

# **CVM UNIVERSITY**

**MASTER OF SCIENCE**

**(BOTANY)**

**PROGRAMME**

**Under Choice Based Credit Scheme**

**Structure with Effect From: 2020-21**



## M.Sc. Botany Programme Details

### Programme Objectives (POs):

At the time of culmination of the program the under study will have created broad information in different zones of Botany. Through the boost of academic movement and scholarly improvement the program plans to furnish under studies with greatness in instruction and abilities, accordingly empowering the under study to seek after a vocation of his/her decision. By developing abilities and advancing all round character improvement through multi-dimensional instruction a feeling of self-assurance and independence will be injected in the under study. The under study will be ingrained with estimations of expert morals and be prepared to add to society as dependable people.

### Programme Specific Outcomes (PSOs):

Toward the finish of the two year program the under study will comprehend and have the option to clarify various parts of Botany. The student will be able to explain about various applications of Botany such as Ecology and Biodiversity, Cell Biology, Systematics of Angiosperms, Plant Reproductive Biology, Development Biology, Molecular Biology, Plant Biotechnology, Genetics and crop improvement and Phytochemistry and Pharmacogony. He/she will be able to design and execute experiments related to Basic botany, Plant Taxonomy, Plant Physiology, Molecular Biology, Plant Biotechnology and Phytochemistry and Pharmacogony tools will be able to execute a short research project incorporating techniques of Basic and Advanced Botany under supervision. The under study will be prepared to take up a reasonable situation in the scholarly world or industry, and to seek after a vocation in look into if so wanted.

### Programme Structure:

The M.Sc. Botany programme is a two-year course divided into four-semester. 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 Code	Name of Course	T/P	Credit	Exam Duration in hrs	Component of Marks		
					Internal	External	Total
					Total/Passing	Total/Passing	Total/Passing
101320101	Ecology and Biodiversity	T	04	03	30/10	70/28	100/40
101320102	Bioanalytical Techniques and Instrumentation	T	04	03	30/10	70/28	100/40
101320103	Cell Biology	T	04	03	30/10	70/28	100/40
101320104	Practicals based on PS01CBOT01 and PS01CBOT02	P	04	03	30/10	70/28	100/40
101320105	Practicals based on PS01CBOT03 and PS01EBOT2X	P	04	03	30/10	70/28	100/40
101320106	Comprehensive Viva- Voce	P	01			50/20	50/20
101320107	Fundamental of Biochemistry and Bioenergetics	T	04	03	30/10	70/28	100/40
101320108	Cytogenetic and Genetics	T	04	03	30/10	70/28	100/40
101320109	Food Microbiology	T	04	03	30/10	70/28	100/40
101320110	Virology	T	04	03	30/10	70/28	100/40
			25				650

## **Course Wise Content Details for M.Sc. (Botany) Programme**

**CHARUTAR VIDYAMANDAL UNIVERSITY  
VALLABH VIDHANAGAR  
SEMESTER I  
M. Sc BOTANY  
SYLLABUS EFFECTIVE FROM: JUNE-2020-21**

### **101320101: Ecology and Biodiversity**

#### **Course objective:**

The aim is to achieve deeper knowledge on ecology and biodiversity and the services that ecosystems provide to human societies, the connection between biodiversity and ecosystem services, and how human societies depend on these services.

#### **Course Learning Outcomes:**

**Unit 1:** Be able to outline different concepts of ecology and discuss the biosphere, biomes and biogeography aspect of ecology.

**Unit 2:** Be able to explain the basic of population dynamics concept and role and also discuss the modular organisms population regulation, population size regulators and patterns in population dynamics community structure.

**Unit 3:** Be able to outline different concepts of biodiversity and discuss the uses, values, loss of biodiversity.

**Unit 4:** Be able to outline and apply different perspectives and questions within conservation biology related to biodiversity and discuss the environmental education.

### **Contents**

#### **Unit – 1**

#### **Biosphere, biomes and Biogeography**

The Biosphere: Biotic Environment: Types of interaction, Intra-specific relationships, Interspecific relationships, Biotic and Abiotic Interactions: Complexity, Pathogens & climate, Abiotic effects on competition. Habitats & Niches: Habitats, Niches – Determining niches, Exclusion principle; Species coexistence – Size ratios, Niche overlap, Fundamental & raised

niches, Resource partitioning, Character displacement, Inter-specific competition Biomes: Terrestrial biomes, Wetland & freshwater biomes, Coastal & marine biomes Biogeography: Species distribution, Historic effects of plate tectonics - Past continental movements, Patterns of biogeography

## **Unit – 2**

### **Population Dynamics**

Population Dynamics: Populations & population change, Dispersal, Dormancy, Study of populations – Basic equation, Age structure, Fate of cohort, Age at Death, Long-term population studies; Demographic data – Life tables, Population pyramids, Survivorship curves, Evolutionary strategies – r & K-strategies; Modular organisms Population Regulation: Population growth – Exponential, Logistic growth curve; Population size regulators – Types, Space, Food & water, Territories, Herbivores & Predators, Weather & climate, Parasites & diseases, Natural disasters, Self-regulation & stress; Patterns in population dynamics Community Structure (Succession): Vegetation changes, Types & Causes of succession, Processes - Primary seres (Xeroseres, Hydroseres, Heterotrophic), Patterns of succession – Variation, Termination, Diversion, Human influence on succession, Climax.

## **Unit – 3**

### **Biodiversity and Uses, Values, Loss**

Biodiversity (General): Types of Biodiversity (Genetic, Species, Ecosystem), Global Biodiversity, Mega-diversity Countries of World, Endemism & Hotspots of Biological Diversity, Biodiversity of India, Hotspots of Indian Biodiversity, Goals of Biodiversity Conservation Biodiversity (Uses, Values, Loss): Biodiversity Values, Uses & Values of Biodiversity, Major Causes for Loss of Biodiversity, Listing of Threatened Biodiversity, IUCN Red Data Books, Endangered Flora and Fauna of India.

## **Unit – 4**

### **Biodiversity Conservation and Environmental Education**

Biodiversity (Conservation): Ex-situ Conservation: Cryo-preservation, Botanical Gardens, Seed Banks, Gene Banks, Germplasm Reserves, In-situ Conservation: Social Forestry, Agro-forestry, National Parks & Sanctuaries, Biosphere Reserves. Environmental Education: Introduction, Definition, Goals, Objectives, Guiding principles of environmental education, Environmental education programmes, Environmental education in India (Formal & Non-formal), Environmental information, Environmental organizations & agencies.

### **REFERENC BOOKS**

1. Ecology - Principles and Applications by J.L. Chapman & M.J. Reiss. (2008) (2nd Ed.) Cambridge University Press, U.K. (ISBN: 978-0-521-68920-5)
2. Ecology and Environment by P.D. Sharma. (2010). (10th Ed.) Rastogi Publications, Meerut (India). (ISBN: 978-81-7133-905-1)
3. Economic Zoology by G.S. Shukla & V.B. Upadhyay. (2000). (4th Ed.) Rastogi Publications, Meerut (India). (ISBN: 81-7133-434-2)

4. Elements of Ecology by Thomas Smith & Robert Smith. (2007) (6th Ed.) Dorling Kindersley Press. (South Asia). (ISBN: 81-317-1557-4)
5. Environmental Science: Practical and Field Manual by Jitendra Pandey and Madhu Sudan Sharma. (2003). Yash Publishing House, Bikaner (India). (ISBN: 81-8688209-X)
6. Fundamentals of Ecology by Eugene Odum & Gray Barrett. (2009) (5th Ed.) Cengage Learning & Nelson Education Press. (ISBN: 978-81-315-0020-0)
7. Practical Statistics for Field Biology by Jim Flower, Lou Cohen & Phil Jarvis. (2006) (2nd Ed.) John Wiley & Sons Ltd., England. (ISBN: 978-0-471-98296-8)
8. Principles of Conservation Biology by Martha Groom, Gary Meffe & Ronald Carroll. (2006) (3rd Ed.) Sinauer Associates, Inc., Sunderland, USA. (ISBN: 978-0-87893-518-5)

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**101320102: Bioanalytical Techniques and Instrumentation**

**Course objective:**

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**

### **Spectroscopy**

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.

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**101320103: Cell Biology**

**Course objective:**

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 enable 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 secretory 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.

## **References:**

- 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.

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**101320107: Fundamental of Biochemistry and Bioenergetics**

**Course objective:**

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

## References:

- 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.

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**101320108: Cytogenetic and Genetics**

**Course objective:**

The students are learning the basic knowledge of mendelian and non-mendelian inheritance, genome organization and cell division. Recombination in eukaryotes learns the linkage and crossing over the different method and mechanism. Basic concept of mutation and different type discuss and and their application. Basic concept of chromosome and different techniques of chromosome study and their application discuss.

**Course Learning Outcomes:**

**Unit1:** Be able to outline the concepts of mendelian, non-mendelian inheritance, genetic interactions and organelle inheritance. Also understand the eukaryotic genome.

**Unit 2:** Understand the recombination in eukaryotes, different maps and molecular mechanism of recombination and QTL mapping.

**Unit 3:** Basic concept of mutation and different types of mutation and molecular basis of mutations discuss. Students learned the concept of developmental genetics.

**Unit 4:** Be able to understand the basic of cytogenetics and role of chromosomal aberrations in crop evolution. Also learn the different techniques of molecular cytogenetics and their application.

**Contents**

**Unit-1**

Mendelian and Non-Mendelian Inheritance: Meiosis; Chromosome theory of inheritance; Mendelian laws; Gene interactions; Organelle inheritance.  
Eukaryotic Genome: Evolution, structure and organization; Gene regulation.

**Unit-2**

Recombination in Eukaryotes: Linkage and crossing over: basic concepts, linkage maps, correlation of genetic and physical maps, molecular markers and construction of linkage maps; Molecular mechanism of recombination; QTL mapping.

**Unit-3**

Mutation: Basic concept, spontaneous and induced mutations, allele theory, physical and chemical mutagens; Molecular basis of mutations; Transposons and their use in mutagenesis and gene tagging in plant systems.

Concepts in: Developmental genetics; Behavioral genetics; Population genetics and Quantitative genetics.

#### **Unit-4**

Cytogenetics: Chromosome: Structure and nomenclature, centromere and telomere; Sex determination: mechanisms, sex chromosomes; Chromosomal aberrations: Duplications, deficiencies/deletions, inversions, interchanges/translocations; Role of chromosomal aberrations in crop evolution; Genome analysis in crop plants; Molecular Cytogenetics: FISH, GISH, FIBER-FISH, Flow Cytogenetics, Flow karyotyping, Applications of molecular cytogenetics

#### **REFERENC BOOKS**

1. Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA.
2. Allard RW (1999). Principles of Plant Breeding (2nd Edition), John Wiley and Sons.
3. Hartl DL and Jones EW (2007). Genetics – Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers.
4. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006). Genetics – From Genes to Genomes, 3rd edition, McGraw Hill.
5. Lewin B (2008). Genes IX, Jones and Barlett Publishers.
6. Singh RJ (2002). Plant Cytogenetics, 2nd edition, CRC Press.
7. Smartt J and Simmonds NW (1995). Evolution of Crop Plants (2nd Edition) Longman.
8. Strickberger MW (2008). Genetics, 3rd Edition, Pearson (Prentice Hall).
9. Weising K, Nybom H, Wolff K and Kahl G (2005) DNA Fingerprinting in Plants: Principles, Methods and Applications, 2nd ed. Taylor and Francis Group, Boca Raton, FL.
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**101320109: Food Microbiology**

**Course objective:**

The course will enable students to understand the taxonomical classification, phenotypic and biochemical identification of food associated molds, yeasts, yeast-like fungi and bacteria. The course will teach the strategies to develop fermented and non-fermented milk products, fermented plant-based products, malt beverages, distilled liquors, etc. The role of microbes in food spoilage, preservation and various foodborne diseases can be discussed.

**Course Learning Outcomes:**

**Unit 1:** Will know about production and evaluation of the quality of starter cultures and fermented milk products. They will understand the role of microbes in food spoilage and how different factors affect this process.

**Unit 2:** Gathers information regarding microbes causing food intoxications and food-borne infections. The students will learn different diagnostics methods and preventive measures.

**Unit 3:** Knows traditional food preservation techniques including drying, salting, refrigeration, vacuum packaging, canning/bottling, chemical preservation and irradiation. The students will also learn use of modern techniques viz. high-pressure processing (HPP), bacteriocins, manosonication (MS), etc. They will be aware of fermentation protocols of different food products and understands the use and production of probiotics, prebiotics and nutraceuticals.

**Unit 4:** Gains knowledge about conventional methods for food quality analysis and is able to use the most recent and non-invasive techniques of quantification and detection of food borne microbes. Understands the relevance of microbial standards for food safety, quality assurance programs that revolutionize food safety.

**Contents**

**Unit I: Microbiology of food**

Microorganisms important in food microbiology

- a) Food associated bacteria, yeasts and molds. Microbiome of food material.
- b) Factors influencing microbial growth in food.

Microbial spoilage of foods

- a) Spoilage of cereals and its products, vegetables, fruits, meat and meat products, milk and milk products, canned and sugar products, fish, seafood and poultry

- b) Study of microbes responsible for spoilage and brief insights into chemical and physical spoilage of foods.

### **Unit II:**

Food borne infections

- a) Bacterial food borne infections and intoxications-*Brucella*, *Campylobacter*, *Clostridium*, *Escherichia* (ETEC/EHEC/EPEC/EAEC), *Salmonella*, *Shigella*, *Listeria*, *Vibrio*, and *Yersinia*.
- b) Non- bacterial food borne infections and intoxications- Nematodes, protozoa, algae, fungi, and viruses.
- c) General methods for diagnosis of infections, intoxications and preventive measures.

### **Unit III:**

Food preservation

General principles of food preservation – Classical, Physical, chemical and biological food preservation methods

Fermentative food products

Starter cultures for fermented foods, Fermented milk products: Yogurt, Cheese, Kefir, etc  
Oriental fermented foods: Shoyu, Temph, Kimchi, etc, Fermented vegetables – Sauerkraut  
Food beverages: Malt beverages, wines, vinegar.  
Role of Probiotics, prebiotics and nutraceuticals

### **Unit IV:**

Molecular techniques in detection of food pathogens and GM foods. Biosensors in food  
Food research organizations/institutes in India  
Food sanitation – Microbiology of food plant sanitation, water and milk testing  
Food laws and quality control – HACCP, Codex alimentarius, PFA, FPO, MFPO, BIS, AGMARK.

### **Books recommended**

1. Food Microbiology by W.C. Frazier, D.C. Westhoff, K.N. Vanitha. 5th edition. McGraw Hill Education. 2013.
2. Fundamental Food Microbiology by B. Ray and A. Bhunia. 5th edition. CRC press. 2013.
3. Food Microbiology by M. R. Adams, M. O. Moss, P. McClure. 4th edition. Royal Society of Chemistry. 2015.
4. Food Microbiology: Fundamentals and Frontiers by M. P. Doyle, L. R. Beuchat. 3<sup>rd</sup> Edition
5. Dairy Microbiology by Robinson. Volume II and I.

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**101320110: Virology**

**Course objective:**

The main objective of the course is to make students to understand the taxonomical classification, phenotypic and biochemical identification of various viruses. The course will teach the strategies to develop isolation and preservation of viruses and their life cycle for development of antiviral compounds for the viral infections and the role of various viruses in the development of vaccines etc.

**Course Learning Outcomes:**

**Unit 1:** Student will be able to describe the defining viral attributes, the general properties of viruses, and steps in virus infection cycle. The principles of virus classification, list the virus families, and describe methods of study virus infection. General overview of viral genomes and their types as well as isolation and preservation of viruses.

**Unit 2:** Student will be able to receive information regarding various bacteriophages life cycles, which are model viruses for the study. Applications of phages in therapy; Concern over phage contamination in food & fermentation industry.

**Unit 3:** Students will be able to know various plant and animal viruses and their isolation, preservation and classifications. Student will be able to describe host defense against virus infection and able to describe general characteristics of acute viral infections, pathogenesis of Influenza virus, Polio virus, Measles virus, and Rotavirus infection. Student will be able to describe general characteristics of chronic, persistent, latent infections

**Unit 4:** Student will be able to describe how different antiviral drugs and their mode of action of viruses, student knows how live viral vaccines are made, how inactivated viral vaccines are made, Polio vaccine and story of polio eradication. Student is able to describe antiviral drug discovery process, mechanism of drug resistance and use of interferons for viral infections.

**Contents**

**Unit – I: Prokaryotic Viruses**

- Discovery of bacteriophages, Structure and composition of bacteriophages, Classification
- system of Baltimore & ICTV
- Phage biodiversity, Genome diversity and host- specific interactions
- Isolation and purification by filtration, ultracentrifugation and affinity chromatography
- Plaque assays

- One step growth, single burst and eclipse experiments

### **Unit – II:**

- Life cycle of model bacteriophages infecting *E coli* –  $\lambda$  (lytic lysogenic)
- 7. Life cycle of model bacteriophages:  $\phi$  X 174, M13
- 8. Life cycle of model bacteriophages: T4, T7
- 9. Life cycle of model bacteriophages: Q $\beta$ , Mu
- 10. Applications of phages - therapy; Concern over phage contamination in industry (dairy)

### **Unit –III : Eukaryotic Viruses**

- Discovery and classification of plant and animal viruses, structure of viruses, viroids, virusoids
- Classification of viruses – ICTV and Baltimore classifications
- Host – viruses interactions, permissive/non – permissive hosts; Cytopathic effects
- Isolation and purification of viruses, Cultivation and propagation
- Assay methods – pock assay, hemagglutination assay, transformation assay.
- Structure, Life cycle and Pathogenicity of Gemini virus
- Structure, Life cycle and Pathogenicity of TMV
- Structure, Life cycle and Pathogenicity of Adenovirus
- Structure, Life cycle and Pathogenicity of Rotavirus
- Structure, Life cycle and Pathogenicity of Rubella, Influenza and Measles viruses
- Structure, Life cycle and Pathogenicity of HIV and Hepatitis B Virus

### **Unit –IV: Prevention & control of viral diseases**

- Antiviral compounds and their mode of action,
- Interferon and their mode of action.
- General principles of viral vaccination
- **Applications of Virology:**
- Use of viral vectors in cloning and expression, Gene therapy and Phage display

### **References:**

1. Principles of Virology, (Vol I & II) Flint SJ, Enquist LW, Racaniello VR, Skalka AM Pub ASN Press
2. Introduction to Modern Virology – Dimmock
3. Basic Virology – Wagner
4. Virology – Saravanan
5. Virology – Maharajan
6. Molecular Virology – A. J. Cann
7. An introduction to Viruses – Biswas

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**COURSE CODE: 101320104 (Practicals based on 101320101 and 101320102)**

**Based on Ecology and Biodiversity and Bioanalytical Techniques and Instrumentation**

**List of practicals:**

1. Introductory Aspects of Ecology
2. To determine the Minimum Size of Quadrant by Species-Area-Curve Method
3. To determine the Minimum Number of Quadrant
4. To Study Community Structure/characteristics – Frequency, Density and Abundance of Species by Quadrates (Random Sampling Method)
5. To Study Community Structure/characteristics – Frequency, Density and Abundance of Species by Line Transect Method
6. To Study Community Structure/characteristics – Frequency, Density and Abundance of Species by Belt Transect Method
7. To study various stages ecosystem succession and its role in community assemblance.
8. To study the Vegetation by Point-Frame Method
9. To study the Vegetation by Physiognomic Method (Biological Spectrum Method)
10. Field Visit to Protected Area (National Park / Sanctuary) or Natural Habitat / Ecosystem of Gujarat State (Compulsory)
11. Introduction to pH, buffer preparation, molar, normal and % solutions.
12. Calculations for making stock solution
13. Separation of amino acids by TLC
14. Separation of cells by density gradient centrifugation
15. Determination of partition coefficient

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**COURSE CODE: 101320105 (Practicals based on 101320103 and 101320107)**

**Based on Cell biology and Fundamentals of Biochemistry & Bioenergetics**

**List of Practicals**

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

## Course Credit Scheme

### SEMESTER – II

Course Code	Name of Course	T/P	Credit	Exam Duration in hrs	Component of Marks		
					Internal	External	Total
					Total/Passing	Total/Passing	Total/Passing
101320201	Systematics of Angiosperms	T	04	03	30/10	70/28	100/40
101320202	Plant Reproductive Biology	T	04	03	30/10	70/28	100/40
101320203	Plant Physiology	T	04	03	30/10	70/28	100/40
101320204	Practicals based on PG01CBOT01 and PG02CBOT02	P	04	03	30/10	70/28	100/40
101320205	Practicals based on PG02CBOT03 and PG01EBOTX	P	04	03	30/10	70/28	100/40
101320206	Comprehensive Viva- Voce	P	01			50/20	50/20
101320207	Biostatistics	T	04	03	30/10	70/28	100/40
101320208	Microtechniques	T	04	03	30/10	70/28	100/40
101320209	Omics and Computational Biology	T	04	03	30/10	70/28	100/40
101320210	Plant Tissue Culture	T	04	03	30/10	70/28	100/40
			<b>25</b>				<b>650</b>

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**101320201: Systematic of Angiosperms**

**Course objective:**

This course aims to give comprehensive understanding in angiosperm taxonomy as well as its practice and applications. The ultimate aim of taxonomy is to understand the evolution at work.

**Course Learning Outcomes:**

**Unit 1:** The students are learning the basic knowledge of plants taxonomy with IUCN Red data list and its conservation priorities and its application. Also learn the floras and monograph preparation and literature in taxonomic studies and resources.

**Unit 2:** Be able to learn the naming of the plant through plant nomenclature.

**Unit 3:** Understanding the classification through different cladistics methods like UPGMA, NJ etc and their use and utility.

**Unit 4:** Students learn the phylogeny and classification of angiosperms of system their use and utility. Salient features of vegetational aspects and study of ten dominates family of flora of Gujarat state.

**Contents**

**Unit 1**

Plant taxonomy: Definition, Principles and golas, historical development, scope and importance; taxonomy as a synthetic discipline; applications - IUCN Red List, Conservation priorities. Taxonomy Tools: Herbarium, floras, Monographs, Botanical gardens, GPS, GIS.

**Unit 2**

Nomenclature: Purpose, Principles, and overall knowledge of International Code of Nomenclature for algae, fungi, and plants (ICN) and articles pertaining to typification, publication, priority, author citation and their application.

Cladistics: Introduction – advantages and problems; classical taxonomy as base for molecular systematics; systematics and phylogenetics classifications – use and utility. The choice of molecules in systematics – Nucleic acids, proteins and amino acids.

**Unit 3**

Cladistics (Phylogeny) – concepts, parsimony, cladograms and trees; characters: apomorphic and plesiomorphic characters, homologous vs analogous; character states, binary and multistate characters, characters transformations; morphometric vs molecular characters. Trees - monophly, polyphyly and paraphyly; rooted and unrooted.

**Unit 4**

Sequences – finding homologous sequences and alignment; local vs global alignment; pairwise and multiple sequence alignment. Tree construction – algorithmic (UPGMA and Neighbour Joining) and tree-searching (Parsimony, Maximum Likelihood and Bayesian). Phylogenomics as the modern trend in plant taxonomy.

Flora of Gujarat State: Salient features of vegetational aspects and study of ten dominant families of flora of Gujarat state.

### **REFERENC BOOKS**

1. Barry G. Hall, 2011. *Phylogenetic Trees Made Easy: A How-To Manual*. Fourth Edition. Sinauer Associates, Inc., Publishers, Sunderland, USA.
2. Davis, P.H. and V.M. Heywood. 1963. *Principles of Angiosperm Taxonomy*. Oliver & Boyd, Edinburgh.
3. Douglas Soltis, Pamela Soltis, Peter Endress, Mark Chase, Steven Manchester, Walter Judd, Lucas Majure, and Evgeny Mavrodiev, 2017. *Phylogeny and Evolution of Angiosperms*. University of Chicago Press: 1427 E. 60th Street Chicago, IL 60637 USA.
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11. Nei, M. and S. Kumar, 2000. *Molecular Evolution and Phylogenetics*. Oxford University Press Inc.
12. Peter Skelton and Andrew Smith, 2002. *Cladistics: A Practical Primer on CD-ROM with accompanying booklet by Neale Monks*. Cambridge University Press.
13. Quicke, D.L.J. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie Academic & Professional.
14. Salemi, M. and A.-M. Vandamme, 2003. *The Phylogenetic Handbook. A Practical Approach to DNA and Protein Phylogeny*. Cambridge University Press.
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18. Stuessy, Tod F., 2009. *Plant taxonomy: the systematic evaluation of comparative data (2nd ed.)*. New York: Columbia University Press.
19. Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellogg, Peter F. Stevens, Michael J. Donoghue, 2015. *Plant Systematics: A Phylogenetic Approach, Fourth Edition*. Sinauer Associates, Inc., Publishers, Sunderland, USA.
20. Shah. G.L. 1978. *Flora of Gujarat. Vol.1 and 2*. Sardar Patel University, Vallabh Vidyanagar,

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**101320202: Plant Reproductive Biology**

**Course objective:**

This course aims to give comprehensive understanding the embryogenesis, development of flower and seed development process. Students also learn the developmental biology of male and female gametophytes and pollen –pistil interaction.

**Course Learning Outcomes:**

**Unit 1:** Be able to outline the concepts of development of flower with suitable flower examples and gender expression in monoecious and dioecious plants.

**Unit 2:** Outline of the developmental biology of male and female gametophytes and male sterility- mechanisms and applications.

**Unit 3:** Students learn the pollen-pistil interaction and their self-compatibility mechanisms.

**Unit 4:** Basic idea of embryogenesis and seed development process and apomixis, polyembryony, somatic embryogenesis.

**Contents**

**Unit-I**

Development of flower: Transition to flowering - vegetative to reproductive evocation, floral homeotic mutations in Arabidopsis, Antirrhinum and Petunia, axis development in flower, gender expression in monoecious and dioecious plants.

**Unit-2**

Developmental biology of male and female gametophytes: Regulation of anther and ovule development, microsporogenesis and microgametogenesis, megasporogenesis and megagametogenesis, male sterility- mechanisms and applications, pollen embryogenesis.

**Unit-3**

Pollen-pistil interaction: In vivo and in vitro pollen germination, pollen tube growth and guidance, double fertilization, self-compatibility mechanisms, incongruity.

**Unit-4**

Embryogenesis and seed development: Polarity during embryogenesis, pattern mutants, in vitro fertilization, endosperm development, apomixis, polyembryony, somatic embryogenesis.

#### **REFERENC BOOKS**

1. Fosket DE. (1994) Plant, Growth and Development: A Molecular Approach, Academic Press.
2. Hopkins WG. (2006). The Green World: Plant Development, Chelsea House Publication
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**101320203: Plant Physiology**

**Course objective:**

This course teaches processes of various plant functions such as plant water relationship, mechanism of water absorption, transpiration, ascent of sap, plant movement and absorption of mineral salts, photosynthesis with emphasis on mechanism of abiotic stresses at physiological and molecular level with reference to crop productivity.

**Course Learning Outcomes:**

**Unit 1:** The students are learning the basic knowledge of plant absorption of water and minerals, transpiration and ascent of sap and their cell activity and its application.

**Unit 2:** Be able to learn the photosynthesis activity, their different mechanism and its application crop productivity. Students learn the role of different growth hormones and their application in plant growth and development process.

**Unit 3:** Be able to learn the photoperiodism and vernalization for crop cultivation and their utility.

**Unit 4:** This course also learns the plant movement and stress physiology and their molecular mechanisms.

**Contents**

**UNIT-1**

**Absorption of water, transpiration and ascent of sap:**

- Water – structure, physical properties and significance to plant life
- Movement of materials into and out of cells – diffusion, osmosis, osmotic pressure, plant cell as osmotic systems, significance of osmosis in plants
- Plasmolysis, its advantages and imbibition.
- Mechanism of water absorption - Active (osmotic and non osmotic) and passive absorption. External factors affecting water absorption.
- Transpiration – kinds of transpiration, mechanism of stomatal transpiration and its significance & factors affecting the rate of transpiration, antitranspirants.

- Ascent of Sap, Path of Ascent Sap. Vital theories, root pressure theory, physical forces theory, transpiration pull and cohesion of water theory
- Absorption of mineral salts: - Mechanism of mineral salt absorption – ion-exchange, passive and active absorption, the carrier concept theory.

## UNIT-2

**Photosynthesis:** Photosynthetic apparatus, Photosynthetic pigments and absorption of light energy.

- Excited states of atoms or molecules – Fluorescence, Phosphorescence, Quantum requirement and quantum yield
- Red drop and Emerson's enhancement effect. Photosynthetic units – the Quantosomes, action spectrum.
- Mechanism of photosynthesis : Light reaction (Hill reaction) and Dark reaction (Calvin cycle), Blackman's law of limiting factors, factors affecting photosynthesis, significance of photosynthesis to mankind

## UNIT-3

**Growth & Growth Hormones:** Growth, Kinetics of growth (Growth curve or sigmoid curve). Natural growth hormones - Auxins, Gibberellins, kinetin & cytokinins, ethylene, abscisic acid (ABA) (Discovery, Chemical nature, physiological effects and practical applications).

- **Photoperiodism and Vernalization** – Classification of plants on the basis of photoperiods, importance of photoperiodism. Vernalization – conditions necessary for vernalization, mechanism of vernalization, practical utility of vernalization

## UNIT-4

**Plant Movements and Stress physiology.**

- Movements of locomotion – Autonomic and Paratonic (tactic)
- Movements of curvature – Autonomic and paratonic (tropic) growth movements, Paratonic Variation movements (Nastic movements) and hygroscopic movements.
- Stress physiology – Introduction, water deficit and drought resistance, salt stress and salt resistance, cold injury and cold resistance, chilling injury and chilling resistance, freezing injury (frost) and freezing resistance, high temperature(heat) stress and high temperature(heat) resistance, heavy metal stress and heavy metal resistance.

## REFERENCE BOOKS

1. Jain, V.K. (2007) Fundamentals of plant physiology (10<sup>th</sup> Edition) S. Chand and Co., New Delhi, India. ISBN; 81 - 219 – 0462 – 5, Code; 03 020.
2. S.N. Pandey & B.K.Sinha (2008) Plant Physiology (4<sup>th</sup> Edition) Vikas Publishing House Pvt. Ltd., A-22, Sector-4, Noida (UP), ISBN : 81-259-1879-5.

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**101320207: Biostatistics**

**Course objective:**

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.

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**101320208: Microtechniques**

**Course objective:**

The course will enable the students to understand the principle of microscopy types of microscopy used to explore the knowledge of microtechniques. The measurement of size of microorganisms, sanctioning of the bigger specimens by using microtome, preparation of temporary and permanent slides of the specimen will be known.

**Course Learning Outcomes:**

**Unit 1:** Deals with the concept and principle of microscopy. It provides the understanding of different optical components of microscopy,

**Unit 2:** Enrich 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).

**Unit 3:** Explore the need and methods of measurement of microorganisms by micrometry. The calibration and working with the stage and ocular micrometer. Illustrations and concept of photomicrography will also be known.

**Unit 4:** The concept of killing and fixation agents, dehydration of the specimens, embedding of specimens in paraffin wax, free hand sanctioning, mounting of sanctioned specimen on slide, staining of specimens and different types of staining will be known.

**Contents**

**Unit 1**

Principles of microscopy – eyepiece lens and objective lenses; Magnification, Resolving power, numerical aperture. Mechanical components: base, pillar, stage, sub stage, body tube, focusing knobs, nose pieces. Optical components: mirror, objectives, ocular lens, condenser, Focussing slides under low/ high power and oil immersion.

**Unit 2**

Types of microscopes: Light microscope, Compound microscope, Dark field, Bright field, Interference microscope (Stereo microscope), Confocal, Inverted microscope, Phase contrast

microscope, Fluorescent microscope, Electron microscope: Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM)

### **Unit 3**

Measurement of Microorganisms- Micrometry – Stage micrometer, Ocular micrometer, Calibration and working. Preparation of illustrations using camera lucida, digital camera and photomicrography.

### **Unit 4**

Killing and fixation agents - carnoy's formula, F. A. A.

Dehydration– general account of dehydration (Ethanol, Isopropyl alcohol, Acetone, Glycerine). Ethanol – Xylene series and Tertiary Butyl Alcohol Series

Infiltration – paraffin wax method, Embedding

Free hand sectioning- Microtome (Rotary and sledge) serial sectioning and its significance.

Mounting- A brief account on whole mounting, maceration, smears and squash preparation, application of permanent whole mounts, permanent sections.

Staining- Classification: natural dyes, coal tar dyes, double staining, vital staining; simple, Gram staining, negative staining, capsule staining, spore staining, flagellar staining, nuclear staining and acid fast staining, stains: saffranin, hematoxylin, acetocarmine.

### **References**

1. Plant Microtechnique, Johansen D.A. 1940, Mc Graw – Hill Book Company, Inc. New York.
2. Manual of Microbiology – Tools and Techniques, Kanika S. 2007, Ane's student edition.
3. Botanical Microtechnique; principles and Practice, Khasim S.K., 2002, Capital Publishing Company New Delhi.
4. Essentials of botanical microtechnique, Toji T. 2004, Apex Infotec Publ.
5. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1<sup>st</sup>ed. Wiley-Liss, 2001.
6. R. Marimuthu – Microscopy and Microtechnique, MJP Publishers, 2015.

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**101320209: Omics and Computational Biology**

**Course objective:**

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 1**

**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 2

### **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 3

Biological Literature Information access, storage and retrieval systems- Primary and secondary databases of genomics, transcriptomics, 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 4

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.

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**101320210: Plant Tissue Culture**

**Course objective:**

The students will be technically and critically trained with theory and practical exposure to perform the plant tissue culture, which is the at most required in this field of science; skilled candidates are absorbed in well established and commercial tissue culture units. Students learn the tissue culture techniques have the ability to set up their own laboratories for the propagation of the plants which is the need in the society.

**Course Learning Outcomes:**

**Unit 1:** Student will be able to know about basic of the plant tissue culture starting from principle, Basic requirements, procedure, Components of culture media and role of plant growth regulators and micropropagation and its application.

**Unit 2:** Be learning the different techniques and application of the crop improvement varieties development and also somaclonal and gametoclonal variation methods application to improve crop variety.

**Unit 3:** Students will be learning the Cell culture and production of secondary metabolites from plants.

**Unit 4:** Be able to learn the different steps of the involved in the production of transgenic plant and role of PTC. Gene insertion through *Agrobacterium* spp and its application.

**Contents**

**Unit 1**

Principles of Plant Tissue Culture: Basic requirements and procedure (media preparation, explants sterilization, inoculation, culture conditions, hardening etc.) Components of culture media and role of plant growth regulators (phytohormones) Basic principle of micropropagation

(totipotency). Difference between direct and indirect organogenesis. Selection of different explants and application of PTC.

## **Unit 2**

Detail Techniques and Applications of PTC: Haploid production: Androgenesis and gynogenesis, pollen embryos, haploid production through distant hybridization, diploidization to raise homozygous diploids, applications. Embryo culture and its applications. Somatic embryogenesis and its application. Method to develop seedless triploid variety through endosperm culture technique. Somaclonal and gametoclonal variation: Principle, method and application to improve crop variety.

## **Unit 3**

Detail Techniques and Applications of PTC : Protoplast culture: Isolation of protoplast, method of somatic hybridization, identification of hybrid protoplast, culture of hybrid protoplast, cybrid production and their applications. Virus eradication through apical meristem culture and micrografting methods. Cell culture and production of secondary metabolites.

## **Unit 4**

Gene Insertion and Production of Transgenic Plant: Steps involved in the production of transgenic plant and role of PTC. Types of explants selected and different techniques for gene insertion. Gene insertion through *Agrobacterium* spp. Process of natural plasmid transformation and limitations, Structure of Ti/Ri plasmids, Construction of binary and co-integrated vectors, Co-culture method, Tri-parental mating. Application of transgenic plants (herbicide resistance, photosynthesis, stress resistance etc.).

## **REFERENC BOOKS**

1. Plant Biotechnology: Practical Manual, C.C. Giri & Archana Giri, IK international, S25, Green park Extension, Uphaar Cinema Market, New Delhi-110016.
2. Experiments in Plant tissue culture- John H. Dodds and Lorin W. Robert.
3. Plant tissue culture : Theory and Practice- S.S. Bhojwani and M.K. Razdan (1996) Elsevier, Amsterdam.
4. Plant propagation by tissue culture- George and Sherington.
5. Plant cell, tissue and organ culture- O.L. Gamborg and G.C. Phillips.
6. Plant tissue culture and molecular biology application and prospects-P.S. Srivastava.
7. Micropropagation by plant tissue culture –Reinert and Bajaj.
8. Plant tissue culture- S. Narayanswamy.
9. Introduction to plant tissue culture- M.K. Razdan.
10. Plant tissue culture: Applications and Limitations- S.S. Bhojwani (1990) Elsevier, Amsterdam.

**CHARUTAR VIDYAMANDAL UNIVERSITY**  
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**COURSE CODE: 101320204 (Practicals based on 101320201 and 101320202)**

**Based on Systematic of Angiosperms and Plant Reproductive biology**

**List of practicals:**

1. Writing of technical descriptions.
2. Construction of keys.
3. Identification of local species using Floras, keys and campus field trips.
4. Identification of 25 families using diagnostic characters; diagnostic characters to be illustrated.
5. Construction of phylogentic tree based on gene sequences available at NCBI database.
6. Study of the stages of pollen and ovule development in the wild and mutant plants using permanent slides, electron micrograph and available phenotypes.
7. Pollen in vitro germination methods: Sitting drop culture, suspension culture, surface culture.
8. Correlation between fertility (stainability), viability (TTC and FDA staining) and germinability (in vitro) of pollen grains.
9. Assessment of stigma receptivity by localizing peroxidases, non-specific esterases and phosphatases.
10. Aniline blue fluorescence method to localize pollen tubes to study different aspects of pollen-pistil interaction.
11. Study of post-fertilization stage with the help of permanent slides and electron micrographs.
12. Dissection of embryo and endosperm.

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**COURSE CODE: 101320205 (Practicals based on 101320203 and 101320207)**

**Based on Plant Physiology and Biostatistics**

**List of Practicals**

1. Demonstration the phenomenon of osmosis using potato osmoscope.
2. Measurement of diffusion pressure deficit of plant cell.
3. Demonstrate the phenomenon of Imbibitions.
4. Determination of osmotic pressure of cell sap by plasmolytic method.
5. To demonstrate the transpiration by four leaves method.
6. Measurement of root pressure and water lifting power of transpiration.
7. To demonstrate O<sub>2</sub> evolved during photosynthesis by inverted funnel method.
8. To compare rate of photosynthesis under different conditions.
9. Demonstration of CO<sub>2</sub> is necessary for photosynthesis (By Moll's half leaf experiment.
10. Separation of Chloroplast pigments by TLC / Paper Chromatography.
11. Demonstration of plant movements.
12. To convert ungrouped data in to grouped data using Sturge's formula.
13. To study representation of data by one dimensional diagram.
14. To study representation of data by two dimensional diagram.
15. To study representation of data by means of graphs. (Histogram & frequency polygon).
16. To study the data representation by graphs (Frequency polygon & frequency curve).
17. To study how to calculate descriptive statistics for the given data. (Mean mode, median, standard deviation and mean deviation).
18. To study the concept of permutation and combination in practical counting problems.
19. To study the concept of normal distribution and apply it to practical problems.
20. To study the concept of estimation (point estimation and interval estimation).
21. To apply the concept of skewness in the field of biosciences.
22. To apply the concept of F- test for biological problems.
23. To apply the concept of  $\chi^2$  – test for biological problems.

## Course Credit Scheme

### SEMESTER – III

Course Code	Course Title	T / P	No. of Credits	Class room/lab hrs per week	Exam Duration in hrs	Component of Marks		
						Internal/ Passing	External /Passing	Total/ Passing
101320301	Plant Biotechnology	T	4	4	3	40/16	60/24	100/40
101320302	Phytochemistry and Pharmacogony	T	4	4	3	40/16	60/24	100/40
101320303	Genetics and crop improvement	T	4	4	3	40/16	60/24	100/40
101320304	Lab I (Practicals based on 101320301 and 101320302)	P	4	6	3	40/16	60/24	100/40
101320305	Lab II (Practicals based on 101320303 and 101320307)	P	4	6	3	40/16	60/24	100/40
101320306	Comprehensive Viva	P	1				50/20	50/20
101320307	Bioinformatics	T	4	4	3	40/16	60/24	100/40
101320308	Pathogens and Pests of Crop Plants	T	4	4	3	40/16	60/24	100/40
101320309	Chemoinformatics	T	4	4	3	40/16	60/24	100/40
101320310	Environment Impact Assessment	T	4	4	3	40/16	60/24	100/40
	Summer Training	P	2					

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

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### **101320301: Plant Biotechnology**

#### **Course objective:**

The students will be technically and critically trained with theory and practical exposure to perform the plant biotechnology, which is the at most required in this field of plant science; skilled candidates are absorbed in well established and commercial plant based biotechnology industry. Students learn the plant biotechnology techniques have the ability to set up their own laboratories for the propagation of the plants and crop improvement which is the need in the society.

#### **Course Learning Outcomes:**

- 1: Student will be able to know about basic of the plant tissue culture starting from principle, basic requirements, procedure, components of culture media and role of plant growth regulators and micropropagation and its application. Be learning the different techniques of *in vitro* morphogenesis and application of the crop improve variety.
- 2: Be able to learn the different technique of the gene transfer through *Agrobacterium* spp and its application and also different technique of the gene transfer technique.
- 3: Students will be learning the secondary metabolites production using different techniques and Cell culture and production of secondary metabolites from plants.
- 4: Be able to learn the different steps of the involved in the production of transgenic plant and its application.

#### **Contents**

##### **Unit -1**

Plant biotechnology present scenario, Micropropagation and its application; Types of different organ culture and its application; Somaclonal variation: Introduction, Different pathways of somaclonal variation; factor affecting of somaclonal variation, Detection of somaclonal variation; Somaclonal variation its application in crop improvement.

##### **Unit -2**

Chloroplast transformation: Structure of chloroplast; Plastid chromosome; Transformation methods-Agrobacterium mediated transformation, Particle gun method, Gene replacement, Gene insertion; Limitation of chloroplast transformation; Application of chloroplast transformation.

### Unit -3

Secondary metabolite: Role of secondary metabolites, Basic biosynthetic pathways, Techniques used in biosynthesis, Source of secondary metabolites; criteria for cell selection, factor affecting the culture of cells, Different bioreactors and their use in secondary metabolites production, Production of bioactive secondary metabolites by plant tissue culture.

### Unit-4

Transgenic plants production: Development of abiotic (Insect, Disease, Herbicide) and biotic (Drought) resistant plants.

Peptide production, biodegradable plastic and edible vaccine.

DNA barcoding in plants its application.

### Reference Book

- An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.
- Plant biotechnology – J Hammond, et. al., Springer Verlag.
- Biotechnology in crop improvement – H S Chawla.
- Practical application of plant molecular biology – R J Henry, Chapman & Hall. ¾
- Elements of biotechnology – P K Gupta.
- Plant propagation by tissue culture: The technology (Vols. 1 & 2) – Edwin George.
- Applied and fundamental aspects of plant cell tissue and organ culture edited by Reinert & Bajaj Y P S, Springer Verlag.
- Plant cell and tissue culture – S Narayanswamy, Tata Mc Graw Hill Co.
- Introduction of plant biotechnology – H.S. Chawla. Third Edition; Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- <http://pnrsolution.org/Datacenter/Vol3/Issue2/291.pdf>
- <https://www.sciencedirect.com/science/article>

### PRACTICAL

1. Media preparation
2. Mass multiplication of banana
3. *Agrobacterium tumefaciens* mediated plant transformation
4. Embryo dissection and culture
5. Isolation of Chloroplast
6. DNA isolation of plant material

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**101320302: Phytochemistry and Pharmacognosy**

**Course objective:**

The students will be technically and critically trained with theory and practical exposure to perform the phytochemistry and pharmacognosy, which is the at most required in this field of herbal medicine science; skilled candidates are absorbed in well established and commercial plant based herbal industry. Students learn the phytochemistry and pharmacognosy techniques have the ability to set up their own laboratories and industry for the herbal medicine production which is the need in the society.

**Course Learning Outcomes:**

- 1: Student will be able to know about basic of the pharmacognosy and sources of the drug and their classification.
- 2: Be able to learn the different technique of the isolation and properties of active drug from different source of drugs and its therapeutic application.
- 3: Students will be learning the quality control of crude drugs and different methods of evaluation of crude drugs.
- 4: Be able to learn the systematic pharmaceutical studies of carbohydrates and derived products and its therapeutic uses.

**Contents**

**Unit 1**

General Introduction: Definition, history, scope and development of Pharmacognosy Sources of drugs: Biological, marine, mineral and plant tissue cultures as sources of drugs Classification of drugs: Alphabetical, morphological, taxonomical, chemical and pharmacological classification of drugs.

**Unit 2**

Isolation and properties of active Drug: Occurrence, distribution, organoleptic evaluation, active constituents of drugs: their isolation, classification and properties including tests of drugs: Antineoplastic, Antidiabetics, Diuretics, Antiseptic and disinfectants, Antimalarials, Oxytocics.

**Unit 3**

Quality control of crude drugs: Classification of crude drug, scheme for pharmacognostic studies of crude drug, drug Adulteration, Methods for drug evaluation, organoleptic, Microscopic, chemical evaluation, biological testing of herbal drug, phytochemical investigations.

#### **Unit 4**

Pharmacognostic study: Systematic Pharmaceutical Studies of following Carbohydrates and derived products: agar, guar gum acacia, Honey, Isabgol, pectin, Starch, sterculia and Tragacanth. Lipids: Bees wax, Castor oil, Cocoa butter, Cod-liver oil, Hydnocarpus oil, Kokum butter, Lard, Linseed oil, Bran oil.

#### **REFERENC BOOKS**

1. Mukherjee Pulok, Quality Control of Herbal Drugs, Business Horizons Limited, New Delhi.
2. J.B. Harborne, Chapman and Hall, Phytochemical methods, International Ed., London.
3. Modern methods of plant analysis by Peach and Tracey, Vol. II, IV, Springer Verlag.
4. G.E. Trease and W.C. Evans., Pharmacognosy, Harcourt Publishers Ltd. UK.
5. Chaudhari R.D., Herbal Drug Industry, Eastern Publication.
6. Quality Control Methods for medicinal plant material, WHO Geneva.
7. S.S. Agrawal and M. Paridhavi, Herbal Drug technology, Orient Longman
8. Indian Herbal Pharmacopoeia, Vol. I- II, S.S. Handa, RRL Jammu Tawi, and IDMA Mumbai.
9. The Aurvedic Pharmacopoeia of India, 1999. Government of India, Ministry of Health and Family Welfare, Department of Indian Systems of Medicine and Homeopathy, New Delhi.
10. Houghton P, Mukherjee PK. Evaluation of Herbal Medicinal Product, Pharmaceutical Press, London, 2009.
10. [http://www.ayurvedjournal.com/JAHM\\_201513](http://www.ayurvedjournal.com/JAHM_201513)
11. <https://www.glocaluniversity.edu.in/eBpharm>

#### **Practical**

1. Basic phytochemical procedures, extraction methods using Soxhlet extractor.
2. Separations of compound using thin layer chromatography or HPTLC.
3. Drugs with carbohydrate content study from plants materials.
4. Drugs with alkaloid content study from plants materials and test.
5. Drugs with terpenoid content study from plants materials and test.
6. Drugs with saponin content study from plants materials and test.
7. Comparison of fixed oils derived from different drugs with TLC

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**101320303: Genetics and Crop Improvement**

**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 signaling mechanism and acquainted with cell cycle, its regulation and apoptosis.

**Course Learning Outcomes:**

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.

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 secretory 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.

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 signaling pathways which regulate apoptosis process.

**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
- 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
- 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
- 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.
- <https://www.frontiersin.org/articles/10.3389/fpls>
- <https://www.nhbs.com/en/practical-applications-of-plant-molecular-biology-book>

## **PRACTICAL**

1. Isolation of DNA from plant material.
2. Quantification of DNA using spectrophotometer.
3. Isolation of plasmid DNA by Boiling / lysis method.
4. Size determination and fractionation of nucleic acids – Agarose gel Electrophoresis.
5. Different variant identified using RAPD marker.
6. Transformation of plasmid DNA by using CaCl<sub>2</sub>.

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**101320304: Lab I (Practicals based on 101320301 and 101320302)**

1. Media preparation
2. Mass multiplication of banana
3. *Agrobacterium tumefaciens* mediated plant transformation
4. Embryo dissection and culture
5. Isolation of Chloroplast
6. DNA isolation of plant material
7. Basic phytochemical procedures, extraction methods using Soxhlet extractor.
8. Separations of compound using thin layer chromatography or HPTLC.
9. Drugs with carbohydrate content study from plants materials.
10. Drugs with alkaloid content study from plants materials and test.
11. Drugs with teiterpene content study from plants materials and test.
12. Drugs with saponin content study from plants materials and test.
13. Comparison of fixed oils derived from different drugs with TLC

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**101320305: Lab II (Practicals based on 101320303 and 10132030X)**

1. Isolation of DNA from plant material.
2. Quantification of DNA using spectrophotometer.
3. Isolation of plasmid DNA by Boiling / lysis method.
4. Size determination and fractionation of nucleic acids – Agarose gel Electrophoresis.
5. Different variant identified using RAPD marker.
6. Transformation of plasmid DNA by using CaCl<sub>2</sub>.

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**101320306: COMPREHENSIVE VIVA (BASED ON ALL  
THEORY PAPERS)**

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**101320307: 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:**

- 1: 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.
- 2: 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.
- 3: 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.
- 4: 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.

**Contents**

**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, xenologues.

## **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 (2<sup>nd</sup> 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.
11. <https://www.sciencedirect.com/topics/chemistry/molecular-modeling>
12. <https://www.nature.com/subjects/functional-genomics>

**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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**101320308: Pathogens and Pests of Crop Plants**

**Course Objectives:**

The course will enable the students to understand the concept of pathogens and pests of crop plants, various causes of the plants disease in different crops. This course will enable to students for general characteristics of plant pathogenic organisms and pests including bacteria, fungi, viruses, insects and nematodes. Students will also able to know the economically important causative agents with specific references to crop plants and control measures for plant diseases.

**Course Learning Outcomes:**

- 1: General characteristics of plant pathogenic organisms and pests including bacteria, fungi and viruses.
- 2: General characteristics of plant pathogenic organisms and pests including insects and nematodes.
- 3: Case studies of economically important causative agents with specific references to crop plants.
- 4: Control measures for plant diseases and molecular mechanisms and signaling pathways in plant defenses.

**Contents**

**Unit 1**

General characteristics of plant pathogenic organisms and pests including bacteria, fungi and viruses with reference to the following:

- Life cycles
- Nature of disease(s) and damage caused
- Host range
- Control mechanisms based on genetics, chemical treatments, biological control and genetic engineering.

**Unit 2**

General characteristics of plant pathogenic organisms and pests including insects and nematodes with reference to the following:

- Life cycles

- Nature of disease(s) and damage caused
- Host range
- Control mechanisms based on genetics, chemical treatments, biological control and genetic engineering.

### **Unit 3**

Case studies of economically important causative agents with specific references to crop plants:

- Plant-virus interactions with emphasis on potyviruses and horticultural crops.
- Plant-bacterial interactions with emphasis on *Erwinia* sp. and potatoes.
- Plant-fungus interactions with emphasis on *Magnaporthe* sp. and rice.
- Plant-nematode interactions with emphasis on *Meloidogyne* sp. and tomato.
- Plant-Insect interactions with emphasis on *Pieris* sp. and crucifers.

### **Unit 4**

Control measures for plant diseases. Chemical control, biological control and integrated disease and pest management. Host- pathogen interactions, plant defense mechanisms. HR and SAR in plant defense. Molecular mechanisms and signaling pathways in plant defenses.

### **REFERENC BOOKS**

1. Alexopoulos, C. J., Mims, C. W. and Blackwel, M., *Introductory Mycology*, John Wiley & Sons Inc.
2. Mandahar, C. L. *Introduction to Plant Viruses*. Chand & Co. Ltd., Delhi.
3. Mehrotra, R. S. and Aneja, R. S. *An Introduction to Mycology*. New Age Intermediate Press.
4. Rangaswamy, G. and Mahadevan, A. 1999. *Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh R S. *Plant diseases*. 6th edition. Oxford and IBH, New Delhi
6. Singh R.S. *Principles of plant pathology*. 3rd edition. Oxford and IBH, New Delhi
7. H C Dube: *An introduction to Fungi*. (Fourth edition) Scientific publishers (India)
8. Agrios GN (2005) *Plant Pathology*, 5th Edition.
- 9.. Buchanan B, Gruissem G and Jones R (2000) *Biochemistry and Molecular Biology of Plants*", American Society of Plant Physiologists, USA.

10. <https://u.osu.edu/cardina.2/files/2017>

11. <https://www.mdpi.com/1999-4915/12/2/132/htm>

## **PRACTICAL**

1. Methods of sterilization; Media preparation (selective media); inoculation procedures.
2. Characterization of disease symptoms and identification of pathogenic organisms.
3. A study on effects of various formulation and doses of BTK on growth and development of selected pest species.
4. Isolation and identification of rhizosphere soil fungi, seed borne fungi
5. Isolation and estimation of DNA from fungus
6. Estimation of total phenols and O-dihydroxyphenols in sugarcane and groundnut
7. Estimation of activity of Phenylalanine ammonia lyase in healthy and diseased leaves of sugarcane
8. Estimation of deoxyribonuclease and ribonuclease enzymes produced by virus infected and healthy leaves of tobacco

**CHARUTAR VIDYAMANDAL UNIVERSITY**  
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**M. Sc BOTANY**  
**SYLLABUS EFFECTIVE FROM: JUNE-2020-21**  
**101320309: Chemoinformatics**

**Course Objectives:**

The course will enable the students to understand the concept of organization of chemical structure and methods for chemical structure determination. Knowledge of three dimensional structure of chemical and application of chemoinformatics in drug designing. Pharmacokinetics action of drugs on human body and concept of molecular mechanics energy function and application of energy minimization. Molecular modeling in drug discovery and drug designing tools.

**Course Learning Outcomes:**

- 1: Students learn the application of chemoinformatics in drug designing and manipulations in 2D and 3D structures of chemical compounds.
- 2: Development of drug, drug life cycle, drug development time lines and their different steps.
- 3: Students learn about the molecular modeling and drug design and its application.
- 4: Molecular dynamics simulation methods and drug designing related applications.

**Contents**

**Unit-1**

Introduction, history and applications of cheminformatics; Representation of chemical compounds, manipulations in 2D and 3D structures of chemical compounds, representation of chemical reactions, molecular descriptors, calculations of physical and chemical data, calculations of structural deciphers.

**Unit-2**

Development of drug, drug life cycle, drug development time lines, stages of drug discovery, strategic issues in drug discovery, emerging approaches to drug design and discovery, drug metabolism physicochemical properties, 22 days pharmacokinetic action of drug on human body.

**Unit-3**

Molecular Modeling and Drug Design: Concepts in Molecular Modeling, Molecular Mechanics, Derivatives of molecular mechanics energy function, Application of energy minimization.

**Unit-4**

Molecular Dynamics Simulation Methods, Drug Designing Related Applications: Molecular Simulations, Molecular Modeling in Drug Discovery, Structure Activity Relationship, Drug designing softwares.

## REFERENC BOOKS

- Andrew R Leach and Valerie J. Gillet. (2007). Introduction to Chemoinformatics. Springer publications.
- Chemoinformatics (2003) by Johann Gasteiger and Thomas Engel. Wiley Publisher.
- Frank Jensen. (1999). Introduction to Computational Chemistry. John Wiley & Sons Ltd.
- Johann Gasteiger and Thomas Engel. (2003). Cheminformatics. WILEY-VCH Verlag GmbH & Co, KgaA, Weinheim.
- Vyas SP and Khar RK. (2002). Targeted and Controlled Drug Discovery. 1st edn, CBS Publisher and distributors (New Delhi)
- Drug design: Structure and ligand based approaches (2010) by Kenneth M Merz, Jr, Dagmar Ringe, Charles H. Reynolds. Cambridge University press Publisher.
- Molecular modeling for Beginners: 2nd edition (2008) by Alan Hinchliffe. Wiley Publisher.
- Basics Pharmacokinetics and Pharmacodynamics: An integrated Textbook and computer simulations (2011) by Sara E, Rosenbaum. Wiley Publisher.
- Fenniri, H. (2000). Combinatorial Chemistry – A practical approach. Oxford University Press, UK.
- Lednicer, D. (1998). Strategies for Organic Drug Discovery Synthesis and Design. Wiley International Publishers.
- Gordon, E.M. and Kerwin, J.F. (1998). Combinatorial chemistry and molecular diversity in drug discovery. Wiley-Liss Publishers.
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- <https://udel.edu/~arthij/MD.pdf>

## PRACTICAL

1. Relational Chemical Databases: Creation, Management, and Usage
2. Compound Library Creation
3. Compound Library Analysis
4. Normalization of Descriptor Value
5. Data Analysis and Visualization

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**SYLLABUS EFFECTIVE FROM: JUNE-2020-21**

**101320310: Environment Impact Assessment**

**Course Objectives:**

The course will enable the students to understand the concept of environmental impact assessment and their application. Knowledge of different methods of the environmental impact assessment. Student acquired the knowledge of the industries and environmental guidelines EIA. Environmental auditing, environmental clearance for industries and their legislation.

**Course Learning Outcomes:**

- 1: Students learn the application of environmental impact assessment and assessment of methodologies.
- 2: Environmental impact assessment and their commonly used methodologies and its application.
- 3: Students learn about the industries and environmental guidelines and its application.
- 4: Environmental auditing, EIA notification and Indian policies for EIA environmental legislation.

**Contents**

**Unit 1**

Environmental Impact Assessment (EIA): Introduction, Basic elements and methods General Aspects: EIA study -Aim, Types of organizations, Contents; Prediction of changes – Air quality, Water quality, Noise, Biological, Cultural, Socio-economic Components of EIA: Screening, IEE (Initial Environmental Examination), Scoping, Terms of Reference (TOR), EIA report; Assessment of methodologies – Mitigation measures, Review of draft, Impact monitoring and Evaluation, Overall assessment and Selection of methods.

**Unit 2**

Environmental Impact Assessment (EIA): Commonly Used Methodologies: Ad-hoc method, Map overlay method, Matrices, Delphi method Less Commonly Used Methodologies: Content analysis, Survey methods, Strategic Impact and Assumption Identification (SIAM) method, Priority Trade-off Scanning (PTS) approach, Sondheim method Emergency Methodologies: Cross Impact Analysis (CIA), Impact Tree Analysis (ITA), Modelling, Computerization, Analysis framework.

### Unit 3

Industries and Environmental Guidelines: Ecological Sensitive Areas (ESAs), Site criteria, EIA purpose and preparation, Environmental master plan, Liquid effluents, Air pollutants, Solid waste, Noise and vibration, Occupation system and health, Human settlements, Transport system, Recovery and rescue of waste products, Vegetation cover, Environmental Management Planning Cell (EMPC); Criteria for EIA of Water-related projects: Environmental setting, Indicators of water quality, Biological factors, Ecological indicators, Laboratories studies, Field survey, Data collection, Recent approaches, Carrying capacity Criteria for Transport-related EIA: Scope; Individual Impact Assessment (IIA) – Noise, Air-craft noise, Road-traffic noise, Air pollution, Land abuse.

### Unit 4

Environmental Auditing: Importance, Concepts, Components, Assessment, Verification, Objectives, Enterprising, Environmental consciousness, Regulatory, Methods, Pre-audit activities, On-site activities, Post-audit activities, Environmental audit Environmental Clearance for Industries: Environmental clearance, EIA notification, Projects for Central government, Composition of expert committees, Projects for State government, Procedure for environmental clearance, Industrial licensing, Preparation of documents, Environmental appraisal, Siting guidelines for industries, Indian policies for EIA Environmental Legislation: Indian constitution and environment; Environmental policy of India and legislative framework – Policy monitoring and control, Central Pollution Control Board (CPCB).

### REFERENC BOOKS

- Environmental Impact Assessment and Management by BB Hosetti and A Kumar. 1998. Daya Publishing House, Delhi. (ISBN 81-7035-182-0)
- Environmental Impact Assessment by SA Abbasi and DS Arya, 2004. Discovery Publishing House, New Delhi. (ISBN 81-7141-554-7)
- Shyam Divan and Armin Rosencranz, 2005, Environmental Law and Policy in India, Oxford University Press, New Delhi, 2005
- Leelakrishnan. P, 2008, Environmental Law Case Book ,Lexis Nexis, Butterworths
- Mohanty. S. K., 2011, Environment and Pollution Law, Universal Law Publishing Co.Pvt. Ltd.
- Shastri S C, 2008, Environmental Law, (2nd Edn.), Eastern Book Company, Lucknow
- Singh Gurdip, 2004, Environmental Law in India, Mcmillan& Co.
- Shantakumar S,2005 Introduction to Environmental Law, (2nd Edn.), Wadhwa& Company, Nagpur
- Sahasranaman P B, 2008 Handbook of Environmental Law in India, Oxford University Press (India)
- [http://moef.gov.in/wpcontent/uploads/2017/06/moef\\_gov.html.pdf](http://moef.gov.in/wpcontent/uploads/2017/06/moef_gov.html.pdf)
- [https://thefactfactor.com/facts/law/civil\\_law/environmental\\_laws](https://thefactfactor.com/facts/law/civil_law/environmental_laws)

## **Practical**

1. Introduction of EIA.
2. Industry sector project
3. Mining project
4. Port harbor project
5. River valley and hydro project
6. Stage -1 of River valley and hydro project
7. Stage -2 of River valley and hydro project
8. New town project
9. New construction site project
10. New industrial estates project

## Course Credit Scheme

### SEMESTER – IV

Course Code	Course Title	T / P	No. of Credits	Class room/ lab hrs per week	Exam Duration in hrs	Component of Marks		
						Internal/ Passing	External /Passing	Total/ Passing
101320401	Applied Botany	T	4	4	3	40/16	60/24	100/40
101320402	Gene Regulation and Genetic Engineering	T	4	4	3	40/16	60/24	100/40
101320403	Lab I (Practicals based on 101320401 and 101320403)	P	4	4	3	40/16	60/24	100/40
101320404	Comprehensive Viva	P	1				50/20	50/20
101320405	Dissertation	P	12				300/120	300/120
	<b>OR</b>							
101320406	Nutraceutical and Functional Foods	T	4	4	3	40/16	60/24	100/40
101320407	IPR and Biosafety	T	4	4	3	40/16	60/24	100/40
101320408	Lab II (Practicals based on 101320406 and 101320407)	P	4	6	3	40/16	60/24	100/40

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**101320401: Applied Botany**

**Course Objectives:**

The objective of this course is to make students understand the horticulture and landscaping techniques, industrial use of microbes and phytopathology and medicobotany. This knowledge will then be used to meet the main objective of this course, which is to make the student understand the different techniques of the horticulture, industrial use of microbes and medicobotany.

**Course Learning Outcomes:**

- 1: Students should be able to acquire basic knowledge of horticulture, landscaping and floriculture techniques.
- 2: Students should know about different application of the organisms in the industrial use of microbes and Phytopathology.
- 3: Students should have understood the traditional systems of medicine and its application and pharmacognosy and their classification of crude drugs and adulteration.
- 4: Student should have learnt the general methods of extraction and isolation, eluotropic series of solvent and advanced method using identification of chemical compound.

**Contents:**

**Unit- I**

**Horticulture and Landscaping :** Ornamental plant- Diversity, types, sources and production practices for - Ornamental Foliage - Ornamental Shrub, Hedges - Ornamental Climbers - Ornamental Trees ; Landscaping: Principles and elements of design, scope and types of landscaping, use of plants in landscaping; Floriculture: Components of floriculture; current scenario at world and national level; Floriculture of Rosa, Gladiolus, Gerbera, Tuberose, Dianthus.

**Unit – II**

**Industrial use of microbes and Phytopathology:** Algal culture (type), Different methods of isolation, Conditions for growing and maintaining cultures, Media components, Cultivation of Chlorella in open ponds; Use of different substrates and their processing for Mushroom cultivation; Classification of diseases, Epidemiology of plant diseases, Horizontal and vertical resistance, Mechanism of penetration and process of disease development, Plant diseases caused by biotic agents (Fungal, Viral, Bacterial, Mycoplasmal), Defense Mechanisms, Biopesticides (Microbials, Botanicals) & Biofertilizers.

**Unit – III**

**Medicobotany** - Traditional systems of medicine – principles & literature – Ayurveda, Unani, Homeopathy, Siddha. Plants in medicine: Origins of pharmacognosy, the scope and practice of pharmacognosy, crude drugs, classification of crude drugs, commerce of drugs, Adulteration.

#### **Unit-IV**

**Medicobotany** – General Methods of Extraction and Isolation, General methods of extraction, eluotropic series of solvents. Methods of isolation, various chromatographic methods, Methods of identification, spectrometry, methods of isolation and analysis of sugars, polysaccharides, organic acids and triacyl lipids.

#### **REFERENC BOOKS**

- Hartmann and Kester's Plant Propagation: Principles and Practices (7th Edition)
- Agrios G. N. ( 2007) Plant Pathology. Pub. by American Phytopath. Soc.
- Punja Z.K. De Boer S.H. and Sanjacon H. (2008) Biotechnology and Plant Diseases Management. Pub. Pacific Agri food Research centre Agriculture and Agrifood, Canada.
- Smith K.M.(1990) Plant Viruses, Universal Book Stall Delhi
- Singh R.S. (2008) Plant diseases. Oxford and IBH Pub, Delhi.
- Mehrotra R.S., Aggarwal A. (2003) Plant Pathology Mc Graw Hill
- Robinson, T. (1981). The Organic Constituents of Higher Plants. Cordus Press, Mass.
- Sabnis, S.D. and Daniel M. (1990). A Phytochemical Approach to Economic Botany, Kalyani Publishers, New Delhi.
- Stumpf, P.K. and Conn. E.E. (1980). The Biochemistry of Plants. Vol.1-14, Academic Press, London.
- Daniel, M. (2005). Medicinal Plants : Chemistry and Properties Oxford & IBH Publishers, New Delhi.
- <https://www.sciencedirect.com/science/article/pii/S0038071714003678>
- [https://medium.com/@preetisharma\\_51610/floriculture](https://medium.com/@preetisharma_51610/floriculture)

#### **Practical**

1. Demonstration of different techniques of grafting.
2. Cultivation of algae
3. Cultivation of mushroom
4. Separations of compound using thin layer chromatography.
5. Detection of compound using spectrometry.
6. Isolation of different sugar from plant material.

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**SYLLABUS EFFECTIVE FROM: JUNE-2020-21**  
**101320402: 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:**

- 1: Students should be able to acquire basic knowledge of regulation of prokaryotic gene expression at different levels.
- 2: Students should know about different types of enzymes and vectors that are used in recombinant DNA technology.
- 3: 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.
- 4: 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 4 th Edition – Glick and Pasternak
4. Principles of Gene Manipulation and Genomics 7 th 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
8. <https://www.sigmaaldrich.com/technical-documents/protocols/biology/>
9. <https://www.nhbs.com/en/principles-of-gene-manipulation-and-genomics-book>

**Practicals:**

1. Isolation of plasmid DNA by boiling lysis method.
2. Isolation of plasmid DNA by Alkaline lysis method.
3. Large scale preparation of plasmid with chloramphenicol amplification.
4. Preparation of competent cells of E.coli
5. Transformation of artificially induced competent cells of E.coli by plasmid DNA.
6. Cloning of gene in E.coli
7. Expression of cloned gene.
8. Restriction digestion.
9. Demonstration of DNA amplification by PCR

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**101320403: Lab I (Practicals based on 101320401 and 101320402)**

**Practical**

1. Demonstration of different techniques of grafting.
2. Cultivation of algae
3. Cultivation of mushroom
4. Separations of compound using thin layer chromatography.
5. Detection of compound using spectrometry.
6. Isolation of different sugar from plant material.
7. Isolation of plasmid DNA by boiling lysis method.
8. Isolation of plasmid DNA by Alkaline lysis method.
9. Large scale preparation of plasmid with chloramphenicol amplification.
10. Preparation of competent cells of E.coli
11. Transformation of artificially induced competent cells of E.coli by plasmid DNA.
12. Cloning of gene in E.coli
13. Expression of cloned gene.
14. Restriction digestion.
15. Demonstration of DNA amplification by PCR

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**101320404: COMPREHENSIVE VIVA (BASED ON ALL  
THEORY PAPERS)**

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**101320405: DISSERATION**

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**SYLLABUS EFFECTIVE FROM: JUNE-2020-21**  
**101320406: Nutraceuticals and Functional Foods**

**Course Objectives:**

The course will enable the students to understand the concept of nutraceutical and functional foods and its application. This course will enable to students for general characteristics of functional food and non-nutritive food components with potential health effects. Source and role of the functional role with suitable examples. Nutritional genomics **using** production technology for recombinant therapeutic products using E.coli with examples. Plants as bioreactors as a tool for production of Nutraceuticals.

**Course Learning Outcomes:**

- 1: General characteristics of functional foods and nutraceutical food and their potential health effects.
- 2: Functional foods source and role with suitable example and their health effects.
- 3: Production technology for recombinant therapeutic products using E.coli with examples.
- 4: Plants as bioreactors as a tool for production of Nutraceuticals and pharmaceutical and industrial uses.

**Contents**

**Unit 1**

**Functional Foods-1:** Definition, Relation of functional foods & Nutraceutical (FFN) to foods & drugs. Applications of herbs to functional foods. Concept of free radicals and antioxidants; Nutritive and Non-nutritive food components with potential health effects. Effect of processing on Nutrients. Soy proteins and soy isoflavones in human health; Role of nuts in cardiovascular disease prevention. Functional foods from wheat and rice and their health effects. Role of Dietary fibers in disease prevention.

**Unit 2**

**Functional Foods-2:** Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols, polyunsaturated fatty acids, sphingolipids, lecithin, choline. terpenoids. Vegetables, Cereals, milk and dairy products as Functional foods. Health effects of common beans, Capsicum annum, mustards, Ginseng, garlic, grape, citrus fruits, fish oils, and sea foods.

**Unit 3**

**Nutritional Genomics:** Production technology for recombinant therapeutic products using E.coli with examples like human insulin, growth hormones, interferons, erythropoietin.

## Unit 4

Plants as bioreactors as a tool for production of Nutraceuticals. 'Tailor-made' carbohydrates and lipids of plant and non-plant origin. Transgenic plants for the large scale production of proteins for pharmaceutical and industrial uses. Plants as an alternative for biotransformation of raw materials into special chemicals.

### REFERENC BOOKS

- Modern Food Microbiology By Jay, James M., Loessner, Martin J., Golden, David A. Springer.
- Hand book of Nutraceuticals and Functional Foods Edited by Robert E.C. Wildman, Routledge Publishers.
- Nutraceuticals by L. Rapport and B. Lockwood, Pharmaceutical Press.
- Food is Medicine by P.J Cousion; Duncan Baird Publishers, London. 29. Dietary Supplements of Plant Origin, M. Maffei (Ed.), Taylor & Francis, 2003.
- Nutraceutical beverages Chemistry, Nutrition and health Effects, Shahidi and Weerasinghe (Ed.), American Chemical Society, 2004.
- Dietary Fiber: Handbook of Dietary Fiber, Susan Sungsoo Cho, Mark L. Dreher.
- Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean - Richard Neeser & J. Bruce German, Marcel Dekker, Inc., 2004.
- Herbal Products -Timotht S. Tracy, Richard L. Kingston.
- Ayurveda Aahar (Food / Diet)-Prof. P.H.Kulkarni. 35. Dietary Supplements and Alternative Medicines -W. Marvin Davis.
- Flavour in Food-Andree' Voilley, Patrick Etievant.
- Dietary Supplements and Functional Foods -Geoffrey P. Webb.
- <https://www.sciencedirect.com/topics/food-science/functional-food>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7125752/>

### PRACTICAL

1. To study nutritional composition (Proteins, carbohydrates, lipids, vitamin C and presence of secondary metabolites) of the following: Mushrooms, Beans, Spinach, Carrot, Apple, Amla, Pineapple, Papaya, Lentil and Soya.
2. Extraction and estimation of oil or crude fat content in oil seeds.
3. Estimation of total phenols and chlorogenic acid (Phenolic compound) in plant material.
4. Qualitative test for tannins, phenolics and alkaloids using TLC.
5. To estimate cholesterol content in given sample by Lievermann-Burchard method.

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**101320407: 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:**

1: 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.

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

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

4: 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, M.K. Sateesh

##### **Practicals:**

1. Design of r-DNA laboratory
2. Various methods to discard the Bio-hazardous waste
3. Introduction to intellectual property
4. Method to handle the recombinants
5. Patent Case Study

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**101320408: Lab I (Practicals based on 101320406 and 101320407)**

**Practicals:**

1. To study nutritional composition (Proteins, carbohydrates, lipids, vitamin C and presence of secondary metabolites) of the following: Mushrooms, Beans, Spinach, Carrot, Apple, Amla, Pineapple, Papaya, Lentil and Soya.
2. Extraction and estimation of oil or crude fat content in oil seeds.
3. Estimation of total phenols and chlorogenic acid (Phenolic compound) in plant material.
4. Qualitative test for tannins, phenolics and alkaloids using TLC.
5. To estimate cholesterol content in given sample by Liebermann-Burchard method.
6. Design of r-DNA laboratory
7. Various methods to discard the Bio-hazardous waste
8. Introduction to intellectual property
9. Method to handle the recombinants
10. Patent Case Study