ParvatibaiChowgule College (Autonomous)
Margao, Goa

Programme Outcome (PO) and Course Outcome (CO)

Name of the Department: **Botany**

ProgrammeOutcomes:

PO1: Recognize all forms ofplant groups (Algae, Fungi, Bryophytes, Pteridophytes,Gymnosperms and Angiosperms) and infer/ predict their Phylogenetic linkages. Illustrate distinct features.

PO2: Recognize cell organelles and bio molecules including enzymes, Predict and interpret their significances in cell metabolism/functioning and Pathways.

PO3: Apply physiological mechanism of plants to analyze synthesis of valuable plant products (Primary/ Secondary) with economic potential and health effects through the field of Horticulture.

PO4: Analyze the techniques and working principles of Instruments used in Botanical studies and apply the knowledge in Basic and applied Plant research (Microbiology, Plant Physiology, plant breeding, Fungi, Plant Tissue Culture, Plant Genetic Engineering, Ecology, plant drug technology. etc.) through bio statistical parameters.

PO5: Analyze applications of online biological database, data handling in plant drug discovery and interactions.

PO6: Appraise the students knowledge in Botany including fundamental basis of all living organisms (Plant and Microbes) and applying the same in sustainable usage of resources for the quality human survival on planet earth.

Sr. No.	Course Code	Course Title	Course Outcomes
1.	BOT-I.C-1	Plant diversity	**CO1:**Recogniseand understand the evolutionary aspects of different plant groups of lower plants. **CO2:** classify lower plants. **CO3:** describe the lower plant groups. **CO4:** sketch the morphology and anatomy of selected lower plants.
2.	BOT-I.C-2	Cell Biology & Biomolecules	**CO1:**Recognise, classify cell, explain cell theory, evolution and biogenesis **CO2:** Define, describe, classify and explain cytoskeleton, cell organelle, biomolecules **CO3:** Define, describe, compare, explain, illustrate cell

			wall and plasma membrane **CO4:** Predict and interpret the importance of cell organelles and biomolecules in cell functioning
3.	**BOT-II.C-3**	Plant Anatomy and Embryology	**CO1:**Define, describe and explain the basic plant anatomical and embryological features **CO2:** Compare the interrelatedness of organ-systems and their functions **CO3:** Examine the features throughhistological techniques. **CO4:** Define, describe, explain, compare theories in organization of tissues
4.	**BOT-II. C-4**	Microbiology	**CO1:** appraise the student knowledge to fundamental basis of all living microbes and their interaction with the environment. **CO2:** Apply the knowledge of microbial world towards the sustainable usage of resources for the quality human survival on the planet Earth.
5.	**BOT-III.C-5**	Physiology of Plants	**CO1:**Analyse Physiological processes in plants. **CO2:**Formulate and design experiments to analyse and interpret data. **CO3:**Learn to describe the processes through practicals and mini projects. **CO4:**Estimate and evaluate methods of quantitation of pigments, enzymes and metabolites.
6.	**BOT-IV.C-6**	Cytogenetics	**CO1:**To restate fundamentals of genetics **CO2:**To identify different stages of cell division. **CO3:**To construct chromosome maps. **CO4:**To review the effects of mutagens on seed germination.
7.	**BOT-V.C-7**	Plant Molecular Biology	**CO1:**Outline, memorize and express process of central dogma **CO2:**Estimate and evaluate methods of quantitation of macromolecules **CO3:**Understand molecular basis of life **CO4:**Learn and demonstrate basic molecular technique of DNA isolation and separation through electrophoresis.
8.	**BOT-VI.C-8**	Genetic Engineering	**CO1:**Apply the basic knowledge of Plant Genetic Engineering in research **CO2:**Perform experiments by themselves **CO3:**Compare and assess the different DNA sequencing techniques **CO4:**Design experiments in plant genetics
9.	**BOT- III.E-1**	Ecology & Conservation	**CO1:**To discuss role and importance of biotic and abiotic environment factors in the sustenance of plant life **CO2:**To analyze the pollution scenario of the area. **CO3:**To estimate the oxygen and

			Carbondioxide from different water samples. **CO4:**To evaluate and determine minimum area of sampling unit (using quadrat) for the study of localvegetation.
10.	**BOT-III.E-2**	Techniques and Instrumentation in Botany	**CO1:**Learn the Principle and working of techniques and instruments used in Botanical research **CO2:**Analyze the research problem and formulate the methodology for carrying out research/experiment **CO3:**Examine various parameters before setting up an experiment **CO4:**Apply the knowledge in further studies and research in Botany
11.	**BOT-III.E-3**	Enzymes and metabolic pathways	**CO1:**To identify the role of enzymes in various biological processes **CO2:**To classify the different enzymes based on its structure **CO3:**To restate the various mechanisms of enzyme action
12.	**BOT-III.E-4**	Herbal Cosmetology	-
13.	**BOT-IV.E-5**	Plant Breeding and Biostatistics	**CO1:**To recognize various techniques in plant breeding **CO2:**To differentiate between modes of plant breeding **CO3:**To employ manual emasculation procedure. **CO4:**To calculate mean, median, mode, standard deviation, std. error for provided material.
14.	**BOT-IV.E-6**	Systematics of Flowering plants and Phylogeny	**CO1:**Name, arrange, describe and compare the taxa **CO2:**Outline keys for identification of flowering plants **CO3:**Interpret phylogenetic trees, cladograms, etc.
15.	**BOT-IV.E-7**	Plant pathology	**CO1:**Identify various diseases and causal agents of economically important plants **CO2:**Find effective control measures
16.	**BOT- IV.E-8**	Horticulture, Floriculture & Landscaping	**CO1:**Explain the basics of Horticulture, floriculture and landscaping **CO2:**Outline the requirements for building up nurseries, garden, etc. **CO3:**Inculcate the technique of vegetative propagation of plants. **CO4:**Identify and relate the scope of these fields in building up career
17.	**BOT-V.E-9**	Bioinformatics	**CO1:**Explain basics of bioinformatics, biological databases **CO2:**Compare and contrast protein information resources and genome information resources **CO3:**Relate the theoretical knowledge with practical sessions.Enable data handling and analysis. **CO4:**Compare the homology between different

			biological species.
18.	**BOT-V.E-10**	Seed Technology	-
19.	**BOT-V.E-11**	Plant Drug Technology and Pharmacognosy	**CO1:**Explain, discuss and classify medicinal plants, plant drug and technology **CO2:**Explain and illustrate, biosynthetic pathways, bioassays and working of instruments **CO3:**Discuss and compare methods of extraction and analysis of phytochemicals.
20.	**BOT-V.E-12**	Organic Farming	**CO1:**Create awareness of the social, economic and environmental context for current and future organic agriculture production and management **CO2:**Assess the importance of organic foods in todays World. **CO3:**Apply the knowledge in becoming an entrepreneur in Organic Farming.
21.	**BOT-VI.E-13**	Plant tissue culture	**CO1:**Explain and discuss the general theoretical backgrounds and practical techniques **CO2:**Describe, define, explain/ discuss, compare, concept of differentiation and culture types **CO3:**Define, describe, explain/ discuss, techniques in PTC in media preparation, sterilisation, callus culture and organogenesis **CO4:**Describe, explain, discuss applications in forestry, agriculture etc
22.	**BOT-VI.E-14**	Algal Biotechnology	-
23.	**BOT-VI.E-15**	Economic Botany	**CO1:**To identify economically important plants /plant parts **CO2:**To identify valuable plant products of potential market and economic value. **CO3:**To evaluate, describe and create awareness of the uses of natural plant products as alternative to synthetic and chemical products
24.	**BOT-VI.E-16**	Applied Mycology	**CO1:** Toexplain techniques involved insampling, culturing and maintaining fungal cultures. **CO2**: To discuss industrial and agricultural applications of fungi.

Instructions to write Programme outcomes and Course outcomes:

Programme Outcomes :

1. It is expected that each department puts 6 Programme Outcomes (PO).

2. Programme Outcomes will highlight knowledge and skills that the students will acquire during 3/2/1 (Undergraduate, Postgraduate, Diploma) in this college.
   For eg. Critical Analysis, Use of technology, Research, Effective Communication, written as well as verbal communication.
3. Programme Outcomes would be sum total of Core Courses, Electives and Compulsory Courses like Academic Writing, Research Writing, Environmental Studies, Interdisciplinary etc.
4. It should be measurable through your teaching methodologies and evaluation methods.

Course Outcomes :

1. There should be minimum 4 Course Outcomes for each course.

2. Course outcomes are learning outcomes (as per our structure) that signify skill sets that students are expected to achieve after completion of the course. Usually it focuses on higher order skills (please find attached action verbs for your reference)

Attainment of each course outcomes should lead to attainment of programme outcomes.

COURSE STRUCTURE – DEPARTMENT OF BOTANY
Three year B.Sc Degree Course in BOTANY 2018-19

Sem.	Core		Elective			
I	**BOT-I.C-1** Plant diversity	**BOT-I.C-2** Cell Biology & Biomolecules	--------	--------	--------	--------
II	**BOT-II.C-3** Plant Anatomy and Embryology	**BOT-II.C-4** Microbiology	--------	--------	--------	--------
III	**BOT-III.C-5** Physiology of Plants		**BOT- E-1** Ecology & Conservation	**BOT-.E-2** Techniques and Instrumentation in Botany	**BOT-E-3** Enzymes and metabolic pathways	**BOT- E-4** Herbal Cosmetology
IV	**BOT-IV.C-6** Cytogenetics		**BOT-E-5** Plant Breeding and Biostatistics	**BOT- E-6** Systematics of Flowering plants and Phylogeny	**BOT- E-7** Plant pathology	**BOT- E-8** Algal Biotechnology
V	**BOT-V.C-7** Plant Molecular Biology		**BOT- E-9** Bioinformatics	**BOT-E-10** Seed Technology	**BOT- E-11** Plant Drug Technology and Pharmacognosy	**BOT-E-12** Organic Farming
VI	**BOT-VI.C-8** Plant Genetic Engineering		**BOT- E-13** Plant tissue culture	**BOT-E-14** Horticulture, Floriculture & Landscaping	**BOT-E-15** Economic Botany	**BOT-E-16** Applied Mycology

COURSE TITLE: PLANT DIVERSITY (THEORY)

COURSE CODE: BOT-I.C1

MARKS: 75

CREDITS: 3

COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

This paper provides knowledge on morphology, structure and importance of the lower group of organisms. Education and awareness about plant diversity, its role in sustainable livelihoods.

LEARNING OUTCOMES:

On completion of the course: The students will be able to differentiate between various groups of algae, fungi, lichens, bryophytes and pteridophytes. Students will gain knowledge about the economic and ecological importance of the lower group of plants also to effectively conserve the plantbiodiversity.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: ALGAE AND LICHENS	11
1.1	Five kingdom classification	1
1.2	Classification of algae (Cyanobacteria, Chlorophyta, Phaeophyta and Rhodophyta) following Lee (1999) upto groups with general characters and examples	2
1.3	Endosymbiotic theory: origin of plastids	1
1.4	Cyanophyceae: Ecology, importance. Distribution,systematic position and life cycle of *Nostoc* and Charophyta: *Chara*	4
1.5	Economic importance of algae	1
1.6	Structure and reproduction: Ecological and economic importance of lichens	2
	UNIT II: FUNGI	08
2.1	General characteristics, Classification, economic importance. systematic position, life history of *Puccinia* and *Penicillium*	8
	UNIT III: BRYOPHYTES	09
3.1	General characters, brief classification and alternation of generation	2
3.2	Study of morphological and anatomical studies and reproductive character of *Riccia, Marchantia , Anthoceros and Funaria.*	7

UNIT IV: PTERIDOPHYTES		08
4.1	General characters, brief classification, alternation of generation.	2
4.2	Structure, reproduction, life history and systematic position of *Psilotum*, *Lycopodium* and *Marsilea*.	6
UNIT V: GYMNOSPERMS AND PALEOBOTANY		09
5.1	General characters, brief classification, alternation of generation of Gymnosperms	2
5.2	Systematic position, life history of *Pinus* and *Gnetum*	6
5.3	Fossils and fossilization, importance of fossils (with a mention of Birbal Sahni institute)	1
	TOTAL	**45**

COURSE TITLE: PLANT DIVERSITY (PRACTICAL)
COURSE CODE: BOT-I.C-1
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	**Topics**	**Practical Sessions**
1.	Morphological study of algal and Blue green algal forms: *Oscillatoria/Nostoc,Chara,Sargassum, Polysiphonia*	03
2.	Morphological study of fungal forms: *Puccinia*, *Penicillium*, *Albugo* and *Rhizopus*	03
3.	Study of lichens (Permanent slide/ specimen)	01
4.	Study of fossils: (Permanent slide/ specimen)	01
5.	Morphological and anatomical study of: i. Bryophyte (preferably *Riccia* or *Anthoceros*) ii. Pteridophyte (preferably *Selaginella*) iii. Gymnosperm (preferably *Cycas*)	05
6.	Mini project: Collection and field study of locally available Algae, Bryophytes, Pteridophyte, Gymnosperms and Lichens	02
	Total	15

REFERENCES:

1. Alexopoulos, Constantine J.;Mims, Charles W. (1983). Introductory Mycology; 3rd edition; New Delhi: Wiley EasternLimited.

2. Kar, Ashok Kumar;Gangulee, Hirendra Chandra (2006). College Botany: Volume II; 2nd Edition; Kolkata: New Central Book Agency (P)Ltd.

3. Smith, Gilbert M. (1955).Cryptogamic Botany Algae & Fungi Volume 1;2nd Edition; McGraw-Hill Book Comp. Tokyo.

4. Smith, Gilbert M. (1955). Cryptogamic Botany Bryophyta&Pteridophyta Volume 2; 2nd Edition; McGraw-Hill book Comp.Tokyo.

5. Vasishtha B.R. And Sinha A. K. (2005). Botany for degree students Part 1 Algae; 1st Edition S. Chand & CompanyLtd.

6. Parihar N.S., (2013); An introduction to Embryophyta: Bryophyta.Vol I, fifth edition, Surjeet Publications.

7. Parihar N.S., (2012); An introduction to Embryophyta: Pteridophytes.Vol II, fifth edition, Surjeet Publications.

8. Fritsch, F.E.,(1956). The structure and reproduction of the Algae; Volume I and II. Cambridge University Press.

COURSE TITLE: CELL BIOLOGY AND BIOMOLECULES (THEORY)
COURSE CODE: BOT-I.C-2
MARKS: 75 MARKS
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

This course will provide a detailed discussion on a wide range of topics in Cell biology & Bio-molecules emphasizing experimental approaches and key experiments that have provided important insights. The course is aimed at conveying an understanding of how cellular structure and function arise as a result of the properties of cellular macromolecules. Emphasis will be on the dynamic nature of cellular organization, structure and function.

LEARNING OUTCOME:

Students will understand the structures and purpose of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, organelles and importance of cells as basic units of living organisms & the role of cell membrane in movement of substances into and out of cells. It will also help to understand the chemical structure of water, carbohydrates, lipids and proteins and their role in living organisms.

Sr. No	Units, Topics and Sub- Topics	Hours
	Unit-I: Overview of cells	**04**
1.1	Discovery of cells, Basic properties of cells	1
1.2	Prokaryotic and Eukaryotic cell; Cell theory	2
1.3	Cell evolution and biogenesis	1
	Unit-II: Cytoskeleton and its role in motility	**03**
2.1	Structure and functions of cytoskeleton; Structure and function of Microtubule, Intermediate filaments, Microfilaments	03
	Unit-III: The Ultra-structure and Function of Cell wall and Plasma membrane	**11**
3.1	Structure and function of cell wall; Chemical composition of cell wall; Extracellular matrix and cell interactions; Gap -Junctions & plasmodesmata	4
3.2	Structure and function of plasma membrane; Active and Passive transport of solute (channels & pumps); Cell signaling- molecules and receptors, signaling network	7
	Unit-IV: The Cell Organelle studies	**14**
4.1	Structural organization and functions; Semiautonomy and gene control; Structure & functions of peroxisome, glyoxysome & lysosomes	5
4.2	Nucleus and its Organization; Nuclear envelope, nuclear pore complex Nuclear matrix, Chromosomes and chromatin structure	5
4.3	Structure and function of ribosome ; Endomembrane systems- Endoplasmic reticulum and Golgi complex	4

UNIT- V: BIOCHEMISTRY OF CARBOHYDRATES AND LIPIDS		**08**
5.1	Definition & importance of biomolecules; types of bonds in bio-molecules; pH and buffers ; Water as a biological solvent	4
5.2	Classification and biological functions of carbohydrates and lipids	4
UNIT VI: AMINO ACIDS AND PROTEINS		**05**
6.1	Classification and biological functions of amino acids and proteins	05
	Total	**45**

COURSE TITLE: CELL BIOLOGY & BIOMOLECULES (PRACTICAL)
COURSE CODE: BOT-I.C-2
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr.No	TOPICS	PRACTICAL SESSIONS
1.	Study of cell structure in *Hydrilla* and *Tradescantia* staminal hairs	1
2.	Examination of prokaryotic cell, eukaryotic cell and cell organelles by EM graphs	1
3.	Preparation of temporary slides to observe different types of cells	2
4.	Staining and Preparation of slides	6
	I. Cytochemical staining of Nucleus- Acetocarmine II. Cytochemical staining of polysaccharides- Periodic Acid Schiff's (PAS) III. Cytochemical staining of Mitochondria – Jannis Green IV. Cytochemical staining of Total proteins –Bromophenol blue V. Cytochemical staining of Histones – Fast Green	
5.	Determination of pH using pH meter	1
6.	Quantitative determination of carbohydrates (Anthrone reagent)	1
7.	Estimation of oil in fatty seeds	2
8.	Estimation of proteins	1
	Total	**15**

REFERENCES:

1. David L. Nelson. & Michael M. Cox. (2013). Lehninger Principles of Biochemistry, 4th ed. W.H. Freeman & Co,New York.
2. Donald Voet., Judith G. Voet and Charlotte W. Pratt. (2002). Fundamentals of Biochemistry**,** 2nd edition, John Wiley and Sons (Asia) Pvt Ltd.
3. Gupta, P.K. (1999). A Text-book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
4. H.Robert Horton. (2006).Principals of biochemistry.4th ed. Pearson Prentice Hall.
5. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer.(2002). Biochemistry 5th edition, W.H.Freeman & Company, New York
6. Karp, G. (1999). Cell and molecular Biology, Concepts and experiments (John Wiley and Sons Inc) 2nd edition. USA.
7. Paul Flinch (1999). Carbohydrates structure, Synthesis & Dynamics. Kluwer Academic Pub.The Netherlands.
8. U. Satyanarayana and U. Chakrapani. (2000).Biochemistry, 4th edition., Elsvier Pub. Kolkata.
9. Verma P.S. and Agarwal V. K. (1998).Cell Biology, Genetics, Molecular Biology, Evolution and ecology. Edn.14

SEMESTER II

COURSE TITLE:PLANT ANATOMY AND EMBRYOLOGY (THEORY)

COURSE CODE: BOT-II. C-3

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This paper deals to understand the plant anatomy and embryology of angiospermic plant. Importance of studying this paper is highlighted reflecting on the current changing needs of the students by providing latest information. Practical component will provide an ample understanding of anatomical and embryological features.

COURSE OUTCOME:

- Define, describe and explain the basic plant anatomical and embryological features
- Compare the interrelatedness of organ-systems and their functions
- Examine the features through histological techniques.
- Define, describe, explain, compare theories in organization of tissues

Sr.No.	TOPICS	Hours
Module I: Shoot, Root and Leaf Anatomy		15
1.1	Organization of Shoot apical meristem	
1.2	Apical cell theory, Histogen theory, Tunica-Corpus theory, Cyto-histological zonation.	
1.3	Organization of root apical meristem	
1.4	Korper-Kappe theory, Quiescent centre.	
1.5	Anatomy of leaf: epidermis, mesophyll and vascular tissue	
1.6	Stomata and its diversity, leaf abscission	
Module II: Wood Structure		15
2.1	Vascular cambium, Secondary xylem, Xylary elements	
2.2	Secondary phloem, Phloem elements and Periderm	
2.3	Conifer wood, Dicotyledon wood, wood anatomy-TS, TLS, RLS.	
Module III: Reproductive biology, Pollination and fertilization		15
3.1	Floral development: ABC model of flowering	
3.2	Structure and development of male gametophyte- Microsporangium Microsporogenesis & Pollen grains	
3.3	Structure and development female gametophyte – Megasporangium, Megasporogenesis, Forms of ovule-Monosporic, bisporic and Tetrasporic	

3.4 3.5	Mechanism of pollination and fertilization- types of pollination, germination of pollen grain, pollen pistil interaction, self-incompatibility Double fertilization, embryo (dicot and monocot) and endosperm formation. General account of Apomixis and Polyembryony		
		TOTAL	45

COURSE TITLE:PLANT ANATOMY AND EMBRYOLOGY (PRACTICAL)

COURSE CODE: BOT-II.C-3

MARKS: 25

CREDITS: 1

Sr.No.	**Module 4: TOPICS**	**PRACTICAL**
1.	Study of simple and complex tissues by using permanent slides/ EM graphs.	**2**
2.	Microscopic study of wood tissues in T.S, T.L.S. and R.L.S. and maceration (Any one species)**1**	**3**
3.	Study of Meristems, Microsporogenesis and Megasporogenesis through permanent slides	**2**
4.	Mini Project- Study of diversity in leaf anatomy, stomata and female gametophyte exhibiting self-incompatibility.	**3**
5.	Embryo and Endosperm with haustoria mounting (*Tridax/ Cucurbit*).	**2**
6.	In vitro growth of pollen tube in *Portulaca/ Vinca.*	**1**
7.	Pollen studies: Chitaley's method for analysis in *Ipomoea*, *Ocimum, Hibiscus*, *Acacia auriculiformis*and Grass.	**2**
	TOTAL	**15**

REFERENCES: -

1. Bhojwani, S. S and Bhatnagar, S.P. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.
2. Dwivedi. J.N. (1988). Embryology of Angiosperms. Rastogi and Co. Meerut.
3. Esau, K. (1977). Plant Anatomy, 2nd Edition. Wiley Eastern Private Limited. New Delhi.
4. Fahn, A. (1982). Plant Anatomy (3rd edition).Pergoman Press, Oxford.
5. John Jothi Prakash, E. (1987). A Text Book of Plant Anatomy.
6. Mauselth, J.D. (1988). Plant Anatomy. The Benjamin Cummings Publishing Co. Inc., Mehlo Park, California, USA.
7. Maheswari, P. (1971). An Introduction to the Embryology of Angiosperms. Tata McGra
8. Pandey, B.P. (1981). A textbook of Botany Angiosperms. S. Chand and Co., New Delhi.
9. Pandey, B.P. (1978). Plant Anatomy, S. Chand and Co., New Delhi.
10. Vashista, P.C. (1968). A text Book of plant Anatomy.

COURSETITLE:MICROBIOLOGY (THEORY)

COURSE CODE:BOT.II.C-4

MARKS: 75

CREDITS:3

COURSE OBJECTIVES:

The objective of this course is to familiarize the student with basic concepts that help in understanding of microbial world. The course is aimed to understand microbial survival and distribution, it's relation and interaction with environment and human beings. The laboratory exercises are designed so that students acquire basic and bacteriological skills and are able to successfully use them.

COURSE OUTCOME: **Students will be able to:**

- Appraise student's to fundamental basis of all living organisms (Plant and Microbes) and their interactions with the environment.
- Apply the knowledge of microbial world for sustainable usage of resources for the quality human survival on planet earth and protect environment.

Sr.No.	TOPICS	Hours
Module I: Overview of microbial world & development		**15**
1.1	Developments of microbiology in the twentieth century Microbial taxonomy & phylogeny (archea, bacteria, fungi, algae, protozoa)	
1.2	Structure & General characteristics of viruses, viroids, Prions, Bacteriophages, TMV & mycoplasma	
1.3	Distribution of microbes in the environment (air, soil & water) Scope of microbiology and Microbial diseases	
Module 2: Isolation, characterization, growth of microorganisms & microbial genetics		**15**
2.1	**Control of microbial growth:** Biochemical characterization & nutritional types; Sterilization techniques,	
2.2	Preparation ofpurecultures; growth factors & growth curve.	
2.3	Staining techniques	

2.4 **2.5**	**Bacterial Reproduction**: Conjugation, Transformation & transduction; **Methods of viral replication** (Lytic & Lysogenic mode)	
Module 3: ApplicationMicrobiology		**15**
3.1 **3.2** **3.3** **3.4**	**Applications in Environment**: Applications of microbes in environment sustenance (microbial degradation of cellulose, hemicelluloses, lignin, biodegradation ofhydrocarbons), **Applications in Agriculture**: Association of plants with cyanobacteria, actinomycetes, fungus; Xenobiotics (biodegradation of pesticides, herbicides; metals, biofuels **Applications in Medicine**: Microbial antibiotics **Applications in Industry:** Microbes in Fermentation technology & dairy industry.	
	TOTAL	**45**

COURSETITLE: MICROBIOLOGY(PRACTICAL)

COURSE CODE:BOT.II.C-4

MARKS: 25

CREDITS:1

Sr.No.	Module 4: Topics	Practical
1	Preparation of culture media for bacteria, pure cultures and aseptic transfer of pure culture	3
2	Staining of microorganisms	2
3	Measurement of bacterial growth, cell number in a culture (Turbidity, serial dilution &Haemocytometer	3
4.	Distribution of microorganisms in our environment (Skin, air, water and soil sample)	2
5	Mini Projects: i) Microbiological examination ofwater ii) Bacteriological testing ofmilk iii) Fermentation of carbohydrates and wine preparation	5
	TOTAL	**15**

REFRENCES:

1. Aneja, K. R. (2007). Experiments in Microbiology Plant Pathology & Biotechnology. 5th ed., New Age InternationalPublishers.
2. Atlas, RM., Principles of Microbiology, 2nded.,(1997),McGraw-Hill
3. Dubey, R.C & Maheshwari, D.K.(2002).Practical Microbiology. S. Chand &Comapany Ltd., NewDelhi.
4. Frazier, W.C. and Westhoff, D.C.(2008), Food Microbiology 4th ed., the McGraw Hill.
5. Pelczar. M,(2000). Microbiology, 5th ed., Tata-McGrawHill.
6. Powar, C.B &Daginawala, H.F.(1982). General Microbiology–Volume II. Himalaya Publishing house:Bombay.
7. Prescott Harley (2008). Microbiology. McGraw-Hill Higher Education,Boston.
8. Prescott, LM. (2005), Microbiology. 6th ed. 2005.,McGraw-Hill.
9. Salle, AJ., Fundamental Principles of Bacteriology, 7thed.,(1999). Tata- McGraw Hill.
10. Shivkumar PK., MM Joe &SukeshK.(2010).An Introduction to Industrial Microbiology. 1st ed., S.Chand& Company Pvt.Ltd

COURSE TITLE: PHYSIOLOGY OF PLANTS (THEORY)
COURSE CODE: BOT.III.C-5
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of this introductory course is to provide understanding of how plants function. The course explain principle of plant functions covering physiological processes in plants, such as biochemical metabolism, secondary products, water & solute (organic & inorganic) uptake and growth & development.

LEARNING OUTCOMES: Upon completing this course, students will be familiar with contemporary concepts in Plant Physiology and the physiological mechanisms controlling plant growth and development. Students will have an understanding of movement of water and solutes in plant, know the importance of the photosynthesis as related to harvesting solar energy and plant productivity, hormone and its relation with plant growth and development.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT-I: PLANT WATER RELATIONS	**09**
1.1	Water and its significance to plants	3
1.2	Osmotic & water potential of cell	3
1.3	Transpiration, stomatal regulation & anti-transpirants	3
	UNIT-II: SOLUTE TRANSPORT	**08**
2.1	Uptake, transport and translocation of water	3
2.2	Essentiality of mineral nutrition and its uptake (active, passive and its role on membranes)	2
2.3	Transport of organic solutes (source sink relationship)	3
	UNIT III: PHOTOSYNTHESIS	**12**
3.1	Chloroplast and Light harvesting complexes	3
3.2	Z scheme of photosynthesis & Mechanisms of electron transport	3
3.3	CO_2 fixation (C3, C4 and CAM pathways)	3
3.4	Photoprotective mechanisms (photorespiration); Environmental change and its impact on photosynthesis	3
	UNIT IV: PLANT GROWTH AND DEVELOPMENT	**09**
4.1	Role of phytochromes & cryptochromes and its functions	2
4.2	Plant hormones, transport and physiological functions	3
4.3	Photoperiodism and & vernalization	2
4.4	Senescence, seed dormancy & germination	2
	UNIT V: SECONDARY METABOLITES AND STRESS PHYSIOLOGY	**07**

5.1 5.2	Responses of plants to abiotic (water, temperature and salt) stresses Biosynthetic pathway of terpenes, phenols and alkaloids and their functions.	4 3
	TOTAL	**45**

COURSE TITLE: PHYSIOLOGY OF PLANTS (PRACTICALS)
COURSE CODE: BOT.III.C-5
MARKS: 25
CREDITS: 1
PRACTICAL SESSION: 15

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Determination of osmotic potential of plant cell sap by plasmolytic method.	2
2	Determine water potential of given tissue by falling drop method	2
3.	Chromatographic separation of plant pigments and plant sugars	4
4	Quantitation of total free amino acids	2
5	**Mini Project**: 1. Mineral deficiency symptoms in plants 2. Secondary metabolites in plants. 3. Oxygen consumption during respiration 4. Role of Plant hormones in plant growth 5. Light intensity and starch production	5
		15

REFERENCES:

1. William G. Hopkins (1999). Introduction to Plant Physiology, 2nd edition, John Wiley A Sons, Inc.
2. Taiz, L. and Zeiger, E. (2006). Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA.
3. Frank B. Salisbury and Cleon W. Ross (2002). Plant Physiology 3rd edition. CBS publishers and distributers.
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6. Galstone A.W. (1989). Life processes in Plants. Scientific American Library, Springer Verlag, New York,
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9. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
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11. David I. Nelson and Michael M. Cox (2000). Lehninger. Principles of biochemistry, 3rdedition, Macmillan U.K.
12. David T Plummer (1985).An introduction to Practical Biochemistry 2nd edition. Tata Mcgraw Hill Publishing company Ltd.

13. D. Bajracharya (1999). Experiments in Plant Physiology. Narosa Publishing House new Delhi.

CURRENT LITERATURE (JOURNAL ARTICLES):

Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American.

COURSE TITLE: ECOLOGY & CONSERVATION (THEORY)
COURSE CODE: BOT E-1
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of this paper is to provide introductory knowledge on biotic and abiotic environmental factors, pollution and phytogeography with regards to Govt regulations towards environmental management with respect to agriculture and food security.

LEARNING OUTCOMES:

The Students will be able to understand the role and importance of biotic and abiotic environment factors in the sustenance of plant life and causes, consequences, prevention, remediation of pollution and efforts taken in reducing or controlling the pollution causing factor. The course will impart importance of phytogeography and forestry to teach managing regional flora.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
	UNIT I: CONCEPT OF ECOSYSTEM	**05**
1.1	Concept of Ecosystem: Components and their interactions, food chains and food web; Ecological pyramids; age pyramids; Ecological adaptations of plants belonging to following ecological groups: Hydrophytes, Xerophytes and Halophytes. Shelford's law of tolerance.	**5**

UNIT II: ECOLOGICAL FACTORS (Biotic & Abiotic)		**15**
2.1	Light - quality, duration, absorption, intensity & effects on plants	**03**
2.2	Temperature-variation due to altitude effects on plants, thermal constant and stratification	**03**
2.3	Water- precipitation, moisture & measurement of rainfall	**03**
2.4	Wind - speed, advantages and damage caused to plants	**03**
2.5	Soil- soil profile, texture, classification and organic matter	**02**
2.6	Biotic-community relationships	**01**
UNIT III: POLLUTION (CAUSES AND CONSEQUENCES) AND LAWS		**15**
3.1	Air pollution- polluting gases; ozone depletion, greenhouse effect, global warming, acid rain and smog	**03**
3.2	Water pollution-eutrophication, sewage, industrial waste, heavy metals	**04**
3.3	Soil pollution – chemical pollutants	**03**
3.4	Bioremediation	**01**
	Forest conservation act, Indian forest act, biodiversity act, western Ghat protection act, Kasthurirangan Act, Gadgil committee report, Mining committee reports, wild life act (**recent acts to be studied**)	**04**
UNIT IV: PHYTOGEOGRAPHY AND POPULATION ECOLGY		**13**
4.1	Phytogeography- plant distribution, theories on plant distribution	**03**
4.2	Endemism, major biomes of the world, minor biomes, and phytogeographical regions of India, biosphere reserves, Forest training institutes.	**02**
4.3	Population Ecology: Survivorship curves- Type I, Type II, Type III.	**03**
4.4	Population growth: Population growth curves – Carrying capacity K, Exponential growth (J shaped curve) and Logistic growth (S shaped curve).	
	TOTAL	**45**

COURSE TITLE: ECOLOGY & CONSERVATION (PRACTICAL)

COURSE CODE: BOT.E-1

MARKS: 25

CREDITS: 1

PRACTICAL SESSIONS: 15

Sr. No	Topics	Practical sessions
1.	Study of ecological instruments i.e. lux meter, rain guage, hygrometer, wet and dry bulb thermometer, maximum and minimum thermometer	02
2.	To study the physical and chemical characters (moisture, texture and pH) of different types of soils.	02
3.	Analysis of different water samples for oxygen and carbon-dioxide content	03
4.	Estimation of total carbonates from soil sample	01
5.	Visual interpretation of remotely sensed image for vegetation types	01
6.	Study of community relationships- Mutualism (mycorrhizae)	01
7.	Mini project: To determine minimum area of sampling unit (quadrat) for the study of local community and to determine species diversity index (Simpson's & Shannon-Weiner) of herbaceous vegetation	05
	Total	**15**

REFERENCES:

1. Ambasht, R.S. A Text Book of Plant Ecology. Students Friends Co., Varanasi. 1988
2. Ecology and environment; P. D. Sharma, Rastogi publications, Meerut. 7th ed – 2004.
3. Ecology- N.S. Subrahmanyam and A.V.S.S. Sambamurty, Narosa Publishing House, 2000.
4. Environmental Biotechnology. Jogdand, SN 1995. Himalaya Publishing House, Mumbai.
5. Environmental chemistry by B. K. Sharma, Goel publication house, Meerut, Sixth revised edition – 2001.
6. Environmental Chemistry, A. K. Day, Fourth Edition, New Age International Publishers-2002

7. Environmental Science; by-Santra SC; Central Publ. New Delhi.
8. Fundamental of Ecology: EP Odum; WB Saunders Company. 1971
9. Moore, P.W.and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
10. Piper, C.S. 1950. Soil and Plant Analysis. University of Adelaide, Australia.
11. Sharma, P.D. Ecology and Environment; 7th edition; Meerut :Rastogi Publishers , 1998.
12. Subrahmanyam, N.S.;Sambamurty, A.V.S.S.; Ecology; 1st edition; New Delhi : Narosa Publishing House , 2000.

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY
COURSE CODE: BOT.E-2
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of the course is to impart knowledge of principle, methodology and application of various techniques & instrumentation.

LEARNING OUTCOMES:

Students will learn the principle, working and applications of various instruments essential to study different facets of Botany.

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: MICROSCOPY	**11**
1.1	Light microscopy (compound microscopy and Phase contrast microscopy)	**3**
1.2	Fluorescence microscopy	**2**
1.3	Transmission and Scanning electron microscopy (sample preparation for electron microscopy, cryofixation,)	**4**
1.4	Microscopic measurements and photography (Micrometry & cytometry)	2
	UNIT-II : CENTRIFUGATION AND RADIOISOTOPY: PRINCIPLE, METHODOLOGY AND APPLICATIONS	**09**
2.1	Centrifugation: Low speed, high speed, cooling centrifuges and ultracentrifugation Analytical, preparatory and gradient centrifugation	04
2.2	Various types of rotor heads and their maintenance	01
2.3	Radioactivity and its measurements (Geiger Muller and Scintillation counter and autoradiography)	04

UNIT – III: SPECTROPHOTOMETRY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**08**
3.1	UV visual spectrophotometry	02
3.2	Fluorescence spectrophotometry	02
3.3	Flame (Atomic absorption) spectrophotometry	02
3.4	Mass spectrophotometry	02
UNIT –IV: CHROMATOGRAPHY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**09**
4.1	Adsorption and partition chromatography	03
4.2	Column chromatography (isocratic and gradient)	03
4.3	HPLC & GC	03
UNIT- V: ELECTROPHORESIS & MOLECULAR TECHNIQUES: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**08**
5.1	Electrophoresis: AGE,SDS- PAGE , IEF and 2D Electrophoresis	05
5.2	PCR, Real Time PCR	03
	TOTAL	**45**

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY (PRACTICAL)
COURSE CODE: BOT.E-2
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

SR.NO	TOPICS	PRACTICAL SESSIONS
1	Use of pH meter to set pH of a given solution	**1**
2	Determination of Lambda (λ) max of a given solution Verification of Beer's Law	**2**
3	Micrometric dimensions (cytometry and micrometry)	**2**
4	Demonstration of SDS- PAGE/ Agarose gel Electrophoresis	**2**
5	Preparation of TLC and Separation of biomolecule	**2**
6	Centrifugation	**1**
7.	Visit to Instrumentation Lab (NIO,/College/ GoaUniversity)	**1**
8	Microscopy and photography	**2**
9	Flame photometry	**2**
	Total	**15**

REFERENCES:

1. Karp, G. (1999). Cell and molecular Biology, Concepts and experiments (John Wiley and Sons Inc) 2nd edition. USA.
2. Bajpai P. K. (2006). Biological instrumentation and methodology (S. Chand and Company. Ltd. Mumbai.
3. Plummer D.T. (2009). An Introduction to Practical Biochemistry. 3rd edition. Tata Mc Graw Hill Education Private ltd. New Delhi.

COURSE TITLE: ENZYMES AND METABOLIC PATHWAYS (THEORY)
COURSE CODE: BOT. E-3
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:
The objective of this course is to understand the importance and mechanisms of enzyme action. The course also discusses about enzymatic regulation & metabolic control of biochemical reactions.

LEARNING OUTCOMES:
On completion of this course students will be able to relate the relationship between structure and function of enzymes, importance of enzymes in regulation of metabolic processes.

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT I: NOMENCLATURE, CLASSIFICATION AND HARACTERISTICS OF ENZYMES ,		**11**
1.1	Classifications & nomenclature (IUB system); Biological role of enzymes; Concept of holoenzyme & apoenzymes, prosthetic group, iso-enzymes and allosteric enzymes.	5
1.2	Chemical nature of enzymes; Characteristics **(**Physico-chemical and biological properties); specificity of enzyme action (thermolability, reversibility and pH sensitivity)	6
UNIT II: MECHANISM OF ENZYME ACTION		**10**
2.1	Applications of Michalis Menten equation; Active sites, Fisher's lock and key module and Koschland (induced fit theory);	5
2.2	Enzyme action (competitive, noncompetitive and reversible)	5
UNIT III: METABOLIC CONCEPTS		**14**
3.1	Catabolic and anabolic pathway of Carbohydrate, Lipids and Proteins.	7
3.2	Respiratory substrate , Glycolysis (aerobic & anaerobic) Citric acid cycle and Mitochondrial electron transport (alternate oxidase pathway)	7
UNIT IV: AMINO ACID METABOLISM		**10**
4.1	Nitrogen cycle	3
4.2	Biological Nitrogen Fixation	5
4.3	Pathway of amino acid catabolism Nitrogenase enzyme complex **,** NIF and Nod genes.	2
	TOTAL	**45**

COURSE TITLE: ENZYMES AND METABOLIC PATHWAYS (practicals)
COURSE CODE: BOT. E-3
MARKS: 25 MARKS
CREDITS: 1
COURSE DURATION: 15 SESSIONS

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Qualitative determination for amylase enzyme in the given plant samples.	3
2	Effect of enzyme concentration, temperature, substrate, inhibitors and pH on the activity of α-amylases	5
3	To demonstrate anaerobic respiration in germinating seeds	2
4	To extract and study the activity of catalase , lipase and peroxidase enzymes Mini project on role of Nitrogen in plants	5
	TOTAL	**15**

REFERENCES:

1. Bennett, T. P., and Frieden, (1969) E.: Modern Topics in Biochemistry, pg. 43-45, Macmillan, London
2. Breaker, Ronald R. "Making Catalytic DNAs." *Science* 290 (2000): 2095–2096.
3. Campbell, Neil A., Jane B. Reece, and Lawrence G. Mitchell (1999) *Biology,* 5th ed. Menlo Park, CA: Benjamin/Cummings.
4. Deeth, Robert J. (1997)"Chemical Choreography." *New Scientist* 155: 24–27.
5. Harrow, B., and Mazur, A.(1958): Textbook of Biochemistry, 109, Saunders, Philadelphia.
6. Holum, J (1968): Elements of General and Biological Chemistry, 2nd ed., 377, Wiley, NY.
7. Koshland, Daniel E.,(1973). Jr. "Protein Shape and Biological Control." *Scientific American* 229: 52–64.
8. Madigan, Michael R., and Barry L. Marrs. (1997) "Extremophiles." *Scientific American* 276: 82–87.
9. Martinek, R.: Practical Clinical Enzymology(1969). *J. Am. Med. Tech., 31,* 162.
10. Pfeiffer, J. (1954). Enzymes, the Physics and Chemistry of Life, pg 171-173, Simon and Schuster, NY.
11. Price C. Nicholas, Stevens Lewis: Fundamentals of Enzymology (1999) Oxford University Press.

COURSE TITLE: HERBAL COSMETOLOGY (THEORY)
COURSE CODE: BOT.E-4
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

Objective of this course is to impart knowledge about the different plants that play a very important role in enriching inner health and skin quality.

LEARNING OUTCOMES:

The student by the end of this course will gain knowledge of most of the herbs that are useful in the cosmetic industry.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
	UNIT I - INTRODUCTION TO HERBAL COSMETICS	**09**
1.1	Definition, Collection and processing of herbal material, Natural and artificial drying of herbal material	02
1.2	Herbal remedies for holistic health (including weight gain and weight loss)	04
1.3	Current status and future prospects of Herbal Cosmetic Industry	03
	UNIT II- IDENTIFICATION (BOTANICAL NAME AND FAMILY), UTILIZATION OF FOLLOWING PLANTS WITH COSMETIC BENEFITS & THEIR COSMETIC USES	**20**
2.1	*Curcuma longa, Aloe vera, Azadirachta indica, Ocimum sp., Cymbopogon flexuosus, Murraya koenigii, Citrus limon, Rosa sp., Rubia cordifolia*	13
2.2	Commonly used herbs in the following herbal cosmetics -Herbal Shampoo , Herbal Conditioner, Herbal Hair Dye/ Herbal Hair Oil/Hair Cream/Hair Gel, Herbal Face Mask, Herbal Bath Oil and aroma therapy.	07

UNIT III - STANDARDIZATION OF RAW MATERIAL		**06**
3.1	Importance of standardization, Physical and chemical methods of standardization Quantitative and qualitative estimation of phytoconstituents	06
UNIT IV- PROTOCOLS FOR PREPARATION		**06**
4.1	Different types of Herbal face masks- for dry skin, oily skin, pigmented skin & wrinkled skin, Special Herbal masks for sensitive skin, Herbal Shampoo	06
UNIT V -HERBAL EDIBLE CHURNAS BENEFICIAL FOR SKIN TO HAIR		**04**
	TOTAL	**45**

COURSE TITLE: HERBAL COSMETOLOGY (PRACTICAL)
COURSE CODE: BOT. E-4
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Herbal face masks for dry skin, oily skin, pigmented skin, wrinkled skin	02
2	Study of plants valued in the cosmetic industry- skin and hair	02
3	Preparation of Herbal Shampoo	02
4	Visit to Ayurvedic institute and a local clinic.	02
5	Demonstration of Churna preparation	01
6	Extraction of plant pigments- *Lawsonia inermis* (mehndi) and *Curcuma longa* (turmeric),	01

7	Mini projects: 1. Local Survey to know about awareness about home remedies for cosmetic purposes 2. Study of various skin and hair care herbal products available in the market 3. Comparision of Herbal products to non-herbal products 4. Study of herbal products for weight loss and weight gain 5. Study of locally available herbal Churnas.	05
	TOTAL	**15**

REFERENCES:

1. Fuller, K.W. and Gallon, J.A. Plant Products and New Technology. Clarendon Press, Oxford, New York. 1985
2. Kocchar, S.L. Economic Botany in Tropics, 'i.'d edition. Macmillan India Ltd., New Delhi. 1998.
3. Simpson, B.B. and Conner-Ogorzaly, M. Economic Botany- Plants in Our World. McGraw Hill, New York. 1986.
4. Sachs, M. Ayurvedic Beauty Care: Ageless Techniques to Invoke Natural Beauty. ISBN: 9788120818804. 2014
5. Sharma, O.P. Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd., New Delhi. 1996.

SEMESTER-IV

COURSE TITLE: CYTOGENETICS (THEORY)

COURSE CODE:BOT-IV.C-6

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This course will enable the students to understand fundamentals of genetics and evolution.

COURSE OUTCOMES: Students will be able to:

- restate fundamentals of genetics
- identify different stages of cell division.
- construct chromosome maps.
- review the effects of mutagens on seed germination.

Sr.No.	TOPICS	HOURS
Module 1: Mendelian Genetics and Linkage		**15**
Mendelian genetics and principles of inheritance and Multiple allelism		
1.1 1.2 1.3	Mendel's Laws, backcross and test cross. Allelic and non-allelic interactions, Epistatic interactions Multiple alleles in Drosophila (eye colour), man (blood groups) and plants (self-incompatibility).	
Linkage, Mutations and Molecular basis of mutations		
1.4 1.5 1.6	Linkage- Coupling and Repulsion Hypothesis Chromosome maps. Mutations and its types. Types of mutagens. Transitions and transversions; frame shift mutations. DNA repair mechanisms, Applications of mutations	
Module 2: Extranuclear inheritance and Sex linked inheritance		**15**
Extranuclear inheritance and Maternal influence		
2.1	Extranuclear inheritance and maternal influence: Kappa particles in *Paramecium;* CO_2 sensitivity in *Drosophila*; cytoplasmic inheritance in mitochondria and plastids; Shell coiling in snails; eye colour in flour moth.	

Sex Determination and Sex Linkage		
2.2	Sex Chromosomes, Mechanisms of sex determination; Genic balance mechanism.	
2.3	Sex-linked inheritance- X linked and Y linked inheritance.	
Module 3: Genetic variation due to chromosome structure and number		**15**
Genetic variation due to chromosome structure and number		
3.1	Chromosomal aberrations – duplications, deletions, inversions and translocation	
3.2	Variations in chromosome number; auto-and allo-polyploidy - types and effects; artificial induction of polyploidy. Auto and allo-polyploid crop species Aneuploid segregations in plants- tetrasomics and nullisomics; triploid and tetraploid plants. Applications of polyploidy	
	TOTAL	**45 HOURS**

COURSE TITLE: CYTOGENETICS (PRACTICAL)

COURSE CODE:BOT-IV.C-6

CREDITS: 1

Sr. No	MODULE 4: TOPICS	Practical
1.	Study of Mitosis and meiosis using suitable plant material	**03**
2.	Karyotype analysis and preparation of ideogram	**02**
3.	Detection of anomalies in cell division using suitable plant material.	**02**
4.	Study of multiple allelism in blood groups of human beings.	**01**
5.	Effect of physical and chemical mutagen on seed germination	**03**
6.	Preparation of chromosome maps from 3-point test cross data and calculation of Interference and coincidence	**01**
7.	Induction of polyploidy using Colchicine treatment.	**02**
8.	Study of sex linked inheritance	**01**
	TOTAL	**15 P**

REFERENCES:

1. Concepts of Genetics W. S. Klug, M. R. Cummings, C. A. Spencer. 8 Edition, Pearson Education International (2006)
2. Gardner, Eldon J.; Snustad, Peter D.; Principles of genetics; 7th edition; New York: John Wiley &Sons ,(1984).
3. Genetics : A Conceptual Approach B. Pierce, 3rd Edition, Freeman & Co., (2008)
4. Genetics Peter Russell, 2nd Edition, Pearson International, (2006)
5. Gupta, P.K. Genetics. Rastogi Publications. (1990).
6. Gupta, P.K.; Cytogenetics; 1st edition, reprint; Meerut :Rastogi Publications , (2004).
7. Gupta, P.K.; Genetics: A textbook for University students; 3rd edition; Meerut: Rastogi Publications , (2007).
8. Introduction to Genetic Analysis A. J. Griffiths, S. R. Wessler, R. C. Lewontin, S. B. Carroll. 9th Edition, Freeman and Company (2008)

   Molecular Biology of the Gene J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. 5th Edition, Pearson Education (2004)
9. Principles of Genetics P. Snustad, M. Simmons, 4th Edition, John Wiley and Sons Co., (2006)
10. Shukla, R.S. and Chandel, P.S.; Cytogenetics, Evolution, Biostatistics and Plant Breeding. (2007)

COURSE TITLE: PLANT BREEDING & BIOSTATISTICS (THEORY)

COURSE CODE: BOT-IV.E-5

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

To enable the students to learn various techniques in plant breeding with regards to crop productivity**.**

COURSE OUTCOMES: Students will be able to:

- To recognise various techniques in plant breeding
- To differentiate between modes of plant breeding
- To employ manual emasculation procedure.
- To calculate mean, median, mode, standard deviation, std. error for provided material.

Sr.No.	TOPICS	HOURS
Module 1: Introduction to Plant breeding, Organisations and Certifications		**15**
Introduction to Plant breeding and Organisations		
1.1	Introduction, history, objectives, achievements and prospects. Centres of origin of crop plants.	
1.2	Organizations & their mandate - ICAR, ICRISAT, IRRI (Indian& International)	
1.3	Plant breeders' & Farmers' Rights Phytosanitary and Seed Certifications	
Module 2: Hybridisation, Heterosis, Inbreeding Depression and Mutation breeding		**15**
Hybridisation, Heterosis and Inbreeding Depression		
2.1	Pure line and mass selection	
2.2	Types and Techniques in hybridization Introduction, domestication and acclimatization.	
2.3	Heterosis and inbreeding depression.	
Mutation Breeding; Plant breeders'rights; Breeding for stresses.		

2.4 **2.5**	Varieties developed in India through mutation breeding; Limitations of mutation breeding	
Module 3: Biostatistical methods and Genetics of Pathogenicity		**15**
Biostatistical methods and Genetics of Pathogenicity		
3.1 **3.2** **3.3** **3.4**	Introduction to biostatistics: Terms used in biostatistics, types of data, Sampling theories- random sample, sample size determination, precision, data collection, processing and presentation of data: qualitative and quantitative Measures of central tendency: Mean, Median, Mode. Measures of variation: standard deviation, standard error Concept of correlation between two variables and regression line Chi square Physiological races and types. Genetics of pathogenicity; vertical and horizontal resistance & breeding for various biotic stresses in rice/wheat.	
	TOTAL	**45**

COURSE TITLE: PLANT BREEDING & BIOSTATISTICS

(PRACTICAL) COURSE CODE: BOT-IV.E-5

MARKS: 25

CREDITS: 1

Sr. No	MODULE 4: TOPICS	Practical
1.	Emasculation and bagging of flowers using suitable plant material and Estimation of fruit and seed set in emasculated flowers	**03**
2.	Correlation of floral structure with pollination system	**01**
3.	Estimation of pollen fertility (pollen viability) in (any two) locally grown crop species.	**02**
4.	Study of centres of origin of some important crop plants.	**01**
5.	Study of soil pH using different soil types & relate it to crops	**01**
6.	Analysis of data for mean, median & mode, Standard deviation and standard error using suitable plant samples	**03**
7.	Determination of correlation and regression, Chi square analysis	**03**
8.	Visit to ICAR	**01**
	TOTAL	**15 P**

REFERENCES:

1. Mahajan, B.K.; Methods in biostatistics; 6th edition; New Delhi:Jaypee Brothers, (1997)
2. Rastogi, Veer Bala.; Fundamentals of Biostatistics; 2nd edition, reprint; New Delhi: Ane Books India,2006(2008).
3. Shukla, R.S. and Chandel, P.S.; Cytogenetics, Evolution, Biostatistics and Plant Breeding.(2007)
4. Singh, B.D.; A textbook of Plant Breeding; Kalyani Publishers.(2009)
5. Sokal R R and Rahlf H A. Biometry: the principles and practice of Statistics for Biology. research. 3rd edi W H Freeman and Co.(1995)
6. Zar J H, Biostatistical analysis 4th ed. Prentice Hall.(1998)

COURSE TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY

COURSE CODE: BOT-IV.E-6

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

To study the morphology, systematics and phylogeny of flowering plants.

COURSE OUTCOME: **Students will be able to:**

- Name, arrange, describe and compare the taxa
- Outline keys for identification of flowering plants
- Interpret phylogenetic trees, cladograms, etc.

	TOPICS	Hours
Module 1: Introduction to Plant classification, Nomenclature		**15**
1.1	Plant classification, nomenclature & biosystematics	
1.2	Field inventory; Functions of Herbarium; Important herbaria and botanical gardens (India & world), virtual herbarium; e-flora	
1.3	Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access	
1.4	Principles and rules (ICBN); Ranks and names (names of hybrids); Typification, author citation, valid publication, Rejection of names, principle of priority and its limitations	
Module 2: Concept, Taxonomic evidences and Phylogeny of Angiosperms		**15**
2.1	Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; species concept (taxonomic, biological, evolutionary).	
2.2	Evidence from palynology, cytology, phytochemistry and molecular data.	
2.3	Origin & evolution of angiosperms, Co-evolution of angiosperms Characters; Variations; OTUs, cluster analysis, Phenograms, cladograms (definitions and differences)	

Module 3: Systems of classification; position and diagnostic features of families		**15**
3.1	Concepts of evolution and phylogeny	
3.2	Study of classification systems (major contributions by Linnaeus, Bentham and Hooker, Englerand Prantl) and Angiosperm Phylogeny group (APG III).	
3.3	Position and diagnostic features of families: Annonaceae, Capparidaceae, Brassicaceae, Fabaceae, Rutaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Apocyanaceae, Asclepiadaceae, Solanaceae, Verbenaceae, Lamiaceae, Amaranthaceae, Orchidaceae, Araceae, Asteraceae, Zingiberaceae, Commelinaceae, Poaceae.	
	Total:	**45**

COURSE TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY

COURSE CODE: BOT-IV.E-6

MARKS: 75

CREDITS: 3

Sr.no	Module 4: Topics	Practical
1	Plant identification using flora book and database	**01**
2	Preparation ofherbarium	**01**
3	Identification of 15 families mentioned in unit IV (Bentham & Hooker's system) studied in theory from locally available specimens (with floral diagram).	**10**
4	Use of taxonomic keys and construction of dichotomous keys	**01**
5	Taxonomic interpretation using pollen of related species	**01**
6	Construction of Phenogram and Cladogram	**01**
	Total	**15**

REFERENCES:

1. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford &IBH Pvt. Ltd., NewDelhi.
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6. Mondal, A.K. Advanced Plant Taxonomy, New Central Book Agency Ltd., 2009.
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8. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row, NewYork.
9. Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd,London.
10. Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press,London.

COURSE TITLE: PLANT PATHOLOGY (THEORY)

COURSE CODE: BOT-IV.E-7

MARKS: 75

CREDITS: 3

Course Objectives

Make the students aware of various plant pathogens and their control

Course Outcome: Students will be able to:

- Identify various diseases and causal agents of economically important plants
- Find effective control measures

Sr. No	TOPICS	Hours
MODULE I: : AN INTRODUCTION AND EPIDEMOLOGY OF PLANTS DISEASES		**15**
1.1	History, Definitions and Importance of plant pathology	
1.2	Concepts and types of diseases in plants	
1.3	Biotic causes of plant diseases.	
1.4	Infectious agents (nematodes, protozoans, bacteria, fungi & viruses)	
	Growth, reproduction, survival and dispersal of important plant pathogens	
	Role of environment and host nutrition on disease development	
MODULE II::PLANT DISEASE DEVELOPMENT (PATHOGENESIS) AND MANAGEMENT		**15**
2.1	Parasitism and pathogenicity	
2.2	Symptomatology	
2.3	Host parasite interaction	
2.4	Recognition concept and infection,	
2.5	Role of enzymes, toxins & growth regulators in pathogenesis	
2.6	Quantitative resistance (Physical, Biological & cultural methods)	
	Biochemical defences (oxidative burst; Phenolics, Phytoalexins, PR proteins, antimicrobial substances and plantibodies), Quarantine	

	measures		
UNIT IV: GENETICS OF PLANT DISEASE AND STUDY OF PLANT DISEASES IN INDIA			**15**
3.1	Altered plant metabolism due to pathogens attack		
3.2	Genetics of resistance ('R' &avr genes, elicitors responses)		
3.3	Signalling and programmed cell death		
3.4	**Study of Diseases** (Name of disease, pathogen, symptoms and control measures need to be studied) Important diseases (Any 2 of each) of Paddy, Arecanut, Wheat, Banana, Coconut, Sugarcane, Mango and Amaranth/ Raddish		
		TOTAL	**45**

COURSE TITLE: PLANT PATHOLOGY (PRACTICAL)

COURSE CODE: BOT-IV.E-7

MARKS: 25

Sr. No	MODULE 4: Topics	Practicals
1	Isolation and culture of fungal and bacterial pathogens.	02
2.	Demonstration of Koch's postulates	01
3.	Assay for cellulase /pectinase enzyme from diseased plant	02
4.	Study of plant diseases with reference to pathogen &symptomology (Viral, Bacterial & Fungal) (any 10 as per theory)	05
5	Anatomical observations of fungal infected plants (rust, blight, rots)	3
6	Study of antagonistic behaviour of bacterial pathogens	1
7.	Visit to Plant Pathology Laboratory (ICAR)	1
	Total	**15**

References

1. Agros, G.N. (1997) Plant Pathology (4th ed) Academic Press.
2. Bilgrami K.H. & H.C. Dube (1976) A textbook of Modern Plant Pathology. International BookDistributing Co. Lucknow.
3. Mehrotra, R.S. (1980) Plant Pathology, TMH, New Delhi.
4. Pandey, B.P. (1999) Plant Pathology. Pathogen and Plant diseases. Chand & Co. New Delhi.
5. Rangaswami, G. (1999) Disease of Crop plants of India Prentice Hall of India Pvt. Ltd.
6. Sharma P.D. (2004). Plant Pathology Rastogi Publishers.
7. P Gunasekaran (2005) Laboratory manual in Microbiology. New Age International (P) Limited, Pub. New Delhi.
8. K.R. Aneja (2009). Experiments in Microbiology Plant Pathology & Biotechnology, 4th edition New Age International (P) Limited, Pub. New Delhi.

COURSE TITLE: HORTICULTURE, FLORICULTURE & LANDSCAPING (THEORY)

COURSE CODE: BOT-IV.E-14

MARKS: 60

CREDITS: 3

COURSE OBJECTIVES:

Is to provide entrepreneur opportunities.

COURSE OUTCOMES:**Students will be able to:**

- Explain the basics of Horticulture, floriculture and landscaping
- Outline the requirements for building up nurseries, garden, etc.
- Inculcate the technique of vegetative propagation of plants.
- Identify and relate the scope of these fields in building up career

Sr.No	Topics	Hours
Module 1: Tools and Techniques in Horticulture, floriculture		**15**
1.1	**Theory sessions:** Definition and importance; Pomoculture, Olericulture, Floriculture. **Fertilizers**: inorganic, Organic – biofertilizers: vermicomposting, green manure, algal culture, FYM. Knowledge of annual, biennials and perennials with reference to ornamental flowers Irrigation:- Surface, Sprinkle, Drip and Gravity irrigation Introduction to Green house, Poly house, Moist chamber, Net frame, Introduction to Hydroponics. **Practice sessions:**	
1.2	i) Local visits to nurseries, home gardens to know about different pots and its potting system ii) Preparation of potting mixture – Potting, repotting iii) Preparation of organic compost & vermicompost iv) Familiarizing gardening tools and implements v) Improving the shelf life of cut flowers using chemicals vi) Study of Hydroponics vii) Local visit to an established green house/polyhouse and report making.	

Module 2: Propagation Methods		**15**
2.1	**Theory sessions:** Introduction to sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds. Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops. Use of plant growth regulators in horticulture	
2.2	Practice sessions: i) Field work in cutting, grafting, budding, layering ii) To design experiments for induction of rooting, flowering, fruit set, fruit development and control of fruit crops iii) To study the cultivation practices of local commercial flowers iv) Field work in Nursery management; Cut flowers; to improve shelf life of cut flowers.	
Module 3: Landscaping		**15**
3.1	**Theory sessions:** Types of garden: Formal, informal and kitchen garden Locations in the garden- edges, hedges, fence, lawn, flower beds, Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing.Bonsai techniques	
3.2	**Practice session:** i) Visit to local gardens and giving comparative account of types of garden ii) Listing of plants used for edges, fence, lawn, flower beds, water gardens, etc. iii) Visit to a botanical gardens/ water garden iv) To learn different styles of Bonsai techniques v) Lawn making: type of lawn grasses and maintenance. Plants suitable for hedges. Aftercare: Weeding, top dressing methods of pruning and topiary vi) Garden designing using (preferably Auto CAD) software	

Module 4: Applications of Horticulture, Floriculture and Landscaping		**15**
4.1 4.2	Theory sessions: Entrepreneurship skills, Invited lecture by Guests (Spice Farm owner, Ecotourism sector, Organic farmer/ Organic products outlet owner, Nursery manager/ Landscaper, Krishivigyan Kendra, Agriculture dept, Forest Dept, etc) Latest schemes in horticulture, floriculture, agriculture in Goa. **Practice sessions:** Preparation of garden design (area of the campus) Innovative ideas for beautification of the campus and preparation of the same. Establishment of vegetable garden using organic compost &vermi-compost Or Internship at any firm related to Horticulture.	
	Total	**60**

REFERENCES:

1. Swarup V. (1997). Ornamental horticulture. MaMillan India Limited, NewDelhi.
2. Randhava, G.S, 1973 – Ornamental horticultural in India Today andTomorrow Printers and Publishers, NewDelhi.
3. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research NewDelhi.
4. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj&Co.,&LingichettiStreet,Madras.
5. EdmentSenn Andrews 1994 Fundamentals of Horticulture – TataMcGraw Hill Publishing Co., Ltd.,Delhi

COURSE TITLE: PLANT MOLECULAR BIOLOGY (THEORY)
COURSE: BOT-V.C-7
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:
To introduce the students with fundamental knowledge of molecular system in cells.

LEARNING OUTCOMES:
The students will be able to understand general principles of gene organization and functions.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT-I: NATURE OF GENETIC MATERIAL	**08**
1.1	Characteristics of genetic material, physical and biological evidences to prove DNA & RNA as genetic material, Watson and Crick's model of DNA, polymorphism of DNA; comparison between DNA and RNA.	5
1.2	Central Dogma of molecular biology, Model organism for studying molecular biology; C-value paradox	2
1.3	Chargoff's Law, Franklin's and Wilkin's work	1
	UNIT II: REPLICATION OF DNA	**12**
2.1	General feature of DNA replication (replication eye, replication forks);	3
	Types of DNA replication, mechanism of DNA replication in;	
	Prokaryotes (Transduction, transformation and conjugation), & in Eukaryotes (Dispersive, Conservative and Semi- conservative)	3
2.2	Enzymes of replication –DNA Primase; DNA polymerases I, II, III,	3
2.3	Types of DNA damages and repair (direct reversal of damage, excision repair)	3
	UNIT III: TRANSCRIPTION	**09**

3.1	Structure and functions of mRNA, tRNA and rRNA	2
3.2	Transcription of mRNA in Prokaryotes & eukaryotes	4
3.3	Post transcriptional event; eukaryotes splicing, processing	3
UNIT IV: GENE REGULATION & EXPRESSION		**10**
4.1	Units of Gene (Cistron, recon, muton, Enhancers, Split genes, overlapping genes; transposons and its role in gene structure, promoters & terminators.	5
4.2	Gene regulation in prokaryotes (Lac operon concept) and eukaryotes Inducible and repressible mechanism.	5
UNIT V: TRANSLATION-PROTEIN SYNTHESIS		**06**
5.1	Secondary structure of mRNA and its functions; Genetic code.	2
5.2	Mechanism & factors Translation; RNA polymerases; and factors	2
5.3	Post translational modifications; Protein targeting	2
	Total	**45**

COURSE TITLE: PLANT MOLECULAR BIOLOGY (PRACTICALS)
COURSE CODE: BOT-V. C-7
MARKS 25
CREDIT 1
PRACTICAL SESSIONS: 15

SR. NO	TOPICS	PRACTICAL SESSIONS
1	Isolation of plant genomic-DNA	3
2	Spooling of DNA from different plant samples	3
3	Quantification of DNA by DPA method.	2
4	Isolation and estimation of RNA from plant tissue	3
5	Preparation of Agarose gel and running of DNA (demonstration)	2
6	Demonstration of DNA amplification by PCR	2
	Total	**15**

REFERENCES:

1. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter (1999). Molecular Biology of the Cell. Garland Publishing, Inc., New York

2. David Freifelder (1983) Jones & Bartlett publishers. 2ed Molecular biology. Reprint 1993. Narosa Publishing House.

3. J.K.Pal and S.S.Ghaskadabi (2008) Fundamentals of Molecular Biology. Oxford.

4. James D. Watson (2007). Molecular Biology of the Gene (6th Edition) by, Tania A. Baker, Stephen P. Bell, and Alexander Gann.

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7. R.C. Dube (2008) A Text Book of Biotechnology S. Chand pub.

8. R.L. Adams, J.T. Knowler, and D.P. Leader (1992). The Biochemistry of the Nucleic Acids.

9. Lewin B. (2000). Genes VII. Oxford University Press, New York.

10. Buchanan B.B, Gruissm W. and Jones R.L (2000). Biochemistry and Molecular biology.

COURSE TITLE: BIOINFORMATICS (THEORY)
COURSE CODE: BOT. E-9
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES: The course will help the students to understand the fundamentals of bioinformatics and tools available.

LEARNING OUTCOMES:

It will enable the students to gain knowledge in vast data handling and analysis, and to develop skills.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	HOURS
UNIT I: INTRODUCTION TO BIOINFORMATICS		**08**
1.1	Introduction to bio-informatics, The biological sequence / structure deficit	02
1.2	Genome projects, Pattern recognition and prediction, Levels of protein structure	03
1.3	Role of Chaperons, Sequence analysis	01
1.4	Fields Related to Bioinformatics: Computational Biology, Genomics, Proteomics, Pharmacogenomics, Cheminformatics, Medical Informatics Importance of Bioinformatics	02
UNIT II: INFORMATION NETWORKS		**07**
2.1	Internet and the facilities available on it, computational biology, What is World Wide Web, Web browsers and Web Addresses	03
2.2	HTTP, HTML, CORBA and URLs	01

2.3 **2.4**	The National Centre for Biotechnology Information- NCBI The European Molecular Biology Network- EMBnet Bioinformatics programme in India- BTISNet, BPI-2004	02 01
UNIT III : INTRODUCTION TO BIOLOGICAL DATABASE		**04**
3.1	Introduction To Biological Database : GenBank, EMBL, SwissProt, PROSITE, EC-ENZYME, PDB, GDB, PIR-PSD,	04
UNIT IV : PROTEIN AND GENOME INFORMATION RESOURCES		**15**
4.1 **4.2**	Introduction to Protein information resources, Primary Sequence Databases, Composite protein sequence databases, Secondary databases, Composite protein pattern databases; Structure classification databases. Introduction to genome information resources, DNA sequence databases, Specialised genomic resources, ORF (Open Reading Frame Finder), TIGR Genome Resources , Genome comparison, Genome Annotation, Microarray image analysis	07 08
UNIT V : HOMOLOGY, ANALOGY, ORTHOLOGY, PARALOGY, PAIRWISE ALIGNMENT AND MULTIPLE SEQUENCE ALIGNMENTS		**11**
5.1 5.2	Introduction, Comparision of Homology, Analogy, Orthology And Paralogy. Alignment based methods and Hybrid method; Comparision of Computer Prediction Algorithms. Introduction to pairwise and multiple sequence alignment; Comparison of sequences; Global alignment: The Needleman and Wunsch algorithm; Database interrogation, Alphabets and complexity; Pairwise database searching, BLAST; Databases of Multiple Alignments, Clustal Omega	05 06
	TOTAL	**45**

COURSE TITLE: BIOINFORMATICS (PRACTICALS)
COURSE CODE: BOT.E-9
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS:15

SR. NO	TOPICS	PRACTICAL SESSIONS
1	Biological databases and exploring various websites- NCBI, PUBMED and Gen Bank databases, To study the file formats- FASTA, PDB, Mol	5
2	To explore EBI server and searching EMBL	2
3	Exploring and querying UniProt KB	1
4	Pairwise global alignment of protein and DNA using Needleman- Wunsh algorithm with 6	2
5	Obtaining sequences for Pairwise alignment and to interpret the results to study the homology between the sequences Database searching using different versions of BLAST and FASTA and Derivation of relationships of query sequences	4
6	Use of Clustal Omega for multiple sequence alignment	1
	TOTAL	**15**

REFERENCES:

1. Attwood, D. J., Parry Smith D.J. and Phukan, S. (2011). Introduction to Bioinformatics; Pearson education.
2. Ignacimuthu, S. (2005). Basic Bioinformatics. Narosa Publishing House
3. Khan, I. A. and Khanum, A. (2003). Fundamentals of Bioinformatics –Ukaaz publications.
4. Mani, K. and Vijayaraj, K.A. (2002). Bioinformatics for Beginners. Aparnaa Publication.
5. Murthy, C. S. V. (2004). Bioinformatics. Himalaya Publishing House.

Web Resources

1. http://genes.mit.edu/GENSCAN.html

2. http://vmoc.museophile.org Computer History
3. http://www.clcbio.com/index
4. http://www.genome.jp
5. http://www.genome.jp/dbget/ LinkDB
6. http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml
7. http://www.softberry.com/berry
8. http://www.studentworkzone.com/
9. www.ebi.ac.uk
10. www.fgcu.edu/support/office2000
11. www.learnthenet.com Web Primer
12. www.clustawomega.org
13. www.embl.org

COURSE TITLE: SEED TECHNOLOGY (THEORY)
COURSE CODE: BOT. E-10
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HRS

COURSE OBJECTIVES:
The course is focused in training students with knowledge of seed health, seed testing techniques, importance of plant breeding for production of high yielding seeds and various storage & protection techniques.

LEARNING OUTCOMES:
Student will have better understanding of seed physiology and vigor. The course knowledge will create trained human resource for seed industry and research organizations dealing with seed.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT-I: PRINCIPLES OF SEED TECHNOLOGY		**07**
1.1	History, concepts, and role of seed technology	2
1.2	Seed definition and its types (nucleus seed, breeders seed, foundation seed, certified seed and truthful seed),characteristics of good seeds	2
		3
1.3	Difference between seed and grain, Seed development programmes in Indian seed industry, national seed corporation.	
UNIT-II: ORGANIZATIONS OF SEED TESTING		**08**
2.1	International seed testing association	2
2.2	Association of official seed analysts.	
	Central and state seed testing laboratory	2
2.3	Role of ICRISAT and ICAR	2
2.4		2
UNIT III: SEED TESTING AND CERTIFICATION		**10**
3.1	Objectives and concept of seed certification, Phases of seed certification	3
3.2	Procedure of seed certification: Minimum seed certification standards , General seed certification standard, and Specific crop standards.	4
3.3	Principles and procedure of seed testing; Equipments for seed testing	3

	Importance of seed testing, Seed heterogeneity test and tolerance value	
UNIT IV: PLANT BREEDING IN RELATION TO SEED TECHNOLOGY , SEED PROTECTION, PROCESSING AND STORAGE		**10**
4.1	Maintenance of breeders seed methods in self and cross fertilized crops.	3
4.2	Development trial and release of seed variety	2
4.3	Germ plasm and its conservation, seed banks and types of seed collections	3
4.4	Use of heterosis in crop improvement	2
UNIT V: SEED PROTECTION, PROCESSING AND STORAGE		**10**
5.1	Importance of epidemic and seed borne diseases	3
5.2	Factors affecting seed infection	1
5.3	Seed borne pathogens and control measures; Seed drying- principles; its advantages and methods; Seed treating chemicals and equipments Pest problems and their treatment during storage; Concept of seed marketing	5
5.4	Forecasting of seed demand and supply.	1
	TOTAL	**45**

COURSE TITLE: SEED TECHNOLOGY (Practicals)
COURSE CODE: BOT-V.E-2
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	TOPICS	Practical sessions
1	Analysis of physical and chemical properties of seed	3
2	Study of structure of dicot and monocot seeds from various plant species	3
3	Testing of seed viability (2,3,5-triphenyl tetrazolium chloride test)	2
4	**Mini Projects** 1. Breaking of seed dormancy methods (chemical, hormone &	6

	temperature) 2. Seeds and diseases 3. Seed moisture and germination	
5	Visit to seed production plant and report submission	1
	Total	15

REFERENCES:

1. Agrawal (2005). Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Dutta (1983). A Class book of Botany, Oxford University Press, Calcutta
3. Pandey (2010). A text book of Botany. S. Chand and Company Ltd., New Delhi.
4. Reddy (2008). Principles of crop production. Kalyani Publishers, New Delhi.
5. Santra and Chatterjee (2007).College Botany, New Central Book Agency (P) Ltd., Kolkata .
6. Singh, (2009). Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
7. Umaraniet. A.L. (2006). Experimental Seed Science and Technology, Agrobios, Jodhpur

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (THEORY)
COURSE CODE: BOT.E-11
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS
COURSE OBJECTIVES:

To enable the students to learn and understand fundamental knowledge, the techniques & skills in plant drug industry, drug discovery and development.

LEARNING OUTCOMES:

To understand and use the techniques in plant drug industry along with bioassays and creating human resource in the field of drug development and pharmacognosy.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: INTRODUCTION	**08**
1.1	History, present status, future scope & development of plant drug technology and Pharmacognosy	04
1.2	Classification of drugs: Morphological, Chemical And Pharmacological.	04
	UNIT II: CULTIVATION COLLECTION AND CONSTITUENTS OF FOLLOWING	**15**
2.1	ROOTS/ RHIZOME: *Rauwolfia* and *Curcuma*	03
2.2	LEAVES: *Adathoda* and *Ocimum*	03
2.3	SEEDS: Fenugreek and Nutmeg	03
2.4	FRUITS: Coriander and Senna pod	03
2.5	FLOWERS: Clove and Rose	03
	UNIT III: PHYTOCHEMICALS	**11**
3.1	Biosynthesis of alkaloids and effect of biological and chemical factors which affects biosynthetic pathways with e`xamples. Metabolic pathways of selected plants (from Tulsi and Rauwolfia).	05
3.2	Methods of Characterization: NMR,MS,UV-Vis,GC-MS.LC-MS	06
	UNIT IV:Extraction and analysis of Phytochemicals	**11**
4.1	Extraction methods and principles. Traditional and modern techniques	04
4.2	Analysis of Pigments, Phenolics, Flavonoids and Alkaloids	04
4.3	Bioassays: Identification of marker compounds in the formulations. Fingerprint and identification of plant drugs.	03
	Total	**45**

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY (PRACTICAL)
COURSE CODE: BOT.E-11
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No.	Experiments	Practical
1.	Test for alkaloids: Mayer's, Wagner's, Dragendorffs' reagent	**01**
2.	Isolation of alkaloids and Phenolics	**02**
3.	Disc diffusion for antimicrobial assay	**02**
4.	MIC evaluation for antimicrobial assay	**02**
5.	Anatomical study of *Nux vomica* seeds, Ginger, Citronella leaf, Senna leaf & its medicinal properties	**04**
6.	Histochemical tests for Oils And Fats – Castor seed/ Citrus	**01**
7.	Microchemical test of Arum / *Colocasia* leaves for observation of Calcium oxalate crystals.	**01**
8.	Mini project Adulteration of crude drugs	**02**
	TOTAL	**15**

REFERENCES:

1. Gokhale S.B and Kokate, C.K. (2009). Pharmacognosy. Nirali Prakashan.
2. Khandelwal, K. R. (2008). Practical Pharmacognosy. Nirali Prakashan.
3. Kokate, C. K. (2008). Pharmacognosy. Nirali Prakashan.
4. Qadry, J.S. (2014). A Textbook of Pharmacognosy Theory And Practicals, CBS Publishers & Distributors.
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9. Daniel Mammen. (1991). Methods in plant chemistry and economic botany, Kalyani publishers, New Delhi.

COURSE TITLE: ORGANIC FARMING (THEORY)
COURSE CODE: BOT.E-12
MARKS: 75
CREDITS: 3
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:

The course provides knowledge of principles and practices of organic agriculture and its role in sustainable crop production.

LEARNING OUTCOMES:

On completion of the course: the students will develop an understanding of the social, economic and environmental context for current and future organic agriculture production and management.

Sr.No.	UNITS, TOPICS AND SUB-TOPICS	Hours
	UNIT I: CONCEPT OF ORGANIC FARMING	**09**
1.1	Introduction: Farming, organic farming, concept and development of organic farming.	02
1.2	Principles of organic farming, Types of organic farming	02
1.3	Needs and benefits of organic farming.	02
1.4	Agencies and institutions related to organic agriculture	01
1.5	Farm components for an organic farm	02
	UNIT II: COMPOSTS, MANURES AND ITS APPLICATION	**11**
2.1	Manure application: Composted vs. uncomposted manure	03
2.2	Composting- principles, stages, types and factors	03
2.3	Composting methods, Vermicomposting Bio-fertilizers, Microbial inoculants , FarmYard Manure, Neem cake,	02 03

	Mulching, Alley farming/ cropping.	
UNIT III: SOILS, SOIL FERTILITY MANAGEMENT AND FERTILIZERS		**13**
3.1	Soil types, Soil profile and Soil tillage	03
3.2	Factors affecting soil fertility and productivity	02
3.3	Land preparation	01
3.4	Water management for good soil, Commercial fertilizers, composition	03
3.5	Residual effects and fertilizer use efficiency	02
3.6	Foliar application and its concept	02
UNIT IV: ORGANIC PLANT PROTECTION AND SEED CERTIFICATION		**07**
4.1	Plant protection- cultural and mechanical methods	02
4.2	Plant protection- bio pesticide and bio control agents	02
4.3	Allelopathic methods of weed control	02
4.4	Certification of organically produces seeds.	01
UNIT V: ENTREPRENEURSHIP DEVELOPMENT		**05**
5.1	Entrepreneurship – Concept, characteristics, approaches, need for entrepreneurship in Organic farming	02
5.2	Popularization of organic farming. Marketing of organic produce. Organic farming in the rest of the world.	03
TOTAL		**45**

COURSE TITLE: ORGANIC FARMING (PRACTICAL)
COURSE CODE: BOT.E-12
MARKS: 25
CREDITS: 1
PRACTICAL SESSION: 15

Sr. No.	TOPICS	PRACTICAL SESSIONS
1.	Comparative analysis of pH, EC, organic C, total N, available N, P, K and S from organic and inorganic data (obtained data).	1
2.	Survey of weeds in crop fields (Organic v/s inorganic farming)	1
3.	Study of soil types.	1
4.	Study of bio pesticide (Neem cake)	1
5.	Study of Mulching	1
6.	Visit to an organic farm	2
7.	Effectt of various manures on plant growth	3
8.	Mini projects - Preparation of Compost/ vermi-compost Study of Algal biofertilisers	5
	TOTAL 15	

REFERENCES:

1. Chakraverty, A. (1991). Post-harvest technology of cereal, pulses and oil seeds. Oxford IBH Publishing Co. Pvt Ltd.

2. Deshmukh, S.N. (2012). Organic Farming: Principles, Prospects and Problems, Agrobios Publishers (India).
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13. Singh, B. D. (2006). Plant Breeding Principles and Methods. Kalyani Publishers.
14. Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J. L. (2013). Soil fertility and fertilizers. Pearson Publishers.
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COURSE TITLE: PLANT GENETIC ENGINEERING

COURSE CODE: BOT- VI.C-8

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: This course is to develop fundamental knowledge and skills in various aspects of Genetic engineering.

COURSE OUTCOME: **Students will be able to:**

- Apply the basic knowledge of Plant Genetic Engineering in research
- Perform experiments by themselves
- Compare and assess the different DNA sequencing techniques
- Design experiments in plant genetics

Sr.No	TOPICS	Hours
	Module 1: Recombinant DNA technology: Tools	**15**
1.1	Enzymes- Exonucleases; Endonucleases; Restriction endonucleases Type I, II&III; ligases, methylases; Reverse Transcriptase, Polymerase.	
1. 2	Prokaryotic and eukaryotic cloning vectors; General account of plasmids, cosmids, bacteriophages, Phasmids – Advantages and disadvantages; Structure of pBR 322; Artificial chromosome vectors – BAC, YAC, Shuttle vectors.	
1.3	DNA Ligation – Linkers, adaptors, Homopolymer tailing, Transformation, selection of transformed bacteria – antibiotic selection, reporter genes - GUS,GFP.	
	Module 2 : Techniques in Recombinant DNA technology	**15**
2.1	Polymerase chain reaction – Principle, types of primers, Taq polymerase, Protocol, Reverse Transcriptase PCR and Real Time PCR	
2.2	Prokaryotic expression of foreign genes; Isolation of gene of interest – Construction of cDNA library; Genomic Library	
2.3	DNA sequencing – Maxam Gilbert's method, Sanger's method,Automated DNA sequencing, Pyrosequencing	

2.4	Molecular Analysis of gene and gene products – Southern, Northern and Western blotting, ELISA, RIA	
2.5	Molecular markers – RAPD, RFLP, AFLP, Brief account of DNA Fingerprinting and Bar coding of plants	
2.6	Brief account of: Antisense RNA technology – FLAVR SAVR Tomato; Gene Silencing; RNA interference; mtRNA	
	Module 3: Gene transfer methods in plants, Biosafety and Applications of Genetic Engineering	**15**
3.1	Vector mediated gene transfer- Agrobacterium mediated gene transfer – T DNA, Ti plasmid and Ri plasmid derived vector systems*;* hairy-root culture; Plastid/ Mitochondria transformation.	
3.2	Process of transfer - Bacterial colonization, Induction of virulence, generation of TDNA transfer complex, T-DNA transfer, Integration of TDNA into plant genome	
3.3	Direct methods of gene transfer – Biolistics, Lipofection, Electroporation, microinjection – Advantages and disadvantages	
3.4	Intellectual Property Rights, Genetic engineering and Public issues Biosafety regulation	
3.5	Applications: Agricultural: Bt cotton, Golden rice Environmental: Biodiversity and conservation; Waste management and Bioremediation Industrial- Large scale production of beverages, Pharmaceuticals,	
		45

COURSE TITLE: PLANT GENETIC ENGINEERING (PRACTICAL)

COURSE CODE: BOT- VI.C-8

MARKS: 25

CREDITS: 1

Sr. No	Module4: Topics	Practical
1	DNA isolation by CTAB/(any other) method	02
2.	Estimation of DNA	02
3.	Agarose Gel Electrophoresis	02
4.	Restriction of DNA	02
5	Sequence reading – Sanger method/Maxam Gilbert method – problem	02
6	*Agrobacterium tumefaciens*-mediated plant transformation. (Virtual Library)	01
7	Small scale plasmid preparation from *E. coli*	03
8	Visit to a leading biotechnology institute and Report making.	01
	Total	**15**

REFERENCES:

1. Brown, T. A. (2006) Gene cloning and DNA analysis; Blackwell scientific publishers
2. Sobti,R.C.&Pachauri,S.S.(2009)EssentialsofBiotechnology;AneBooks,NewDelhi
3. Dubey, R.C. Introduction to Plant Biotechnology; S. Chand & Co
4. Purohit, S.S. (2003) Agricultural Biotechnology, Agrobios (India)
5. Chawla, H.S. (2000) Introduction to Plant Biotechnology
6. Dovstekel (2005) Microarray Bioinformatics; Cambridge University press
7. Ignacimuthu, S. (1997) Plant Biotechnology, New Hampshire Science Publishers
8. Gupta, P. K. (1996) Elements of Biotechnology; Rastogi and Company, Meerut
9. Lewin, B. (2004) Genes VIII. Oxford University Press
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11. Smith, J.E. (2005) Biotechnology; Cambridge University press, UK
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13. Brown TA (2002) Genome, Blackwell.

COURSE TITLE: PLANT TISSUE CULTURE

COURSE CODE: BOT-VI.E-13

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES: To develop the plant tissue culture skills.

COURSE OUTCOME:**Students will be able to:**

- Explain and discuss the general theoretical backgrounds and practical techniques
- Describe, define, explain/ discuss, compare, concept of differentiation and culture types
- Define, describe, explain/ discuss, techniques in PTC in media preparation, sterilisation, callus culture and organogenesis
- Describe, explain, discuss applications in forestry, agriculture etc

Sr.No	TOPICS	Hours
	Module – I: Introduction and differentiation Concept	**15**
1.1 **1.2** **1.3**	Scope and history of plant tissue culture, Laboratory organization. Culture techniques – Sterilization methods of glasswares, Explant preparation, sterilization, media composition and preparation. Cellular differentiation and totipotency; effect of growth regulators ondifferentiation.	
	Module – II: Culture types and Techniques in Tissue culture	**15**
2.1 **2.2**	Cell culture types- callus, single cell and suspension culture Organogenesis and embryogenesis; Somaclonal variation; meristem Micropropagation, Germplasmconservation; Isolation and regeneration of protoplasm; Somatic hybridization, Synthetic seeds, Cryopreservation, secondary metabolite production.	
	Module- III: Application of Plant tissue culture	**15**
3.1 **3.2**	Horticulture Agriculture	

3.3	Forestry	
	Total	**45**

COURSE TITLE: PLANT TISSUE CULTURE (Practical)

COURSE CODE: BOT-VI.E-13

MARKS: 25

CREDITS: 1

Sr. No	**MODULE 4: Topics**	**Practical**
1	Preparation of MS Medium; Sterilization techniques	03
2	Embryo culture of maize	02
3	Callus induction and its morphological studies	04
4	Sub-culturing callus for rooting and shooting	03
5	Enzymatic Isolation of plant protoplast	01
6	Synthetic seed production	01
7	Visit to Plant tissue culture unit	01
		15

REFERENCES:

1. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York,USA.
2. Kumar, U. (1999). *Methods in Plant Tissue Culture.* Jodhpur: Agrobios(India).
3. Razdan, M. K. (2002). *Introduction to Plant Tissue Culture.* New Delhi: Oxford &IBH Publishing Co. Pvt.Ltd.
4. Satyanarayana U.(2013). Biotechnology. Books and allied (P)Ltd.
5. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, TheNetherlands.

COURSE TITLE: ALGAL BIOTECHNOLOGY (THEORY)

COURSE CODE: BOT-VI.E-14

MARKS: 75
CREDITS: 3

COURSE OBJECTIVES:

Goa being a coastal state, this course will provide an understanding of alternate resources of food, fuel and environment.

LEARNING OUTCOMES:

This course will enable the students for exploring bio-resources from algae through various algal techniques for sustainable development.

Sr. No	UNITS, TOPICS AND SUB-TOPICS	Hours
UNIT-I: METHODS OF ALGAL ISOLATION AND CULTURE		**10**
1.1	Method of algal isolation	2
1.2	Types of algal cultures (synchronous, continuous, mass and "in vitro" culture)	3
1.3	Maintenance and growth of algal culture (freshwater and marine algae)	3
1.4	Multiplication of economically important algae (Rhodophyta, Phaeophyta, Chlorophyta, Cyanophyta)	2
UNIT-II: PHYCOREMEDIATION		**08**
2.1	Phycoremediation	3
2.2	Sewage disposal and waste treatment, textile and effluent sugar industry	3
2.3	Single cell algal protein and phycocolloids	2

UNIT III: ALGAE AND POLLUTION		**11**
3.1	Algae as indicator ofpollution, aquatic pollution by algae: causes and consequence	3
3.2	Eutrophication and its impact on water quality	3

	Algae in environmental health, sewage treatment and treatment in industrial water quality, Algal blooms and their control	3 2
	UNIT IV: COMMERCIAL APPLICATIONS OF ALGAL TECHNOLOGY	16
4.1	Application of algae in carbon sequestration	2
4.2	Application of algae as food and fodder	2
4.3	Application of algae in pharmaceutical industries	2
4.4	Algae in biofuels	3
4.5	Algae as Biofertilzers Algae as secondary metabolites	3
	TOTAL	**45**

COURSE CODE: ALGAL BIOTECHNOLOGY (Practical)

COURSE CODE: BOT-V.E-14

NAME OF THE FACULTY: Dr. SANGEETA G. SANKHALKAR

MARKS: 25

CREDIT: 1

Sr. No	TOPICS	Practicals
1	Survey of market products of algal material	1
2	Culture of algae (Fresh & marine water, one each)	4
3	Chromatographic separation of algal pigments (β-carotene containing algal species eg. *Synechococcus*)	2
4.	Use of algae as biofertilizer	2
5	Isolation and estimation of algal proteins and lipids	4
6	Visit to NIO and submission of report.	2
	Total	**15**

REFERENCES:

1 Becker S. W. 1994. Micro Algae Biotechnology and Microbiology. Cambridge University Press.

2. Ignacimuthu S. 1996. Basic Biotechnology. Tata McGraw Hill Publishing Limited. New Delhi.

3. Power M., Van der Meer, J., Tchelat, R. 1998. Molecular based methods can contribute to assessments of toxological risks and bioremediation strategies. J. Microbiol. Methods, 32: 107 –119.

4. Tridevi P. C. 2001. Algal Biotechnology. Point Publisher, Jaipur, India.

5. Venkatraman G. S. 1972. Algal Biofertilizers and rice cultivation. Today and Tomorrows Printers and Publishers, New Delhi.

6. Zajic J. E. 1970. Properties and Products of Algae. Plenum Press, New York.

7. Bold H.C.and Wynne ,M.J. 1976 Introduction to Algae structure and reproduction. Prentice -hall.

8. Presott G.W. 1970 How to know freshwater Algae W.C. Braun & Co. 11. Round , F.E. 1966

9. Desikachary T.V. 1972. Taxonomy and Biology of Blue Green Algae. University of Madras

SEMESTER: VI

COURSE TITLE: ECONOMIC BOTANY (THEORY)

COURSE CODE: BOT-VI. E-15

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This course provides knowledge on the value of plants with scientific information and critical thinking to enhance economic botany.

COURSE OUTCOMES:Students will be able

- To identify economically important plants/plant parts.
- To identify valuable plant products of potential market and economic value.
- To evaluate, describe and create awareness of the uses of natural plant products as alternative to synthetic and chemical products.

Sr. No	**TOPICS**	**Hours**
Module 1: Origin of Cultivated Plants (Centres of Origin, Cereals & legumes)		**15**
1. 1 1.2 1.3 1.4	**Centres of origin**: Concept, Vavilov's work, examples of major plant introductions; evolution of new crops/ varieties; crop domestication, Genetic diversity and its loss, Importance of germplasm **Cereals:** Wheat, Rice (local varieties) and Millets (any one) **Legumes**: Chick pea, Cow pea and one fodder legumes	
Module 2: Sources of sugars & Starch, Oils & Fats, Drugs & Natural Rubber		**15**
2.1 2.2 2.3	**Sugar & sugarcane sources**: Sugarcane ; Potato &Dioscorea **Fat and Oil sources**: Groundnut, Coconut, Soybean and; extraction and applications of essential oils, Eucalyptus and mustard oils **Therapeutic and habit-forming drugs**: C*inchona,Cannabis*; Tobacco (Morphology, processing, uses and healthhazards)	

2.4	**Tapping, processing and uses of** *Heveabrasiliensis*	
Module 3: Classification, general description and uses of Spices, &beverages, Fruit and Nuts, Fibers and Timber Plants		**15**
3.1	**Spices & condiments:** Clove, Black pepper, cinnamon, turmeric	
3.2	**Beverages**: Tea & Coffee	
3.3	**Fruits:** Mango, Cashew & Jackfruit	
3.4	**Fibers**: Coconut, cotton &Jute.	
3.5	**General account of Timber Plants**: Teak and Matti	
		45

COURSE TITLE: ECONOMIC BOTANY(PRACTICAL)

COURSE CODE: BOT-VI.E-15 MARKS: 25

CREDITS: 1

Sr. No	Module 4: Topics	Practical
1	Morphological and Microscopic study of cereal and legumes seeds (rice and groundnut)	04
2	Study of essential oil yielding plants (Coconut, Eucalyptus, Citrus)	02
3.	Mini Projects: i. Essential oil from plant sources ii. Analysis of starch content from plant sources(fruits, rhizome, tubers) iii. Analysis of plants for drugs, alkaloids anddyes iv. Fibers fromplants v. Study of local fruits andspices .	07
4	Visit to a Spice Farm/ Rubber Plantation/ economically important plant farm	02
	Total	**15**

REFERENCES:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi,India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, theNetherlands.
3. Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.
4. Subrahmanyam N.S. Sammbamurty A.V.S.S. (2008). A textbook of Modern economic Botany. CBS Publishers &Distributors.

COURSE TITLE: APPLIED MYCOLOGY (THEORY)

COURSE CODE: BOT-IV.E-16

MARKS: 75

CREDITS: 3

COURSE OBJECTIVES:

This paper provides knowledge on culture techniques and the applicative aspects of fungi.

COURSE OUTCOMES: The students be able to:

- Toexplain techniques involved in sampling, culturing and maintaining fungal cultures.
- To discuss industrial and agricultural applications of fungi.

Sr.No.	TOPICS	Hours
Module 1: Introduction and Fungal Culture studies		**15**
INTRODUCTION		
1.1	General account of fungi. Microscopic structure, Chemical composition and understanding of fungal cell wall	
1.2	Environmental factors influencing fungal growth	
STUDIES OF FUNGAL CULTURE		
1.3	Introduction to culture collections, Culture Media formulations and types of media used in mycology. Culture databases.	
1.4	Various techniques for pure culture isolation and maximum recovery from different habitats (Soil, Litter, Water, Dung) Baiting, moist-chamber and particle-plating techniques	
1.5	Isolation of pure cultures and maintenance.	
1.6	Study of colony characters and growth patterns	
1.7	Fungal gene banks- Culture Collection Centres.	
Module 2: Industrial Mycology		
INDUSTRIAL MYCOLOGY		**15**
2.1	Role of fungi in biotechnology	
2.2	Applications of fungi in food industry • Flavour and texture • Fermentation and baking • Organic acids (Preferably Citric acid)	

	• Enzymes (Preferably Cellulases and Pectinases) Mycoproteins– SCP (Yeast)	
2.3	Endophytic fungi and its industrial applications.	
Module 3: Fungi in Agriculture, medicine and recent mycological advances.		**15**
FUNGI IN AGRICULTURE		
3.1	Fungi as biofertilizers (Preferably *Trichoderma*) Fungi as biocontrol agents- Mycofungicides, Mycoherbicides, Mycoinsecticides	
3.2	Mycorrhizae and its role	
3.3	Medical mycology - Secondary metabolites- Pharmaceutical preparations from fungi, antibiotics from fungi. (Preferably *Penicillium* and *Ganoderma*)	
MUSHROOM CULTIVATION & RECENT ADVANCES IN MYCOTECHNOLOGY		
3.4	Mushroom cultivation techniques: Oyster and Button mushrooms.	
3.5	Applications of PCR and other molecular techniques in mycology, Mycoinformatics, Mycoremediation	
		TOTAL: 45 Hours

COURSE TITLE: APPLIED MYCOLOGY (PRACTICAL)

COURSE CODE:BOT-IV.E-8

MARKS: 25

CREDITS: 1

Sr. No.	MODULE 4: TOPICS	Practicals
1.	Isolation and preparation of pure culture from a mixed culture plate on solid medium.	02
2.	Preparation of moist chamber and incubation of fungi	01
3.	Particle dilution plating for fungi	01
4.	Isolation of endophytic fungi from plant leaves	01
5.	Study of effect of incubation temperatures and pH on fungal growth	02
6.	Colorimetric estimation of cellulase and amylase produced by fungi	02
7.	Production of Citric acid (using *Aspergillus*) in broth and testing for its presence.	02
8.	Mushroom cultivation- Oyster mushrooms and its protein estimation	03
9.	Understanding structures of fungal enzymes using Bioinformatics tools.	01
	TOTAL	15

REFERNCES:

1. Aneja, K. R. (2007) Experiments in Microbiology Plant Pathology & Biotechnology. 5th ed., New Age International Publishers.

2. Bhat, D. J. (2010) Fascinating Microfungi (Hyphomycetes) of Western Ghats – India. First edition.,Broadway Book Centre, Goa.

3. Powar, C.B. and Daginawala, H.F.(1982) General Microbiology–Volume II. Himalaya Publishing house: Bombay.

4. Prescott, L. M. (2005) Microbiology. 6th ed., Mc Graw-Hill.

5. Shivkumar, P.K., Joe, M.M. &SukeshK.(2010) An Introduction to Industrial Microbiology. 1st ed., S.Chand& Company Pvt. Ltd.

6. Trivedi, P.S. and Pandey, S.N. (2009) A Textbook of Botany. Volume I. Vikas Publishing House Pvt Limited, New Delhi.