# CVM UNIVERSITY

## MASTER OF SCIENCE

## (APPLIED GENETICS)

### PROGRAMME

### Under Choice Based Credit Scheme

### Structure with Effect From: 2020-21

# M. Sc. Applied Genetics Programme Details

Postgraduation / Master degrees course in Applied Genetics offer advanced knowledge in developing and understanding mechanisms for genetic processes such as inheritance, mutation and variation. This knowledge is very much useful for the benefits of living organisms especially human and animals.

Students will learn to develop models for understanding genetic patterns, including practices such as bioinformatics and qualitative genetics. Students will explore issues such as gene therapy and cytogenetics, honing transferrable skills through practical activities including DNA sampling, experiment design, lab testing, fieldwork, and case studies.

The experience gained by the student will be utilized in various industries, including agriculture, Diagnostics, healthcare and biopharmaceuticals. Your expertise would make you suitable for consultancy for NGOs and private SMEs, or in public policy and as a genetic counselor. Students can also enter in research, developing new techniques for understanding biological processes at molecular level (Doctoral research).

## Programme Objectives (POs):

By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the student. The student will be instilled with values of professional ethics and be made ready to contribute to society as responsible individuals.

1. Knowledgeable persons in concerned subjects.
2. Qualified and employable candidates in careers related to teaching and research that require Post graduation.
3. Individuals with aptitude and skill in research.
4. Persons having innovative ideas and necessary training to initiate unique start-ups.
5. Young leaders who offer their service to the betterment of the community.

## Programme Specific Outcomes (PSOs):

Individuals having in-depth knowledge in different branches of Genetics. Employable candidates in careers related to teaching in Biology in universities and colleges. Individuals with aptitude and skill in research in different applied branches of Genetics as well as related disciplines. Persons

having innovative ideas and necessary training to initiate unique start-ups in molecular diagnostics and Genetic counselling.

At the end of the two year programme the student will acquires deep understanding of various aspects of applied genetics such as Mendelian genetics, population genetics, human genetics, animal and microbial genetics, etc,. The student will be equipped to take up a suitable position in academia or industry and to pursue a career in research if so desired.

## Programme Structure:

The M.Sc. Applied Genetics programme is a two-year course divided into four-semesters. A student is required to complete hundred credits for the completion of course and the award of degree. A student has to accumulate twenty-five credits in each of the four semesters.

| | | | |
|---|---|---|---|
| PART ONE | FIRST YEAR | SEMESTER - I | SEMESTER - II |
| PART TWO | SECOND YEAR | SEMESTER - III | SEMESTER - IV |

# Course Credit Scheme

## SEMESTER - I

| Course Type | Course Code | Name of Course | T/P | Credits | Exam Duration (Hrs) | Components of Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | Total |
| | | | | | | Total/ Passing | Total/ Passing | Total/ Passing |
| Core Course | 101440101 | Principles of Genetics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440102 | Bioanalytical Techniques and Instrumentation | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440103 | Cell Biology | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440104 | Lab -I (Practicals based on 101440101 and 101440102) | P | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440105 | Lab -II (Practicals based on 101440103 and Elective Any One) | P | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440106 | Comprehensive Viva | P | 1 | | | 50/20 | 50/20 |
| Elective Course | 101440107 | Fundamentals of Biochemistry and Bioenergetics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440108 | Model Organisms Genetics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440109 | Human Physiology | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440110 | Methods and Applications of Transgenic Plants | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| Total Credits | | | | 25 | | | | 650 |

# Course Credit Scheme

## SEMESTER- II

| Course Type | Course Code | Name of Course | T/P | Credits | Exam Duration (Hrs) | Components of Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | Total |
| | | | | | | Total/ Passing | Total/ Passing | Total/ Passing |
| Core Course | 101440201 | Cytogenetics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440202 | Basics of Microbial Genetics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440203 | Immunology | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440204 | Lab -I (Practicals based on 101440201 and 101440202) | P | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440205 | Lab -II (Practicals based on 101440203 and Elective Any One) | P | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440206 | Comprehensive Viva | P | 1 | | | 50/20 | 50/20 |
| Elective Course | 101440207 | Biostatistics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440208 | Forensic Genetics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440209 | Toxicology | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440210 | Population Genetics | T | 4 | 3 | 40/16 | 60/24 | 100/40 |
| Total Credits | | | | 25 | | | | 650 |

# Course Credit Scheme

## SEMESTER - III

| Course Type | Course Code | Name of Course | T/P | No. of Credits | Class/ Lab hrs per week | Exam Duration in hrs | Components of Marks | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Internal | External | Total |
| | | | | | | | Total/ Passing | Total/ Passing | Total/ Passing |
| Core Course | 101440301 | Human Molecular Genetics | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440302 | Gene Regulation and Genetic Engineering | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440303 | Genetics in Crop Improvement | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440304 | Lab I (Sub – I Human Molecular Genetics and Sub – II Gene Regulation and Genetic Engineering) | P | 4 | 6 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440305 | Lab II (Sub – I Genetics in Crop Improvement and Sub – II (Elective (Any One) Subject) | P | 4 | 6 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440306 | Comprehensive Viva | P | 1 | | | | 50/20 | 50/20 |
| Elective Course (Any 1) | 101440307 | Bioinformatics | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440308 | Advanced Immunology | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440309 | Cancer Genetics | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440310 | Omics and Computational Biology | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| Total Credits | | | | 25 | | | | | 650 |

# Course Credit Scheme

# SEMESTER – IV

| Course Type | Course Code | Name of Course | T/P | No. of Credits | Class/ Lab hrs per week | Exam Duration in hrs | Components of Marks | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Internal | External | Total |
| | | | | | | | Total/ Passing | Total/ Passing | Total/ Passing |
| Core Course | 101440401 | Dairy Animal Genetics | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440402 | Genetic Counselling | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440403 | Lab I (Sub – I Dairy Animal Genetics and Sub – II Genetic Counselling) | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440404 | Comprehensive Viva | P | 1 | | | | 50/20 | 50/20 |
| Elective Course | 101440405 | Dissertation | P | 25 | | | 40/16 | 60/24 | 100/40 |
| | | **OR** | | | | | 40/16 | 60/24 | 100/40 |
| | 101440406 | Genetics of Mammalian Development | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440407 | IPR and Biosafety | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| | 101440408 | Lab II (Sub – I Genetics of Mammalian Development and Sub – II IPR and Biosafety) | T | 4 | 4 | 3 | 40/16 | 60/24 | 100/40 |
| Total Credits | | | | 25 | | | | | 650 |

# Course Wise Content Details for M.Sc. (Applied Genetics) Programme

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - I
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440101: Principles of Genetics

**Course Objectives:**
The objectives of this course are to make students understand basic principles of Genetics. Genetic concepts provide the framework for the study of Modern Biology. The Science of genetics includes the rules of inheritance in cells, individuals and populations and the molecular mechanisms by which genes control the growth, development and appearance of organisms.

**Course Learning Outcomes:**
**Unit 1:** Students should be able to acquire basic knowledge on Mendelism (Laws of inheritance), Modes of inheritance and different types of crosses.

**Unit 2:** Students should be clear about various genetic interactions, dominance, multiple alleles and overview of mutations.

**Unit 3:** Students should understand the process of linkage, Crossing over and Chromosome mapping, Sex determination and sex linkage.

**Unit 4:** Student should know about transposable genetic elements and Extrachromosomal Inheritance as well as imprinting phenomena with examples.

## Contents:

**Unit-1: Mendelian Genetics, Deviation from Mendelism and inheritance of complex trait:**

- Introduction to genetics.
- Law of segregation, Independent Assortment, Monohybrid Cross, Dihybrid Cross, trihybrid Cross, Test cross, back cross.
- Complex patterns of inheritance, qualitative and quantitative traits, Inbreeding and resemblance between relatives, Genes and environment.
- Modes of inheritance.

**Unit-2 : Gene Interaction and Multiple Alleles:**

- Types of gene interactions, Molecular basis of gene interaction, Epistasis.
- Dominance: complete dominance, incomplete dominance, codominance, over-dominanace; Molecular basis of dominance.
- Lethal genes and their action, Pleiotropy.
- Multiple alleles: ABO blood groups in human, Rh blood group system, Fur colour in rabbits, characteristics of multiple alleles.
- Mutation: Classification, Methods of inducing mutations & CIB technique, mutagenic agents and induction of mutation.

**Unit-3 : Linkage, Crossing over and Chromosome mapping**

- Linkage, Crossing over
- Cytological basis of crossing over, Molecular mechanism of crossing over
- Chromosome mapping: two factor crosses, three factor crosses
- Chromosome maps.
- Sex determination and sex linkage: Mechanism of sex determination, Environmental factors and sex determination, molecular basis of sex determination, sex differentiation: *Chlamydomonas*, sex linked inheritance.

**Unit-4 : Transposable elements and Extrachromosomal Inheritance:**

- Types of transposable elements, structure, genetic organization.
- General mechanism of transposition.
- Criteria for extrachromosomal inheritance
- Cytoplasmic organelles and symbionts; maternal effects in snails, streptomycin resistance in *Chlamydomonas*.
- Mitochondrial mutations in yeast, Kappa particles in *Paramecium*.
- Plasmid inheritance in *Mirabilis jalpa*, male sterility in plants.
- Imprinting

**Reference Books:**


1. Strickberger M.W. Genetics. Third Edition. Prentice-Hall of India Pvt. Ltd, New Delhi, 2005. ISBN: 81-203-0949-9.
2. Emund W. Sinnot, L. C. Dunn & T. Dobzhansky. Principles of Genetics, Tata Mcgraw Hill Publishing Company Limited, New Delhi, ISBN: 978-0070994133.
3. P. K. Gupta, Genetics. Rastogi Publications, Meerut, India., ISBN: 81-7133-842-9.
4. Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. Eighth edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.
5. Klug W. S. & Cummings M. R. Concepts of Genetics. Seventh edition. Pearson Education. ISBN 81-317-0811-X.

6. Stent G. S. & Calendar R. Molecular Genetics: An Introductory Narrative. Second edition CBS Publishers and Distributors, New Delhi ISBN 81-239-0857-1.
7. Streips U. And Yasbin R. Modern Microbial genetics, Wiley-Liss, USA. ISBN: 0-471-38665-0.
8. Molay S., Cronan J. & Frifelder, D. Microbial Genetics Narosa Publishing House, New Delhi. ISBN: 81-7319-697-4.
9. Genetics by B. D. Singh

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - I
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440102: Bioanalytical Techniques and Instrumentation

**Course Objectives:**

The course will enable the students to understand the principle and working of visualization techniques, separation techniques, spectroscopic techniques for analysis of the samples and principles and applications of tracer techniques in biology. Principles and applications of different types of microscopy, principle & application of cytophotometry and flow cytometry, centrifugation, electrophoresis chromatography, spectroscopy, radioactivity, radiation counters, x-ray diffraction will be known to the students.

**Course Learning Outcomes:**

**Unit 1:** Deals with the knowledge of different types of microscopes such as Light microscope, Compound microscope, Dark field, Bright field, Stereo microscope, Confocal, Phase contrast microscope, Fluorescent microscope, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). It also deals with the principle and application of cytophotometry and flow cytometry.

**Unit 2:** Enrich the concept and application for separation of molecules by different types of centrifugation techniques. Knowledge of separation by horizontal and vertical gel electrophoresis is also anticipated. The separation of molecules by different types of chromatographic techniques will be learnt.

**Unit 3:** Explore the consideration of principle and analysis of samples by different spectroscopic techniques such as UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence, CD spectroscopy etc. will be learnt.

**Unit 4:** Gather the concept of radioactivity autoradiography, different types of counters used to trace the radiation will be studied. The principle and application of x-ray diffraction methods to study the structure of biopolymer will be known.

## Contents:

**Unit I**

**Visualization techniques:**

Principle of working and applications of bright field & dark field microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy. Principle and applications of cytophotometry and flow cytometry.

**Unit II**

**Separation techniques:**

Basic principle and application of analytical and preparative centrifugation, settling time & velocity, types of rotor, sedimentation coefficient, relative centrifugal force (RCF) differential, density and ultracentrifugation.

Principle and applications agarose and 2D gel electrophoresis. Capillary electrophoresis and its applications. Native-PAGE, SDS-PAGE

Principle, methodology and applications of gel–filtration, ion–exchange and affinity chromatography; Thin layer and High-Performance Thin Layer Chromatography. Gas chromatography, High performance liquid chromatography and FPLC.

**Unit III**

**Spectropscopy**

Basic principle of electromagnetic radiation, instrumentation and applications of UV, Visible, IR (including FTIR and ATR), AAS, NMR, Mass, MALDI-TOF, fluorescence and CD spectroscopy.

**Unit IV**

**Principle and applications of tracer technique in biology:**

Concept of radioactivity, rate of radioactive decay; units of radioactivity- uses of radioisotopes in life sciences and biotechnology; autoradiography; cerenkov radiation; radiation dosimetry; ionization and scintillation-based detection of radioactivity.

Principle of biophysical methods used for analysis of biopolymer structure: X-ray diffraction.

**Reference Books:**


1. Instrumental method of chemical analysis: Sharma B K
2. Instrumental methods of analysis: D A Skoog
3. An introduction to practical Biochemistry: Plummer
4. Instrumentation: Chatwal and Anand
5. Modern experimental Biology: Boyer

6. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
7. Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th ed. Cambridge Univ. Press, 2000.
8. West & Todd. Biochemistry. 4th ed. Oxford and IBH.
9. Horst Friebolin. Basic One and Two-dimensional spectroscopy. VCH Publ, 1991.
10. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st ed. Wiley-Liss, 2001.
11. R. Marimuthu – Microscopy and Microtechnique, MJP Publishers, 2015.

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - I
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440103: Cell Biology

**Course Objectives:**

The major objective of this paper is to develop clear understanding of various aspects of cell biology along with diverse metabolic pathways existing at cellular level in relation to survival and propagation. This course enables the students to understand the structure and function of cell organelles, protein transport mechanism, intracellular signalling mechanism and acquainted with cell cycle, its regulation and apoptosis.

**Course Learning Outcomes:**

**Unit 1**: The students will understand the evolution of the cell, Cell as a unit of living organisms. They will learn structural details of prokaryotic and eukaryotic cells, their cell wall, cell membrane and other outer appendages.

**Unit 2**: The students can gain knowledge for molecular organization of Mitochondria, Chloroplast. Will know the ultrastructure and functions of Nucleus, Endoplasmic reticulum, Golgi complex, Lysosomes and other microbodies. They will also gain the knowledge of Protein sorting: organelle biogenesis and protein secretion, synthesis and its intracellular traffic, vesicular traffic in the secretary pathways

**Unit 3:** Will get the information for cytoskeleton topography which include the role of Microtubule and its dynamics, motor proteins, Microfilament and its functions, Intermediate filaments and their functions, Cilia and centrioles

**Unit 4:** Will be acquainted with overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, checkpoints in cell cycle regulation and signalling pathways which regulate apoptosis process

## Contents

**Unit I**

**The origin and Evolution of cells**: Evolution of metabolism, Diversity of cell size and shapes, Structure of Prokaryotic and Eukaryotic cells, Single cell to multicellular organism

**The Structure of cell membrane:** The fluid Mosaic Model, Membrane lipids and Proteins, The Glycocalyx, Transport across plasma membrane.

**Endocytosis:** Phagocytosis and Receptor mediated endocytosis)

Cell walls and extracellular matrix & Cell Matrix Interactions

**Cell-Cell interactions:** Adhesion protein, Tight junctions, gap junctions and plasmodesmata.

**Unit II**

**Cell Organelles:** Molecular organization of Mitochondria, Chloroplast, Ultrastructure and Functions of Nucleus

**Molecular Organization and functions** of Endoplasmic reticulum, Golgi complex, Lysosomes (Protein sorting and transport, Types of vesicular transport and their functions), Microbodies: Peroxisomes, Ribosomes.

**Unit III**

**The cytoskeleton:** The nature of cytoskeleton, Intermediate filaments, Microtubules: Organization of tubules, assembly and organization within the cells, microtubule motors and movements, cilia and flagella: structure and function.

**Cell signalling:** Signalling molecules and their receptors, Functions of cell surface receptors, pathways of intracellular signal transduction, signal transduction and cytoskeleton.

**Unit IV**

**Cell growth and division**: Overview of the Cell cycle and its control, the molecular mechanisms for regulating mitotic events, Cell cycle control in mammalian cells, Checkpoints in cell cycle regulation, regulators of cell cycle progression-MPF, cyclins and CDKs, Inhibitors of cell cycle progression; M-phase and cytokinesis.

**Programmed Cell Death:** Difference between necrosis, apoptosis and necroptosis, Caspases, Central regulators of apoptosis (Bcl-2 family), signalling pathways that regulate apoptosis.

**Reference Books:**

- The cell: A molecular approach-Geoffrey M Cooper and Robert E. Hausman
- Cell Biology-Karp
- Molecular Biology of the cell- Alberts
- Molecular Cell Biology-Lodish et al.

# CHARUTAR VIDYAMANDAL UNIVERSITY
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# SEMESTER - I
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440107: Fundamentals of Biochemistry and Bioenergetics

**Course Objectives:**

The major objective of this paper is to develop clear understanding of various aspects of biochemistry which includes properties of biomolecules, their metabolism and regulation. This course content enables students to better understand concept of bioenergetics and its importance in cellular metabolism. Moreover, useful to understand key role of water in metabolism which maintain acid base equilibrium at cellular level as well as an importance of physiological buffers.

**Course Learning Outcomes:**

**Unit 1**: Will have learnt carbohydrates, their types and properties. Further, will be acquainted with central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions.

**Unit 2**: Understands types of amino acids and their properties. Moreover, will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains. Will understand biochemical basis of nucleotides and its metabolism.

**Unit 3**: Will understand details of lipid, its metabolism and regulation along with biochemical basis of lipid accumulation at cellular level.

**Unit 4**: Will have learnt basic concepts of bioenergetics and its importance in cellular metabolism. The students will be aware with different electron carriers compounds and their role in ATP generation. Moreover, gain in depth knowledge of Water and Acid-Base Equilibrium.

## Contents:

**Unit I**

**Carbohydrates and Glycobiology:** Monosaccharide - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides).

**Carbohydrate metabolism:** Glycolysis, Gluconeogenesis, PP Pathway, Citric acid cycle- steps involved, amphibolic nature, anaplerotic reactions, Coordinated regulation of glycolysis and gluconeogenesis, Glycogen synthesis

**Unit II**

**Amino acids:** Structure of amino acids, physical, chemical and optical properties of amino acids, Classification of amino acids, Peptides and Proteins, Secondary, tertiary and Quaternary structure of proteins

**Protein metabolism:** Nitrogen metabolism, Biosynthesis of amino acids, molecules derived from the amino acids, amino acid oxidation and production of urea

**Nucleotides and Nucleic acids:** Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry – UV absorption, effect of acid and alkali on DNA.

**Nucleotides metabolism:** Biosynthesis and Degradation of Nucleotides

**Unit III**

**Lipids -** fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes, Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids, Lipids as signals, cofactors and pigments

**Lipid Metabolism:** Biosynthesis of fatty acids, Triacylglycerol, membrane lipids and cholesterol, Fatty acid catabolism

**Unit IV**

**Bioenergetics:** The laws of thermodynamics, concept of entropy and free energy; ATP synthesis and hydrolysis, Biological oxidation: oxygenases, hydrolases, dehydrogenases, free energy changes and redox potentials, Gibbs energy

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization, ATP- synthetase complex, Chemiosmotic theory of Energy Coupling, Inhibitors of ETC

**Water and Acid-Base Equilibrium:** Ionization of Water, Weak Acids, and Weak Bases, buffering against pH Changes in Biological Systems: Henderson and Hassebach equation, Buffers and their importance, pKa of amino acid and their relevance, Importance of discontinuous buffer system used in SDS PAGE, Water as a Reactant

**Reference Books:**


- Lehninger's Principles of Biochemistry: D. L. Nelson and M. M. Cox, Macmillan, Worth Pub. Inc., NY.
- Chemistry of Biomolecules by S. P. Bhutani, Ane Books Pvt. Ltd. CRC Press
- Biochemistry: Lubert Stryer WH Freeman & Co., NY.
- Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford.
- Text book of Biochemistry with clinical correlations by Delvin.


# CHARUTAR VIDYAMANDAL UNIVERSITY
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# SEMESTER - I
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440108: Model Organisms Genetics

**Course Objectives:**

The basic principles of genetics have been elucidated largely by studies using a small number of species: from the peas used by Mendel to more recent examples such as the zebrafish. In this course highlights many of these key species that have become model organisms, including the yeast (*Saccharomyces cerevisiae*), the nematode (*Caenorhabditis elegans*), the fruit fly (*Drosophila melanogaster*), and the mouse (*Mus musculus*). Students should know Why were these species chosen to study genetics? What important findings in genetics have these studies yielded? How do you 'do' genetics in these model systems? How can experiments with these species help us to understand the basis of human genetic disease?

**Course Learning Outcomes:**

**Unit 1:**

Students should know various Model systems in Genetic analysis.

**Unit 2:**

Student should understand life cycle and Genetic techniques associated with *C. elegans*.

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**Unit 3:**
Highlights advantages and Life cycle of Arabidopsis and mouse

**Unit 4:**
Gains knowledge about life cycle and advantages of *Saccharomyces cerevisiae*.

**Contents:**

**Unit I**
Model systems in Genetic Analysis: Bacteriophage, *E. coli, Neurospora crassa*, yeast, Arabidopsis, maize, Drosophila, *C. elegans*, Zebra fish, *Homo sapiens*- General outline of life cycle, importance in Genetic analysis.
The Fruit Fly *Drosophila melanogaster*: Introduction, Advantages of *D. melanogaster* as a model genetic organism.
The Bacterium *Escherichia coli* : Advantages of *E. coli* as a model genetic organism, The *E. coli* genome, Life cycle of *E. coli*, Genetic techniques with *E. coli.*
**Unit II**
The Nematode Worm *Caenorhabditis elegans*: Advantages of *C. elegans* as a model genetic organism, Life cycle of *C. elegans*, The *C. elegans* genome, Genetic techniques with *C. elegans*.
**Unit III**
The Plant *Arabidopsis thaliana*: Advantages of Arabidopsis as a model genetic organism, The Arabidoposis genome, Life cycle of Arabidopsis, Genetic techniques with Arabidopsis,
The Mouse *Mus musculus*: Advantages of the mouse as a model genetic organism, Life cycle of the mouse, The mouse genome, Genetic techniques with the mouse.
**Unit IV**
The Yeast *Saccharomyces cerevisiae*: Advantages of yeast as a model genetic organism, Life cycle of yeast, The yeast genome, Genetic techniques with yeast.
Functional genomics and animal models in human disease: An overview; cDNA/gene cloning; site-directed mutagenesis; mammalian tissue culture; cell line transfections; functional assays; Use of model organisms, methods for generation of transgenic animals/ knock in, knock out models (microinjection, ES cell transformation); mutagenesis; RNAi approach; Some examples.

**Reference Books:**

Genetics: A Conceptual Approach, 4 th Edition by Benjamin A. Pierce, ISBN-13: 978-1-

4292-3250-0.

Strickberger M.W. Genetics. Third Edition. Prentice-Hall of India Pvt. Ltd, New Delhi, 2005. ISBN: 81-203-0949-9.

Emund W. Sinnot, L. C. Dunn & T. Dobzhansky. Principles of Genetics, Tata Mcgraw Hill Publishing Company Limited, New Delhi, ISBN: 978-0070994133.

P. K. Gupta, Genetics. Rastogi Publications, Meerut, India., ISBN: 81-7133-842-9.

Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. Eighth edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.

Klug W. S. & Cummings M. R. Concepts of Genetics. Seventh edition. Pearson Education. ISBN 81-317-0811-X.

Stent G. S. & Calendar R. Molecular Genetics: An Introductory Narrative. Second edition CBS Publishers and Distributors, New Delhi ISBN 81-239-0857-1.

Streips U. And Yasbin R. Modern Microbial genetics, Wiley-Liss, USA. ISBN: 0-471-38665-0.

Molay S., Cronan J. & Frifelder, D. Microbial Genetics Narosa Publishing House, New Delhi. ISBN: 81-7319-697-4.

Genetics by B. D. Singh

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - I
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440109: Human Physiology

**Course Objectives:**

The goal of this course is to develop understanding for the fundamental concepts of physiology of nutrition and digestion. To Develop understanding of blood vascular system. Develop the fundamental concepts of physiology of respiration. Develop basic understanding of nervous system and its interactions with other systems. Familiarize students with renal physiology and reproductive systems.

**Course Learning Outcomes:**

**Unit 1:** Student will be able to know about the nutrition and types of foods. They will understand metabolism of carbohydrates, proteins and lipids and students will enable to understand the digestion and absorption of these components. Students will also know about the types, properties and contraction relaxation process in muscles tissue.

**Unit 2:** Student will be able to learn the physiology of respiration i.e. exchange of respiratory gases, transport of respiratory gases in blood and overview of respiratory disorders. Students will also learn circulatory system, components of blood, blood clotting mechanism and about the types of blood groups.

**Unit 3:** To understand the organisation of nervous system, structure and types of neurons. Student will be able to understand the signal transmission, membrane potential and synapses. Students will learn about neurotransmitters and overview of disorders of nervous system.

**Unit 4:** Understanding for Excretory system; ultrafiltration, reabsorption and secretion as transport mechanisms involved in urine formation. Understand the role of kidney in body water, electrolyte and acid-base balance. Student will enable to understand the physiology of reproductive system. Hormonal regulation of female reproductive cycle. Student will able to understand the Birth control methods.

**Unit I:**

**Physiology of Nutrition and Digestion:** The essential nutrients, types of food, vitamins, minerals, water and the concept of 'balanced diet'. An overview of human digestive tract. Physiological role of digestive juices. Digestion and absorption of carbohydrates, proteins and fats, Neural and endocrine regulation of gastro-intestinal movement and secretion.

**Physiology of Muscular System:**

An overview of the muscular tissue: types of muscle tissue, properties and functions of the muscle tissues. Skeletal muscle tissue and types. Contraction and relaxation processes and metabolism of skeletal muscle fibres.

**Unit II:**

**Physiology of Respiration:** An overview of human respiratory system, Respiratory movements and the exchange of respiratory gases at pulmonary surfaces, Neural and humoral control of respiration. Transport of respiratory gases in blood

**Physiology of Circulation:** An overview of human circulatory system. The myogenic heart. Pacemaker system and conducting fibers, Neural, humoral and pharmacological regulation of cardiac amplitude and frequency, Cardiac cycle, cardiac output, blood pressure and regulation, Blood-components and functional significance. Blood coagulation and factors involved in coagulation. Haemopoiesis and blood groups, Lymph- composition and dynamics.

**Unit III:**

**Physiology of Nervous System:** An overview of the human nervous system and organization. Structure of neuron, types of neurons, neuralgia, myelination. Electrical signals and signal transmission. Membrane channels, resting and action potentials, propagation of nerve impulses, synapses and types, synaptic knobs and synaptic potentials. Neurotransmitters: Physiological role of acetyl choline, aminoacids, GABA, catecholamines, nitric oxide and neuropeptides. General properties of sensory receptors, chemical senses, hearing and vision.

**Unit IV:**

**Physiology of Excretory Systems:** An overview of human urinary system. The functional anatomy of human kidney and the functional units. Ultrafiltration, reabsorption and secretion as transport mechanisms involved in urine formation. Physiological roles of aldosterone, anti-diuretic hormone and renninangiotensin system in renal functions.

**Physiology of Reproductive Systems:** An overview of organization of human male and female reproductive systems. Histological features of male and female gonads. The process of gametogenesis (spermatogenesis and oogenesis). Phases and hormonal regulation of female reproductive cycles. Birth control: Physiology of birth control methods.

**Reference Books:**


- Animal physiology by Verma, Tyagi and Aggarwal, Pub. S. Chand & Company Ltd. New Delhi. ISBN-81-219-0351-3.
- A textbook of Animal physiology by A. K. Berry, Emkay Publications, Delhi. ISBN-81-85712-03-4.
- Animal physiology by Mohan P. Arora, Himalaya publishing House. ISBN-81-7866-723-1.
- Animal physiology by Goyal and Shastry, Rastogi Publications. ISBN-81-7133-864-X.
- Tortora, G. J.: Principles of Anatomy and Physiology. John Wiley & Sons,Inc.
- Guyton, A.C and Hall J.E.: Textbook of Medical Physiology. W.B.Saunders Co. Philadelphia.
- Chatterjee, C.C.: Human Physiology (Vol. I, II, III). Medical & Allied Agency.
- James A. Wilson: Principles of Anatomy and Physiology. Macmillan Publishing Co.


# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - I
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440110: Methods and Applications of Transgenic Plants

## Course outline:

These topics would be taught with emphasis on going methods and applications of genetics manipulation in plants and crops. Through the use of transgenics, one can produce plants with desired traits and even increased yields. After being introduced to the topics students will cover 'methods available for plant transformation through *Agrobacterium* mediated. Students will also study about the role of precise genome modification in crops, role of vectors and markers in gene expressions. The students are expected to read, research and discuss papers related to the topics.

**Unit I**
Students should get information about various methods of plant transformation.

**Unit II**
Highlights different methods for Precise genome modification in crops.

**Unit III**
Students should know Vectors, promoters and markers used in Transgenic plants

**Unit IV**
Provides information related to characterization of transgenic plants, Applications of plant transgenic technology

## Contents:

**Unit I**
**Methods of plant transformation:** Genetic modification by plant breeding versus genetic engineering, stable and transient transformation, *Agrobacterium tumefaciens* and *Agrobacterium rhizogenes* mediated transformation, microprojectile bombardment, agrolistics, in-planta transformation.
**Unit II**
**Precise genome modification in crops:** Transformation by homologous recombination, gene editing nucleases, site specific recombination using zinc-finger nucleases, chloroplast transformation and maternal inheritance, gene containment.

**Unit III**
**Vectors, promoters and markers used in Transgenic plants:** Constitutive, tissue-specific and inducible promoters, deletion analysis, isolation of promoter, transcription initiation site determination, selectable and screenable markers, marker free transgenics.

**Unit IV**
**Characterization of transgenic plants**: Screening of transformants- copy number determination, expression of transgene at RNA and protein level, analysis of metabolites using biochemical methods, homozygosity of transformants in progeny, position effect, transgene silencing, field trials and risks, global status of GM crops, regulatory committee.

**Applications of plant transgenic technology**:Transgenic crops for resistance against biotic and abiotic stresses. Engineering crops for male sterility and modification of flower colour, flowering, fruit ripening and senescencec. GM crops for nutritional quality and quantity.Molecular pharming; Metabolic engineering and hairy root culture for secondary plant products; Global status and biosafety of transgenic plants.

**Reference Books**


- Ashwani Kumar and Sudhir K Sopory. “Recent advances in plant biotechnology and its applications” I.K. international publishers, 2008
- Adrian Slater, Nigel W. Scott, Mark R. Fowler. “Plant biotechnology:the genetic manipulation of plants” Oxford University Press, 2008.
- Ramalingam Sathiskumar, Sarma Rajeev Kumar and Jagdeesan Hema. Advances in Plant Transgenics: Methods and Applications. Springer Nature Singapore Pte Ltd.2019. ISBN 978-981-13-9623-6.
- Sandeep Kumar, Pierluigi Barone, Michelle Smith. Transgenic Plants: Methods and Protocols.Springer New York, 2018.ISBN- 1493987771, 9781493987771.
- Hau-Hsuan Hwang, Stanton B. Gelvin. Agrobacterium biology and its application to transgenic plant production.Published In: Frontiers in Plant Sciences and Frontiers in Microbiology.ISSN-1664-8714.
- Hammond, J., McGarvey & Yusibov, V. (Eds.). 2000. Plant Biotechnology- New Products and Applications. Springer-Verlag, Heidelberg, Germany. Joyner, A.L.2000. Gene Targeting - A Practical Approach. Oxford University Press, Oxford.

- Molecular Cloning: A Laboratory Manual (Cold Spring Harbor)-M. R. Green, J. Sambrook.
- An Introduction to Genetic Engineering-Desmond S.T. Nicholl-Cambridge University Press.
- Principles of Gene Manipulation and Genomics-SandyB. Primrose, Richard Twyman-7th Edition; Blackwell Publishing.
- Gene Cloning and DNA Analysis: An Introduction-T. A. Brown-John Wiley & Sons.
- Principles of Plant Breeding, Allard RW –Wiley.

## 101440104: Lab – I (Practicals based on 101440101 and 101440102)

**List of Practicals**

1. Basic laboratory rules, hazards and first aid
2. Introduction to pH, buffer preparation, molar, normal and percent solutions.
3. Calculations for making stock solution
4. Demonstration of Barr bodies
5. Problems based on Mendelian genetics
6. To solve the problems related to Mendelian genetics
7. DNA estimation by DPA method
8. RNA estimation by orcinol method
9. Isolation of chromosomal DNA
10. To solve the problems related to Mendelian genetics
11. Separation of proteins by PAGE
12. Separation of amino acids by TLC
13. Separation of cells by density gradient centrifugation
14. Determination of partition coefficient

## 101440105: Lab – II (Practicals based on 101440103 and Elective Any One)

**List of Practicals**

1. Study of Cell structure (Eukaryotic & Prokaryotic)
2. Study of Meiosis and Mitosis
3. Estimation of Reducing Sugar in Jaggery by Cole's Method
4. Estimation of Protein by Folin-Lowry Method
5. Estimation of Reducing Sugar by DNS Method
6. Total Sugar Estimation by Phenol Sulphuric acid estimation
7. Estimation of RNA by Orcinol Method
8. Localization of Cell Organelle and Determination of Chlorophyll and Carotenoids
9. Estimation of Amino Acid (Proline)
10. Estimation of Amino Acid (Methionine from Food Grains)

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - II
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440201: Cytogenetics

**Course Objectives:**

Cytogenetics is the study of chromosome, via microscopic analysis of the karyotype. This paper will include theory and techniques in human chromosome analysis. Methods used to identify and analyse individual cytogenetic alterations: banding and nomenclature of banding, Pathology of human chromosomes: nomenclature of aberrant karyotypes; Common syndromes due to numerical chromosome changes; Common syndromes due to structural alterations translocations, duplications, deletions, microdeletion, fragile sites; Common chromosome abnormalities in cancer, Fluorescent in situ hybridization (FISH).

**Course Learning Outcomes:**

**Unit 1.** Is able to describe the cell division and various staining and banding techniques for the identification of human chromosomes. It also describes advance methods for chromosomal analysis.

**Unit 2.** Understand and investigate the cause and effect of chromosome abnormalities and associated human diseases. Students should be able to diagnose and interpret pathology of human chromosomes (chromosome aberrations, trisomy, rearrangements etc.).

**Unit 3.** Understands theoretical and practical aspects of cancer, pregnancy and cell lines.

**Unit 4.** Is able to describe various applied aspects of cytogenetics in plants, dairy animals and human.

## Contents:

**Unit I**

**Introduction, chromosomal staining, banding and FISH techniques:** An over view of Cell cycle, Mitosis and Meiosis, Global structure of Chromosomes, ISCN nomenclature system
Image Analysis System: Charge-coupled device cameras, Image analysis Systems.
Interpretation and reporting of chromosomal analysis Conventional staining (Giemsa and aceto-orcein), Giemsa banding, Quinacrine banding, Constitutive heterochromatin banding Reverse banding, Nucleolar organizing region staining
Sister chromatid exchange Miscellaneous/Other banding Techniques. Applications of fluorescence *in situ* hybridization to chromosome analysis Latest techniques- Fiber FISH, Spectral karyotyping and Chromosomal painting (WCP & PCP).

**Unit II**

**Cytogenetics:**

Collection , transport and storage of samples for cytogenetic analysis Morphology and classification of human chromosomes

Numerical chromosomal aberrations (Aneuploidy and Euploidy)

Structural chromosomal abnormalities (Translocations, Inversions, Deletions, Insertions Duplications, Dicentric and sochromosomes, Ring chromosomes, Chromosomes breaks, gaps and fragile sites, Marker chromosomes).

**Unit III**

**Cytogenetics of pregnancy, cancer and cell lines:**

Lymphocyte culture, Amniotic fluid cell culture,

Chorionic villus culture, Establishing fibroblast culture,

Cytogenetic analysis of human sperm, oocyte and embryo,

Chromosomal abnormalities in malignant disease (CML, AML, ALL etc.), Cytogenetic characterization of various cell lines.

**Unit IV**

**Applications of cytogenetics in Humans, Domestic animals & Plants**

**Humans:**

Individual with clinical features of Genetic diseases during the following: (Embryonic period, Neonatal period, During early childhood level, During puberty and secondary sexual development, During adulthood, During infertility or reproductive failure)

**Domestic animals:** Normal chromosomal complements in cattle, buffalo, sheep, goat, horse, pig, cat, dog and poultry; Importance of cytogenetic investigations in domestic animals.

**Plants :** Role of cytogenetics in plants, Types of polyploidy, Artificial induction of polyploidy in plants, Polyploidy in Triticum spelta, Gossypium hirsutam and Triticosecale wittmack, Phenotypic effects of polyploidy.

**Genotoxicity testing.**

**Reference Books:**


- Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P S Verma and V K Agraval (Multicolour/14th Edition) Published by S. Chand and company Ltd., New Delhi (ISBN: 81-219-2442-1).
- Human Cytogenetics: Constitutional analysis by D. E. Rooney. Oxford University Press. New York (ISBN: 0-19-96384-3 (Hbk.)).
- Essential of Human Genetics (4th edition) by S. M. Bhatnagar, M. L. Kothari and L. A. Mehta (ISBN: 81-250-1426-8).
- Genetics in Medicine (3rd Edition) by Thompson and Thompson, W B Saunders and company, West Washington square, Philadelphia, PA-19105 (ISBN: 0-7216-8857-8).
- Genetics (2nd Edition) by Jan M Friedman, Fred J Dill, Michael R Hayden and Barbara
- McGillivray, B I Waverly Pvt. Ltd., New Delhi, Noida, U.P. (ISBN: 81-7431-025-8).
- Essential of Modern Genetics by V C Shah. Nirav Prakashan, Ahmedabad.
- Cytogenetics in Animal reproduction by W. C. D. Hare and Elizabeth L. Singh, published by Commonwealth Agricultural Bureaux (ISBN: 0 85198 444 4)
- The AGT Cytogenetics Laboratory Manual Barch, Margaret J. / Knutsen, Turid./ Spurbeck, Jack L. (eds.) 3rd edition, Lippincott_raven Publishers, Philadelphia, 1997 ISBN 0-397-51651-7 (New updated edition is about to release)

- Human Cytogenetics: Malignancy and acquired abnormalities. A Practical Approach. 3rd edition, Oxford University Press, 2001, ISBN 1-19-963842-X (Hardback) / ISBN 1-19-963841-1 (Paperback).
- Verma, Ram S. / Babu, Arvind, Human Chromosomes, Principles and Techniques 2nd edition, Mc Graw-Hill, Inc., New York, 1995, ISBN 0-07-105432-4
- Hema Purandare & Amit Chakravarty, Bhalani Publishing House, Mumbai. Human Cytogenetic Techniques & Clinical Applications, 2000, ISBN 81 85578 41 9
- Lisa G. Shaffer, Marilyn L. Slovak, Lynda J. Campbell. International System for Human Cytogenetic Nomenclature: ISCN 2009, S. Karger Publishers, ISBN 978-3-8055-8985-7
- Borgaonkar, Digamber S., Chromosomal Variation in Man: A Catalog of Chromosomal Variants and Anomalies 8th edition, Wiley-Liss, New York, 1997, ISBN 0-471-24332-9


# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - II
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440202: Basics of Microbial Genetics

**Course Objectives:**
The objectives of this course are to take students through basics of microbial genetics covering different types of mutations, plasmid biology, prokaryotic genetics and agrobacterium genetics. On covering the course the student will be exposed to concepts of mutation, DNA damage and repair, plasmid biology, microbial and phage genetics.

**Course Learning Outcomes:**
**Unit 1**: Students will know that genome is transient and mutation keeps on happening. They will know the types mutation and different mechanisms involved in their repair.

**Unit 2**: Students should be clear about types of plasmids, their compatibility regulation of copy number and segregation. Students will also learn about phage genetics and recombination.

**Unit 3**: Students should have understood the types and process of transformation, conjugation and transduction at the end of this unit

**Unit 4**: Here student should have learnt Agrobacterium genetics, types of restriction modification systems and different types of transposable elements.

## Contents:

**UNIT -1**

**Mutation, DNA damage and Repair**

Spontaneous mutations (Random v/s Adaptive nature of mutation; Mutation rate and its determination, Types of DNA damage and their consequences (spontaneous and chemical induced deamination, radiation induced DNA damage, loss of nitrogen bases, alkylation, intra and inter strand cross linking) , DNA repair pathways (Mis-match repair in prokaryotes and eukaryotes, Nucleotide excision repair in prokaryotes and in eukaryotes, base excision repair, recombinational repair, SOS pathway, specific repair of oxidative DNA damage, repair of pyrimidine dimers, repair of alkylation induced damage and adaptive response and other specific repair mechanisms).

**UNIT –II**

**Plasmid Biology, Phage Genetics & Recombination**

Types of plasmids, compatibility, regulation of plasmid copy number & plasmid segregation

T-series, complementation and Fine structure analysis, biology of lambda phages.

Types of recombination, Different models of recombination, Molecular mechanism of homologous recombination in eukaryotes, Mating type switching, Site specific recombination and its biological significance.

**UNIT -III**

**Genetic exchange in prokaryotes**

Natural transformation in *Bacillus subtilis*, Transformation by inducing artificial competence, Gene linkage and mapping by transformation.

Generalized transduction in T4 bacteriophage, Specialized transduction, homologous recombination with recipient's chromosome, measuring transduction (co-transduction of markers, marker effects, abortive transduction, transduction of plasmids). Applications of transduction.

F-factor mediated Conjugation in *E. coli*, Hfr conjugation and chromosomal transfer, F-prime conjugation and merodiploids, Conjugation of fertility inhibited F-like plasmids, Non conjugative mobilizable plasmids, chromosomal mobilization of non-F plasmids, Interrupted mating and conjugational mapping.

**UNIT-IV**

**Agrobacterium genetics, Restriction Modification Systems, Transposable Elements**

Ti plasmid, Interkingdom gene transfer (Key early experiments, vir regulon, protein secretion apparatus, conjugation model of T-DNA transfer, Integration products)

Types of RM systems, Role of RM systems, salient features and insights into evolution of diverse types of Restriction endonucleases and Methyl transferases, Regulation of RM systems.

Types of bacterial transposable elements; Structure, genetic organization and mechanism of transposition of Tn5, Tn3, phage Mu, Tn7, IS911, Integrons, Retrotransposons, conjugative and mobilizable transposons, Assays of transposition.

**Reference Books**


1. Lewin's Genes X: Jocelyn E. Krebs
2. Molecular Biology of the Gene 6th Edition-Watson et al.
3. Modern Microbial Genetics 2nd Edition-Uldis Streips and Ronald Yasbin
4. Microbial genetics 2nd Edition-Stanley Molay, John Cronan and David Freifelder.
5. Molecular Genetics of Bacteria 3rd Edition-Snyder and Champness.
6. Molecular Genetics: An Introductory Narrative 2nd Edition-Stent and Calender
7. Principles of Genetics 6th Edition- Snustad and Simmons
8. Molecular Biology of the Cell 5th Edition-Alberts et al.


# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - II
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440203: Immunology

**Course Objectives:**

The objective of this course is to understand various components of the host immune system; their structure, organization and role in defence mechanism. The student will gain knowledge to understand the operational mechanisms which underlie the host defence system. It would make them clear to understand genetic organization and expression of receptors to show immune response. They will also learn the role of immune system in health and diseases.

**Course Learning Outcomes:**

Upon successful completion of the course, the student will learn:

**Unit 1:** Will be able to understand the types of immunity and basic components of immune system; the role played by complement system as an interface between innate and adaptive immunity.

**Unit 2:** Will be able to understand the genetic organization of the genes meant for expression ofimmune cell receptors and the basis of the generation of their diversity. The principle of antigen-antibody interactions and methods to measure them will become clear to students.

**Unit 3:** Will be able to understand the importance of MHC molecule in an individual's immunity to various antigens, the mechanism of antigen processing and presentation. They will be able to understand the mechanism of B and T cell activation and memory generation.

**Unit 4:** The students will gain knowledge about the mechanism of cell mediated immunity.

They will learn about the cytokines, important biopharmaceuticals and their role in modulation of immune response. The students will also learn how body shows different kinds of immune response to different infections.

## Contents:

**Unit I**

- Immunity: Innate and Adaptive, Cells of the Immune system: Haematopoiesis and its regulation
- Cells and organs of the immune system: Primary and secondary lymphoid organs
- Induced Innate immunity: receptors of the innate immunity (TLR and sensing of PAMPs, CLR,RLR and CLR); Inflammatory responses, Natural Killer cells
- Antigens: Immunogenicity versus antigenicity, Epitopes, Haptens.
- Complement system: The Major Pathways of Complement Activation: Classical, alternative and lectin complement pathways, functions of complement, regulation of complement, complement deficiencies, microbial complement evasion strategies

**Unit II**

- Antibody: Structure of immunoglobulin; classes of immunoglobulins, Signal transduction pathways emanating from the BCR
- The Organization and Expression of Lymphocyte Receptor Genes: Hozumi and Tonegawa's Experiment, Multigene organization of Ig Gene, Mechanism of VDJ recombination, B cell receptor expression: Allelic exclusion,B cell isotype switching and somatic hypermutation; expression of membrane bound and soluble immunoglobulin; T cell receptor genes and expression
- Basics of Antigen-antibody interactions: Immunoprecipitation and agglutination based techniques, Methods to determine affinity of antigen-antibody interactions, Immunofluroscence, FACS

**Unit III**

- The Major Histocompatibility Complex and Antigen Presentation: The structure and function of MHC molecules, general organization and inheritance of MHC genes, The role and expression Pattern of MHC, Endogenous and exogenous pathway of antigen processing and presentation; presentation of non-peptide antigens.
- B Cell activation: T dependent and T independent B cell responses and memory generation
- T Cell activation: Two signal hypothesis, superantigens, activation and differentiation of T cell into effector and memory cells.$T_H1$ and $T_H2$ responses.

**Unit IV**

- Cell mediated effector response (Generation of effector CTL's, Granzyme and Perforin Mediated Cytolysis, Fas-FasL Mediated Cytolysis, NK cell mediated cytolysis
- Cytokines: properties, receptors, associated diseases, therapeutic applications, cytokine signalling pathways: JAK-STAT and FAS-FASL signalling pathways
- Immune response to infection by viruses, bacteria, fungi and parasite: Mechanism of Immune response and evasion by pathogen

**Reference Books**


1. Owen, J. A., Punt, J., &Stranford, S. A. (2013). ***Kuby immunology*** (7thEdn). New York: WH Freeman.
2. Murphy, K., & Weaver, C. (2016). ***Janeway's immunobiology*** (9thEdn) Garland Science.
3. Male, D., Brostoff, J., Roth, D., &Roitt, I. (2012). ***Immunology***(8thEdn) *With STUDENT CONSULT Online Access*. Elsevier Health Sciences.
4. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). ***Cellular and molecular immunology*** (6thEdn) Elsevier Health Sciences.
5. Relevant review articles / research papers / handouts of latest development in the subject.


# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - II
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440207: BIOSTATISTICS

**Course Objectives:**

The course aims to develop competency and expertise in the application of statistical methods applied to biological data obtained in experimental techniques.

**Course Learning Outcomes:**

**Unit 1:** Student will be able to know about basic terms and use in biostatistics. They will understand types of data, their organisation and various graphical representation methods to represent data, and will enable students to understand the basic statistics and its importance in research.

**Unit 2:** Student will be able to calculate various measures of central tendencies, measure of dispersion and measure of kurtosis and skewness and its importance.

**Unit 3:** To understand the exact method of data analysis for the problem under investigation. Student will be able to perform various hypothesis testing like T-test, F-test, and chi square tests and its application in biological sciences.

**Unit 4:** Understanding for drawing valid inferences and to plan for future investigations. Student will be able to perform Correlation & regression calculations and its application in Biological sciences. Student will able to perform ANOVA testing.

## Contents:

**Unit I:**
Data Collection and Presentation
Types of Biological Data: Qualitative Data -Nominal, Ordinal, Ranked; Quantitative Data: Discrete and Continuous.
Understanding of Population and sample
Methods of Collection of Data: (i) Experimental Data and (ii) Survey Data- Simple random Sample (with and without replacement), stratified sampling and cluster sampling.
Tables: Frequency Distributions, Relative Frequencies.
Graphical Presentation: Bar charts, Histograms, Frequency Polygons, One way scatter plots, Box plots, two-way scatter plots, line graphs.

**Unit II**:
Descriptive Statistics
Measures of Central Tendency: Mean, Median and Mode, quartiles, deciles and percentiles (both for raw data and grouped data)
Measures of Dispersion: Range, Interquartile Range, Variance, Standard Deviation and Coefficient of Variation.
Measures of Skewness and Kurtosis.

**Unit III**:
Statistical hypotheses: Null and Alternative hypotheses.
Statistical Tests: Acceptance region and Rejection Region. Types of errors and power of the test. Goodness of fit tests.
Random Variables: Discrete and Continuous. Some examples from biological sciences.
Probability Distributions: General Normal Distribution, Standard Normal Distribution ; Sampling Distributions- t, chi-square and F distributions.
Significance Tests for Normal Distribution: One sample tests for mean – z test and t-test.
Two sample tests for normal distributions: Tests for means (i) when variances are known (ii) when variances are unknown. Tests for equality of variances.
Paired t-test for equality of means.
Confidence Intervals

**Unit IV**:
Correlation: Covariance, Calculation of covariance, correlation analysis and correlation Coefficient calculated from ungrouped data.
Regression: Simple linear regressions analysis, regression coefficients, Linear regression line or equation
Analysis of Variance: Completely Randomized Design, Randomized Block Design

**References:**


- Fundamentals of statistics by S.C. Gupta
- Principles of Biostatistics by Marcello Pagano and Kimberlee Gaurea
- Biostatistics : A Foundation For Analysis in the Health Sciences by Daniel, Wayne (Seventh Edition), Wiley India Pub.

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - II
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440208: Forensic Genetics

**Course Objectives:**
Recent development of forensic genetics through discussion of genetic and statistical issues emerging since the introduction of DNA profiling. DNA profiling has had an enormous impact on forensic science over the past 25 years, by determining whether a person either matches or does not match biological evidence associated with a crime Students develop the skills to interpret the evidence of matching genetic profiles, to perform calculations relevant for parentage determination and the identification of remains, and to consider the implications of familial searching of DNA databases.

**Course Learning Outcomes:**

**Unit 1:** Student should be able to know the principles of genetics in forensic medical investigations and explain how these are carried out.

**Unit 2:** Students gathered information related to human genome projects and DNA Forensic Databases, also understand the Ethical, Legal, and Social Issues Associated with DNA Data banking,
**Unit 3:** Students should state different types of genetic markers that are used for forensic genetic analysis and critically evaluate and understand problems concerning various types of markers and methods for DNA analyses.

**Unit 4:** Students would be able to carry out different experiments that are used in forensic genetics and apply statistical calculations for evaluation of results

## Contents

**Unit I:**
Basic of human Genetics, Heredity, Alleles, Mutations and Population Genetics, The concept of Genetics polymorphism, Hardy-Weinberg Law.

**Unit II:**
Human Genome Project: Introduction, History, Goals, Benefits, Social, Ethical and Legal Issues
DNA Forensic Databases, Ethical, Legal, and Social Issues Associated with DNA Databanking, Benefits of DNA Databanking
Quality control, certification

**Unit III:**
DNA Profiling: Introduction, History of DNATyping, molecular biology of DNA, variations, polymorphism, DNA Extraction from forensic biology specimens.

DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, YSTR, Mitochondrial DNA, Ancient DNA typing, DNA chips, SNPs.
Forensic Significance/ Applications of DNA profiling: Human, wildlife and agriculture
DNA profiling in India and abroad.
Limitations of DNA profiling.

**Unit IV:**
DNA Statistics: frequency estimate calculations, interpretations, allele frequency determination.
Paternity/Maternity index, Sibling index, Probability of match.


1. DNAstructure and functions by Richard R. Sinden; Academic Press, Inc. 1994.
2. DNA Profiling and DNA fingerprinting (1999) Edited by Jorg T. Epplen and Thomas Lubjuhn, Birkhauser Verlag, Switzerland.
3. DNA and other Polymorphism in Forensic Science (1990) Henry C. Lee and R.E. Gaensslen; Year book Medical Publishers, Inc.
4. Forensic DNA Profiling Protocols (1998) Patrick J. Lincoln and Jim Thomson; Humana Press, Inc.
5. John M. Butler (2005) Forensic DNA Typing: Biology, Technology, and Genetics of STR Markers Academic Press.
6. Keith In man and Norah Rudin (1997) An Introduction to Forensic DNAAnalysis, CRC Press; NY.
7. Koblinsky et al. (2005) DNA -Forensic and Legal Implications.
8. Saferstein, R. (1982) Science Handbook, Vol. I, II, & III, Prentice Hall New Jersey.
   Kirby : DNA Fingerprinting Technology.

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - II
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440209: Toxicology

**Course Objectives:**

The course will cover basic toxicology and ecotoxicology, including how toxic substances are taken up in the organisms, distributed, biotransformed and excreted, how toxic substances react with biomolecules and downstream consequenses for the organism, as well as knowledge about toxic substances, e.g. metals, organic contaminants and pesticides. The course aims to provide a general view of the topic by bridging human toxicology and ecotoxicology.

**Course Learning Outcomes:**

**Unit 1:**

Upon completion of this unit, the student should have an understanding of basic principles, factors and effect of toxic substances in the body parts.

**Unit 2:**

Students should gained knowledge of mechanisms of action for toxic substances also understand the exposure, uptake, metabolism, distribution and excretion of toxicants.

**Unit 3:**

Student should know different categories of toxic substances/ pesticides.

**Unit 4:**

Students would be able to understand heavy metal toxicity.

## Contents

**Unit I**

- Definition and scope of toxicology: Eco-toxicology and its environmental significance.
- Toxic effects : Basic for general classification & nature. Dose-Response relationship: Synergism and Antagonism, Determination of ED50 & LD50. Acute and Chronic exposures.
- Factors influencing Toxicity. Pharmacodynamics & Chemodynamics, dose conversion between animals and human
- Diagnosis of toxic changes in liver and kidneys : Metabolism of drugs: paracetamol and asprin with their toxic effects on tissues.

**Unit II**

- Xenobiotics Metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reaction/Conjugation: Methylation, Glutathione and amino acid conjugation. Detoxification.
- Biochemical basis of toxicity: Metabolism of Toxicity : Disturbances of Exitable membrane function. Altered calcium Homeostasis. Covalent binding of cellular macromolecules & Genotoxicity. Tissue specificity of Toxicity.
- Toxicity testing: Test protocol, Genetic toxicity testing & Mutagenesis assays: In vitro Test systems – Bacterial Mutation Test, Ames Test, Fluctuation Tests, *In vivo* Mammalian Mutation tests –DNA repair assays, Chromosome damage test, Evaluation of Apoptosis and necrosis.

**Unit III**

- Pesticide toxicity: Insecticides : Organochlorines, Anti cholinesterases – Organophosphates and Carbamates, Fungicides. Herbicides, Environmental consequences of pesticide toxicity.
- Biopesticides.
- Food Toxicity: Role of diet in cardio-vascular disease and cancer. Toxicology of food additives.

**Unit IV**

- Metal Toxicity: Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors, affecting metal toxicity effect of light, temperature & pH.
- Air pollution: Common air Pollutant & their sources. Air pollution & ozone. Air pollution due to chlorofluorocarbons (CFCS) and asbestos.

**Reference Books**:

1. Klaassen, C. D (8th Eds.). (2013). *Casarett and Doull's toxicology: the basic science of poisons* . New York: McGraw-Hill.
2. John A. Timbrell (4th Edn) (2008) Principles of biochemical toxicology. Taylor & Francis Ltd, London,.
3. Smart, R. C., & Hodgson, E. (4th Eds.). (2013). Molecular and biochemical toxicology. John Wiley & Sons.
4. Relevant review articles / research papers / handouts of latest development in the subject.

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - II
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440210: Population Genetics

**Course Objectives:**

The course will enable the students to understand the importance of genetics at population level. A thorough understanding of the population genetics is necessary to comprehend the evolutionary processes. This course will make the students to understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits. Various type of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics. Population genetics helps in identifying genetic diversity based on the statistical comparisons.

Various factors such as mutation, migration, selection and genetic drift alters gene and genotype frequency. This course are very much useful for the identification of genetic variabilities within the populations. Hardy – Weinberg laws are useful for the identification of lethal alleles in the populations.

**Course Learning Outcomes:**

**Unit 1:** Deals with Concept and theories of evolution, Hardy-Weinberg law and its applications in calculating gene and genotype frequencies.

**Unit 2:** Discussing factors influencing gene and genotype frequencies such as mutation, migration, selection and genetic drift.

**Unit 3:** Deals with the Molecular population genetics, Molecular evolution (neutral theory, punctuated equilibrium), DNA-based phylogenetic trees, Molecular phylogenetics of *Homo sapiens*

And Molecular clock.

**Unit 4:** students should understand various selection and breeding Methods in animals. It also provides informations on Inbreeding and assortative mating and construction of Path diagram.

## Contents

## 101440210: Population Genetics

**UNIT - I**

Concept and theories of evolution

Microevolution in Mendelian population

Mendelian Population

Allele frequencies and genotype frequencies

Hardy-Weinberg equilibrium and conditions for its maintenance

Chromosomal, DNA and allozyme polymorphism in natural population

**UNIT - II**

**Deviations from Hardy-Weinberg Equilibrium**

Mutation

Selection (Types of selection, selection coefficient, selection in natural populations)

Genetic drift

Migration

**UNIT - III**

**Molecular population genetics**

Molecular evolution (neutral theory, punctuated equilibrium)

DNA-based phylogenetic trees

Molecular phylogenetics of *Homo sapiens*

Molecular clock

**UNIT - IV**

**Selection and Breeding Methods in animals**

Line Breeding

Ordinary Breeding

Cross Breeding

Artificial selection

**Nonrandom breeding**

Inbreeding and assortative mating

Path diagram construction and inbreeding coefficient

**Reference Books:**

- Population Genetics by Rao and Nallari
- Genetics of Populations by Philip W Hedrick
- Genetic Variation and its Maintenance Roberts & DeStefano

## 101440204: Lab – I (Practicals based on 101440201 and 101440202)

### List of Practicals

1. Whole blood culture for chromosome preparation
2. To prepare and perform Giemsa staining
3. To perform GTG banding
4. To perform C banding
5. To perform NOR banding
6. To identify banded human chromosomes
7. Conjugation in *E. coli*.
8. Transduction in *E. coli*
9. Transposon assay
10. β-galactosidase induction and assay
11. Isolation and enumeration of bacteriophage
12. Demonstration of Lysogeny

## 101440205: Lab – II (Practicals based on 1014402031 and Elective Any One)

### List of Practicals

To perform total WBC count using Haemocytometer

To Perform Differential Leukocyte count

To learn the technique of Ouchterlony Double Diffusion

To learn the technique of Radial Immunodiffusion

To learn the technique of Immunoelectrophoresis

To perform sandwich Dot ELISA test for antigen

To learn the technique of latex -agglutination

To separate lymphocytes by density gradient method

To convert ungrouped data in to grouped data using Sturge's formula.

To study representation of data by one dimensional diagram.

To study representation of data by two dimensional diagram.

To study representation of data by means of graphs. (Histogram & frequency polygon).

To study the data representation by graphs (Frequency polygon & frequency curve).

To study how to calculate descriptive statistics for the given data. (Mean mode, median, standard deviation and mean deviation).

To study the concept of permutation and combination in practical counting problems.

To study the concept of normal distribution and apply it to practical problems.

To study the concept of estimation (point estimation and interval estimation).

To apply the concept of skewness in the field of biosciences.

To apply the concept of F- test for biological problems.

To apply the concept of $\chi^2$ – test for biological problems.

# Course Wise Content Details for M.Sc. (Applied Genetics) Programme

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - III
# M.SC. APPLIED GENETICS
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## 101440301: HUMAN MOLECULAR GENETICS

**Course Objectives:**
The Science of genetics includes the rules of inheritance in cells, individuals and populations and the molecular mechanisms by which genes control the growth, development and appearance of organisms.
The objectives of this course are to make students understand the role of genetics in studying molecular pathology. Selected monogenic and polygenic diseases with global importance help students to understand type of mutation and their consequences in human populations. Genetic concepts provides the framework for the study of Modern Biology.

**Course Learning Outcomes:**
**Unit 1:** Students should be able to acquire basic knowledge on various genome mapping techniques.

**Unit 2:** Students should be clear about various susceptibility factors and understand molecular genetic changes occur during mutation for diagnosis and treatment.

**Unit 3:** Students should understand the pathways and enzymatic defects leading to various metabolic disorders associate with protein, carbohydrates and lipid metabolism as well mitochondria.

**Unit 4:** Student should know about applied aspects of Human genome project knowledge in society, medical sciences especially in diagnosis and management of genetic disorders.

## Contents:

## Unit-1: Genome Mapping:
Genetic mapping

Physical mapping techniques,

Identifying human diseases genes by Positional dependent and positional independent strategies

Chromosome walking.

Applications of Pulse field gel electrophoresis

Next generation sequencing technology

## Unit-2 : Monogenic and polygenic disorders:

Genetic susceptibility to common diseases

Monogenic diseases

(Neurofibromatosis, Cystic fibrosis, Hemophilia A and B, Sickle cell anemia),

Trinucleotide repeat expansion mutations

Polygenic diseases (Diabetes mellitus, Obesity and Cancer).

## Unit-3 : Biochemical Genetics:

Inborn errors of metabolism:

Molecular and biochemical pathways:

Phenyl ketonuria, Alkaptonuria, Maple syrup urine disease, Albinism

Mucopolysaccharidosis, and Glycogen storage disorders

Lipidosis

Human mitochondrial syndromes

## Unit-4 : Human genome projects and its practical implications

DNA testing: Screening for known and unknown mutations

Pharmacogenetics and pharacogenomics: Definition, Genetic variations affecting

drug metabolism

Hereditory disorders with altered drug response

Social and ethical issues in medical genetics

## Reference Books:


1. Human molecular Genetics, Strachan T. & Read A.P., 3rd edition, published by Garland Science, 2004. 978-0815341840.
2. Genetics in medicine by Thompson and Thompson, 7th edition, published by Elsevier Science ISBN: 978-81-312-1819-9.
3. Lecture Notes on Molecular Medicine, Bradley J., Johnson D.& Rubenstein D., 2nd edition, published by Blackwell Science, 2001. ISBN: 0632058390
4. Essentials of Human Genetics by S.M. Bhatnagar et al, 4th Edition, (1999), Orient Longman. ISBN: 81-250-1426-8
5. Human Genetics by Peter Sudbury, 3rd Edition, Pearson Education Limited. ISBN: 0582322669.
6. http://www.aribas.edu.in/Library.aspx (e - Library)
7. Topic related review articles.

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - IV
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440302: GENE REGULATION AND GENETIC ENGINEERING

**Course Objectives:**

The objective of this course is to make students understand the transcriptional, translational and processing level control of gene expression in prokaryotes. This knowledge will then be used to meet the main objective of this course, which is to make the student understand the process of cloning, screening and expression of genes in heterologous systems.

**Course Learning Outcomes:**

**Unit – I**: Students should be able to acquire basic knowledge of regulation of prokaryotic gene expression at different levels.

**Unit – II**: Students should know about different types of enzymes and vectors that are used in recombinant DNA technology.

**Unit – III**: Students should have understood the process of transferring the cloned DNA in another host by different methods and various screening methods to select the transformed cells from the non-transformed cells.

**Unit – IV**: Student should have learnt advanced selection and screening techniques including molecular markers, PCR and sequencing.

## Contents:

**Unit 1: Regulation of gene expression**

Regulation of gene expression in prokaryotes: Operon concept, positive and negative regulation. Examples of lac and trp operon regulation; global regulatory responses. Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

**Unit 2: Restriction enzymes & Vectors**

General strategies and Steps involved in gene cloning; Extraction and purification of DNA from bacteria, plant and animal cells.

Restriction enzymes, DNA ligase and other enzymes involved in gene cloning

Cloning and expression vectors- Plasmids, - bacteriophages, M-13 based vectors, Phagemids, Cosmids, YAC, BAC, PAC, HAC/MAC, etc. Expression of cloned gene in heterologous host.

**Unit 3: Recombinant selection & screening**
Introduction of DNA into host system
Chemical synthesis of DNA, Construction of genomic and cDNA libraries, Recombinant selection and screening, Southern blotting & hybridization, Northern analysis, Western blot analysis, DNA sequencing, Nucleic Acid Microarray

**Unit 4: Molecular Markers, PCR & Sequencing**
Molecular markers (RFLP, RAPD, AFLP, SSR)
Polymerase chain reaction (PCR), Types of PCR
DNA sequencing and its assembly: Maxam -Gilbert and Sanger's methods, Shot gun sequencing, Next generation sequencing strategies for large genomes.

**Reference Books :**


1. Molecular Genetics of Bacteria, 3rd Edition, Snyder and Champness
2. Genome 3rd Edition – T. A. Brown
3. Molecular Biotechnology 4th Edition – Glick and Pasternak
4. Principles of Gene Manipulation and Genomics 7th Edition– S. B. Primrose & R.M. Twyman
5. Applied Molecular Genetics – Roger L. Miesfeld
6. Biotechnology – H. K. Das
7. Genetic Engineering – Rastogi and Pathak


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## 101440303: Genetics in Crop Improvement

**Course Objectives:**

The major objective of this paper is to develop clear understanding of various aspects such as methods for crop breeding, tissue culture methods, Molecular markers, Somaclonal variation and transgenics methodology for Crop Improvement.

**Course Learning Outcomes:**

**Unit 1**: Students will understand the methods in crop breeding for self pollinated and cross pollinated crops.

**Unit 2**: The students can gain knowledge for various methods for haploid production, Tissue culture techniques and somatic cell hybrid.

**Unit 3:** Will get the information on somaclonal variations and methods for Resistance to biotic stresses.

**Unit 4:** Will be acquainted with overview of the Transgenic in Crop Improvement by using PCR and Non-PCR based Molecular markers for Crop Improvements.

## Contents

**Unit I**

**Introduction to Crop Improvement:**

**Methods for crop breeding**

**Self pollinated crops** - pure line theory and pure line method, pedigree method, Bulk population method and Back cross method of crop breeding.

**Cross pollinated Crops**- Theory of selection and response to selection, Mating systems and their consequence Male sterility and its types, Applications of male sterility in crop improvement.

Heterosis breeding and Hybrid varieties. Polyploidy and mutation breeding as methods of crop improvement.

**Unit II**

**Tissue culture for Crop Improvement:**

**Production and uses of haploids** - Anther culture, Pollen culture,

Chromosome elimination (Bulbosm method), Ovule culture, Detection of haploids, Methods for diploidization of haploids, Uses of haploids and dihaploids in crop improvement.

**Somatic hybrids** – Isolation of protoplast, culture and purification of protoplasts, Viability and plating density of protoplast, Protoplast fusion and somatic hybridization.

**Unit III**

**Somaclonal variation for Crop Improvement and Transgenic in Crop Improvement - I**

Definition, Schemes for obtaining somaclonal Variation, Factors influencing somaclonal variation, genetic basis of somaclonal variation, Applications and disadvantages of somaclonal variation. Resistance to biotic stresses- Insect resistance, Virus resistance, Bacterial and fungal disease resistance.

**Unit IV**

**Transgenic in Crop Improvement - II and Molecular markers for Crop Improvement**

**Resistance to abiotic stresses**-, Salt resistance, Drought resistance Herbicide resistance Transgenic for quality improvement, Commercial transgenic crops.

**Non – PCR based approaches**- RFLP (Procedure, Construction of RFLP maps, Uses of RFLP) **PCR based approaches**- Random Amplified Polymorphic DNA (RAPD), DNA Amplification Fingerprinting (DAF), Arbitrarily Primed Polymerase Chain Reaction (AP-PCR), Amplified Fragment Length Polymorphism (AFLP), Simple Sequences Repeat (SSR),Marker Assisted Selection (MAS) and DNA Barcoding.

**Reference Books:**


- Principles of plant breeding by Robert W. Allard, Johan Wiley and Sons. ISBN-047023094.
- Plant breeding by Briggs and Knowles, Reinhold Publishing Crop , Newyork.ISBN-0-582-45586-3
- Plant tissue culture: Theory and Practice by S. S. Bhojwani and M. K. Razdan, Springer Publication.ISBN:-0-444-81623-2
- Plant tissue culture manual by K. Lindsey, Springer Publication. ISBN:81-8128-582-4
- Introduction to plant tissue culture by M.K. Razdan, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN: 81-204-1571-X
- Experiment in plant tissue culture by John H. Dodds and Lorin W. Robert, Cambridge University Press. ISBN: 0521299659
- Plant propagation by tissue culture by George and Sherington, Exegetics Publisher. ISBN:978-0950932507
- Micropropagation by plant tissue culture by Reinert and Bajaj, Springer Publication, Netherland. ISBN: 978-1-4020-5004-6
- Introduction to plant biotechnology by H. S. Chawla, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN:81-204-1549-3
- Fundamentals of genetics by B. D. Singh, Kalyani Publication, New Delhi. ISBN: 81-272-3292-0
- Element of biotechnology by P. K. Gupta, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN: 81-7133-481-4
- Genetics by P. K. Gupta, Oxford and IBH Publishing Co. Pvt Ltd, New Delhi. ISBN: 81-7133-842-9
- Practical applications of plant molecular biology by R.J. Henry, Chapman and Hall.ISBN:978-041273201
- Plant propagation by tissue culture (Vol.1&2) by Edwin George, Springer Publication, Netherland.ISBN: 1402050046
- Plant Breeding: Theory and Practice by V.L. Chopra, intercept Ltd. ISBN: 8120403886
- General Plant Breeding by A. R. Dabholkar, Concept Publishing Company. ISBN: 8180692426
- Plant Genotying: The DNA Fingerprinting of plants by R. J. Henry, CABI Publishing. ISBN: 0857995152
- DNA fingerprinting in plants: Principle, method and application by Kurt Weising, Kirsten Wolf,Hilde Nybom, CRC Press. ISBN: 0849314887.
- Practical manual of plant tissue culture by H. S. Chawla, Oxford and IBH Publishing Co. Pvt Ltd,New Delhi. ISBN: 81-204-1613-9.
- http://www.aribas.edu.in/Library.aspx (e - Library)

## 101440304: Lab I (Sub – I Human Molecular Genetics and Sub – II Gene Regulation and Genetic Engineering) Practicals based on 101440301and 101440302

**List of Practicals**

1. Recording family history for construction of pedigree
2. DNA isolation from semen
3. Separation of urinary aminoacids by TLC
4. Biochemical analysis of urine for the detection of IEM
5. Screening of MPS by Spot test
6. Diagnosis of Sickle cell anemia by PCR
7. Multiplex PCR (Kit based, GeNei, Merck)
8. Isolation of plasmid DNA by boiling lysis method.
9. Isolation of plasmid DNA by Alkaline lysis method.
10. Large scale preparation of plasmid with chloramphenicol amplification.
11. Preparation of competent cells of *E.coli*
12. Transformation of artificially induced competent cells of *E.coli* by plasmid DNA.
13. Cloning of gene in *E.coli*
14. Expression of cloned gene.
15. Demonstration for Real time PCR .
16. Restriction digestion.

## 101440305: Lab II (Sub – I Genetics in Crop Improvement and Sub – II (Elective (Any One) Subject) Practicals based on 101440303 and Elective (Any One) Subject

**List of Practicals:**

1. Floral biology of self and cross pollinated crops with one suitable example from each group.
2. Anther culture in crop plants.
3. Pollen culture in crop plants.
4. Isolation of protoplast from plant using enzymatic method.
5. Protoplast fusion from plant.
6. Isolation of plant genomic DNA by CTAB method.
7. Agarose gel preparation and electrophoresis to confirm DNA from plants.
8. DNA quantification by UV spectroscopy.

9. RAPD PCR
10. Visit to the plant breeding stations and plant tissue culture labs to know practical applications.
11. **Practicals Related to Elective Subject (Any One).**

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## 101440307: Bioinformatics

**Course Objectives:**

The course will enable the students to understand the concept of bioinformatics, various types databases and their importance. This course will enable to students for algorithms and concept of sequence alignments, understanding the phylogenetic relationship among the organisms in evolution. Students will also able to know the 2D structure and 3D structure of protein which ultimately enable the students to understand the active site prediction, drug design & development.

**Course Learning Outcomes:**

**Unit – I:** Envisages about the concept of bioinformatics and its application. It provides the knowledge of various databases, nucleic acid databases, protein sequence databases, formats of various databases and their importance.

**Unit – II:** Gathers information regarding concept of scoring matrix, search of databases, algorithms of the BLAST and FASTA. The students will learn the basic concepts of pairwise sequence alignment and multiple sequence alignments.

**Unit – III:** Deals with the pairwise and multiple sequence alignment for analysis of nucleic acid and proteins sequences. The students will also learn to construct the phylogenetic trees, molecular basis of evolution using different methods.

**Unit – IV:** Accords to gain the knowledge of structure of protein, prediction of 2-dimentional, 3-dimentional structure of protein and their algorithms. Students will enable to predict the active site of protein, folding of protein, protein modeling and drug design using software.

**UNIT – I**

**Introduction to Bioinformatics:**

Overview, Internet and bioinformatics, Applications.

Introduction and Bioinformatics Resources:

Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases:

Nucleic acid sequence databases: GenBank, EMBL, DDBJ

Protein sequence databases: SWISS-PROT, PDB, SCOP, CATH

Genome Databases at NCBI, EBI

Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources)

Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrfpir etc.

Basic concepts of sequence similarity, identity and homology, Definitions of homologues, orthologues, paralogues, xenologus.

**UNI – II**

**Sequence analysis**:- Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.

Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA.

Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA.

**UNIT – III**

**Functional genomics**

Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.

Multiple sequence Alignment: CLUSTAL W

Definition and description of phylogenetic trees and various types of trees, Molecular basis of evolution, Method of construction of Phylogenetic trees: Distance based method (UPGMA, NJ), Character Based Method (Maximum Parsimony and Maximum Likelihood method).

**UNIT – IV**

**Molecular Modeling**

Structural classification of proteins, Protein structure analysis, Classes, folds, motif, domain Secondary structure and evaluation: algorithms of Chou Fasman, GOR methods.

Tertiary Structure: basic principles and protocols, Methods to study 3D structure.

Active site prediction, Protein folding, Protein modeling and drug design.

**REFERENCES BOOKS**


1. Mount DW, Bioinformatics: Sequence and Genome Analysis (2nd edition). Spring Harbor Press.
2. Arthur Lesk. Introduction to Bioinformatics. Oxford University Press.
3. S. C. Rastogi, Namita Mendiratta, Parag Rastogi, Bioinformatics: Methods and Applications: (Genomics, Proteomics and Drug Discovery) 4th Edition

4. Ghosh Z and Mallick B, Bioinformatics-Principles and Applications, Oxford University. Press (First Print: 2008; Second Print: 2009)
5. Creighton TE, Protein Structure: A Practical Approach
6. Creighton TE, Protein Structure and Molecular Properties, Freeman
7. Leach AR, Molecular Modeling : Principles and Application
8. Bourne PE, Weissig H, Structural Bioinformatics, Wiley Schlick T. Molecular Modelling and Simulation An Inter disciplinary Guide, Springer
9. Pevzner PA Computational Molecular Biology, An Algorithmic Approach. Prentice Hall
10. Thomas Lengauer, Bioinformatics - From Genomes to Therapies: Volume 1.

**Practicals:**

1. Introduction of different database of NCBI
2. Introduction of PIR, ExPasy, EMBL, SCOP,CATH
3. Database introduction- Pfam, Prodom
4. Introduction of Genome browser – UCSC, ensemble, vista, WGS by NCBI, RAST
5. Use of L-ALIGN
6. Clustal-W and Phylogenetic Analysis
7. Protein Sequence Databases and visualization by RASMOL & SPDBV
8. Homology modeling, structure validation and quality of protein structure
9. *In Silico* study of ligand protein interaction
10. Introduction to Reactome and iPath3 (Metabolic Pathway Databases)

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### 101430308: ADVANCED IMMUNOLOGY

**Course Objectives:** The objective of the courser is to give an extension to the basic knowledge of immunology acquired by students earlier as a core subject with emphasis on the applied aspect of the subject. The course provides an insight into the developments in the diagnostic field based on antigen-antibody reaction; the role of immune system in transplantation and disease development including cancer and autoimmunity and immunodeficiency.

**Course Learning Outcomes:**

**Unit I:** The students will learn about the various methods for antibody productionand antibody engineering, which can be then used for diagnostic or treatment purpose. The laboratory/diagnostics techniques based on antigen-antibody reaction, methods to determine antibody affinity etc. The students will also learn about the basis of vaccination and developments in the vaccine production

**Unit II:** The students will learn about the development, differentiation and maturation of B and T lymphocytes, positive and negative selection to rule out self- reactive lymphocytes and memory generation.

**Unit III:** The students will learn about the types of the hypersensitivity reactions, factors triggering them and the consequences. They will also learn about the role of immune system in acceptance or rejection of a graft, in particular MHC and different immunotherapies available to extend the life of a graft.

**Unit IV:** The students will learn about the types of immunodeficiency and the specific defect in the immune system causing a particular immunodeficiency. The students will also learn about the selection of self-tolerant cells and development of autoimuune diseases due to breakdown of tolerance.

## Contents:

**Unit I**

**Experimental systems and methods for diagnostics and therapy**: Antibody production (polyclonal, monoclonal), Methods to Determine the Affinity (Equilibrium dialysis, surface Plasmon resonance), Microscopic visualization of cells and sub cellular structures (Immunocytochemistry, Immunohistochemistry, Immunoelectron microscopy), Immunofluorescence-Based Imaging Techniques of Antigen-Antibody Interactions (Flow cytometry, Magnetic activated cell sorting, cell cycle analysis, assays of cell death)

**Antibody Engineering**: Chimeric and hybrid monoclonal antibodies, Construction of monoclonal antibodies from Ig-gene libraries

**Vaccines:** Active and passive immunization, conjugate or multivalent vaccines, DNA vaccines, vaccines under development – malaria and cancer

**Unit II**

**T cell Development:** Early Thymocyte Development, Positive and Negative Selection, Lineage Commitment, Exit from the Thymus and Final Maturation, Other Mechanisms That Maintain Self-Tolerance, Apoptosis

**B cell Development:** The Site of Hematopoiesis, B-Cell Development in the Bone Marrow, The Development of B-1 and Marginal-Zone B Cells, Comparison of B- and T-Cell Development

**T-Cell Activation, Differentiation, and Memory:** T-Cell Activation and the Two Signal Hypothesis, T-Cell Differentiation, T-Cell Memory

**B-Cell Activation, Differentiation, and Memory generation**: T-Dependent B-Cell Responses, T-Independent B Cell Responses, Negative Regulation of B Cells

**Unit III**

**Allergy, Hypersensitivity and Chronic inflammation:** Allergy: A Type I Hypersensitivity Reaction, Antibody-Mediated (Type II) Hypersensitivity Reactions, Immune Complex-Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity (DTH), Chronic Inflammation

**Transplantation immunology:** Immunological principles of graft rejection, Role of T cells in graft rejection, Role of Blood Group and MHC Antigens in Graft Tolerance, Predictable clinical course of graft rejection, General and target specific immunosuppressive therapy

**Unit IV**

**Immunodeficiency disorders:** Primary and secondary immunodeficiencies

**Tolerance and autoimmunity:** Establishment and maintenance of tolerance (antigen sequestration, central tolerance, peripheral tolerance), Autoimmunity (Organ specific autoimmune disease, systemic autoimmune disease, intrinsic and extrinsic factors that can favor susceptibility to autoimmune disease, proposed mechanisms for induction of autoimmunity, treatment of autoimmune diseases).

**Cancer and immune system:** Terminology and Common types of cancer, Malignant transformation of cells, Tumor antigens, The Immune Response to Cancer, Cancer immunotherapy

**Basic Text and Reference Books:**


1. Owen, J. A., Punt, J., & Stranford, S. A. (2013). Kuby immunology (7th Edn). New York: WH Freeman.
2. I. Kannan (2007), Immunology. MJP Publisher, Chennai.
3. Murphy, K., & Weaver, C. (2016). Janeway's immunobiology(9th Edn) Garland Science.
4. Male, D., Brostoff, J., Roth, D., & Roitt, I. (2012). Immunology(8th Edn) With STUDENT CONSULT Online Access. Elsevier Health Sciences.
5. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2014). Cellular and molecular immunology (6th Edn) Elsevier Health Sciences.
6. Relevant review articles / research papers / handouts of latest development in the subject.

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## 101430309: CANCER GENETICS

**Course Objectives:**

**At the end of this course, the student will be able to:**

1. Students able to understand various types, properties and progression of cancers.
2. Provides information about various genetics and epigenetics factors causing cancers.
3. Focusing on tumor markers, Tumor viruses and Chromosomal defects in cancers.
4. Students unerstand selected familial cancers occuringin populations

**Course Learning Outcomes:**

**Unit 1:** Student will be able to know about Types and properties of cancers, theories associated with cancer, Angiogenesis and Metastasis.

**Unit 2:** Highlights Oncogenes, Tumour suppressor genes, DNA repair genes and genetic instability, Epigenetic modifications, telomerase activity, centrosome malfunction, Cell cycle dysregulation .

**Unit 3:** To understand the Chromosomal aberrations in neoplasia, Tumour specific markers, Overview of Tumor viruses and Cervical cancer,

**Familial cancers:** Retinoblastoma, Wilms' tumour, Prostate cancer, Colorectal cancer, Breast cancer

**Unit 4:** Focusing on the **Diagnosis and treatment of Cancer.**

**Course Outcomes**

**At the end of this course, the student will be able to:**

1. Students able to understand various types, properties and progression of cancers.
2. Provides information about various genetics and epigenetics factors causing cancers.
3. Focusing on tumor markers, Tumor viruses and Chromosomal defects in cancers.
4. Students unerstand selected familial cancers occuringin populations
5. To define the genetic instability, involvement of cancer stem cells and treatment strategies for cancer

## Contents:

**UNIT I:**
Introduction to cancer, Types and properties of cancers, Cell transformation and tumourigenesis

Genetic heterogeneity and clonal evolution, Cancer and environment: physical, chemical and biological carcinogens (Viruses).

Angiogenesis – Angiogenesis, mechanism and role in tumour; Metastasis – Overview of metastasis – Seed and soil theory and beyond; epithelial to mesenchymal transition, signalling pathways in metastasis.

**UNIT II:**
Oncogenes, Tumour suppressor genes, DNA repair genes and genetic instability, Epigenetic modifications, telomerase activity, centrosome malfunction, Cell cycle dysregulation – Cancer gene pathways converge on cell cycle regulators, Cyclins and cyclindependent kinases; Cell Cycle Checkpoints (deficient).

**UNIT III:**
Chromosomal aberrations in neoplasia, Tumour specific markers, Overview of Tumor viruses and Cervical cancer,

**Familial cancers:** Retinoblastoma, Wilms' tumour, Prostate cancer, Colorectal cancer, Breast cancer.

**UNIT IV: Diagnosis and treatment of Cancer**
Conventional and new diagnostic techniques, molecular screening and detection. Conventional therapy, Gene therapy, Immunotherapy, Hormone therapy, multi-targeted therapy (allele-specific, antibody-mediated inhibition of RTKs, personalized cancer therapy), patient-derived xenografts (PDXs), clonal evolution and cancer resistance.

The stem cell theory of cancer, origin of cancer stem cells, markers of cancer stem cells.

**REFERENCE BOOKS:**


1. Molecular Biology of the Cell by Alberts *et al*
2. Genes VIII by Lewin
3. Molecular Cell Biology by Lodish*et al*
4. Molecular Genetics of Cancer by Stillman
5. Cell Biology by Cooper
6. http://www.aribas.edu.in/Library.aspx (e - Library)

**PRACTICALS:**

1. Preparation of Culture Media for Chromosomes analysis.
2. Human Blood Lymphocyte Culture
3. Genetic diagnosis of cancer by PCR
4. Visit to medical hospitals and report submission
5. A novel non-invasive method for detection of breast and ovarian cancer using volatile organic compounds from urine
6. Comet assay for genotoxicity
7. Visit to centres like GCRI- for spectral karyotyping and other techniques

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - III
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101430310: Omics and Computational Biology

**Course Objectives:**

The course will enable the students to understand the concept of genome mapping, genome sequencing, functional genomics, basic concepts of proteomics tools, data mining, basic concepts and tools of lipidomics, glycomics and phosphoproteomics. Storage and retrieval of various types of databases collection and storing of sequence data will be understood by the students. Students will also be able to know the local and global alignment through scoring matrices, gene prediction methods, RNA fold analysis, splice site identification.

**Course Learning Outcomes:**

**Unit 1:** Deals with genome, genomics and transcriptomics. The concept and application of physical map, genetic map, genome sequencing, functional genomics, small or large regulatory RNAs and dark matter will be known.

**Unit 2:** Gathers information regarding concept of proteomics, metabolomics and lipidomics. The the basic tools of proteomics, metabolomics, lipidomics and their applications will be learnt by the students.

**Unit 3:** Deals with the primary and secondary databases, collection, storage and retrieval of databases, knowledge of freeware, software and hardware. The sequence databases, sequence format, annotation and archival of databases will be understood.

**Unit 4:** Accords the sequence alignment and applications. The choice of alignment, local alignment, global alignment scoring matrices, codon usages analysis, RNA fold analysis, splice site identification will also be studied by the students.

## Contents

**Unit I**

**Genome, Genomics & Transcriptomics:**

Genome mapping: Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods, Genome Annotation, Functional Genomics. Transcription factor binding sites, RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Dark matter.

**Unit II**

**Proteomics, Metabolomics & Lipidomics:**

Basic concepts, Tools of proteomics- SDS PAGE, 2D PAGE, Liquid chromatography, Mass Spectrometry (ESI and MALDI), Protein identification by peptide mass fingerprinting, Applications of proteomics.

Fundamental concept, data integration and data mining; Tools of metabolomics-Capillary electrophoresis, Gas chromatography, Electrochemical detectors.

Basic concepts and tools of lipidomics, glycomics and phosphoproteomics.

**Unit III**

Biological Literature Information access, storage and retrieval systems- Primary and secondary databases of genomics, trascriptomics, proteomics and metabolomics. Knowledge on freeware and commercial software. Importance of hardware and software creations.

Collecting and Storing Sequence Data: Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Annotation and Archival.

**Unit IV**

Sequence alignment and applications: Uses: Choice to be made for alignment; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments tools- FASTA, BLAST, statistical and Biological significance.

Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis

**REFERENCES**


1. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press.
2. Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press.
3. Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley.
4. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
5. Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH.
6. Web/Journal Resources.
7. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science.
8. Current Protocols in Bioinformatics, Edited by A.D. Baxevanis et al, Wiley Publishers. 2005.
9. Bioinformatics by David W. Mount, Cold Spring Harbor Laboratory Press. 2001.
10. Fundamental concepts of Bioinformatics by D.E. Krane and M.L Raymer, Pearson Education. 2003.
11. Bioinformatics and Functional Genomics by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2003
12. Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman, R.M., Blackwell Publishing Company, Oxford, UK. 2003.
13. Introduction to proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., 2002, Human Press Inc., New Jersey, USA.
14. Bioinformatics: Sequence and Genome Analysis by Mount, D., Cold Spring Harbor Laboratory Press, New York. 2004.

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - IV
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440401: DAIRY ANIMAL GENETICS

**Course Objectives:**

Through Dairy Animal Genetics course, students gain the knowledge and skills required to apply quantitative genetics theory to practical problems in the animal-science and dairy industry and to undertake research in quantitative genetics, genome analysis and animal improvement.

**Course Learning Outcomes:**

**Unit 1.** Student will be able to describe the cell division and various staining and banding techniques for the identification of human chromosomal abnormalities. It also describes advance methods for chromosomal analysis.

**Unit 2.** Understand the Principles of quantitative genetics applied to improvement of livestock.
Methods of selection and Breeding systems. It also highlights the diagnostics for selected genetic diseases in cattles.

**Unit 3.** Understands theoretical and practical aspects Percentage verification, Progeny testing
Artificial insemination and Germ cell storage, IVF, animal cell culture and its importance.

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**Unit 4.** Students can learn various Gene transfer techniques and Applications of transgenic animals.

## Contents:

**Unit I**

**Animal Cytogenetics:**

Breeds of Cattles and buffaloes

Principles and techniques of cytogenetics applied to animals system, Blood culturing and harvesting, Karyotyping, Chromosome banding,

Numerical and structural anomalies in animals (Cattle and buffaloes).

**Unit II**

**Genetics and Animal Breeding:**

Principles of quantitative genetics applied to improvement of livestock.

Economically important traits, production records

Methods of selection and Breeding systems

Diagnostics for selected genetic diseases in cattles (BLAD, Citrullinaemia, Factor XI deficiency syndrome and DUMPS)

Genotyping for Milk protein and fat

**Unit III**

**Genetic improvement in cattle and buffaloes**

Parentage verification.

Progeny testing

Artificial insemination and Germ cell storage.

In vitro fertilization and embryo transfer for improved breeding, embryo splitting, embryo sexing and embryo cloning

Introduction to Animal cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

**Unit IV : Transgenic Animal Technology**

The concept of transgene and transgenics

Gene transfer techniques, Gene transfer through direct DNA micro injection, Gene transfer with Retro viral vector assistance, Gene transfer through production of germ line chimeras Breeding with transgenic livestock.

Applications of transgenic animals – Organ transplant and pharmaceutical proteins.

**Reference Books:**


- Animal Biotechnology by M M Ranga, Agrobios, Jodhpur. ISBN- 81-7754-309-1.
- Animal Biotechnology: recent concepts and developments by P Ramadas, MJP Publishers, Chennai. ISBN: 81-8094-042-X.
- Genetics of Livestock improvement by John F. Lasley, Prentice-Hall of India Priv.Ltd. New Delhi. ISBN: 9780133511062.

- Biotechnology by U Satyanarayana. ISBN: 9780133511062.
- Elements of Breeding and breeds of cattle and Buffalo- P Kanakraj, Jaypee Brothers Medical, ISBN: 978-8180618420.
- http://www.aribas.edu.in/Library.aspx (e - Library)

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - IV
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440402: GENETIC COUNSELLING

**Course Objectives:**
The Genetic counseling is defined as a process of communication and education, which addresses concerns relating to the development and/or transmission of a hereditary disorder. Genetic counseling in improving the clinical outcome and quality-of-life of people, its overall contribution in the health sector has remained far from expected. Recognizing the scope of genetic counseling, the need of the hour is to deliver easily accessible and quality-assured genetic counseling services to the entire population. In conclusion, global expansion of genetic counseling services is the need of the hour, to have a significant impact on the patient-related clinical outcomes and on the psychosocial concerns of the family members.

**Course Learning Outcomes:**
**Unit 1**: Students will understand the importance of Genetic Counseling and Genetic Testing.

**Unit 2**: This unit focussing on the complex polygenic syndromes and components of Genetic counselling.

**Unit 3**: Students should have understing about Principles of effective counselling.

**Unit 4**: Here student should understand causes and factors responsible for counselling as well as tests.

## Contents:

**UNIT -1**

**Genetic Counseling and Genetic Testing Provide Information to Those Concerned about Genetic Diseases and Traits:** Genetic Counseling, Genetic Testing: Ultrasonography, Amniocentesis, Chorionic villus sampling, Maternal blood screening tests, Noninvasive fetal diagnosis, Prenatal and Preimplantation screening and diagnosis: Indications for prenatal diagnosis, Indications for chromosomal testing, Newborn screening, Presymptomatic testing. Interpreting Genetic Test, Direct-to-Consumer Genetic Testing, Genetic Discrimination and Privacy.

**UNIT –II**

Complex polygenic syndromes: Hyperlipidemia, Atherosclerosis, Diabetes mellitus; Mitochondrial syndromes; Management of genetic disorders; Genetic counseling: Historical overview (philosophy ethos) and Components of genetic counseling: Indications for and purpose; Information gathering and construction of pedigrees; Medical Genetic evaluation (Basic components of Medical History, past medical history, social & family history).

**UNIT -III**

Principles of effective counselling: Including basic concepts of normal and abnormal psychology, normal human psychological development, interviewing and counselling principles and skills, crisis intervention, family dynamics and interventions, principles and techniques of assessment.

**UNIT-IV**

Genetic Counseling: Principles of genetic counselling, Causes and factors for seeking counselling, Dysmorphology, Ethical and legal issues in genetic counselling, Risk evaluation (Mendelian risk, empirical risk), Prenatal and preimplantation diagnosis. Non -invasive: Triple test, Ultrsonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling (CVS), Fetal blood sampling (FBS), Population screening for genetic disorders, Treatment and management of genetic disorders.

**Reference Books**


- Genetics: A Conceptual Approach, 4th Edition by Benjamin A. Pierce, ISBN-13: 978-1-4292-3250-0.
- Baker et al, A Guide to Genetic Counseling, Wiley-Liss, 1998.
- Pastemak, An Introduction to Molecular Human Genetics: Mechanisms of Inherited Diseases, 2nd Edition, Fritzgarald, Wiley Liss, 2005.
- Iankowski and Polak, Clinical Gene Analysis and Manipulation: Tools, Techniques and Troubleshooting, Cambridge University Press, 1996.
- Wilson, Clinical Genetics, Wiley-Liss, 2000.
- Robinson and Linden, Clinical Genetics Handbook, 2nd Edition Blackwell Science, 1994.
- Rasko and Downes, Genes in Medicine, Chapman & Hall, 1996.
- Young, Introduction to Risk Calculation in Genetic Counseling, 3rd Edition Oxford University Press, 2006.


## 101440403: Lab I (Lab I (Sub – I Dairy Animal Genetics and Sub – II Genetic Counselling)

## Practicals based on 101440401and 101440402

**List of Practicals:**

1. Introduction to Animal genetics
2. To carry out whole blood culture for chromosome preparation from cattle and buffalo
3. To prepare and perform Giemsa staining
4. To isolate DNA from semen of cattle and buffalo
5. Primer Dilutions and calculations
6. To screen bovine Leukocyte Adhesion Deficiency (BLAD) in cattle and buffalo
7. To screen Deficiency of Uridine MonoPhosphate Synthase (DUMPS) in cattle and buffalo
8. To screen factor XI deficiency in cattle and buffalo
9. Genetic Counseling proforma
10. Visit to Genetics Laboratory or Lab visit to laboratory who are involved in semen cryopreservation.

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - IV
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

## 101440406: GENETICS OF MAMMALIAN DEVELOPMENT

**Course Objectives:**

The objective of this course is to :

Know the process of embryogenesis, organogenesis and various stem cells.

Understand teratogenesis, Causes and genetic regulation of aging.

Study the gene expression during mammalian Development.

Know Medical implications of developmental biology

**Course Learning Outcomes:**
Students who successfully complete the course will be able to:

**Unit I:** Describe and order the main stages of development common to most multicellular organisms. Describe the main anatomical changes that occur during development. Identify the cellular behaviors that lead to morphological change during development.

**Unit II:** Describes teratogenic agents, Classification of teratomas, tumor suppressor genes, protooncogenes and oncogenes. Highlights genetic regulation of aging.

**Unit III:** Focusing on Gene expression during Development. Differential gene expression during development, RNA localization techniques Determination of functions of genes and transcriptional factors.

**Unit IV:** Describes Medical implications of Developmental biology: Genetic errors of human development, human syndromes, Gene expression and human diseases Infertility.

## Contents:

**Unit I**
**Overview of embryogenesis in mammals:**

Structures of spermatozoa and ovum Fertilization, Cleavage and blastulation, Gastrulation.

**Organogenesis and Stem cells**

Sex determination in mammals Types and functions of stem cells

Development of human brain Epidermis and the origin of cutaneous structures.

**Unit II**
**Teratogenesis and Aging:**

Teratogenic agents, Classification of teratomas, Tumerogenesis

Overview of tumor suppressor genes, protooncogenes and oncogenes Causes and genetic regulation of aging, Promoting longevity

**Unit III**
**Gene expression during Developmental:**

Differential gene expression during development,

RNA localization techniques Determination of functions of genes,

Overview of transcriptional factors and human development

**Unit IV**
**Medical implications of Developmental biology:**

Genetic errors of human development,

Identification of defective genes,

Nature of human syndromes, Gene expression and human diseases Infertility.

**Reference Books**


- Scott F Gilbert, Developmental Biology, 8th edition, Sinauer Associates Inc., USA. ISBN 0-87893-250-X
- Shastry and Shukal, Developmental Biology, Rastogi Publications, ISBN 81-7133-734-1
- Klug W. S. & Cummings M. R. Concepts of Genetics. Seventh edition. Pearson Education. ISBN 81-317-0811-X
- WWW.devbio.com
- Fundamentals of Genetics by B D Singh.
- P. K. Gupta, Genetics. Rastogi Publications, Meerut, India, ISBN: 81-7133-842-9.
- Gardner E. J., Simmons M. J. & Snustad D. P. Principles of Genetics. Eighth edition. John Wiley & Sons Inc. ISBN 9971-51-346-3.
- Elements of Breeding and breeds of cattle and Buffalo- P Kanakraj, Jaypee Brothers Medical, ISBN:978-8180618420.
- http://www.aribas.edu.in/Library.aspx (e - Library)

# CHARUTAR VIDYAMANDAL UNIVERSITY
# VALLABH VIDHYANAGAR
# SEMESTER - IV
# M.SC. APPLIED GENETICS
# SYLLABUS EFFECTIVE FROM: JUNE-2020-21

### 101430407: IPR AND BIOSAFETY

**Course Objectives:**
The objectives of this course are to provide basic knowledge on intellectual property rights and their implications in biological research and product development. This course enables the student to become familiar with India's IPR Policy to learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.

**Course Learning Outcomes:**
**Unit – I**: Students should know origin of IPR and its relevant history along with different organisations which led to current state of IPR in order to better appreciate it.

**Unit – II**: Students should be able to understand the IPR, its types and the type of legal rights it provides to the owner.

**Unit – III**: Students should know about different types of Patents, procedure for filing a patent, their rights and different organizations across the globe who accepts patents.

**Unit – IV**: Students should have understood the concept of Biosafety, Biological and Physical level of containment, Risk assessment, GLP, GMP etc.

## Contents:

**UNIT – I**
**Need for Intellectual Property Rights**
Introduction to history of ITO, GATT, WTO, WIPO and TRIPS; plant variety protection and farmer's rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

**UNIT – II**
**Intellectual Property Rights & Its Types**
Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP.

**UNIT – III**

**Patenting**

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting - disclosure/non-disclosure - patent application - forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for Patenting introduction to existing schemes.

**UNIT – IV**

**Biosafety**

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops.

**Reference Books:**


1. Ethics in engineering, Martin. M.W. and Schinzinger.R. 3rd Edition, Tata McGraw-Hill, New Delhi. 2003.
2. BARE ACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
3. Kankanala, K . C. 2007. Genetic Patent Law & Strategy, 1st Edition. Manupatra Information Solution Pvt. Ltd., Noida, India.
4. Jose B. Cibelli, Robert P. Lanza, Keith H. S . Campbell, Michael D.West. 2002. Principles of Cloning, Academic Press, SanDiego, Gurdon.
5. Hoosetti, B.B.2002. Glimpses of Biodiversity. Daya, New delhi.
6. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
7. http://www.cbd.int/biosafety/background.shtml
8. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html
9. Bioethics and Biosafety by M.K. Sateesh. I. K. International publishing house, New Delhi, ISBN: 978-81-96675703.

## 101440408: Lab II (Sub – I Genetics of Mammalian Development and Sub – II IPR and Biosafety)

## Practicals based on 101440406 and 101440407

**Practicals:**

1. To study the morphology and motility of sperm.
2. To study viability of sperm.
3. To perform Acrosomal integrity test.
4. To study different stages of embryogenesis.
5. To study different developmental stages of frog embryo.
6. To study different developmental stages of chick embryo.
7. Design of r-DNA laboratory.
8. Various methods to discard the Bio-hazardous waste.
9. Introduction to intellectual property.
10. Method to handle the recombinants.
11. Patent Case Study
12. Laboratory Visit related to subject specific practicals.