Measures of Variability: Standard deviation, standard error, Range, Mean deviation , Quartile deviation and coefficient of variation.

Correlation and Regression: Positive and negative correlation, calculation of correlation coefficient, regression, linear regression and regression equation.

ANOVA : ANOVA, one and two way classification.

Unit III Test of significance

Tests of significance: Chi square test, t-test, F-test, Z-test.

Probability theory and distribution: Concept of probability. Binomial, Poisson and Normal distribution.

Unit IV Determinants and Matrices

Determinants: Introduction, expansion by co-factors, properties of determinants.

Matrix Algebra: Definition, various types of matrices, matrices as a rectangular array of real numbers, equality of matrices, addition, multiplication by a scalar and product of matrices, transpose of a matrix, determinant of the square matrix (order upto three) Inverse of a square matrix (order upto three), Properties of these matrix operations, Diagonal, symmetric and skew-symmetric matrices and their properties, Solutions of simultaneous equations.

Unit V Calculus

Differential Calculus: Real valued functions of a real variable, into, onto, one-to- one function, sum, difference, product and quotient of two functions. Composite functions, absolute value, polynomial, rational, trigonometric, exponential and logarithmic functions.

Limit and continuity of a function, limit and continuity of the sum difference, product and quotient of two functions. L'Hospital rule of evaluation of limits of functions. Even and odd functions, inverse of a function, continuity of composite functions, intermediate value property of continuous functions

Derivatives: Derivative of the sum, difference, product and quotient of two functions, chain rule, derivatives of polynomial, rational, trigonometric, inverse trigonometric, exponential and logarithmic functions.

Integration: Integration as the inverse process of differentiation, indefinite integrals of standard functions, definite integrals and their properties, applications of the Fundamental Theorem of Integral Calculus.

Integration by parts, integration by methods of substitution and partial fractions, application of definite integrals to the determination of areas involving simple curves.

PRACTICALS

1. Representation of statistical data by histogram, ogive curves and pie diagrams.
2. Measurement of central tendencies: Arithmetic mean, median and mode.
3. Calculation of measures of dispersion: mean deviation, standard deviation and coefficient of variation, quartile deviation.
4. Problems based on Tests of significance: Chi square test, t-test, standard deviation and ANOVA(one –way ,two-way).
5. Solving assignment problems based on determinants- evaluation of determinants using factor theorem, application of determinants in solving a system of linear equations, application of determinants to co-ordinate Geometry.
6. Solving assignment problems based on matrices:- Scalar multiplication, subtraction, transpose of a matrix, matrix multiplication, elementary transformations of a matrix.
7. Solving assignment problems based on function and its domains, limit and continuity of the function.

8. Solving assignment problems based on integration by substitution, by parts, partial fractions and application of definite integrals.

REFERENCES

1. Campbell R.C.- Statistics for Biologists, Cambridge University Press, Cambridge.
2. Ward Law A.C. (1985)- Practical statistics for Experimental Biologists.
3. Baily N.T.J- Statistical Methods in Biology, English University Press.
4. P.S.S. Sunderrao and J. Richards-An introduction to Biostatistics, Prentice Hall Pvt. Ltd. India.
5. Fundamentals of Mathematical Statistics by S.C. Gupta and V.K.Kapoor. Sultan Chand & Co.
6. Discrete Mathematics By B.S. Verma, Vishwa Prakashan.

P-12 BG Basics Of Genetics

Total 75 (50+25)

Unit-I

Concept of Heredity and variation, Mendelian experiments and laws of inheritance, Law of segregation, Law of independent assortment, dihybrid cross, genetic explanations of genotypic and phenotypic ratios ratios, test and back cross, mendelian factors and chromosomes, haploid organisms, tetrad analysis.

DNA in chrosomes: Nuclein, nucleotides and nucleotide chain, double helical model of DNA, chemical composition, Feulgen reaction, ultraviolet absorption, DNA in Lampbrush and polytene chromosomes

Unit-II

Dominance relations and multiple alleles: complete dominance, Incomplete dominance, over-dominance, co-dominance, Multiple allelic blood group system, Rh factor and ABO incompatibilities.

Gene interactions and lethality: Complementary and supplementary gene action, Duplicate gene interaction, Modifiers, lethal genes, Segregation destoration.

Unit-III

Sex determination and sex linkage: Diploid sex chromosome, Mechanism of sex determination, sex ratio, Y chromosome, meiotic behavior of sex chromosome and nondisjunction, Sex linkage in moths, birds and humans, sex linked diseases in human.

Cytoplasmic heredity: Maternal effect, mitochondrial DNA (mtDNA), chloroplast DNA (cpDNA), Streptomycin resistance in chlamydomonas, respiratory deficiency, criteria for extrachromosomal genetics, infectious heredity.

Unit IV

Linkage and Recombination-Linkage group, complete linkage, incomplete linkage and recombination, four strand crossing over, detection of linkage, calculation of autosomal recombination frequencies by backcrossing to homozygous recessive, recombination frequencies for sex linked genes, recombination frequencies in F1XF1 crosses.

Gene mapping in diploids: linkage maps, linkage in humans, somatic cell hybridization, factor affecting recombination frequencies, relationship between genetic cytological crossing over, relationship between crossing over and chiasma formation, theories of crossing over.

Unit V

Chromosome number variation: Euploidy, segregation and linkage in polyploids, aneuploidy, genic balance, detection of linkage groups with aneuploidy, Mosaics and chimeras.

Human chromosome: sex chromosome numbers, Barr bodies and heterochromatinization, trisomy for chromosome 21, further human aneuploid variation.

PRACTICALS

1 Isolation and dissection of drosophila salivary glands and preparation of aceto-orcein stained polytene chromosome squashes.

2 Induction of puffing in polytene chromosome by heat shocks.

3 Isolation of plant nuclei.

4 Extraction of histone protein and analysis by SDS-PAGE.

5 Problems based on interaction of genes

6 Problems based on sex linked inheritance

7 Karyotype preparation

8 Mutant study in drosophila

REFERENCE BOOKS

1. Genetics: B.D. Singh

2. The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonald, Hardcover

3. Genes VIII by Benjamin Lewin, Hardcover

4. Cell and molecular biology by Dr. P.K. Gupta

P-13BIT BIOTECHNIQUES* *Total 75 (50+25)

Unit I

Basics: Basic principles of centrifugation, RCF and other factors affecting sedimentation, sedimentation velocity, sedimentation equilibrium, sedimentation coefficient, factors affecting Standard Sedimentation Coefficient.

Instrumentation: Types of centrifuge machines, Rotors, Preparative and analytical centrifuges, Applications of Boundary Sedimentation, Band sedimentation, Determination of Molecular weights.

Cell Disintegration: Physical, chemical and enzymatic methods of microbial, plant and animal cell disintegration.

Unit II

Chromatographic techniques: History Basic principles, Partition coefficient, the nature of partition forces, counter current distribution, Introduction to planar and column chromatography. Theory, principle and applications of Paper, Thin Layer, Gel Filtration, Ion

Exchange, Affinity, Reverse phase chromatographic techniques, GLC and HPLC, Some specialized techniques of chromatography.

Electrophoretic Techniques: Basic Principles of Electrophoresis, Types of electrophoresis: free, zone and capillary electrophoresis.

Theory, principles and applications of Paper, Cellulose acetate and Gel Electrophoresis, Isoelectric focusing, Specialized Electrophoretic techniques viz., Discontinuous gel electrophoresis, Immunoelectrophoresis, Gradient, 2-D gel and Pulse-field gel electrophoresis, High voltage electrophoresis, Electrophoresis on cellular gels, Electroblotting and Conventional blotting techniques by capillary action.

Unit III

Basics: Basic principles, Laws of absorption, Absorption spectrum, Chromophore concept.

Theory, Principles, Instrumentations and Applications of UV-Visible and IR spectrophotometry, Fluorescence, NMR, Atomic absorption, Mass, Raman, CD, ORD and Flame spectrophotometry, Luminometry, ESR Spectrometry, Mossbauer Spectrophotometry, LASER and X-Ray Diffraction methods.

Unit IV

History, Introduction to Isotopes and Radioactivity, Radioactive Decay, Production of Isotopes, Synthesis of radioactive compounds, Radioactive labeling procedures, Interaction of radioactivity with matter, Use of radio isotopes in Life Sciences, Commonly used isotopes, Safety aspects.

Detection and Measurement of radioactivity: Methods based upon Gas Ionization (ionization chambers, Proportional Counters and Geiger-Muller counters), Photographic methods, Methods based upon Excitation (Scintillation counters and their types).

Principles and applications of Tracer Techniques, Autoradiography and its applications, Dosimetry.

Unit V: Microscopy and PCR

Microscopic techniques: Properties of light, Microscopic resolution numerical aperture, Types of lens. Aberration and their correlation.

Principal and applications of Light, Bright field, Dark field, Phase Contrast, Fluorescence, NIDC, and Conofocal microscopy. Principles and applications of Cytophotometry and Flowcytometry. Study of Inverted microscope

PCR: History, theory and principles of PCR. Working of PCR machine. History, theory, principles and applications of Gradient PCR, RT PCR and Real Time PCR.

PRACTICALS

1. Paper chromatography of amino acids by ascending and descending methods.
2. Separation of sugars by chromatography.
3. TLC of lipids.
4. TLC of antibiotics.
5. Column chromatography for proteins, pigments.
6. Paper electrophoresis.
7. Agarose gel electrophoresis.
8. PAGE and determination of molecular weights.
9. Cell disintegration.
10. Cell fractionation and assay of marker enzymes.
11. Friske Dosimetry.
12. Spectrophotometric analyses of proteins and nucleic acids.
13. Use of centrifugation techniques for separation of blood cells, isolation of chloroplast, isolation of microbial enzymes, etc.
14. Experiments related to PCR.
15. Experiments related to microscopy.

REFERENCE BOOKS

1. Biophysical Chemistry: Principles and Techniques; by Nath & Upadhyay; Himalaya Publishing House.
2. Practical Biochemistry: Principle and Techniques; by Keith Wilson & John Walker; Cambridge University Press

P-14BBG Biochemistry & Biochemical genetics Total 75 (50+25)

Unit – I

Chemistry of Biomolecules , Introduction of Biochemistry, its significance, scope and application, Properties of water in relation of life processes, Molecular structure and dissociation of water ,Water balance, Electrolyte balance and electroosmosis Concept and definition of acid, base, buffers and pH ,Buffers of biological systems , Henderson – Hassebalch Equation.

First and second law of thermodynamics, enthalpy, entropy. Concept of free energy and standard free energy , Phosphate compounds.

Unit-II

Carbohydrate-Classification, structure, general properties and functions, Carbohydrate metabolism: Glycolysis, Gluconeogenesis, TCA cycle, Oxidative phosphorylation, Glycogen synthesis & breakdown, oxidative phosphorylation, Related Metabolic disorders.

Unit –III

Lipids- Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, Steroid hormones, bile acids, prostaglandins, , lipoproteins, , lipopolysaccharides

Metabolism of Lipids: Fatty acid biosynthesis &, Degredations, phospholipids sphingolipids & Cholesterol biosynthesis, Related Metabolic disorders.

Unit – IV

Amino acids and proteins; Amino acids • Definition. Classification and properties of amino acids, essential and nonessential amino acids ,peptide bond Proteins • Classification,

physico-chemical properties, structure [primary, secondary, tertiary and quaternary], and stabilizing bond Protein metabolism: protein turnover, amino acid biosynthesis & breakdown, Related Metabolic disorders.

Unit V

Nucleic acids- Nucleic acid, nitrogen bases, nucleosides and nucleotides. Structure of DNA- Watson and Crick model, DNA forms and conformations, Denaturation of DNA. RNA - Types, structure and role.

Metabolism of nucleotides: Biosynthesis & degradation of purine & pyrimidine nucleotide, Related Metabolic disorders.

Enzymes and Vitamins- Enzymes: Definition, nomenclature and classification of enzymes, Specificity of enzymes, lock and key model. ,Michalis-Menten equation , Enzyme inhibition , Factors affecting enzymes activity. Coenzymes, cofactors, Isoenzyme

Vitamins: Definition and classification of vitamins, Water-soluble vitamins, chemistry of vit. B1, B2, B6 and C., Sources, recommended dietary requirements and deficiency disorders. Fat-soluble vitamins (A, D, E and K)- Structure and physiological functions, sources, recommended dietary requirement and deficiency disorder

PRACTICALS

- 1) Introduction to basic laboratory instruments like – pH meter, colorimeter, single pan balance - calibration, centrifuge etc.
- 2) Preparation of reagents, buffers etc.
- 3) Determination of total amino acid concentration by ninhydrin method.
- 4) Estimation of protein concentration
 - i) Biuret method ii) Lowry method
- 5) Estimation of reducing sugar concentration by
 - i) DNSA method
- 6) Estimation total sugar concentration by
 - i) Phenol-H₂SO₄ method ii) Anthrone method

- 7) Determination of fructose concentration by resorcinol method.
- 8) Isolation and characterization of casein from milk.
- 9) Isolation and characterization of starch from potato.
- 10) Estimation of Inorganic phosphate by Fiske & Subbarow Method
- 11) Estimation of Vit. C concentration by DCPIP method
- 12) Isolation of cholesterol and lecithin from egg yolk.
- 13) Determination of hyperchromicity and study of melting curves of DNA
- 14) Study of effect of temperature, PH on activity of enzyme

REFERENCE BOOKS

- 1) Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications
- 2) Biochemistry by Lubert Stryer, 4th Edition
- 3) Biochemistry by David Rawn
- 4) Principles of protein structure by Shulz and Schirmer
- 5) Fundamentals of Enzymology by Royer
- 6] Fundamentals of Enzymology by Price and Steavenson
- 7) Biochemistry by Zubay
- 8) Biochemistry By Garrett and Grisham
- 9) Practical Biochemistry : An Introductory Course by Fiona Fraiss.
- 10) Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
- 11) Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M.Griffith
- 12) Biochemical Methods 2nd ed. by S.Sadasivam and A. Manickam.
- 13) Hawk's Physiological Chemistry ed. by Bernard L Oser.
- 14) A Textbook of Practical Biochemistry by David Plummer.
- 15) Laboratory Manual in Biochemistry by S. Jayaraman.

Semester II

Unit-I

Cell- ultrastructure and function, Diversity of cell size and shape, structure of prokaryotic and eukaryotic cell, organization and functions of subcellular organelles, bacterial cell, yeast, plant and animal cell

Unit –II

Cell division- Cell division, molecular control of cell division, abnormal cell division, cancer, cell cycle, regulation of cell cycle, cell death, cell division in prokaryotic cell.

Unit-III

Biomembrane and cell Architecture- Structure and function of biomembrane, plasma membrane, E.R. membrane, mitochondrial and chloroplast membrane, membranes in nitrobacter sp. Preparation and application of liposomes.

The cytoskeleton: Types of filament system (actin, intermediate filament, microtubules) structure and function

Unit IV

Cellular interaction - Cell-cell interaction, nerve cell- muscle cell interaction, rhizobium-legume interaction, Cell-cell interaction in Myxobacteria and Bdellovibrio life cycles., Siderophores producing microbes and its applications

Unit V

Cell signaling- Overview of intracellular signaling mechanism, concept of receptors, receptor ligand interactions, endocrine, autocrine, paracrine transmission, coupling of receptors to different signal transducing machinery, G protein structure and function, adenylate cyclase system, cAMP, protein kinase and CREB proteins, calcium channels and second messengers

PRACTICALS

1 Microscopy

- 2 Effect of detergent on membrane permeability
- 3 Isolation of cellular organelles
- 4 Study of marker enzyme from the isolated organelles
- 5 Preparation of liposomes
- 6 Growth and assay of siderophores
- 7 Microtomy (fixation, sectioning,)
- 8 Cell staining
- 9 Studies of Mitosis and Meiosis

REFERENCE BOOKS

Cell and molecular biology- By EDP De Robertis

Molecular biology of the cell -By Alberts et.al.

Cell and molecular biology- by Lodish et.al.

P-22MIG MICROBIAL GENETICS *Total 75 (50+25)*

Unit I

Prokaryotes Vs Eukaryotes; Morphology and life cycles of bacteria, fungi, yeast and viruses;
Essentials of prokaryotic genetics; Concept of genome; Genetic code and its properties;
Deciphering of genetic code; Genome size; Chromosome organization;
DNA - RNA - Protein: A review of central dogma - DNA replication, Supercoiling,
Transcription, Translation and Polarity;

Unit II

DNA Damage and repair: What causes mutations? DNA damage mechanisms: Spontaneous
and due to mutagens; DNA Repair Mechanisms: Direct Repair, Mismatch Repair,
Recombinational Repair, SOS and Translesion synthesis; Mutator genes.

Mutations: Types of mutation: Spontaneous mutation (Fluctuation test, Replica plate technique, etc.); Induced mutation (UV rays, Base analogues, Deaminating agents, Alkylating agents, Intercalating agents, etc.); Effect on the DNA sequence: point mutations, insertions, deletions, and Rearrangements; Effect on the gene product: Loss of function mutants: null, leaky, and conditional mutations; Gain of function mutants; Are mutations random events or adaptive? Mutation rates, probability, and target theory; Isolation of mutants: Selections, screens, and enrichments; Uses of mutants; Genotype vs. phenotype, genetic nomenclature, wild-type and isogenic strains; Reversion and Suppression; Complementation studies.

Unit III

Properties and types of bacterial plasmids; Plasmid replication: Origin of replication and replication proteins, Partitioning of plasmids at cell division, Regulation of plasmid copy number and amplification, Incompatibility. Mode of action of antibiotics and mechanism of resistance.

Conjugation: Cell-cell contact and adhesion, Mobilization and transfer, Regulation of conjugation, HFR strains: Isolation of HFR strains, Interrupted mating and time-of-entry mapping, Chromosome transfer in other bacteria, Isolation of F' plasmids; Suicide plasmids and allele replacement. Yeast Plasmids.

Unit IV

Virulent and avirulent phages; General properties of phages: Lytic growth, Host specificity
Lysogenic phage: **Phage Lambda and M13 phage** – Lysis, Transcription, DNA replication, maturation, and assembly, Lysogeny: Discovery- zygotic induction, immunity, and clear-plaque mutants, Repression: *cI*, *cII*, *cIII*, and *cro*, Integration and excision, Prophage induction, What determines the lysis-lysogeny decision? Antitermination; Infectivity.

Phage P22 - Antirepressor and superinfection immunity; **Phage P1** - Plasmid prophage; Lysogenic conversion. Transduction: Specialized transduction, Generalized transduction-

Phage P22 and P1, Cotransduction, linkage and multifactor crosses, Genetic mapping: How and why? (Why not just sequence?)

Unit V

Mechanisms of genetic exchange: transformation (discovery, natural competence, chemical transformation, electrotransformation, genetic mapping by transformation), conjugation, and transduction; Genetic exchange in nature; Genetic exchange in the lab; Barriers to genetic exchange: host restriction and modification.

Recombination between heteroduplex DNA, holiday intermediate, proteins involved in recombination, role of recA, recBCD pathway in E. coli, single strand assimilation in bacteria; Recombination hot spots, gene conversions.

Transposons: IS elements (types and functions), Insertion sequence, integrons and composite transposones; Phages as transposones; replicative, non-replicative and conservative transpositions; Mutations i.e. deletions, inversions and frame shift due to transpositions; Mechanism of transposition, controlling elements of maize-autonomous, non-autonomous elements, P-elements in drosophila, Retro viruses as retroposones; Phage Mu; Transposones and evolution.

PRACTICALS

1. Extraction of genomic DNA of bacteria.
2. Extraction of plasmid DNA from bacteria.
3. Detection of R-plasmids in bacterial strains.
4. Curing of bacterial plasmids
5. Extraction of DNA from bacteriophage
6. Induction of lytic cycle by U.V.
7. Oligodynamic action of metals on bacteria and yeast.
8. Detection of transposons in bacterial strains
9. Detection of mutants using replica plating techniques

10 Transfer of genetic markers through transformation, conjugation and transduction

11 Gene mapping by interrupted mating in bacteria

12 Detection of mutagenic activity by Ames test/yeast system.

13 Isolation of auxotrophic mutants.

REFERENCE BOOKS

1. Maloy S. R. , J. Jr Cronan, D. Freifelder, J. E. Cronan, Microbial Genetics, Second Edition, Jones & Bartlett Pub; 1994
2. Dale J. , Molecular Genetics of Bacteria, 3rd edition, John Wiley & Son Ltd; 1998
3. Streips U. N. , R. E. Yasbin, Modern Microbial Genetics 2nd edition, John Wiley & Sons;2002

P-23 PEG Population and Evolution Genetics Total 75(50+25)

Unit 1

Concept and theories of evolution, Microevolution in Mendelian population--Mendelian Population, Allele frequencies and genotype frequencies, Hardy-Weinberg equilibrium and conditions for its maintenance,

Unit 2

Elemental forces of evolution-Mutation, Selection (Types of selection, selection coefficient, selection in natural populations), Genetic drift, Migration,

Chromosomal, DNA and allozyme polymorphism in natural population-Adaptive genetic polymorphism, Balanced polymorphism and heterosis, Genetic coadaptation and linkage disequilibrium, Isolating mechanisms

Unit 3

Concept of species and modes of speciation: sympatric, allopatric, stasipatric, Molecular population genetics- Molecular evolution (neutral theory, punctuated equilibrium), DNA-based phylogenetic trees, Molecular clock

Unit 4

Nonrandom breeding, Inbreeding and assortative mating, Path diagram construction and inbreeding coefficient, allelic identities by descent, Human phylogeny.

Hominid evolution: anatomical, geographical, cultural , Molecular phylogenetics of *Homo sapiens* , Peopling of continents (Europe, Africa, Asia)

Unit 5

Selection - basic diploid model, dominance, heterosis and underdominance, X linked genes, haplodiploids, multiple alleles (Good), viability, sexual, and gametic selection (Good), estimation from natural populations , ecological genetics and natural examples

Population Structure - models of migration, estimation of gene flow, Linkage disequilibrium,

Molecular population genetics - neutral theory, the coalescent process, tests of selection, tests of selection (Good), Human molecular variation

Practicals

1. Problems on calculation of genotype and allele frequency
2. Problems on Hardy-Weinberg equilibrium.
3. Collection of data for Hardy-Weinberg equilibrium.
4. Observation of personal traits and determine which are dominant and recessive traits
5. Determination of the frequencies (%) of dominant and recessive traits in a population
6. Effect of spontaneous mutations on bacterial population
7. Effect of induced physical mutations on bacterial population
8. Effect of induced chemical mutations on bacterial population
9. Study of drosophila population.
10. RFLP for phylogenetic tree construction.
11. To design and development of protocol for Animals Diversity study.
12. To design and development of protocol Animal Behavior, Behavioral Ecology
13. Evolution Mechanisms – Simulations – planning- for Pop Gen
14. Protein polymorphism study.

Recommended Books

1. Brown **Genomes** Bios 1999
2. Hartl & Clark--**Principles of Population Genetics**- Sinaur- 1997
3. Hartl & Jones--**Genetics : Principles and Analysis**--Jones and Bartlett—1998
4. Hoelzel--**Molecular Genetic Analysis of Populations**--Oxford Univ.—1998
5. Jobling *et al*--**Human Evolutionary Genetics**—Garland—2004
6. Moody—**Evolution**--Harper and Row—1964
7. Roberts & DeStefano--**Genetic Variation and its Maintenance**--Cambridge Univ.—1986
8. Smith--**Evolutionary Genetics**—Oxford—1998
9. Strickberger --**Evolution** --Jones and Barlett--2000

P-24HMG Human genetics

Total 75 (50+25)

Unit I

History of Human Genetics, Patterns of transmission of single gene traits: Pedigree analysis with criteria for identification of various modes of inheritance. Genetic defects in prenatal development, Genetical basis of cancer, Normal chromosomes, congenital malformations, Metabolic variation and diseases: In-born errors in Amino acid, carbohydrate, Lipids and Nucleic acid metabolism, Errors in transport system, Inherited variations, Genetic linkage: Eugenics. Twin studies.

Unit-II

Human karyotype: banding, nomenclature of banding, Common syndromes due to numerical chromosome changes Differentiation: The constancy of genome, Differential gene expression at various stages of development: Role of heterochromatin. Cytoplasmic regulation of gene expression during development: Nuclear Cytoplasmic interactions. Metamorphosis and Regeneration: Sexual differentiation in Mammals.

Unit-III

Heredity and behavior in human and animals; Effect of hormone, Behavior due to abnormal chromosome constitution, gene mutation, Psychoses and socially event behavior, Heredity

and I. Q . scores. Genetic counseling, Artificial insemination, Aging: Memory, Intellectual development.

Unit-IV

Genetic constitution of a population: Hardy-Weingberg (HW) equilibrium. Changes in gene frequency: Migration, mutation, selection and genetic drift. Inbreeding and heterosis.

Variance: components, Genetic and environmental variances. Repeatability. Offspring and one parent, offspring mild parent, half sibs, full sibs, Selection : response and its prediction, Correlation: Genetic and environmental.

Unit-V

Human genome, Genetic diseases and disorders, somatic cell genetics, Immunogenetics, , DNA fingureprinting, Gene manipulation, gene therapy, cryopreservation of embryo and cell, congenital abnormalities, Genetic Counseling, Methods of studying human genome.

PRACTICALS

1. Study of different qualitative and quantitative traits.
2. Pedigree analysis.
3. Analysis of sex chromosomes in Inter-phase nuclei.
4. Karyotyping of normal and abnormal human chromosomes.
5. Screening of metabolic and other disorders.
6. Dermatology of normal and mentally retarded individuals.
7. Problems solving on genetic counseling.
8. Problems on HW law and changes in gene frequencies under migration, mutation, selection and genetic drift.
9. Estimation of phenotypic, genotypic and environmental variances.
10. Partitioning of genetic variance into additive, dominance and epistatic components, and estimation of heritability in board and narrow sense.
11. Calculation of co-efficient of Inbreeding through pedigrees.

12. Estimations of genetic covariance through pedigrees.

13. Problems on Genetic and environmental correlation.

REFERENCE BOOKS

1. Tomn S. A. P. Read, Human Molecular Genetics, 2nd edition, Wiley- Liss 1999.

2. Ehrlich P.R. , Human Natures: Genes, Cultures, and the Human Prospect, 1st edition, Penguin USA Paper, 2002.

3. Relethford J. H. , Genetics and the Search for Modern Human Origins, Wiley-Liss 2001.

4. Annual Review of Genomics and Human Genetics (Annual Review of Genomics and Human Genetics, Vol 2, Annual Reviews, 2001.

5. Dennis C. , R. Gallagher, J. Watson, The Human Genome, 1st edition, Palgrave 2002.

6. Nordgren A. , Responsible Genetics: The Moral Responsibility of Geneticists for the Consequences of Human Genetics Research, Kluwer Academic Publishers, 2001

7. Glannon W. , Genes and Future People: Philosophical Issues in Human Genetics, Westview Press, 2002

8. Laurie G. , Law and Ethics of Genetic Privacy, Cambridge University Press, 2002

9. Plomin R. , John C. Defries, Gerald E. McClearn, McGuffin, Behavioral Genetics W H Freeman & Co.; 4th edition 2000

10. Christine R. B. B., Quantitative Genetic Studies of Behavioral Evolution University of Chicago Press; 1994

11. Plomin R. , Nature and Nurture : An Introduction to Human Behavioral Genetics, Wadsworth Pub Co; 1990

12. Plomin R. , John C. Defries, Gerald E. McClearn, M. Rutter, Behavioral Genetics W H Freeman & Co.; 1997

M.Sc. Genetics 2nd (3rd and 4th semester) syllabus

3rd Semester Syllabus

Paper No.	Paper Name	Theory Marks	Practical Marks	Total Marks
IX	Molecular Genetics	50	25	75
X	Developmental Genetics	50	25	75
XI	Immunology and Immunogenetics	50	25	75
XII	Molecular Genetics of Viruses	50	25	75

4th Semester Syllabus

Paper No.	Paper Name	Theory Marks	Practical Marks	Total Marks
XIII	Bioinformatics, Proteomics and Research Methodology	50	25	75
XIV	Genetics of Metabolic disorder	50	25	75
XV	Genetic Engineering	50	25	75
XVI	Interventions of Biotechnology in Medicine	50	25	75

3rd semester syllabus

Paper No.	Paper Name	Theory Marks	Practical Marks	Total Marks
IX	Molecular Genetics	50	25	75
X	Developmental Genetics	50	25	75
XI	Immunology and Immunogenetics	50	25	75
XII	Molecular Genetics of Viruses	50	25	75

IX	Molecular Genetics	50 (T)	25(P)	75
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Unit I

Genetic Material

Discovery of genetic material-Experimental evidences,Genome of bacteria viruses & Eukaryotic Cell, C-value Paradox,Cot value,repetitive & Non-repetitive DNA,organelle Genome: mitochondria & chloroplast,Topological Manipulation of DNA

Nucleosomes: Nucleosomes as sub unit of chromatin,organization of histone Octamer, modes of Epigenic inheritance.

Unit II

DNA Replication and Mutation :

Replication of DNA is semiconservative, semidiscontinuous & Primed by RNA, Direction of Replication with experimental evidences, replicons.

Replication of bacteria & Structure of Pol III holoenzyme .

Machanism of replication of chromosomal DNA,circular plasmids,Teleomers, ϕ X174 and Organelle genome.

Replication of eukarotes & DNA polymerase of eukaryotes, role of Licencing factor of eukaryotes during replication, replication of leading & lagging strand. Constancy & Catalytic efficiency of polymerases.

Mutation:

Types of mutation: point ,frame Shift,lethal,conditional lethal,inversion & deletion,null mutation, Reversion of mutation,intra & intergenic suppression. Enrichment of mutant of of single type. Spontaneous & induced Mutation: Physical & chemical mutagen

Unit III

Repair & Recombination

Repair of DNA:

Repair mechanism in prokaryotes: 1] Light dependant repair - photo reactivation. 2] Light independant repair: a) excision repair, b) mismatch repair, c) sos repair and d) recombination repair

Eukaryoptic repair mechanism: 1) Excision repair in Eukaryotes – a] global genome – nucleotide excision repair (GG-NER) and b]transcription coupled - nucleotide excision

repair [TC-NER], 2) Base excision repair (BER) and 3) Double strand break repair in eukaryotes.

Recombination:

Recombination between heteroduplex DNA, Holliday intermediate, Proteins involved in Recombination, Role of recA, rec BCD pathway in E. coli, Single strand assimilation in bacteria. Conjugation in bacteria., replication & transfer of DNA , Transduction- Generalised and Specialised mechanisms, Recombination hot spots. Gene conversions.

Transposons- Insertion sequences and Composite transposons, phages as transposons, Replicative , non –replicative & conservative transpositions.

Controlling elements of maize- autonomous and nonautonomous elements. P- elements in Drosophila., Retroviruses and retroposons.

Unit IV

Transcription

Prokaryotic transcription: Prokaryotic RNA polymerase & its sub unit s, Sigma factor & Specificity of binding to DNA ,structure of bacterial promoter & their consensus sequences.

Initiation of Transcription,elongation & termination,rho dependent & rho independent termination of transcription & post transcriptional modification .

Eukaryotic transcription: RNA polymerase-types & sub units,promoter elements for RNA pol I, pol II and pol III, initiation of transcription by RNA pol I, pol II and pol III and transcription factors involved in initiation, ,elongation & termination of transcription.

chromatin structure & its effect on transcription: a) chromatin structure and gene activity, b) effects of histones on transcription of genes, c)Histone acetylation d) Histone deacetylation, e) chromatin remodeling and f) Nucleosomes and transcription elongation. post transcriptional modification of r RNA, t RNA & m RNA,polyadenylation,intron splicing,role of snurps

Unit V

Translation

Experiment on Direction of protein synthesis, t-RNA as Adaptor, ribosomes & their organization in prokaryotes & eukaryotes.

Bacterial translation: polycistronic RNA in bacteria ,initiation of translation in bacteria small sub unit ,its accessory factor ,SD sequences in bacteria ,initiator t-RNA,elongation of translation,translocation & termination mechanism.

Eukaryotic translation: initiation, elongation and termination. Role of ribosomal RNA in protein synthesis and summary of genetic code.

Post translational modification of proteins, protein folding, membrane localization, localization in organelles, co-translational transfer through ER, transport of proteins to nucleus, oligosaccharide addition to proteins

Practical

1. Spontaneous mutation in bacteria by Fluctuation test.
2. Induced mutation using chemical mutagens.
4. Induced mutation using physical mutagens
5. Auxotroph enrichment by ampicillin method.
- 6.Dark Repair mechanism in E.Coli.
7. Light repair mechanism in E.coli.
- 8.Repair mechanism in Yeast
- 9.Study of genotype & its Conformation.
10. Gene expression in E.coli.

References:

- 1.Benjamin Lewin- Gene VI, Gene VII, Oxford university press
- 2.David Friedlander-Essentials of Molecular Biology, Jones & Barlett Publication
- 3.J.Kendrew-Encyclopedia of Molecular Biology, Black Well Scientific Publication
- 4.Weaver-Molecular Biology
- 5.J D Watson, N H Hopkins, J W Roberts-Molecular Biology of the Gene, Benjamin Cummings Publ.co.inc.California
- 6.J.Darnell, et al Molecular Biology of the cell (2nd edition) Garland publishing inc.
- 7.Meyers R A (ed), Molecular Biology & Biotechnology.VCH Publisher NY inc
- 8.Alberts B ,et al Molecular Biology of the cell ,Garland Publishing inc.
- 9.Watson J D, Recombinant DNA
- 10.Malacinski, Essentials of molecular Biology
- 11.Stansfield, Molecular Biology

12. Walker, Molecular Biology & Biotechnology
13. Brown T A, essentials of Molecular Biology Vol 1 & vol II
14. Dale, Molecular Genetics Of Bacteria

X	Developmental Genetics	50	25	75
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Unit 1:

Basics of Developmental Biology

Developmental Concepts, Brief outline of the Beginnings of Embryology ,Differentiation and Potential Epigenesis Preformation - animalculists vs ovists, Spontaneous Generation, differentiation in viruses, bacteria multicellular organisms, cell migration, Factors controlling development, Stem Cells and commitments, gamete fusion , activation of egg metabolism, Fate mapping the embryo, developmental dynamics of cell specification.

Unit 2

Differential gene Expression

DNA Methylation pattern and control of development, Differential RNA processing, differential RNA processing, mRNA longitivity, selective inhibition of mRNA translation, cell communication in development Induction and competence, paracrine factors, Tissue specific methylation. Differential expression of haemoglobin genes.

Unit 3

Drosophilla Development (Early and late)

Maternal effect genes, pair ruler genes, Gap genes, Segmentation genes , Segment selector genes, Homeotic selector genes, morphological agent for dorsal-ventral polarity, Hox

genes co-linearity, Evolutionary implications of Hox gene structure/activity, Dawkin's Selfish Gene Hypothesis

Unit 4

vertebrates and Plant Development

Early development in birds, axis formation in chick embryo, Mammalian cleavage, gastrulation, compaction, axis specification. Metamorphosis - flies Frogs, chromosomal sex determination in mammals. Plant embryonic development, vegetative growth and reproductive transition, Homeotic genes in genetic control of flower. Flower morphogenesis (Rice and Arabidopsis thaliana),

Unit 5

Medical Implications & environmental assaults

Genetic error of human development, human syndrome, Teratogenesis, teratogenic agents, Developmental Strategies for Exploiting Environments, cancer therapy, control of development by environmental condition, Direct development , Neoteny , Development and Evolution, homologous pathways of development, Epigenetic considerations

Practicals:

1. Genetic and phenotypic variation and sexually dimorphic characteristics in Drosophila
2. Stages of Xenopus embryogenesis: Egg activation and the early cleavage stages.
3. Patterns and pre-patterns in Drosophila wing development.
4. Early Drosophila development in normal and mutant embryos. Characterize 'mystery stocks' by observation of living embryos and analysis of embryonic lethal phenotypes.

Textbooks

1. Developmental biology: Scott F. Gilbert
2. Principles of Development, Lewis Wolpert (2nd edition), Oxford University Press.
3. Genetics- From Genes to Genomes, L. Hartwell and others (2nd edition).

XI	Immunology and Immunogenetics	50	25	75
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Unit I Basics of Immunology:

Basic concepts of immunity, types of immunity.

Cells involved in immune response :- Hematopoiesis, lymphoid and myeloid cells, maturation of T & B cells.

Organs of the immune system :- Primary and secondary organs.

Unit II Antigens and Antibodies

Antigens :- Immunogenicity Vs antigenicity, factors affecting antigenicity, epitopes, haptens, adjuvants. Antibodies :- Basic structure, classes of antibodies, antigenic determinants of antibodies, monoclonal antibodies. Antigen antibody interactions :- forces of antigen antibody interaction, principle, methods and applications of precipitation and agglutination.

Unit III

The immune response

Humoral and cell mediated immune response. Recognition of antigen :- MHC, antigen processing and presentation, T-cell and B - cell activation. Effector mechanisms :- Cytokines, CTL, NK cell mechanism of cytolysis and ADCC, complement activation pathways (classical, alternate and lectin pathway), Regulation of immune response

Unit IV

Immunogenetics

Genetic model of immunoglobulin structure, multigene organization, Variable gene rearrangement, molecular mechanism of recombination, generation of diversity, class switch, Expression of Ig genes and regulation of transcription. Organization and rearrangement of TCR genes.

Unit V

Inappropriate Immune Response

Hypersensitivity :- types I, II and III. Immunodeficiency diseases :- primary and secondary deficiencies. Autoimmunity :- its mechanisms, diagnosis, and control.

Practicals

1. Differential leukocyte count.
2. Diagnostic immunologic principles and methods
 - Precipitation method - Immunodiffusion
 - Immunelectrophoresis
 - Agglutination method - Widal test
 - Haemagglutination
 - ELISA.
3. Separation of serum protein by submerged agarose gel electrophoresis.
4. Purification of human immunoglobulins from serum.
5. Isolation of H and O antigens from *S. typhi*
6. Clinical diagnosis of Rheumatoid arthritis by lattice agglutination test.
7. Demonstration of Western blotting.

8. Conjugation of antibody with enzyme / fluorescent tag.

References

1. Essentials of Immunology by Riott I .M.
2. Immunology by Kuby J.
3. Immunology - Understanding of Immune System by Claus D. Elgert.
4. Fundamentals of Immunology by William Paul.
5. Cellular and Molecular Immunology by Abbas.
6. Immunobiology: The Immune System in Health and Disease by Travers.
7. Immunology- A short Course by Benjamin.

XII	Molecular Genetics of Viruses	50	25	75
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Unit I

Introduction to General Virology

Baltimore Classification and Nomenclature of Viruses, function of the virion, Morphology of viruses. **Building a protective coat:** Helical structure, capsids or nucleocapsids with icosahedral symmetry (Triangulation numbers) & complex viruses.

Viruses with Envelopes: Viral Envelope components, Simple enveloped viruses, enveloped viruses with one or two additional protein layers.

Viroids and Prions.

Unit II

Cultivation And Detection of viruses

Cultivation of Viruses in embryonated eggs, cell culture, laboratory animals, and in transgenic system. **Detection of viruses in host:** Measurement of infectious units: plaque assay, fluorescent focus assay, infectious center assay, transformation assay, endpoint dilution assay. Measurement of virus particles and their components: electron microscopy, Hemagglutination assay, One step growth curve. Measurement of viral Enzyme activity: Serological methods: virus neutralization, Hemagglutination inhibition,

complement fixation, protein detection, immunoprecipitation & immunoblotting, ELISA,GFP, Nucleic acid detection.

Unit III

Bacteriophages

Bacteriophages, Lytic & Lysogenic Life Cycles, Structure, genome organization, replication or infectious cycle :T4 phages, Lambda phage, M13,Mu phage and lambda phage Gene Expression and control of life cycle Phage- lytic & lysogeny,T4 and lambda phage, Antitermination and lambda-repressor control of lysogeny.

Unit IV

Animal Virology :

Classification of animal viruses, Structure, genome organization, replication or infectious cycle and Pathogenicity of : Adenovirus, Hepatitis B virus, vaccinia virus, Simian virus 40(SV40), influenza A virus and HIV. **Prevention and control of viral diseases:** Vaccines: Basics and types of vaccines. The search for new antiviral targets: entry and uncoating inhibitors, proteases, virus specific nucleic acid synthesis and processing, regulatory proteins, antiviral gene therapy and transdominant inhibitors and anti HIV drugs.

Unit V

Plant virology:

Classification of plant viruses, genome organization, life cycle, and Pathogenicity of common plant viruses like TMV, cauliflower mosaic virus, potato virus and Gemini virus.

Transmission by Invertebrates, Nematodes & Fungi -- Invertebrates – a] Arthropoda: Aphids, Leafhoppers & plant hoppers, thripes, beetles and Mealy bugs. B] Arachnida: Mites & pollinating insects. Nematodes & Fungi Mechanical transmission, seed transmission, vegetative propagation, grafting transmission, by dodder.

Control and uses of plant viruses: Removal or avoidance of sources of infection: a] Removal or avoidance of sources of infection in or near crop b] virus free seed, c] virus free vegetative stocks, d] Modified planting and harvesting procedures. **Control or avoidance of vectors:** A] Air borne vectors b] soil born vectors.

PRACTICALS:

1. Isolation of coliphages from sewage.
2. Titration of E.coli phages.
3. Lysate preparation ie. Preservation of phages.
4. Determination of burst size of phages.
5. Precipitation of Bacteriophages by PEG method.
6. Separation of coat proteins by SDS-PAGE.
7. Isolation of plant viruses from diseased material.
8. Precipitation of plant virus.
9. Bacteriophage DNA extraction.
10. Clinical Diagnosis of Viral Diseases by ELISA.

References:

1. Roger Hull Matthews Plant Virology 4th edition ELSEVIER.
2. Morag C and Timbury MC 1994 Medical Virology 10th edition Churchill Livingstone, London
3. Dimmock N J, Primrose S.B 1994 Introduction to modern Virology , 4th edition Blackwell Scientific Publications. Oxford.
4. Conrat H.F., Kimball PC and Levy J.A, 1994, Virology 3rd edition, Prentice Hall Englewood cliff NJ.
5. Topley and Wilsons 1995 text Book on the principles of bacteriology, virology and Immunology, Edward Arnold, London principles of Virology 2000.
6. S.J.Flint Molecular biology, pathogenesis and control ASM Press. Washington DC
7. Edonard Kurstak Applied Virology 1984, edited by Academic press Inc.
8. Dimmock Introduction to modern virology
9. Steven Specter , Adinka R.L. Young S.A Clinical Virology manual
10. Guschup M.H. Prion Diseases

4th Semester Syllabus

Paper No.	Paper Name	Theory Marks	Practical Marks	Total Marks
XIII	Bioinformatics, Proteomics and Research Methodology	50	25	75
XIV	Genetics of Metabolic disorder	50	25	75
XV	Genetic Engineering	50	25	75
XVI	Interventions of Biotechnology in Medicine	50	25	75

XIII	Bioinformatics, Proteomics and Research Methodology	50	25	75
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Unit I

Introduction to Bioinformatics, scope and applications.

Major resources in Bioinformatics –NCBI, EBI, Expasy, GenBank, EMBL, DDBJ, NBRF-PIR, SwissProt. Biological databases -- primary database, secondary database, composite database, derived database(PROSITE, Pfam,BLOCKS,PRINTS, PANTHER, PRODOM). Nucleotide databases, protein databases(PDB).

Search engines-Entrez, SRS. Domains, Patterns, Conserved domains and their databases.

Unit II

Sequence analysis

Sequence alignment-pairwise alignment, multiple alignment, tools for

alignments(CLUSTAL X,CLUSTAL W). Search Tools- BLAST, FASTA, Various

BLAST programs(nBLAST, nBLASTp, xBLAST, BLASTp, PHI-BLAST, PSI-BLAST).

Scoring matrices for Nucleic acids and proteins MDM, BLOSUM,Pair wise sequence

alignment algorithms, Needleman & Wunsch Smith & waterman.Sequence analysis.

Structure analysis.

Unit III

DNA Microarray

Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper.

Whole genome analysis for Global patterns of gene expression using fluorescent-labelled cDNA or end labelled RNA probes. Analyses of single nucleotide polymorphism using DNA chips.

Unit IV

Proteome analysis

Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by Mass Spectroscopy. Protein microarray advantages and disadvantages of DNA and protein microarrays.

Unit V

Research Methodology

What is research? Characteristics and Types of research Elements of research proposal :- Introduction, research problem, purpose of research, research design, sampling, scaling and measurements data collection, data interpretation, results.

Elements of report writing.

Practical

1. Exploring the integrated database system at NCBI server and querying the PUBMED and GenBank databases using the ENTREZ search engine
2. Exploring the integrated database system at EBI server and searching the EMBL

Nucleotide database using the SRS search engine

3. Exploring and querying the SWISSPROT database

4. Exploring and querying the PIR database

5. Database (homology) searches using different versions of BLAST and interpretation of the results to derive the biologically significant relationships of the query sequences (proteins/DNA) with the database sequences

6. Database (homology) searches using different versions of FASTA and interpretation of the results to derive the biologically significant relationships of the query sequences (proteins/DNA) with the database sequences

7. Pair-wise local alignments of protein and DNA sequences using Smith-Waterman algorithm and interpretation of results. Pair-wise global alignments of protein and DNA sequences using Needleman-Wunsch algorithm and interpretation of results to deduce homology between the sequences

8. Multiple sequence alignments of sets of sequences using web-based and stand-alone version of CLUSTAL. Interpretation of results to identify conserved and variable regions and correlate them with physico-chemical and structural properties

9. Exploring and using the derived databases: PRO SITE, PRINTS, BLOCKS, Pfam and Prodom for pattern searching, domain searches etc.

References

1. Introduction to Bioinformatics; Attwood
2. Bioinformatics; C,V. Murthy
3. Bioinformatics;

XIV	Genetics of Metabolic disorder	50	25	75
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Unit 1

Cancer Biology: Retroviruses and Oncogenes, Receptor Tyrosine Kinases and the RAS Pathway, Cell Cycle Regulation and Checkpoints, Chromosomal Rearrangements, Tumor Suppressor Genes and Knockout Mice, RB and p53 Pathways, Cell Growth and Apoptosis, Radiation Biology and DNA Repair, Hypoxia and Angiogenesis, Telomeres, Senescence, and Immortality, Genomics, Epigenetics, and Cancer, WNT Pathway and Colon Cancer, Stromal Interactions and Metastasis, Tumor Immunology, Cancer Epidemiology and Prevention, Nuclear Receptors and Hormones, Cancer Chemotherapy, Clinical Oncology

Unit 2

Disorders of amino acid metabolism-

Anomalies of Tyrosine metabolism- Oculocutaneous albinism, Tyrosinemia,

Alkaptonuria

Anomalies of Phenylalanine metabolism --Phenylketonuria, Hyperphenylalaninemia with defective tetrahydrobiopterin metabolism

Anomalies of branched-chain amino acids metabolism (Leucine, Isoleucine, Valine)

Maple syrup urine disease (Leucinosis)

Anomalies of methionine metabolism -Homocystinuria

Anomalies of glycine metabolism -Nonketotic hyperglycinemia

Anomalies of tryptophan metabolism -Hartnup disease

Biotinidase deficiency , Ornithine carbamoyltransferase deficiency , Carbamoyl-phosphate synthase I deficiency disease , Citrullinemia , Hyperargininemia , Hyperhomocysteinemia , Hyperlysinemias , Hyperprolinemia

Amino acid transport disorders-

Cystinuria, Dicarboxylic aminoaciduria, Phenylketonuria

Amino acid storage disorders- Glutaric acidemia type 2

Unit 3

Disorders of carbohydrate metabolism-

Disorders of carbohydrate metabolism include diabetes mellitus,

Introduction to Diabetes, Classification, History of Diabetes, Epidemiology, Physiology and Biochemistry of Sugar Regulation, The Story of Insulin, Metabolic Factors in Type 1 Diabetes, IDDM1 Contains the HLA, IDDM2 Contains the Insulin (INS), An Inhibitor of the Immune Response (CTLA4), Other Type 1 Diabetes Susceptibility Loci: IDDM3–IDDM18, Metabolic Factors in Type 2 Diabetes,- The Sulfonylurea Receptor (ABCC8), The Calpain 10 Enzyme (CAPN10), The Glucagons Receptor (GCGR) The Enzyme Glucokinase (GCK) The Glucose Transporter GLUT2 The Transcription Factor HNF4A The Insulin Hormone (INS) The Insulin Receptor (INSR) The Potassium Channel KCNJ11 The Enzyme Lipoprotein Lipase (LPL) The Transcription Factor PPARG The Regulatory Subunit of a Phosphorylation Enzyme (PIK3R1), Other Types of Diabetes Genetic Defects of Beta Cell Function, lactose intolerance, and galactosemia.

Disorders of organic acid metabolism (organic acidurias)E.g., [alcaptonuria](#)

Disorders of fatty acid oxidation and mitochondrial metabolism E.g., medium chain acyl dehydrogenase deficiency (glutaric acidemia type 2)

Unit 4

Other metabolic disorders

Disorders of porphyrin metabolism -E.g., acute intermittent porphyria

Disorders of purine or pyrimidine metabolism -E.g., Lesch-Nyhan syndrome

Disorders of steroid metabolism -E.g., congenital adrenal hyperplasia

Disorders of mitochondrial function -E.g., Kearns-Sayre syndrome

Disorders of peroxisomal function --E.g., Zellweger syndrome

Lysosomal storage disorders --E.g., Gaucher's disease, E.g., Niemann Pick disease

Overview of Lipid and Lipoprotein Metabolism, *Disorders of Lipoprotein Metabolism* ,
Dyslipidemias, Disorders of Cholesterol and Bile Acid Synthesis and Storage, Organelle
Functions, Glycolipids and Complex Carbohydrates, *Clinical Management of Inborn
Errors of Metabolism*

Unit 5

Common screening tests used for diagnosis of metabolic disorders

Ferric chloride test (turned colors in reaction to various abnormal metabolites in urine)

Ninhydrin paper chromatography (detected abnormal amino acid patterns)

Guthrie bacterial inhibition assay (detected a few amino acids in excessive amounts in blood) The dried blood spot can be used for multianalyte testing using Tandem Mass Spectroscopy (MS/MS). Quantitative plasma amino acids, quantitative urine amino acids, Urine organic acids by mass spectrometry

Specific diagnostic tests (or focused screening for a small set of disorders):

Tissue biopsy or necropsy: liver, muscle, brain, bone marrow, Skin biopsy and fibroblast cultivation for specific enzyme testing, Specific DNA testing

Newborn screening.

Practicals:

1. Specific diagnostic tests (or focused screening for a small set of disorders):
2. Tissue biopsy or necropsy: liver, muscle, brain, bone marrow, Skin biopsy and fibroblast cultivation for specific enzyme testing, Specific DNA testing

References?

XV	Genetic Engineering	50	25	75
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Unit I.

Enzymes in Genetic Engineering

Restriction endonucleases-,Type I ,II & III, Recognition sequences, properties, nomenclature, classification of Type II Endonucleases, their activity. DNA ligase: Properties & specificity.

Enzymes used in Genetic Engineering. – S1 Nuclease, Bal 31 nuclease., DNA Polymerase, Polynucleotide kinase, Phosphatase, Reverse Transcriptase its activity and mode of action

Chemical synthesis of DNA DNA sequencing: Dideoxy method,Automated DNA sequencing.

Unit II.

Cloning vectors

E.coli vectors

Plasmids: Properties, Incompatibility,pBR322- its construction & derivatives, Beta-lactamase gene of pBR322, transformation techniques, Single stranded plasmids and Runaway plasmid vectors.

Bacteriophage Lambda vector : Essential features, organization of lambda genome , Rationale for vector construction, general structure of lambda vectors, modified vectors: gt series, EMBL vectors, in vitro packaging, Cosmids, Phasmids, Filamentous phage vectors, Zap bluescript vectors,

Cloning Strategies: Genomic DNA libraries, Chromosome Walking and Jumping, cDNA libraries, shotgun cloning ,directed cloning, Phage display

Unit III. Other Cloning Vectors:

Cloning in Bacillus subtilis: Transformation techniques, plasmids and vectors, expression vectors excretion vectors, Shuttle vectors.

Yeast vectors: Genetic markers and selection system, yeast integrating, replicating, episomal vectors, yeast artificial chromosomes, expression vectors.

Unit IV

Techniques for studying genes and their activities I

Direct and indirect Recombinant selection and screening; immunochemical methods; blotting techniques: Northern, Southern, Western blotting; Autoradiography and phosphor imaging; Preparation of probes by radioactive method and non radioactive method, Differential screening. Colony hybridization.

Mapping and qualifying transcripts: S1 mapping, primer extension, and runoff and runoff transcription. Reporter gene expression, hybrid release and arrest translation, Maxi, mini cells, exon cloning.

Unit V

Techniques for studying genes and their activities II

DNA protein interaction: Filter binding assay, Electrophoretic gel mobility shift assay (EMSA), DNase foot printing, DMS foot printing.

Polymerase Chain Reaction: procedure, Types and application, RFLP, RAPD, AFLP analysis, .Chromosome walking. DNA fingerprinting and its applications, Enzyme engineering: Engineering of important enzymes and Antibodies.

Metabolic Engineering: Basic concepts and application with suitable and relevant examples. Invitro Mutagenesis: Directed and Random mutagenesis.

Practical's:

1. Study of Conjugation in E.coli

2. Generalized Transduction in E coli using P1 phage
3. Transposition of tn family and insertional inactivation in E coli
4. Southern hybridization
5. Western hybridization
6. Gene expression in E.coli
7. Isolation of plasmids from E coli , Bacillus
8. Restriction fragment analysis
9. Transformation of E coli
10. PCR
11. RAPD
12. Isolation of RNA from yeast.
13. Isolation of Phage DNA
14. Isolation of RNA from plant.
15. Isolation of RNA from animal tissues.
14. Electrelution to purify the DNA fragments

References:

1. Benjamin Lewin -Gene VI, Gene VII, Oxford University press
2. David Friefieder Essentials of Molecular Biology, Jones & Barlett publications
3. J. Kendrew Encyclopedia of Molecular Biology Blackwell Scientific publications.
4. Weaver Molecular Biology
5. J.D.Watson, N.H.Hopkins ,J.W Roberts, et al Molecular Biology of the Gene, Benjamin Cummings publ.co.inc., California
6. J.Darnell., et al molecular biology of the cell(2nd edition) Garland Publishing Inc.
7. Meyers R.A (ed) ., Molecular biology and biotechnology.VCH publishers NY Inc.
8. Alberts B et al Molecular biology of the cell. Garland Publishing Inc.
9. Watson J.D ., recombinant DNA.
10. Joyner: gene targeting – a practical approach.
11. Nicoll; Genetic engineering.
12. Robertson; Manipulation and expression of recombinant DNA.

13. Brown D.A. Genetics : Molecular Approach
14. Primrose Molecular Biotechnology
15. Berry Yeast Biotechnology
16. Griffith Anthony, Miller J.F., Suzuki D, Lewontin R, and Gelbart W.M – An introduction to Genetic Analysis
17. Nancy Craig, martin Gellert allan Lambowitz Mobile DNA II
18. Helen Kreuzei Recombinant DNA & Biotechnology
19. Winnaker - From Genes to Clones
20. Old & Primrose – Principles of gene Manipulations

XVI	Interventions of Biotechnology in Medicine	50	25	75
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Unit 1:

Biopharmaceuticals derived from genetically modified plants: Medical molecular farming: production of antibodies, biopharmaceuticals and edible vaccines in plants.

Unit 2:

Use of Transgenic Animals in Medicine--Animals for the production of therapeutic substances, Alternatives to the use of animals, Xenotransplantation, Pharmaceuticals from transgenic animals, Transgenic animals in experimental medicine

Unit 3

Introduction to concepts in stem cell biology (renewal, potency, etc.); definition of terms; adult stem cells, Embryonic stem cells, Molecular bases of pluripotency, mechanism of stem cell self-renewal, cell-cycle regulator in stem cell, epigenetic mechanism of cellular memory during development, cell fusion and the differentiation state, different media for stem cell growth, isolation, characterization and maintenance of primate ES cell,

Hematopoietic stem cells, Skin Stem Cells, Cancer Stem Cells, Novel sources of multipotent stem cells

Unit 4

Genetic counseling: Course Overview, Overview of Counseling Models , Models and Methods of Practice of Genetic Counseling, The Role of Nondirective ness, Listening to Clients: Attending Skills, Guidelines for Role Plays. Giving and Responding to Feedback, Listening to Clients: Primary Empathy Skills, Gathering Information: Asking Questions, Collaborating with Clients: Providing Risk Information and Assisting in Decision Making, Responding to Client Cues: Advanced Empathy and Confrontation, Ethical Decision Making Framework-Robin Gold,

Ethical Issues in Presymptomatic testing. Dima El-Khechen (rescheduled), Medical Ethics in Clinical Practice, NSGC Code of Ethics-Gold Privacy and Recent Ethical Issues in Clinical Genetics, Client Issues: Resistance, Defense Mechanisms and Coping Behaviors, Client Issues: Client Affect and Client Styles, Ethical Dilemmas-El-Khechen

Unit 5

Umbilical cord blood, Cord blood bank, Placenta cord banking- Collection, storage and costs, Cord blood procurement, Fetal Cord Blood, Cord blood transplantation, The Application of Umbilical Cord Blood Cells, diseases treated with haematopoietic cells transplantation, Cord blood in regenerative medicine, Cord Blood Donation, Cord Blood Rights

Reference: Articles and Books

1. **Transgenic plants for vaccine production: Expectations and limitations.** *Trends Plant Sci* 2001; **6**:495–6.(Chargelegue D, Obregon P, Drake PMW)

2. **The production of recombinant pharmaceutical proteins in plants.** *Nature Rev Genet* 2003; **4**:794–805.(Ma JKC, Drake PMW, Christou P.)
3. **Antibody production by molecular farming in plants.** *J Biol Regul Hemeost Agents* 2000; **14**:83–92. (Fischer R, Hoffmann K, Schillberg A, Emans N.)
4. **A review of oral vaccination with transgenic vegetables.** *Microbes Infection* 1999; **1**:777–83. (Tacket CO, Mason HS.)
5. **Transgenic plants as protein factories.** *Current Opinion in Biotechnology* Volume 12, Issue 5, 1 October 2001, Pages 450-454
6. **Production of hepatitis B surface antigen in recombinant plant systems: an update.** *Biotechnol Prog.* 2007 May-Jun;23(3):532-9. Epub 2007 Mar 10.
7. **Cattle Mammary Bioreactor Generated by a Novel Procedure of Transgenic Cloning for Large-Scale Production of Functional Human Lactoferrin--Penghua Yang, Jianwu Wang, Guochun Gong, Xiuzhu Sun, Ran Zhang, Zhuo Du, Ying Liu, Rong Li, Fangrong Ding, Bo Tang, Yunping Dai, and Ning Li, PLoS ONE. 2008; 3(10): e3453. Published online 2008 October 20. doi: 10.1371/journal.pone.0003453. PMID: PMC2565487**
8. **Gene–environment interactions influence ecological consequences of transgenic animals** L. F. Sundström, M. Löhmus, W. E. Tymchuk, and Robert H. Devlin *Proc Natl Acad Sci U S A.* 2007 March 6; **104**(10): 3889–3894. Published online 2007 February 27. doi: 10.1073/pnas.0608767104. PMID: PMC1820679
9. **Pigs taking wing with transposons and recombinases--Karl J Clark, Daniel F Carlson, and Scott C Fahrenkrug, Genome Biol. 2007; 8(Suppl 1): S13. Published online 2007 October 31. doi: 10.1186/gb-2007-8-s1-s13. PMID: PMC2106845**

10. Marker tolerant, immunocompetent animals as a new tool for regenerative medicine

and long-term cell tracking --Kathrin I Odörfer, Nina J Unger, Karin Weber, Eric P

Sandgren, and Reinhold G Erben BMC Biotechnol. 2007; 7: 30. Published online 2007

June 8. doi: 10.1186/1472-6750-7-30. PMCID: PMC1899491

11. Zebrafish in hematology: sushi or science? Duncan Carradice and Graham J.

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Practical:

10,000 words Review report on particular subject related topics with seminar for 25

Mraks

