Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot
Department of Biotechnology
B. Sc. BIOTECHNOLOGY

For Students Admitted from A.Y. 2016-2017 & Onwards

SEMESTER- III

16UBTCC09	Core 5: Genetics	4hrs/wk	4 Credits

Objectives:

Students will be able to:

1. Understand the nature of heredity & inheritance and recognize the structure, replication, and function of DNA and RNA.
2. Evaluate how genes control enzyme and protein structure and the causes and effects of genetic mutations on these structures.
3. Realize the genetic basis of sex determination and differentiation and analyseeffect of genes to the level of population.

Unit 1: Principles of Genetic Transmission (10 hrs)

- Introduction, A historical perspective of Genetics.
- Mendelian Laws of Inheritance,
- Genic Interactions, Deviations and Exceptions to Mendelian Rations.
- Laws of Inheritance in Haploid Organisms- Chlamydomonas and Neurospora.
- Degree of gene expression: Penetrance and Expressivity

Unit 2: Sex Linkage and Chromosomal Mapping (10 hrs)

- Chromosomal theory of inheritance and sex linkage, Sex-Linkage inheritance.
- Sex limited and Sex influenced trait.
- Dosage compensation, Linkage, crossing over, The Molecular Basis of Crossing-over, Recombination frequency.
- Genetic Mapping, Multiple Crossing-over, Gene Mapping from Three-Point Testcrosses. Interference in Double Crossing-over, Coincidence Genetic Mapping Functions. Tetrad Analysis, Mitotic Recombination.
- Pedigree analysis, Characteristics of dominant and recessive inheritance, Applications of pedigree analysis

Unit 3: Extranuclear Inheritance &Chromosomal Abberation (10 hrs)

- Recognition of Extranuclear Inheritance: Mitochondrial Genetic Diseases, Heteroplasmy
- Maternal Inheritance and Maternal Effects. Leaf Variegation in Four-O'clock Plants, Drug Resistance in *Chlamydomonas.*

- Respiration-Defective Mitochondrial Mutants,Cytoplasmic Male Sterility in Plants.
- Evolutionary Origin of Organelles, Cytoplasmic Transmission of Symbionts, Maternal Effect in Snail-Shell Coiling.
- Type of chromosomal aberration, diseases and its role in plant improvement.

Unit 4: Sex Determination and Developmental basis of sex (8 hrs)

- Introduction of sex determination
- Sexual Reproduction in prokaryotes & Eukaryotes
- Effect of environment on sex determination
- Genetic basis of sex determination, Chromosomal sex determination mechanism,
- Gonad formation, Role of hormone and gene in gonad formation.

Unit 5: Population Genetic and Evolution (10 hrs)

- Allele Frequencies and Genotype Frequencies, Allele Frequency Calculations.
- Systems of Mating:Random Mating and the Hardy Weinberg Principle, Implications of the Hardy-Weinberg Principle, Exception and application of Hardy Weinberg Principle.
- A Test for Random Mating Frequency of Heterozygotes.
- The Inbreeding Coefficient
- Allelic Identity by Descent Calculation of the Inbreeding Coefficient from Pedigrees, Effects of Inbreeding.

Text books

1. Snusted, D. P., & Simmons, M. J. (2000). *Variation in chromosome number and structure. Principle of genetics.* 2nd ed. John Wiley and sons
2. Klug, W. S., & Cummings, M. R. (2003). *Concepts of genetics*. Pearson Education, Inc.
3. Davis, R. H., & Weller, S. G. (1997). *The Gist of Genetics: guide to learning and review*. Jones & Bartlett Learning.

Reference books

1. Brown, T. A. (1992). *Genetics: a molecular approach* . Chapman & Hall.
2. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (1991). *Principles of genetics* . John Wiley and Sons, Inc..
3. Strickberger, M. W. (1968). Genetics. *The Mac Millan Co., N. York*.
4. Weaver, R. F., & Hedrick, P. W. (1997). Genetics. Wm. C.
5. Singer, M., & Berg, P. (1991). *Genes and Genomes*. Mill Valley.

16UBTCC10	Core 6:Molecular Biology	4hrs/wk	4 Credit

Objectives:

To enable the students to

1. Describe the Organization of Bacterial genome and Eukaryotic chromosomes
2. Explain the concept of DNA replication and repair
3. Understand the mechanism of Transcription and mechanism of protein synthesis
4. Understand the regulation of Gene expression

Unit 1: Organization of Genetic Material (8 hrs)

- Central dogma ,Evidences for DNA as genetic material
- Structure and functions of DNA and RNA
- Forms of DNA [A,B, Z]
- Genome organization in Prokaryotes and Eukaryotes
- C- value paradox and Renaturation Kinetics

Unit 2: DNA replication and repair (10 hrs)

- Experimental Evidences of Replication, Modes of Replication
- Enzymes & accessory proteins involved in DNA replication
- Replication process in Prokaryotes
- Replication process in Eukaryotes, Telomere synthesis - telomerase
- DNA Repair : Types of DNA Repair, Mechanism of DNA Repair

Unit 3: Transcription (12 hrs)

- Bacterial RNA polymerases , Mechanism of Transcription in prokaryotes
- Eukaryotic RNA polymerases , Mechanism of Transcription in Eukaryotes
- Processing of m-RNA : 5' capping, 3' polyadenylation , Splicing
- r-RNA & t- RNA processing
- Transcription Inhibitors

Unit 4: Translation (10 hrs)

- The translation machinery : role of t RNA & ribosome
- Genetic code, Wobble hypothesis
- Mechanism, of translation in prokaryotes and Eukaryotes
- Post translational modification of proteins
- Inhibitors of Translation

Unit 5: Regulation of Gene expression (8 hrs)

- Introduction and type of Gene Regulation
- Operon concept (Lac operon, trp operon)
- Gene silencing : DNA methylation
- Antisense RNA
- Chromatin modification & gene expression.

Text Books

1. Robert F. Weaver (2012) . *Molecular Biology*, Fifth Edition .McGraw Hill
2. Watson (2014). *Molecular Biology of the Genes*. Pearson Publication.

Reference Books

1. Alberts, B. (2002). *Molecular Biology of the Cell* . Garland Science.
2. Walker, J. H. (2002). *Cell and molecular biology concepts and experiments:* Karp, G.
3. Cooper GM. (2000).*The Cell: A Molecular Approach.* Sinauer Associates

16UBTCC11	Core 7: Mathematics for Biologist	4hrs/wk	4 Credit

Objectives:

To enable the students to

1. Understand the basic concepts of mathematics- set relations, functions, linear and quadratic equation, permutation and combination and solve the related problems.
2. Understand the concept of Metrices & Determinant along with the numerical ability
3. Interpret the meaning of graphical representation of sets of data: histogram, polygon, Ogive and pie diagram
4. Calculate the measure of central tendency, measure of variance&Learn the concept of probability of an event & the probability distribution

Unit1: Basic Concepts of Mathematics: (10 hrs)

- Set theory: Sets and their representations, type of sets, Operation on sets
- Relations: Cartesian product of sets
- Functions: Concept & its domain and range, graphs of some well known functions
- Linear & Quadratic Equations
- Permutations and Combinations

Unit 2: Limits, differentiation, Integration & series (10 hrs)

- Limits and Derivative: limits, Derivatives, Derivative of Function,
- Differentiation: introduction, chain rule, product rule and quotient rule
- Indefinite Integrals&Definite Integrals
- Quadratic equation
- Series: Arithmetic progression, Geometric progression, relationship between arithmetic and geometric mean

Unit 3: Matrices& Determinant (10 hrs)

- Determinant: Introduction, properties of determinant
- Matrix: Introduction, types of matrix
- Properties of Metrics
- Elementary operation of matrix
- Applications of matrices and determinants

Unit 4: Data Collection, Sampling, Presentation and Measures Central Tendency (10 hrs)

- Introduction to Biostatistics: Common Terms and Notations, Applications.
- Data Collection: Type of Data, Method of Collection of primary and secondary Data
- Sampling: Representative Sample, Sample Size, Sampling Bias and Sampling techniques.
- Methods of data presentation: Histogram, Polygon, Ogive Curve, Pie Diagram.
- Measure of Central Tendency: Mean, mode, median.

Unit 5: Measure of Variability, Test of Significance & Computer based statistical techniques (8 hrs)

- Measure of Variability: Standard Deviation, Standard Error, Range, Mean Deviation, Coefficient of Variation
- Correlation: Types and Calculation of Correlation Coefficient
- Regression: Linear regression and Regression Coefficient
- Probability
- Probability Distribution: Binomial, Poison and Normal Distributions.

Text Books

1. Narayan, S. (1962). *A text book of matrices*. S. Chand.
2. Dass, H.K (2016). *Applied mathematics for polytechnics,* CBS publisher.
3. Khan, I. A. & Khanum, A. (2004). *Fundamentals of biostatistics.* Ukaaz Publications, Hyderabad.

Reference Books

1. Mahajan, B. K. (1997). *Methods in Biostatistics*. Jaypee Publications.
2. Sundar Rao, P. S., & Richard, J. (1996). *An introduction to biostatistics*. New Delhi. Prentice-Hall India,
3. Campbell, R. C. (1989). *Statistics for Biologists.* Cambridge University Press.
4. Bailey, N. T. (1995). *Statistical methods in biology*. Cambridge university press.
5. Rao, P. S., & Richard, J. (1996). *An Introduction to Biostatistics: A manual for students in health sciences*. Prentice Hall of India.

16UBTCC12	**Core Practical 5: Genetics and Molecular Biology Practical**	**6hrs/wk**	**3 Credits**

Objectives:

Upon completion of the course students will be able to

1. Illustrate the methods of DNA extractions and its qualitative and quantitative analysis.
2. Demonstrate the skills of basic techniques required for Genetic engineering procedures and handling of various instruments of molecular biology lab.
3. Understand the principles of Population and Classical genetics.

List of Experiments

Exp. 1. Problem solving based on Mendelian Principles.
Exp. 2. Problem solving based on Hardy Weinberg Law of equilibrium.
Exp. 3. Study of Karyotyping with the help of photographs.
Exp. 4. Isolation of Bacterial genomic DNA.
Exp. 5. Isolation of Mammalian genomic DNA from Blood.
Exp. 6. Preparation of Plasmid DNA from bacteria by Alkalinelysis method.
Exp. 7. Agarose Gel Electrophoresis of isolated DNA.
Exp. 8. Restriction Enzyme Digestion of Lambda DNA.
Exp. 9. Qualitative and Quantitative assessment of DNA by Spectrophotometry.
Exp. 10. Preparation of Competent cells for Transformation.
Exp. 11. Bacterial Transformation by Heat Shock method.
Exp. 12. UV Induced Mutagenesis for isolation of Lac negative Mutants

Reference Books:

1. Sambrook, J., Fritsch, E. F., &Maniatis, T. (1989). *Molecular cloning* (Vol. 2,). New York: Cold spring Harbor laboratory press.
2. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., &Struhl, K. (1988). *Current Protocols in Molecular Biology*. New York, Greene and Wiley Interscience.
3. Karp, G. (2004). *Cell and Molecular Biology: Concepts and Experiments 4th Edition with Study*. John Wiley & Sons.

SEMESTER- IV

16UBTCC13	Core 8: Analytical Techniques	4hrs/wk	4 Credits

Objectives:

Students will be able to:

1. Understand the usage of different microscopic techniques for observation of biological material,
2. Understand the separation and purification of biological macromolecules.
3. Implement the knowledge of UV-VIS spectroscopy in the determination of enzyme kinetics and understand the basic concepts of the advanced spectroscopy techniques.
4. Explain the concepts and developments in the measurement of Radioactivity and immunochemical techniques.

Unit 1: Microscopy **(8 hrs)**

- Basic Principles of Microscopy
- Light Microscopy I: Bright field, Dark field
- Light Microscopy II: Fluorescent Microscopy & Phase contrast Microscopy
- Electron Microscopy: Transmission EM & Scanning EM
- Specimen Preparation of Light & Electron Microscopy

Unit 2: Spectroscopy Techniques **(10 hrs)**

- Spectroscopic techniques: Beer Lambert's law, Extinction coefficient
- Electromagnetic spectrum, interaction of EM radiation with matter, Physical phenomenon: Absorption, Emission, Refraction, Diffraction, Transmission
- Principles & applications of visible & U.V. spectroscopic technique, Absorption & Emission Spectroscopy
- IR,Mass Spectroscopy & NMR
- X-ray diffraction & crystallization

Unit 3: **Separation Techniques I** **(10 hrs)**

- Basics, principles and classification of centrifugation
- Sedimentation, Relative centrifugal force, preparative and analytical centrifuge, ultracentrifugation and its applications in molecular size determination.
- Basics, principles and classification of electrophoresis
- Zone Electrophoresis: Paper electrophoresis, Thin layer electrophoresis, Cellulose acetate electrophoresis, Gel electrophoresis, Affinity electrophoresis, Isoelectric focusing (2D Electrophoresis).
- Moving boundary electrophoresis: Capillary electrophoresis

Unit 4: **Separation Techniques II** **(10 hrs)**

- Chromatography Theory & Principles
- Understating of Basic terminology: Stationary phase, Mobile phase, Retention time, Column efficiency, Peak shape, Band broadenings

- Planar chromatography: Paper chromatography and Thin layer chromatography
- Column chromatography: Partition, Adsorption, Ion exchange, Size exclusion, Affinity, Hydrophobic chromatography.
- Analytical Chromatography: GC, HPLC

Unit 5: Bio-physical Techniques (10 hrs)

- Radioisotope Techniques: The nature of radioactivity –Atomic Structure, Atomic Stability and Radiation, Types of radioactive decay, Units Of Radioactivity.
- Detection and, Measurement of radioactivity and Safety guidelines
- Biosensors: Introduction, Principle, Characteristics of Ideal Biosensor, Application of Biosensor.
- Electrophysiological methods-Single neuron Recording, Patch Clamp recording, Brain activity recording
- Imaging Techniques: PET, MRI, fMRI, CAT, ECG

Text Books

1. Wilson, K., & Walker, J. M. (2010). *Principles and techniques of biochemistry and molecular biology*. Cambridge: Cambridge University Press.
2. Chatwal, G. R., &Anand, S. K. (2002). *Instrumental methods of chemical analysis*. Himalaya Pub. House.
3. Pattabhi, V., &Gautham, N. (2002). *Biophysics*. Narosa Pub.

References Books

1. Freifelder D. (1982). *Physical Biochemistry, Application to Biochemistry and Molecular Biology.* W.H. Freeman & Company, San Fransisco.
2. Skoog, D. A., Holler, F. J.& Nieman, T. A. (2007). *Principles of instrumental analysis.* Philadelphia: Saunders College Pub.
3. Holme D.& Peck H. (1998). *Analytical Biochemistry*. Longman.
4. Settle, F. A. (1997). *Handbook of instrumental techniques for analytical chemistry*. Prentice Hall PTR.
5. Manz A., Pamme N. And Iossifidis D. (2004). *Bioanalytical Chemistry*. World Scientific Publishing Company.

16UBTCC14	Core 9: Plant Biotechnology	4hrs/wk	4 Credits

Objectives:

Students will be able to:

1. Understand the principle and applications of plant biotechnology
2. Define the principle and application of hybridization and develop skill to isolate, culture and fuse the plant protoplast
3. Understand the principles of secondary metabolite production in cultures
4. Understand basics of transgenic and methods of transformation in plants

Unit 1: Basic of Plant Biotechnology (10 hrs)

- History, scope and applications of plant tissue culture
- Laboratory facilities and supplies
- Asepsis and method of sterilization of explant
- Culture media - composition and method of preparation
- Plant growth regulators, vitamins and other adjuvants used in medium and their role

Unit 2: Establishment of cultures (10 hrs)

- Pathways of micropropagation - enhanced axillary branching, adventitious shoot bud differentiation, somatic embryogenesis and callus organogenesis
- Explant: types, collection, preparation, sterilization and aseptic inoculation of explants
- Management of donor plant and establishment of culture
- In vitro rooting and hardening and acclimatization
- Embryo culture and embryo rescue

Unit 3: Protoplast Culture (10 hrs)

- Isolation of protoplast: physical and enzymatic methods
- Culture of protoplast and special culture methods
- Protoplast fusion: chemical and physical methods
- Selection method of true hybrid after fusion experiments
- Symmetric and Asymmetric hybrids and cybrids

Unit 4: In vitro secondary metabolite production (10 hrs)

- Cell culture and production of secondary metabolites
- Important alkaloids and factors affecting their in vitro production
- Hairy root culture for production of secondary metabolites
- Elicitation and biotransformation
- Bioreactor for secondary metabolite production

Unit 5: Role of tissue culture in genetic engineering (8 hrs)

- Application of tissue culture in transgenic plant development
- *Agrobacterium* mediated transformation in plant
- Direct methods of transformation in plant

- Transgenic plants developed against insect and virus resistance
- Success stories of golden rice and flvrsavr tomato

Text Books

1. HS Chawla. (2002). *Introduction to plant biotechnology*. Science Publishers.
2. Narayanaswamy, S. (1994). *Plant cell and tissue culture*. Tata McGraw-Hill Education.

Reference Books

1. Bhojwani, S. S., & Razdan, M. K. (1986). *Plant tissue culture: Theory and practice* . Elsevier.
2. Gamborg, O. L., & Phillips, G. (Eds.). (2013). *Plant cell, tissue and organ culture: fundamental methods.* Springer Science & Business Media.
3. George, E. F., Hall, M. A., & De Klerk, G. J. (Eds.). (2007). *Plant propagation by tissue culture.* Springer Science & Business Media.

16UBTCC15	Core Practical 6: Analytical Techniques Practical	4hrs/wk	2 Credits

Objectives:

Students will be able to:

1. Illustrate the usage of different microscopic techniques for observation of biological material,
2. Carry out separation and purification of macromolecules involving centrifugation, electrophoresis and chromatographic techniques.
3. Demonstrate practical knowledge of spectroscopy for the estimation of biological sample.

List of Experiments

1. Computation of Percent Solution, Molarity, ppm, ppb and Stock solution
2. Centrifugation (A) Principles and Instrumentation (B) Problem solving g and RPM of centrifuge
3. Complementary color and Determination of λmax of the given solution using spectroscopy
4. Separation of plant pigments by Paper Chromatography
5. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
6. Determination of Molecular Weight by column chromatography
7. Isolation of Leaf pigments by Adsorption Column Chromatography and TLC
8. Gel Filtration Chromatography
9. Ion-exchange Chromatography
10. Ammonium Sulfate precipitation
11. Agarose Gel Electrophoresis
12. SDS-PAGE Gel Electrophoresis

Reference Books

1. Spector, D. L. G., Robert, D., David, L. S., & Robert, D. G. (2006). *Basic methods in microscopy: protocols and concepts from cells: a laboratory manual*
2. Scopes, R. K. (2013). *Protein purification: principles and practice*. Springer Science & Business Media.
3. Ewing, G. W. (1985). *Instrumental methods of chemical analysis*. McGraw-Hill.

16UBTCC16	Core Practical 7: Plant Biotechnology Practical	5hrs/wk	2 Credits

Objectives:

Students will be able to:

1. Define and describe components of plant tissue culture medium and methodology of preparation of medium
2. Independently establish in vitro culture of plant
3. Understand the role of plant tissue culture in elimination pathogen and artificial seed production

List of Experiments

Exp: 1 Plant tissue culture: laboratory organization facilities & equipments

Exp: 2 Preparations of stock solutions

Exp: 3 Preparation of Plant tissue culture media: MS, Nitsch and whites medium.

Exp: 4 In vitro culture of suitable explants for induction of callus

Exp: 5 Study of growth characteristics of callus

Exp: 6 Establishment of cell suspension culture from callus

Exp: 7 In vitro establishment of shoot culture using mature node explant, internode explant or leaf explants

Exp: 8 Root induction in *in vitro* raised shoots

Exp: 9 Hardening and acclimatization of tissue culture raised plantlets

Exp: 10 Culture of anther for production of androgenic haploids

Exp: 11 Protoplast culture, isolation and regeneration

Exp: 12 Meristem tip culture for production of virus free plants

Exp: 13 Encapsulation of somatic embryos/shoot buds for production of synthetic seeds

Reference Books

1. Smith, R. H. (2013). *Plant tissue culture: techniques and experiments*. Academic Press.
2. Purohit S.D. (2007). *Molecular biology and biotechnology (A practical manual)*. Apex publishing house.