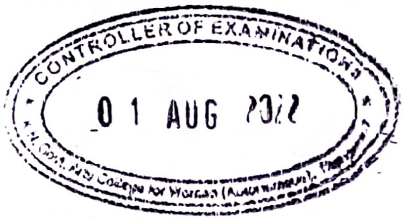
KUNTHAVAI NAACCHIYAAR GOVERNMENT ARTS COLLEGE FOR WOMEN

An Autonomous College Affiliated to Bharathidasan University

Re-Accredited by NAAC with 'B' Grade

Thanjavur -613 007, Tamil Nadu, India.



CBCS & OBE PATTERN

Scheme of Instruction and Syllabus for

M. Sc., BOTANY

I to IV Semester

(For the candidates admitted from 2022-23 onwards)

PG & RESEARCH DEPARTMENT OF BOTANY

PG & RESARCH DEPARTMENT OF BOTANY

I. VISION

To Provide modern Skill, Oriented and Quality Education to the Students contributing the process of life with focus on Plants, their Environment and Social development.

II. MISSION

1. To discover, Maintain and Transmit Knowledge concerning Basic Plant Biology and provide leadership in the Biological Sciences.
2. To expand Academic Co-operation by offering new Courses and upgrading programmes to a wider Spectrum of students and researchers.
3. To produce entrepreneurs for prosperous ventures in the selected fields of their advancements with Global perspectives.

III PROGRAMME OUTCOME

After the completion of M.Sc., Botany CBCS Programme, the students will be able to:

PO 1: Realize Scope, Evolution diversity in habits, Habitats and organization of various groups of Plant kingdom.

PO 2: Recognize and Appreciate the basic Concepts, Approaches, Applications and Develop basic skills to study Botany in detail.

PO 3: Understand, Realize and Relate the Significance and Applications of interdisciplinary nature of Plant Science on social context in day to day life.

PO 4: Analyze the coherent, systematic knowledge and research skills in various disciplines of Botany which are relevant to scientific development, conservation of plant diversity for socio economic development of the country.

PO 5: Facilitate, synthesize and evaluate diverse knowledge, arguments and approaches pertinent to exploring socio – economic development of the country.

PO 6: Acquire the attitude of examining the diversity of Bioresources, plant based products by generalization, identification, classification and formulation of innovative products.

PO 7: Develop and apply the skills gained in botany programme as part of career avenues in various fields as Ecologist, Plant Biochemist, Forest Ranger, Farming Consultant, Park Ranger, Herbalist, Environmental Consultant, Paleobotanist, Genetist, Nursery or Green House Manager and Pathologist.

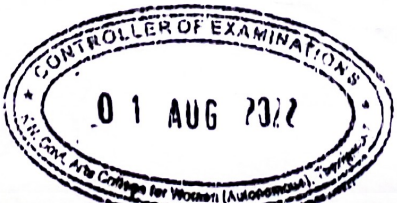
PO 8: Provide basic Knowledge, Methodologies of Scientific research, Designs, Statistical analysis of data, IPR and patents. Become familiar in ethical issues in Biological research.

PO 9: Build Life skills in Mushroom Cultivation, Bioinoculant Technology, Herbarium Techniques, Horticulture, Breeding Techniques, Food Processing, Advance Techniques in Biotechnology, Microbiology and Pharmacognosy.

PO 10: Observe, Characterize and identify Morphological, Anatomical, Embryological, Genomical, Biochemical, Physiological, Biological characters of Plants.

PO 11: Facilitate, Communicate, Understand and Acquiring skills to engage themselves in self employment enhancing Social welfare through Interdisciplinary Courses of Botany.

PO 12: Extrapolate the relationship between Science and Society and will apply the skills to incorporate innovative ideas and value added products from various fields of Botany for Socio-economic development of the country.



IV. PROGRAMME STRUCTURE

M. Sc., Botany Course CBCS Structure with OBE (For the candidates admitted from 2022-23 onwards)

Semester	Course	Subject Code	Title of the Paper	Inst. Hrs.	Credit	Exam Hrs.	Marks		Total
							Int.	Ext.	
I	CC 1	22KP1B01	Plant Diversity – I (Algae, Fungi and Bryophytes)	6	5	3	25	75	100
	CC 2	22KP1B02	Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)	6	5	3	25	75	100
	CC 3	22KP1B03	Bioinoculant Technology	6	4	3	25	75	100
	CC 4 (P)	22KP1B04P	Practical I Covering the Core Courses 1, 2 and 3	6	5	4	40	60	100
	MBE 1:1	22KP1BELB1:1	Bio Analytical Techniques	6	4	3	25	75	100
	MBE 1:2	22KP1BELB1:2	Bioprocess Technology						
				30	23				500
II	CC 5	22KP2B05	Anatomy and Embryology	6	5	3	25	75	100
	CC 6	22KP2B06	Genetics and Molecular Biology	7	5	3	25	75	100
	CC 7	22KP2B07	Plant Physiology and Biochemistry	7	5	3	25	75	100
	CC 8 (P)	22KP2B08P	Practical II Covering the Core Courses 5, 6 and 7	6	5	4	40	60	100
	NME 1	22KP2BEL01	Herbal Technology	4	3	3	25	75	100
	ECC 1:1	22KP2ECCB1:1	Food Science and Nutrition	-	3	3	-	100	100
	ECC 1:2	22KP2ECCB1:2	MOOC						
	ECC 2	22KP2ECC82	Add on Course*	-	4	-	-	-	-
				30	23				500
III	CC 9	22KP3B09	Plant Systematics	7	5	3	25	75	100
	CC 10	22KP3B10	Horticulture and Plant breeding	7	5	3	25	75	100
	CC 11 (P)	22KP3B11P	Practical III Covering the Core Courses 9 and 10	6	5	4	40	60	100
	MBE 2:1	22KP3BELB2:1	Medicinal Botany and Pharmacognosy	6	4	3	25	75	100
	MBE 2:2	22KP3BELB2:2	Medical Microbiology						
	NME 2	22KP3BEL02	Mushroom Cultivation	4	3	3	25	75	100
	ECC 3:1	22KP3ECCB3:1	Stress Biology	-	3	3	-	100	100
	ECC 3:2	22KP3ECCB3:2	MOOC						
				30	22				500
IV	CC 12	22KP4B12	Microbiology and Plant Pathology	6	4	3	25	75	100
	CC 13	22KP4B13	Biotechnology and Bioinformatics	6	4	3	25	75	100
	CC 14 (P)	22KP4B14P	Practical IV Covering the Core Courses 12 and 13	6	5	4	40	60	100
	MBE 3:1	22KP4BELB3:1	Research methodology and Biostatistics	6	4	3	25	75	100
	MBE 3:2	22KP4BELB3:2	Environmental Microbiology						
	Project Work	22KP4B15PW	Project Work	6	5		-	100	100
			Total	30	22				500
			Grand Total	120	90				2000

CONTROLLER OF EXAMINATIONS
01 AUG 2022

Practical:

- ❖ Students should submit duly certified record of their practical work for all the Practical Examinations and those who do not submit the record shall not be permitted to the concerned Practical Examination.

Tour Program:

- ❖ As per the part of Botany Degree Courses every II year students shall undertaken a tour and field study of Vegetation under the guidance of the staff (less than Five Days within the state). They should submit a minimum number of 25 Herbarium sheets along with field note and tour report.

Extra Credit Course

Semester II	***Extra Credit Course***	***Code***
ECC 1:1	Food Science and Nutrition	22KP2ECCB1:1
ECC 1:2	MOOC	22KP2ECCB1:2
ECC 2	Add on Course	-
Semester III	***Extra Credit Course***	***Code***
ECC 3:1	Stress Biology	22KP3ECCB3:1
ECC 3:2	MOOC	22KP3ECCB3:2

V. ELECTIVES

Major Based Elective Courses

Semester I	***Major Based Elective I***	***Code***
MBE1:1	Bio Analytical Techniques	22KP1BELB1:1
MBE1:2	Bioprocess Technology	22KP1BELB1:2
Semester III	***Major Based Elective II***	***Code***
MBE 2:1	Medicinal Botany and Pharmacognosy	22KP3BELB2:1
MBE 2:2	Medical Microbiology	22KP3BELB2:2
Semester IV	***Major Based Elective III***	***Code***
MBE 3:1	Research methodology and Biostatistics	22KP4BELB3:1
MBE 3:2	Environmental Microbiology	22KP4BELB3:2

Non Major Elective Course

Semester II	***Non Major Elective Course I***	***Code***
NME1	Herbal Technology	22KP2BEL01
Semester III	***Non Major Elective Course II***	***Code***
NME2	Mushroom Cultivation	22KP3BEL02

CONTROLLER OF EXAMINATIONS
01 AUG 2022

VI. DETAILS ON THE NUMBER OF COURSES AND CREDITS FOR PG PROGRAM
(For the candidates admitted from 2022 – 23 onwards)

Course	Course Title	No. of Courses	Instruction Hour	Credit
CC	Core Course (Theory & Practical)	14 (10+4)	88	67
MBC	Major Based Elective	3	18	12
NME	Non Major Elective	2	8	6
Project	Project Work	1	6	5
	Total	**20**	**120**	**90**

VII. SEMESTER-WISE COURSE STRUCTURE- ELECTIVE COURSES

Semester	Course	Total	Ins. Hrs./week	Credit
I	CC 1, CC 2, CC 3, CC 4 (P), MBE 1	5	30	23
II	CC 5, CC 6, CC 7, CC 8 (P), NME1	5	30	23
III	CC 9, CC 10, CC 11 (P), MBE 2, NME2	5	30	22
IV	CC 12, CC 13, CC 14 (P), MBE 3, Project-1	5	30	22
	TOTAL	**20**	**120**	**90**

Distribution of Credits and Hours for PG Course

Core Course			
Course	**Semester**	**Hrs.**	**Credit**
1	I	6	5
2	I	6	5
3	I	6	4
4 (P)	I	6	5
5	II	6	5
6	II	7	5
7	II	7	5
8 (P)	II	6	5
9	III	7	5
10	III	7	5
11 (P)	III	6	5
12	IV	6	4
13	IV	6	4
14 (P)	IV	6	5
15 (Project Work)	IV	6	5
Total		**94**	**72**

Major Based Elective Course			
Course	**Semester**	**Hrs.**	**Credit**
MBE 1	I	6	4
MBE 2	III	6	4
MBE 3	IV	6	4
Total		**18**	**12**

Non Major Elective Course			
Course	**Semester**	**Hrs.**	**Credit**
NME 1	II	4	3
NME 2	III	4	3
Total		**8**	**6**

Total Credits : 90
Total Hours : 120

CONTROLLER OF EXAMINATIONS
01 AUG 2022

SEM I	CC1	PLANT DIVERSITY- I (ALGAE, FUNGI AND BRYOPHYTES)	22KP1B01	Ins. Hrs. 6	Credit: 5

Course objectives: *The aspects of Plant Diversity - I highlights* the *Morphology, Anatomy and importance of the organisms and differentiation between various groups of Algae, Fungi and Bryophytes. It leads to understand the life cycles of individuals belonging to Algae, Fungi and Bryophytes.*

CO	STATEMENT
1	Identify, classify and describe the morphological nature of various types of Algae.
2	To impart knowledge and understand the salient features and economic importance of Algae.
3	Gain adequate knowledge about the general characters, classification, structure, Reproduction and life cycle of Fungi.
4	Illustrate the salient features and importance of Fungi and Lichens.
5	To recognize the Morphological, anatomical and reproductive characteristics of extinct and extant of Bryophytes.

UNIT-I: ALGAE

Algae in diversified habitats (terrestrial, fresh water and marine), Classification of Algae (Bold and Wynne (1978-1985), Phylogeny of Algae, Thallus organization in algae, Cell ultra-structure, Reproduction (Vegetative, asexual, sexual) and Patterns of lifecycle.

UNIT-II

Salient features of Cyanophyta, Prochlorophyta, Chlorophyta, Charophyta, Euglenophyta, Phaeophyta, Chrysophyta, Pyrophyta, Cryptophyta and Rhodophyta, Economic importance of Algae.

UNIT-III: FUNGI

General characters of Fungi, Classification of Fungi (Ainsworth, 1971), Ultrastructure, Unicellular and Multicellular organization, Cell wall composition, Nutrition (Saprobic, Biotropic, Symbiotic), Reproduction (Vegetative, Sexual & Asexual), Life cycle patterns, Heterothallism, Heterokaryosis and Parasexuality.

UNIT-IV

General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina, Economic importance of Fungi.

LICHEN

General Characters of Lichens, Classification (Miller-1984), Distribution, Thallus organization and Reproduction of Lichens. Ecological and Economic importance of Lichens.

UNIT-V: BRYOPHYTES

General Characters, Classification (Rothmaler-1959), Structure and Reproduction of Hepaticopsida (Marchantiales and Jungermaniales), Anthocerotopsida (Anthoceratales), Bryopsida (Funariales and Polytrichales), Economic & Ecological importance of Bryophytes.

UNIT-VI

Current contour (Not for semester examination)

Biotechnological potential of Algae - SCP, Biofertilizer, Bioremediation, Biofuels, Neutraceuticals raw materials for industries and Algal toxins.

Text Books

1. Smith, G.M.(1974). Cryptogamic Botany. Vol. I (Algae and Fungi). TMH publishing Company Ltd., New Delhi.
2. Smith, A.L. (1921). Lichens. Cambridge University, Cambridge.
3. Vashistha,B.R., Sinha, A.K. & Kumar, A.(2016). Bryophyta, S.Chand & Co.Ltd., Delhi.
4. Sharma, O.P. (2016). Bryophyta. McGraw Hill Education (India) Private Limited, New Delhi.
5. Alam, A. 2015. Text book of Bryophyta. 1/e, I.K. International Publishing House, New Delhi.

Reference Books

1. Kumar, H.D., 1988. Introductory Phycology. Affiliated East-West Press, New Delhi.
2. Mehrotra, R.S. and Aneja, R.S. 1998. An Introduction to Mycology. New Age International Press.
3. Webster, J., 1985. Introduction to Fungi. Cambridge University Press.
4. Sharma, O.P., 2014. Text book of Algae. Tata Mc.Graw Hill, New Delhi.
5. Sharma, OP., 2014. Bryophyta. McGraw Hill Education, New Delhi.

CO-PO Mapping with Programme Outcomes: **Plant Diversity-I (Algae, Fungi and Bryophytes)**

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	*3*	*3*	*2*	*2*	*1*	*1*	*2*	-	-	-	-	-
2	*2*	*2*	*2*	*2*	*1*	*1*	*2*	-	-	-	*1*	-
3	*3*	*2*	*3*	*1*	*2*	*1*	*2*	-	-	-	-	-
4	*3*	*2*	*2*	*1*	*1*	*1*	*2*	-	-	-	-	-
5	*2*	*2*	*1*	*2*	*1*	*2*	*2*	-	-	-	-	-

1-Low, 2-Moderate, 3-High Correlation

SEM I	CC2	PLANT DIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)	22KP1B02	Ins. Hrs. 6	Credit: 5

Course objectives: *To understand the classification and evolution of Pteridophytes and Gymnosperms with special reference to Indian taxa; To get an insight in to the life histories of embryophytes, tracheophytes and seed plants. To get an understanding of the past history of the biosphere and evolution of plants through fossils.*

CO	STATEMENT
1	To acquire the attitude of examining the general characters, classification, Telome concept, sporangium development and stelar evolution of Pteridophytes.
2	Differentiate and correlate the structure, reproduction, lifecycle and economic importance of Pteridophytes.
3	Describe the classification, origin, phylogeny and economic importance of gymnosperms.
4	Analyze and explain the Structure, Reproduction and Lifecycle of Gymnosperms.
5	Understand the various fossil genera representing different fossil groups.

UNIT-I: PTERIDOPHYTES

General characters, Reimer's classification of Pteridophytes (1954). Telome concept, Sporangium development - Eusporangiate type and Leptosporangiate type, Apogamy, Apospory, Heterospory, seed habit and Stelar evolution.

UNIT-II

Brief account of the Morphology, Structure and Reproduction of the Major groups - Psilopsida, Lycopsida, Sphenopsida and Pteropsida. (No type study). Economic importance of Pteridophytes.

UNIT-III: GYMNOSPERMS

General Introduction and Salient feature of Gymnosperms, Classification of Gymnosperms (Sporne, 1965), Origin and Phylogeny of Gymnosperms, Gymnosperms compared with Pteridophytes and Angiosperms. Economic importance of Gymnosperms.

UNIT-IV

General account of Pteridospermales: (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae). Cycadeoidales and Cordaitales. Structure and reproduction in Cycadales, Ginkgoales, Coniferales, Ephedrales and Gnetales.

UNIT-V: PALEOBOTANY

Principles of Paleobotany and Geological time scale. Fossils - Methods of Fossilization and types of Fossils. Detailed Study of fossil forms - Pteridophytes: Lepidodendron and Calamites. Gymnosperms: *Lyginopteris* and *Cordaites.* Role of fossils in oil Exploration.

UNIT –VI

Current contour (Not for semester examination)

Conservation of Pteridophytes, Fossils of Pteridophytes, Evolutionary trends of Gymnosperms and Current trends in Paleobotany.

Text Books

1. Vashishta , P.C , Sinha and Anilkumar, 2010. Pteridophytes, S.Chand &company Ltd, New Delhi.
2. Sharma, O.P., 2012. Textbook of Pteridophyta, TATA MacMillan India Ltd., New Delhi
3. Smith,G.M., 1955. Cryptogamic Botany Vol. II, Tata Mcgraw Hill Publishing Co., Ltd., New Delhi.
4. Sporne, K.K., 1991. The Morphology of Pteridophytes. BI Publishing, Bombay.
5. Sporne, KR.,1965. The Morphology of Gymnosperms. BI Publications, New Delhi.
6. Kirkaldy, J.E., 1963. The study of Fossils. Hutchinson Educational, London.

Reference Books

1. Bhatnagar, SP and Moitra, A., 1996. Gymnosperms. New Age International, New Delhi.
2. Parihar, NS., 1996. Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
3. Boid, H. C., 1982. Bryophyta. Wiley-Eastern.
4. Jon C. Herron and Scott Freeman., 2014. Evolutionary analysis (5th Edition).

CO-PO Mapping with Programme Outcomes: **Plant Diversity II (Pteridophytes**, **Gymnosperms and Paleobotany)**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*2*	*2*	*2*	*1*	*2*	-	*2*	-	-	-	-	-
2	*3*	*2*	*2*	-	*2*	*1*	*2*	-	-	-	-	-
3	*3*	*2*	*2*	*1*	*1*	-	*2*	-	-	-	-	-
4	*2*	*2*	*3*	-	*2*	-	*2*	-	-	-	-	-
5	*2*	*2*	*2*	*1*	*1*	-	*2*	-	-	-	-	-

1-Low, 2-Moderate, 3-High Correlation

SEM I	CC3	BIOINOCULANT TECHNOLOGY	22KP1B03	Ins. Hrs. 6	Credit: 4

Course objectives: *The aim of the course is to make the student to know the importance of biofertilizer in agriculture.*

CO	STATEMENT
1	Recognize the concept and utilization of Bacterial fertilizer.
2	Observe and analyze the Application of Algal Biofertilizer.
3	Perceive the concept of Mass Multiplication and Application of AM.
4	Recollect the importance and Marketing of Phosphobacteria.
5	Understand and realize the Biological control of Pests and Pathogens.

UNIT – I

Biofertilizer – Definition, Advantages of Biofertilizers. Isolation, Mass Inoculum Production, Field application, Importance and Marketing of Bacterial Biofertilizers - Symbiotic – *Rhizobium*, Associate – *Azospirillum*, Asymbiotic - *Azotobacter*.

UNIT – II

Isolation, Characterization, Mass multiplication and Field application of Algal Biofertilizers - . Symbiotic nitrogen fixers - *Anabaena azollae,* free living nitrogen fixers – BGA (*Cyanobacteria*)

UNIT – III

Mycorrhizal bioinoculants – Morphology, Classification, Isolation, Mass Production and Field application of AM. Role of Mycorrhizae in Agricultural and Ecology. Organic manure - Green manure, Farm yard manure and Vermicompost.

UNIT – IV

Phosphate solubilizers - Isolation, Characterization, Mass Inoculum Production and Field applications of Phosphate solubilizing microbes - *Bacillus megaterium*, Phosphobacteria. Mechanism of Phosphate solubilization.

UNIT – V

Biological control of crop pests - Predators and Parasitioids. Bacterial pesticides, Fungal pesticides, Viral pesticides, Nematodes. Biological control of Pathogens and Weeds. Mycoherbicides.

UNIT – VI Current contour (Not for semester examination)

Role of transgenic plants in Agriculture and Biopharrming. Physical and Chemical control of diseases.

Text Books

1. Motsara, M.R., Bhattacharya, P and Beena Srivastava, 1995. Biofertilizer technology, marketing and usage, Fertilization Development and consultation organization, New Delhi-48.
2. Subba Rao, 2000. Biofertilizers, IBH Publishers, New Delhi.
3. Dubey. R.C., & Maheshwari, D.K., 2004, A Text Book of Microbiology. S.Chand & Company Ltd., New Delhi.
4. Kumaresan. V., 2013. Biotechnology. Saras Publication, Nagercoil.

Reference Books

1. Subba Rao, N.S. 2000. Soil Microbiology. Oxford and IBH Publishing Co. Ltd., New Delhi.
2. Wicklow, D.T. and B.E. Soderstrom. 1997, Environmental and Microbial relationships. Springer Journal.
3. Dubey, R.C., 2001. Text book of Biotechnology, S.Chand & Company, New Delhi.

CO-PO Mapping with Programme Outcomes: **Bioinoculant Technology**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*3*	*2*	*2*	*2*	*2*	*1*	-	-	*1*	*1*	-	*1*
2	*2*	*2*	*2*	*1*	*1*	-	-	-	*1*	-	-	-
3	*2*	*2*	*1*	-	-	-	-	-	*1*	*1*	-	-
4	*1*	*1*	*2*	*1*	-	-	-	-	*1*	*1*	-	*1*
5	*2*	-	*1*	*1*	-	-	-	-	-	-	-	*1*

1-Low, 2-Moderate, 3- High correlation

SEM I	CC4 (P)	PRACTICAL I COVERING THE CORE COURSES 1, 2 AND 3	22KP1B04P	Ins. Hrs. 6	Credit: 5

Course objectives: *To impart hands on training on Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, Paleobotany and Bioinoculant technology.*

CO	STATEMENT
1	Explain the internal structure of Algae and Fungi through microscopic observation.
2	Examine the Morphology, Anatomy and Reproductive parts of Bryophytes.
3	Observe the Morphology, Anatomy and Reproductive parts of Pteridophytes and Gymnosperms.
4	Categorize fossil plants based on Geological time period.
5	Practice the skills for mass production of different Biofertilizers.

ALGAE:

Study of the Morphological, Anatomical and Reproductive parts of the following:-

Cyanophyta : *Gloeocapsa, Anabaena*
Chlorophyta : *Hydrodictyon, Aectabularia*
Charophyta : *Chara*
Xanthophyta : *Vaucheria*
Bacillariophyta : *Cyclotella and Navicula (Diatoms)*
Phaeophyta : *Padina, Sargassum*
Rhodophyta : *Batrachospermum, Gracilaria.*

FUNGI:

Mastigomycotina : *Pythium*
Zygomycotina : *Pilobolus*
Ascomycotina : *Taphrina, Xylaria*
Basidiomycotina : *Pluerotus, Lycoperdon*
Dueteromycotina : *Cercospora, Colletotrichum*
Lichens : *Usnea.*

BRYOPHYTES:

Hepaticopsida : *Targionia, Reboulia*
Anthocerotopsida : *Anthoceros*
Bryopsida : *Pogonatum*

PTERIDOPHYTES:

(Extinct and living forms)
Psilophytopsida : *Rhynia*
Psilotopsida : *Psilotum*
Lycopsida : *Isoetes*
Sphenopsida : *Equisetum*
Pteropsida : *Angiopteris, Osmunda & Azolla*
Extinct and Extant Fossil forms: *Lepidodendron, Stigmaria, Calamites*

GYMNOSPERMS:
Cycadopsida : *Cycas*
Coniferopsida : *Ginkgo, Cupressus, Podocarpus*
Gnetopsida : *Gnetum* and *Ephedra*

PALEOBOTANY:
Extinct & fossil forms: Pteridophytes - *Lepidodendron* and *Calamites*. Gymnosperms - *Lyginopteris* and *Cordaites*

BIOINOCULANT TECHNOLOGY
1. Isolation of *Rhizobium* from legume root nodule.
2. Isolation of *Azospirillum* from Paddy roots.
3. Isolation of *Azotobacter* from Rhizosphere soil.
4. Isolation of BGA from Pond water.
5. Isolation of AM Fungi.

CO-PO Mapping with Programme Outcomes: **Practical I covering the Core Courses 1, 2 and 3**

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	*3*	*2*	*2*	-	*1*	*1*	*2*	-	-	-	-	-
2	*3*	*2*	*2*	-	*1*	*1*	*2*	-	-	-	-	-
3	*3*	*2*	*2*	-	*1*	*1*	*2*	-	-	-	-	-
4	*2*	*2*	*2*	-	*1*	*1*	*2*	-	-	-	-	-
5	*2*	-	*1*	-	*2*	*2*	-	*1*	1	2	-	1

1-Low, 2-Moderate, 3- High correlation

SEM I	MBE 1:1	BIO-ANALYTICAL TECHNIQUES	22KP1BELB1:1	Ins. Hrs. 6	Credit: 4

Course objectives: *To study the Principles and application of microscopy, Chromatography and get the knowledge about the Principle & biological applications of Spectroscopes and Electrophoresis.*

CO	STATEMENT
1	Develope conceptual understanding of Principles and application of microscopy.
2	Apply suitable strategies in cell fractionation and radioisotopes and their applications in biological sciences.
3	Classify different types of chromatography techniques.
4	Examine the Applications of Electromagnetic radiations in various Spectroscopes
5	Evaluate the importance Blotting techniques and DNA sequencing.

UNIT I:
Principles and applications of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Transmission and Scanning electron microscopy – Sample preparation and staining techniques.

UNIT II:
Introduction, Basic Principle of Sedimentation, components and different types of centrifuges - Differential and density gradient centrifugation, analytical centrifugation, ultracentrifugation. Basic concept of radio isotope, GM and scintillation counter, autoradiography, Applications in biological science.

UNIT III:
Basic principle and biological applications. Paper chromatography; Column chromatography, TLC, GLC, HPTLC, Ion-exchange chromatography; Size exclusion chromatography; Affinity chromatography.

UNIT IV:
Properties of Electromagnetic radiations; Beer Lambert's Law, Principle and Applications of UV-Visible light Spectroscopy. Atomic absorption spectroscopic techniques. Mass spectrometry: X-ray diffraction. Principle & biological applications of NMR.

UNIT V:
Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE. Immunoelectrophoresis, Isoelectrofocussing, Polymerase Chain Reaction, DNA sequencing – Maxam and Gilbert technique.

UNIT VI: Current contour (Not for semester examination)
Principles & biological applications of Matrix Assisted Laser Desorption Ionization -Time of Flight Mass Spectrometry (MALDI-TOF MS), RAPD and RFLP and DNA finger Printing.

Text Books

1. Wilson K and Walker J., 2005. "Principles and Techniques of Biochemistry and Molecular Biology" 6th Ed. Cambridge University Press.
2. Van Holde, K E, Johnson, W. and Ho, P. S., 1981. "Principles of Physical Biochemistry", Prentice Hall.

Reference Books

1. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
2. Willard, H.H., Merritt L.L. Dean J.A. and Settle F.A., 1986. "Instrumental Methods of Analysis", 7th Ed., Wadsworth Publishing Co.,
3. Cantor, C. R. and Schimmel, W.H., 1981. "Biophysical Chemistry Part-II", Freeman & Co.,
4. Campbell, I.D. and Dwek, R. A., 1984. "Biological Spectroscopy", Benjamin Curmmings Publication Co. Inc.,

CO-PO mapping with Programme Outcomes: **Bio-Analytical Techniques**

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	-	*2*	-	*1*	-	-	-	-	*1*	*2*	-	-
2	-	*2*	-	-	*2*	-	-	-	*2*	-	-	-
3	-	-	-	*2*	*2*	-	*1*	-	*2*	-	-	-
4	-	-	*2*	-	*3*	*1*	-	*2*	*2*	-	-	-
5	-	-	-	1	2	-	-	-	2	2	-	2

1-Low, 2-Moderate, 3- High correlation

SEM I	MBE1:2	BIOPROCESS TECHNOLOGY	22KP1BELB1:2	Ins. Hrs. 6	Credit: 4

Course objectives: *To impart knowledge on Bioprocess technology and their role in human welfare.*

CO	STATEMENT
1	Understand the types of culture methods and Preservation of microbes.
2	Gain knowledge on the construction of Bio-reactor.
3	Acquire knowledge on Fermentation technology.
4	Recognize the production and application of some microbial products.
5	Know the production and application of microbial products at pharmaceutical level.

UNIT I

Introduction and scope. Basic principles of Bioprocess, Batch, Continuous and Fed batch culture, Isolation methods for industrially important microorganisms, preservation of microbes.

UNIT II

Bioreactor – instrumentation – Types – Stirred tank fermentor, Photobioreactors, Tower fermentor, Airlift bioreactor and Fluidized bed reactor. Bioprocess control parameters – Temperature, Pressure, aeration and agitation. Role of computer in bioprocess technology.

UNIT III

Media for microbial fermentation, Downstream processing stages – Solid-liquid separation, release of intracellular products, concentration, purification, formulation.

UNIT IV

Fermentation by strains of yeast for production of alcohol and beer. Microbial production of antibiotics (*Penicillium* and *Streptomycin*) and Vitamins (Vitamin B-12), Citric acid and Lactic acid production.

UNIT V

Microbial production of health care products – Insulin, Interferon, Monoclonal antibodies and vaccines.

UNIT VI: Current contour (Not for semester examination)

Patent – Concept of patent, Composition and Characteristics of patent. Intellectual Property Rights.

Text Books

1. Patel, A.H., (2015). Industrial Microbiology, 2nd Edition. Laxmi Publication, India.
2. Satyanayana U., (2005). Biotechnology, 1st Edition. Books & Allied (P) Ltd, Kolkata.
3. Kumeresan, V., 2020. Biotechnology, VI Edn., Saras Publication, Nagercoil.

Reference Books

1. Stanbury, P.F and Whitakar, A., (1984). Principles of Fermentation Technology, Pergamon Press.
2. Bailey and Ollis, 1986. Biochemical Engineering Fundamentals, McGraw Hill, New York.
3. Prescott, (2004). Industrial Microbiology, 4th Edition. CBS Publishers & Distributers, New Delhi.

COPO Mapping with Programme Outcomes: **Bioprocess Technology**

CO\PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*2*	*1*	-	-	*2*	-	*2*	-	-	-	-	-
2	-	*1*	*2*	-	*2*	-	-	-	*2*	*2*	-	-
3	-	*1*	-	-	*2*	-	-	*2*	*1*	-	-	-
4	-	-	*1*	-	*1*	*2*	*2*	-	-	*2*	-	-
5	-	-	-	-	*2*	-	*3*	*2*	*3*	-	-	-

1-Low, 2-Moderate, 3-High Correlation

SEM II	CC5	ANATOMY AND EMBRYOLOGY	22KP2B05	Ins. Hrs. 6	Credit: 5

Course objectives: *To understand the concept of plant internal structure and reproductive mechanism.*

CO	STATEMENT
1	Understand the types of tissues and learn epidermal appendages and wood characters.
2	Identify and compare the structural differences among different parts of monocot and dicot plants.
3	Recognize anomalous secondary growth and structural adaptations of plant growth in different environment.
4	Understand the Structure and Development of Micro and Mega Sporogenesis.
5	Get an insight into the endosperm and embryo development

UNIT I: ANATOMY

Tissues – Meristematic, Simple and complex tissues. Epidermal tissue system, trichomes, glands, stomata, secretary tissues, necters and laticifers. Structure of vascular cambium, secondary xylem, xylem tracheids, vessels, wood parenchyma, xylem fibres, secondary phloem, tyloses, sap and heart wood, annular ring porus and diffuse porous wood, phylogenic specialization of xylem and phloem.

UNIT II

Anatomical characteristics and vascular differentiation in primary and secondary structure of root and shoot in dicot and monocot. Origin of lateral root. Transition from root to stem. Anatomy of dicot and monocot leaves.

UNIT III

Secondary growth in normal dicot stem and root, Anomalous secondary growth in dicot stem - *Boerhaavia, Achyranthus, Bignonia, Nyctanthus* and monocot stem - *Dracaena*. Ecological anatomy – Hydrophtes (*Typh*a – root and leaf), Xerophytes (*Casuarina* stem and *Aloe* leaf) and Halophytes (*Rhizophor*a – Peneumatophore).

UNIT IV: EMBRYOLOGY

Microsporangium – Structure, Microsporogenesis, Microspore, Microgametogenesis, Pollen stigma incompatibility, Methods to overcome incompatibility, Megasporangium, Mega gametogenesis, Female gametophyte. Types of embryosac – monosporic (*Oenothera*), bisporic (*Allium*), tetrasporic (*Plumbago*), Pollination and Double fertilization.

UNIT V

Endosperm – Types, Endosperm haustorial cytology, physiology and functions of endosperm. Embryo Development in Dicot and Monocot. Nutrition of embryo, polyembryony, apomixis, apospory and their role in plant's development.

UNIT VI: Current contour (Not for semester examination)

Role of cambium in layering and grafting, leaf fall and healing of wounds. Role of anatomy in taxonomical identification. Embryology in relation to taxonomy and application of embryology.

Text Books

1. Pandey B,P., (2015) Plant Anatomy S. Chand Publ. New Delhi.
2. Vashista P.C (1984). *Plant Anatomy* –Pradeep publication , Jalandhar
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, 5th Edition, Vikas Publishing House. Delhi.
4. Pandey, AK (2000). Introduction to Embryology of Angiosperms 1st Edition :CBS; New Delhi.

Reference Books

1. Chandrasekar, P. (1980) – Plant Anatomy – V Edition, Oxford and IBH Publishing Co New Delhi.
2. Katherine Easu (2011) Anatomy of seed plants – John wisely & Sons U.S.A.
3. Maheswari, P. (1976). An introduction to the Embryology of Angiosperms. TATA McGraw-Hill Publishing Co., Ltd., New Delhi.

COPO Mapping with Programme Outcomes**: Anatomy and Embryology**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	-	*2*	-	-	*3*	*2*	*3*	-	-	-	-	-
2	*2*	*2*	-	-	*2*	*3*	*3*	-	-	-	-	-
3	-	-	-	-	*2*	*3*	*3*	*2*	*2*	-	-	-
4	*2*	*2*	-	*3*	-	-	*1*	-	-	-	-	-
5	*2*	*2*	-	*3*	*2*	-	*2*	-	-	-	-	-

1-Low, 2-Moderate, 3-High Correlation

SEM II	CC6	GENETICS AND MOLECULAR BIOLOGY	22KP2B06	Ins. Hrs. 7	Credit: 5

Course objectives: *To study Mendelian genetics, structure and function of genes. To understand the concept of Linkage and Crossing over. To study the Structure and Function of DNA and RNA*

CO	STATEMENT
1	Explain the whole concept of Mendelian genetics.
2	Compare the linkage and crossing over.
3	Classify the mutation and Chromosomal aberrations types.
4	Analyze the structure of DNA, RNA and replication of DNA.
5	Describe the Processes of Protein synthesis.

UNIT I: GENETICS

Mendelian genetics – Mendel's laws of inheritance – Monohybrid and Dihybrid Cross, Gene Interaction - Allelic - Incomplete dominance and Co dominance, Non Allelic – Complementary, Epistasis and Lethal alleles, Multiple alleles. ABO blood group in man.

UNIT II

Linkage and Crossing over, Tetrad analysis, Chromosome Map, Sex determination in plants, Sex linked inheritance – Colour Blindness, Eye Colour in Drosophila, Cytoplasmic inheritance.

UNIT III

Mutation – Genome mutation, Gene Mutation, Mutagens- Polyploidy - Types, Induction, Role in plant breeding. Population genetics - Hardy and Weingberg Law.

UNIT IV: MOLECULAR BIOLOGY

Nucleic acid- DNA- Structure (Watson and Crick Model of DNA), Properties, Types and Function, RNA- Structure and Function of mRNA, tRNA and rRNA. Replication of DNA and DNA repair. Structure of Gene and Salient feature of Genetic code.

UNIT V

Protein Synthesis – Transcription, Translation (Activation, Attachment, Initiation, Elongation and Termination), Post Translational Processing. Regulation of Gene Expression in Prokaryotes (Lac operon) and Eukaryotes.

UNIT VI: Current Contour (Not for Semester Examination)

Strategies of gene regulation in Eukaryotes. Mapping and Sequencing the genome Linkage mapping and restriction mapping.

Text Books

1. Gupta, P.K. (2000). *Genetics*. Rastogi Publishers, Meerut.
2. Jain, H.K. (1999). *Genetics-Principles, Concepts & Implications.* Oxford &IBH Publishing Co., (P) Ltd., New Delhi.
3. Meyyan, R.P. (2000). *Genetics & Evolution*. Saras Publication, Nagercoil.
4. Pandey, B.P. (2012). *Cytology, Genetics and Molecular Genetics*. Tata McGraw-Hill Education Private Ltd., New Delhi.
5. Vasishta, P. C. and Gill, P. S. (1998). Genetics: Speciation and Plant Breeding. Pradeep Publications, Jalandhar.
6. Verma P.S & Agarwal V.K. 1986, Cell Biology and Molecular Biology, S.Chand& Company, Newdelhi.

Reference Books

1. De Roberties, E.D.P. and De Roberties, E.M.F.,1995, Cell and Molecular Biology, 8thedn. B.I.Waverly Pvt. Ltd. New Delhi.
2. Elliot, D.L. & Jones, E.W., 2001,Genetics: Analysis of genes and genomes (Fifth edition), Jones and Barlett Publishers, Sdbury, Massachustts.
3. Verma,P.S. and Agarwal, V.K., 1986. Cell biology and Molecular Biology. S.Chand and Company, New Delhi.
4. Gardner, E.J., 1972, Principles of genetics - John Wiley and sons, N.Y.
5. Freifelder, D., 1986, Molecular Biology. Jones and BardettPublishin INC. Boston, Portola Valley.

CO-PO Mapping with Programme Outcomes: **Genetics and Molecular Biology**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	-	-	*2*	*1*	*1*	-	*2*	*2*	*2*	-	-	-
2	-	-	*2*	*1*	*2*	-	*2*	*3*	*1*	-	-	-
3	-	*2*	*1*	*1*	-	*1*	*3*	*3*	-	-	-	-
4	-	*1*	*2*	*1*	-	-	*3*	*2*	*1*	-	-	-
5	*1*	-	*2*	*1*	*2*	-	*2*	*2*	-	-	-	-

1-Low, 2- Moderate 3- High Correlation

SEM II	CC 7	PLANT PHYSIOLOGY AND BIOCHEMISTRY	22KP2B07	Int. Hrs. 7	Credit: 5

Course objectives: *The field of Plant physiology includes the study of all the internal activities of plants-those chemical and physical processes associated with life as they occur in plants. The course that focuses on water relations, transpiration, mineral nutrition, especially fundamental processes such as photosynthesis, respiration and plant hormone functions, Photoperiodism etc., and to understand various metabolic activities of plants.*

CO	STATEMENT
1	Remembering water relations of plants with respect to various physiological processes.
2	Acquire knowledge about the mechanism of Photosynthesis and its significance.
3	Understand the mechanism of plant respiration and role of plant growth regulators and Physiology of flowering.
4	Review the structure, properties and classification of carbohydrates, protein and amino acids.
5	Generate knowledge about lipids, nucleic acids, enzymes, vitamins and secondary metabolites.

UNIT I: PHYSIOLOGY

Water relations of plants, osmosis, osmotic pressure, diffusion, diffusion pressure deficit, Chemical Potential, Water Potential, water stress and salt stress, Root pressure - Ascent of sap, Mineral nutrition in plants, Modern concepts of mineral salt absorption and its translocation, Transpiration - Stomatal physiology and its regulation.

UNIT II

Photosynthesis - Photosynthetic apparatus, Pigments, Red Drop and Emerson's enhancement effect. Mechanism – Light reaction (Cyclic and Non-cyclic). Dark reaction – C3 & C4 cycle. Photorespiration and Glycolate metabolism (C2 Cycle) - Factors affecting and significance of photosynthesis, CAM cycle.

UNIT III

Respiration – Glycolysis, Kreb's cycle and Electron transport system. Bioenergetics of ATP - Pentose Phosphate pathway and its significance. Photoperiodism, Vernalization, Phytochrome, Seed Dormancy and Senescence. Plant growth regulators - Structure and functions of Auxins, Gibberellins, Cytokinins, Abscissic acid and Ethylene.

UNIT IV: BIOCHEMISTRY

Structure, Properties and classification of Carbohydrates (Monosaccharide, Disaccharide and Polysaccharide), Protein (Primary, Secondary, tertiary and Quaternary) and Amino acids (Essential and Non-essential).

UNIT V

Structure, Properties and Classification of Lipids, Enzymes and Vitamins, Biosynthesis of Lipid, Structure and function of Phenols, Terpenes, Alkaloids and Flavonoids.

UNIT VI: Current Contour (Not for semester examinations)

Stress Sensing Mechanisms in Plants - Signaling: Hormonal, Calcium modulation, Phospholipid signaling. Solvent fractionation using separating funnel (solvent from polar to non-polar like methanol/Chlorophorm/ isopropanol/butanol/hexane/water).

Text Books

1. Pandey,S.N. and Sinha., 1972. Plant Physiology. Vikas Publishing, New Delhi.
2. Verma,S.K., 1999. A Text book of Plant Physiology. S. Chand & Co., New Delhi.
3. Jain, J.L., 1979. Fundamentals of Biochemistry. S. Chand & Co., Ltd., New Delhi.

Reference Books

1. Salisbury, F.B. and Ross, C.N.,1955. Plant Physiology. CBS Publishers, New Delhi.
2. Devlin, R.M. (1969). Plant Physiology. Holt, Rinehart & Winston & Affiliated East West Press (P) Ltd., New Delhi.
3. Lehninger, A.L., 1987. Biochemistry. CBS Publishres, New Delhi.
4. Stryer.L., 2002. Biochemistry. W.H. Freerman & Co., *5 edn.*, New Delhi.

CO-PO Mapping with Programme Outcomes: **Plant Physiology and Biochemistry**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*1*	*1*	*1*	-	*1*	-	*2*	-	-	-	-	-
2	-	*2*	*2*	-	-	*1*	*1*	-	-	-	-	-
3	-	-	*1*	*2*	*1*	*1*	*1*	*1*	*1*	-	-	-
4	*1*	*2*	*1*	-	*2*	*1*	*1*	-	-	-	-	-
5	-	-	*1*	*1*	*1*	*2*	*1*	*1*	-	-	-	-

1-Low, 2-Moderate

SEM II	CC8 (P)	PRACTICAL II COVERING THE CORE COURSES 5, 6 AND 7	22KP2B08P	Ins. Hrs. 6	Credit: 5

Course objectives: *To impart knowledge on Anatomical characters, Genetic studies, Physiological process, Identification and Estimation of DNA and RNA.*

CO	STATEMENT
1	Identify the anatomical characters of root, stem and leaves.
2	Recognize the structure of Endosperm and Embryo.
3	To be skilled in solving problems in genetics.
4	Observe and understand the physiological and biochemical process in plants.
5	Acquire the capability of isolating plasmid and genomic DNA and RNA.

ANATOMY

1. Anatomy section – Hydrophytes, Mesophytes, Xerophytes, Epiphytes, Parasites & Halophytes.
2. Secondary growth of Root and Stem.
3. Nodal Anatomy – Uni, Tri & Multilacunar node.
4. Wood structure – T.S., T.L.S. and R.L.S., - showing variation in vessel element fibers, axial parenchyma and ray parenchyma.
5. Identification of different types of stomata.
6. Anomalous secondary growth in Dicot stems *Aristolochia* & *Nyctanthus.*
7. Anomalous secondary growth in Monocot stem – *Dracaena.*

EMBRYOLOGY

1. Slides showing developmental stages of Anther, Embryosac, Endosperm and Embryo.
2. Study of different types of pollen grains.
3. Dissection of Endosperm Haustoria – *Cucumis* (Cucurbitaceae)
4. Dissection of Embryo – *Tridax*.
5. Methods of testing pollen viability using – (a). Alexander's stain (b). Acid – test.

GENETICS

1. Genetics practical will include working problems in genetics.

MOLECULAR BIOLOGY

1. Isolation of Plasmid DNA from bacteria.
2. Isolation of Genomic DNA.
3. Estimation of DNA.
4. Estimation of RNA.

PLANT PHYSIOLOGY

1. Determination of water potential in different tissues.
2. Effect of temperature on the membrane permeability.
3. Determination of Stomatal frequency.
4. Determination of rate of Transpiration by Ganong's Potometer.
5. Determination of Respiratory Quotient using Ganong's Respirometer.
6. Determination of chlorophyll–a, chlorophyll–b, and total chlorophyll by Arnon's method.
7. Determination of Carotenoids.
8. Estimation of total Phenols.
9. Separation of Pigments by Paper Chromatography.

BIOCHEMISTRY

- Estimation of Protein (Lowry's method)
- Estimation of Amino acids by Ninhydrin method.
- Estimation of Starch by Iodine method.
- Estimation of total lipid.
- Estimation of Amylase.
- Estimation of Protease.

CO-PO Mapping with Programme Outcomes: **Practical II covering the Core Courses 5, 6 and 7**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*2*	-	-	-	-	-	-	-	*1*	-	-	*1*
2	*2*	*1*	-	*1*	-	-	-	-	-	*1*	-	*1*
3	-	-	-	-	*1*	-	-	*1*	-	-	-	-
4	-	-	*1*	*1*	-	-	-	-	-	-	-	-
5	*2*	*1*	-	*1*	-	-	-	-	*1*	-	-	*1*

1-Low, 2-Moderate

SEM II	NME1	HERBAL TECHNOLOGY	22KP2BEL01	Ins. Hrs. 4	Credit: 3

Course objectives: *The aspects of herbal botany constituents cultivation processing and therapeutic values of plants.*

CO	STATEMENT
1	To gain the knowledge about identification standardization and source of herbal products.
2	Recognize the collection process and seasonal variations of herbal drugs.
3	Learn about medicinal value of some medicinal plants.
4	To perceive the medicinal uses of some medicinal plants.
5	Observe and understand the scope and importance of herbal products.

UNIT – I

General Introduction: Definition, source of herbal raw materials, identification, authentication, standardization of medicinal plants as per WHO guidelines.

UNIT –II

Collection and processing of herbal drugs, natural and artificial drying methods. Packaging and labeling of herbal drugs prior to extraction.

UNIT – III

Detailed study of *Adathoda vasica, Andrographis paniculata, Azardirachta indica* and *Coriandrum sativum.*

UNIT –IV

Detailed study of *Eclipta alba, Emblica officinalis, Ocimum tenuiflorum* and *Phyllanthus amaras.*

UNIT – V

Detailed study of *Ricinus communis, Catharanthus roseus,* and *Zingiber officinalis.*

Herbal Preparations – Collections of wild herb – Capsules Herbal oils – Herbal bath – Extraction of Phytopharmaceuticals: Alkaloids, Volatile oils, Resins and tannins.

UNIT – VI: Current contour (Not for semester examination)

Conservation of Medicinal plants – *In-situ* conservation and *Ex-Situ* Conservation. Storage of Medicinal plants. Trading of Medicinal plants.

Text Books

1. Kokate, C.K., Purokit A.P and Gokahale, 2002. Pharmacognosy, NiraliPrakashan, Pune.
2. Gary Walsh 1998. Biopharmaceutical, John Wisley and Sons, NY.
3. Roy Upton and Alison Graff, 2011. American Herbal Pharmacopoeia: Botanical Pharmacognosy – Microscopic Characterization of Botanical Medicines. Imprint CRC Press, USA.

Reference Books

1. Peter B, Kaufmann *et al.*, 1999. Natural Products from Plants, C.R.C Press. USA.
2. Walter H. Lewis, Memory P.F. and Elvin – Lewis, 2003. Medical Botany: Plants Affecting Human Health.

CO-PO Mapping with Programme Outcomes**: Herbal Technology**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*2*	*1*	-	*1*	-	-	-	-	-	-	-	*1*
2	*1*	-	-	*1*	-	-	-	-	*1*	-	-	*1*
3	-	-	-	-	-	-	-	-	*1*	-	-	-
4	-	-	*1*	*1*	-	-	-	-	-	-	-	-
5	*2*	-	-	-	-	-	-	-	*1*	-	-	*1*

1-Low, 2- Moderate

SEM II	ECC 1:1	FOOD SCIENCE AND NUTRITION	22KP2ECCB1:1	Ins. Hrs.	Credit: 3

Course objectives: *To understand the function and nutritive value of food, adulteration and packaging materials. Perceive the knowledge about sterilization and food preparation.*

CO	STATEMENT
1	Discuss the function of food and daily allowances for nutrition.
2	Explain the nutrition value of foods and food additives.
3	Analyze the food adulteration and Food packaging materials.
4	Prepare the Jam and Jelly by using various fruits.
5	Compare the temporary and Permanent preservation.

UNIT-I

Food as a source of nutrients – Functions of food - Physiological, Social and Psychological function of food. Specific functions of the nutrients – Carbohydrates, Protein, Fats, Minerals, Vitamins and Water. Recommended daily allowances for nutrients.

UNIT-II

Nutritive values of food - Plant foods - Cereals and Millets, Legumes and Pulses, Vegetables and Fruits. Food from animal origins - Egg products, Milk products, Meat products and Fish. Food additives - functions and safety of additives.

UNIT-III

Food adulteration- common adulterants and their ill-effects, Incidental adulterants, Metallic Contamination, Simple physical and chemical tests for detection of food adulterants, Food packaging- packaging materials.

UNIT-IV

Food preservation – Perishable, Semi perishable and non perishable foods. Import and Principles of food preservation, Jam - preparing the fruit for jam making, Jelly - Preparation of jelly, Constituents of jelly. Pectin- composition, Properties and uses.

UNIT-V

Methods of preservation- Temporary preservation- Asepsis, Low temperature, pasteurization and exclusion of air. Premantant preservation – Sterilization or processor by heat, Effect of Acidification and drying. Canning of fruits - Apple and Mangoes, Canning of vegetables - Potato, Carrot.

UNIT-VI: Current Contour (Not for Semester Examination)

Preparation of Fruit juices and squash. Preparation of Milk products - Butter, Ghee, Lessi. Types of Food waste - Methods of disposal - Chemical and biological treatment.

Text Books

1. Swaminathan M.S 1974. Essential of Food and Nutrition Vol.I& II. Ganesh & Co. Madras.
2. Antia F.P. 1973. Clinical dietetics and nutrition, Oxford University Press, New Delhi.
3. Frazier, W.C. and Westhoff, D.C.,1988, Food Microbiology. 3rd ed. Tata MC Graw Hill Publishing Co. Ltd., New Delhi.
4. Adams, M.R. and Moss, M.O.,1996, Food Microbiology. New Age International Pvt. Ltd. Publishers, New Delhi.
5. Giridharilal, Siddappa, G.S. and Tandon, G.L., 1990, Preservation of Fruits and Vegetables, CFTRI, Mysore.
6. Manorajan Kalia and Sangita Sood, 1992, Food Preservation and Processing. Department of Food Science and Nutrition, College of Home Science, Himachal Pradesh Agricultural University, Palampur.

Reference Books

1. Devadas R.P.1972. Nutrition in Tamil Nadu, Sangam publishers.
2. Dietrich Knorr, 1987. Food biotechnology. Marcel Dekker Inc. New York.
3. Potter N.M.1979. Food Science. The AVI Pub., Co., Inc., West post, Connecticut, US.A.
4. Fox B.A. and Camerson S.G.1978. Food science – A chemical approach Second edition. University of London press Ltd.
5. Davidson, S., Pass mere, P., Brock, J.F. &Truwell 1975. Human Nutrition and Dietetics. The English language Book society and Churchill, Livingston.
6. Williams S.R. 1973. Nutrition and diet theory. The C.V. Mosby Co., Saint Louis U.S.A.
7. Grey and Hills S. 1972. The complete Hand book of nutrition. Report speller and sons pub., New York.

CO-PO Mapping with Programme Outcomes: **Food Science and Nutrition**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	-	*1*	*1*	*1*	*1*	-	*3*	*2*	-	-	-	-
2	-	-	*1*	*3*	*2*	-	*3*	*2*	*1*	-	-	-
3	-	-	*3*	*1*	*1*	-	*3*	*2*	*1*	-	-	-
4	-	-	-	*2*	*1*	-	*3*	*1*	*1*	-	-	-
5	-	-	-	*-1*	*1*	-	*3*	*3*	*3*	*2*	-	-

1-Low, 2- Moderate, 3- High Correlation

SEM III	CC 9	PLANT SYSTEMATICS	22KP3B09	Ins. Hrs. 7	Credit: 5

Course objectives: *To Understand the various aspects of plant nomenclature and classification. To Understand the classical and modern trends of Angiosperm Taxonomy. To Understand the salient features of Angiosperm families.*

CO	STATEMENT
1	Illustrate various system of classification and their merits and demerits.
2	Interpret the rules of ICBN in botanical nomenclature. Identify the angiosperms families with specific key characters, Learn various advanced tools to study plant Taxonomy.
3	Extend knowledge on important families with their systematic characteristics and their economic importance.
4	Get knowledge on important families, their characteristics and their economic importance.
5	Understand the salient features of Angiosperm families, appreciate the diversity of plant and the plant products in human use.

UNIT I TAXONOMY

Introduction, Artificial System - Carolus Linnaeus, Natural System - Bentham and Hooker, Modern System - Engler and Prantl, Hutchinson, Takhtajan and Angiosperm Phylogenetic Group IV, 2016. Modern trends in taxonomy - Chemotaxonomy, Numerical Taxonomy, and Biosystematics. Phylogeny and Taxonomy.

UNIT II

Key Preparation - Dichotomous Key, International code of Botanical Nomenclature (ICBN)- Typification, Priority, Publication, Author citation and Retention, Choice and rejection of names, Current changes. Taxonomy in relation to Anatomy, floral anatomy, Palynology, Embryology and Cytology. Plant collection and Preparation of Herbarium. Botanical survey of India.

UNIT III

Taxonomical studies of selected families and their economic importance;

Dicotyledons -**Polypetalae**: Menispermaceae, Polygalaceae, Carryophyllaceae, Portulacaceae, Rhamnaceae, Sapindaceae, Rosaceae, Combretaceae, Myrtaceae and Umbelliferae.

UNIT IV

Taxonomical studies of selected families and their economic importance ;

Gamopetalae: Aizoaceae, Sapotaceae, Oleaceae, Gentianaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Pedaliaceae and Verbenaceae.

UNIT V

Taxonomical studies of selected families and their economic importance;

Monochlamydeae: Nyctaginaceae, Chenopodiaceae, Aristolocaceae, Loranthaceae, Orchidaceae.

Monocotyledons: Amarylidaceae, Commelinaceae, Arecaceae and Cyperaceae.

UNIT VI: Current Contour (Not for Semester Examination)

Tribes of Tamilnadu – Introduction, Kanikkars, Kurumbas, Irulas, Badagas, Kothas, Todas, Malayali. Tribal medicines - Introduction, source of medicines, Forms of Tribal medicines, some medicinal plants of Tribals. Ethno - veterinary medicines, Processing of Tea, Extraction of sandal wood oil, Extraction of Eucalyptus oil.

Text Books

1. Raychudhuri, S.P 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops Vol.1 Today & Tomorrow's printers and publishers, New Delhi
2. Hutchinson, J. (1973) The families of flowering plants. Oxford University Press, London.
3. Lawrence, G.H.M. (1955) The Taxonomy of vascular plants (Vol. I-IV). Central Book Depot, Allahabad.
4. Singh, V. and Jain, V.K. (1989) Taxonomy of Angiosperms. Rastogi Publication, Meerut.

Reference Books

1. Davis, P. H &Hetwood, V.M., 1980, Priniciples of Angiosperm Taxonomy, Oliver& Boyd.
2. Vashista, P.C., 1990. Taxonomy of Angiosperms-S.Chand& Co., New Delhi.
3. Heywood, V.K. & Moore, D.M., 1984, current Concepts in Plants-Clrendon Press.
4. Grant, W.F., 1984, Plant Biosystematics, Acad Press Inc., Canada.
5. Sambamurty, A.V.S.S., 2005 Taxonomy of Angiosperms, I. K. International P vt. Ltd. New Delhi.
6. Pandey, B.P., 1997,Taxonomy of Angiosperms-S.Chand& Co., New Delhi.
7. Sharma O.P,2000, Economic Botany, Tata McGraw Hill Publications, New Delhi.

CO-PO Mapping with Programme Outcomes**: Plant Systematics**

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	*2*	*1*	*2*	-	*1*	*2*	*2*	*1*	-	-	-	-
2	*2*	*2*	*1*	*1*	-	*1*	*2*	*1*	-	-	-	-
3	*2*	*2*	*2*	*2*	*1*	*2*	*2*	*1*	*1*	-	-	-
4	*1*	*2*	*1*	*2*	-	-	*2*	*1*	*2*	*1*	-	-
5	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*1*	-	-	-	-

1-Low, 2-Moderate

SEM III	CC 10	HORTICULTURE AND PLANT BREEDING	22KP3B10	Ins. Hrs. 7	Credit: 5

Course objectives: *To study the Scope and Importance of Horticulture. Establishment of Herbal garden and understand the basic concept and scope of Plant breeding.*

CO	STATEMENT
1	Understand the different classifications of horticultural crops, nursery management and role of growth regulators in plants.
2	Develop their competency on establishment of Herbal garden.
3	Analyze the different methods of cultivation of commercial flower crops.
4	Examine the methods of crop improvement and their significance.
5	Evaluate the importance of various types of ploidy, mutations and breeding techniques.

UNIT I: HORTICULTURE

History, Scope and Importance of Horticulture, Division of Horticulture, climate, soil and nutritional needs, Water irrigation, Plant propagation method – Cutting, layering, grafting and budding. Stock – Scion relationship, micropropagation by induction of rooting. Role of growth hormones in horticultural crops.

UNIT II

Types of Garden, methods of designing outdoor garden – hedges, edges, fences, trees, climbers, rockeries, arches, terrace garden, Lawn making and maintenance, water garden – cultivation of water plants. Establishment of Herbal garden. Indoor gardening and roof gardening,

UNIT III

Importance, species, varieties and production technology of: Rose, Jasmine and Marigold; Mango, Banana and Citrus; Tomato, Brinjal and Cabbage. Ornamental Horticulture: Cultivation, Care and Maintenance of Cacti, Succulents, Ferns, Palms and Cycads. Flower decoration - Dry and Wet decoration.

UNIT IV: PLANT BREEDING

Introduction to Plant Breeding- Introduction, scope of plant breeding, History of plant Breeding, Crop improvement- objectives of crop improvement, methods of crop improvement, acclimatization, mass selection, pure line selection, objectives of hybridization, hybridization technique, emasculation, bagging and crossing.

UNIT V

Ploidy breeding- Types of polyploids, auto polyploids, allopolyploids. Mutation breeding - Types of mutations, spontaneous mutations, induced mutations, induced mutations by radiations, ionizing radiations, non ionizing radiations and Gamma garden. Breeding for disease resistance- Resistance breeding method, advantages and disadvantages of resistance breeding.

UNIT VI: Current Contour (Not for Semester Examination)

Soil fertility: evaluation, soil testing; Use of manures and fertilizers, Maintenance of soil fertility, Method and time of application of fertilizers. Irrigation water quality, Different types of irrigation methods and Microirrigation. Non conventional methods, anther culture, embryo/ovule culture, somoclonal variation, somatic embryogenesis and high yielding varieties.

Text Books

1. Kumar, N. (1987). Introduction to Horticulture, Rajalakshmi publishers, Nagercoil.
2. Arora. J. S. (1992). Introductory ornamental Horticulture, Kalyani Publishers, New Delhi.
3. Kumaresan V. 2009. Horticulture and Plant Breeding (First edition), Saras Publications, Nagercoil.

Reference Books

1. Rao, K.M. (2000). Text Book of Horticulture. Macmillan India Ltd., New Delhi
2. Manibushan Rao, K. (1991). Text book of Horticulture. Macmillan publishing co., New-Yark.

CO-PO Mapping with Programme Outcomes: **Horticulture and Plant Breeding**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*1*	*3*	-	*3*	*3*	*2*	-	*3*	-	*2*	-	*2*
2	*2*	*2*	*2*	*2*	*3*	*1*	-	*2*	-	*3*	-	*2*
3	-	*1*	-	-	*2*	*2*	-	*2*	-	*2*	-	*2*
4	*1*	*2*	*1*	*2*	*2*	*1*	-	*2*	*1*	*2*	-	-
5	*1*	*2*	-	*1*	-	-	-	-	*1*	-	-	-

1-low, 2-Moderate, 3-High correlation

SEM III	CC11 (P)	PRACTICAL III COVERING THE CORE COURSES 9 AND 10	22KP3B11P	Ins. Hrs. 6	Credit: 5

Course objective: *To Understand the various kinds of plants on the surface of earth with their names, affinities, geographical distribution, habit characteristics and their economic importance. To understand the diversities of plant kingdom and their relation to evolution of plants.*

CO	STATEMENT
1	Understand external and internal structure of Plants. Taxonomic families and their useful parts of plants. Acquire knowledge in the preparation of herbarium techniques.
2	Acquire knowledge on Classification of families their characteristics and their economic importance.
3	Understand planning, designing and principles of lay out of garden.
4	Technological developments in plant propagation methods such as cutting, layering, grafting, budding and micropropagation.
5	Explain about selection methods and Hybridization. Gain the knowledge about mutation breeding and seed certification.

PLANT SYSTEMATICS

1. Key Preparation.
2. Nomenclature of Plants with few examples.
3. Embryo & Pollinia dissection.
4. Study the plants belonging to the following families with minimum two examples.
   Training in dissection, observation, identification and sketching of floral parts of plants belonging to the families mentioned in the syllabus along with floral diagrams and floral formula. Field study of flora. Submission of 25 herbarium specimens.

Polypetalae: Menispermaceae, Polygalaceae, Carryophyllaceae, Portulacaceae, Rhamnaceae, Sapindaceae, Rosaceae, Combretaceae, Myrtaceae, Umbelliferae.
Gamopetalae: Aizoaceae, Sapotaceae, Oleaceae, Gentianaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Pedaliaceae and Verbenaceae
Monochlamydeae: Nyctaginaceae, Chenopodiaceae, Aristolocaceae, Loranthaceae, Orchidaceae.
Monocotyledons: Amarylidaceae, Commelinaceae, Arecaceae and Cyperaceae.

HORTICULTURE

- Study of tools and implements used in horticulture and plant propagation.
- Gardens layout-Formal, Informal, Kitchen and Rock.
- Plant propagation methods- Cutting, Layering, Grafting and Budding.

PLANT BREEDING

Hybridization techniques – Emasculation and Bagging.
Selection methods – Mass, Pure line and Clonal Selection.

CO-PO Mapping with Programme Outcomes: **Practical III covering the Core Courses 9 and 10**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*2*	*1*	*2*	-	*1*	*2*	*2*	*1*	-	-	-	-
2	*2*	*2*	*1*	*1*	-	*1*	*2*	*1*	-	-	-	-
3	*2*	*2*	*2*	*2*	*1*	*2*	*2*	*1*	*1*	-	-	-
4	*1*	*2*	*1*	*2*	*2*	*2*	*1*	*2*	*1*	*1*	-	-
5	*1*	*1*	*1*	*1*	*1*	*2*	*2*	*1*	-	-	-	-

1-Low, 2-Moderate.

SEM III	MBE 2:1	MEDICINAL BOTANY AND PHARMACOGNOSY	22KP3BELB2:1	Ins. Hrs. 6	Credit: 4

Course objectives: *The aspects of Pharmacognosy deals with concepts and fundamentals of Alternative system of medicine and to understand the process of collection, cultivation, harvesting, drying, and storage of medicinal drugs. The course used to Develop Skills on Preparation, evaluation and standardization of drugs.*

CO	STATEMENT
1	Understand the core concepts and fundamentals of Traditional and Alternative system of medicine of siddha, Ayurvedha, Unani, Homeopathic, Acupuncture and Yoga.
2	Recognize the basic medicinal plants and understand the process of collection, cultivation, harvesting, screening, drying, packing and storage of medicinal drugs.
3	Develop Skills on Preparation and standardization of drugs from natural origin and Evaluate the drug adulteration.
4	Propose new strategies to enhance the therapeutic value of medicinal herbs considering the practical issues pertinent to India.
5	Understand the IPR and Patenting of active Principles and Entrepreneurship.

UNIT I

Introduction; History, Definition and Scope of Pharmacognosy, Complementary and Alternative system of medicine (CAM) - Ayurvedha, Siddha, Unani, Homeopathic, Acupuncture and Yoga. Crude drugs and their types.

UNIT II

Medicinal plants- Cultivation and Propagation of medicinal plants, Methods of Collection, Harvesting, Drying and Storage of drugs, Indian trade in medicinal and aromatic plants, Conservation of medicinal plants.

UNIT III

Analytical Pharmacognosy - Adulteration and its types, Factors affecting herbal drugs quality. Drug evaluation – Macroscopical, Microscopical, Physicochemical, Phytochemical (Qualitative and Quantitative analysis of secondary metabolites- Alkaloids, Tannin, Phenols, Steroids, Terpenoids and Flavonoids) and Biological Evaluation methods.

UNIT IV

Cultivation and Standardization of drugs from natural orgin. Anticancer drug – *Catharanthus roseus,* Antidiabetic - *Gymnema sylvestris,* Hepatoprotective - *Phyllanthus amarus,* Antiasthmatic – *Toddalia asiatica,* Cardiotonic – *Digitalis purpurea,* Antimalarial- *Chinchona officinalis,* Hypertension – *Rauwolfia serpentina.*

UNIT V

Natural Pesticides (*Vitex, Azardiracta*), Allergenic Plant (*Parthenium, Mucuna*) Poisonus plant (*Abrus precatorius, Nerium oleander*). Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins, oils and miscellaneous uses.IPR and Patenting of active Principles, Entrepreneurship.

UNIT VI: Current Contour (Not for Semester Examination)

Phytopharmaceuticals – Extraction of pharmaceuticals – Herbal remedies – Ointments – Pain balms – Hair oils. Preparation of Decoctions – Syrups – Face packs –Skin cares.

Text Books

1. Saroya, A.S. (2017). Ethnobotany. ICAR publications.
2. Kokate, C.K., Purohit, A.P and Gokhalae, S.B.2005. Pharmacognosy, Nirali Prakasam, Pune.
3. Kapoor, L.D.1990. Handbook of Ayurvedic medicinal plants. CRC Press, New York,USA.
4. Evans, W.C. (2009). Trease and Evans Pharmacognosy, 16th edn. Philadelphia, PA: Elsevier Saunders Ltd.

Reference Books

1. Jain, S.K. and Jain, Vartika. (eds.) (2017). Methods and Approaches in Ethnobotany: Concepts, Practices and Prospects. Deep Publications, Delhi
2. Kapoor, L. D. (2001). *Handbook of Ayurvedic medicinal plants.* Boca Raton, FL: CRC Press.
3. Sharma, R. (2003). Medicinal Plants of India-An Encyclopaedia. Delhi: Daya Publishing House..
4. Thakur, R. S., H. S. Puri, and Husain, A. (1989). *Major medicinal plants of India.* Central Institute of Medicinal and Aromatic Plants, Lucknow, India

Website: AYUSHWebsite :(www.indianmedicine.nic.in).

CO-PO Mapping with Programme Outcomes: **Medicinal Botany and Pharmacognosy**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*2*	*3*	-	*2*	-	*1*	-	*2*	-	-	-	-
2	*1*	-	-	-	-	*2*	*3*	*2*	-	-	*2*	*1*
3	-	*1*	*2*	-	*2*	*2*	*3*	-	*2*	-	-	-
4	-	-	*3*	*2*	-	-	-	*3*	-	*2*	-	-
5	-	-	-	*2*	-	-	-	*2*	-	-	*2*	*3*

1-Low, 2-Moderate, 3-High correlation

SEM III	MBE 2:2	MEDICAL MICROBIOLOGY	22KP3BELB2:2	Ins. Hrs. 6	Credit: 4

Course objectives: To impart knowledge about diagnosis, symptoms and control measures of various microbial diseases.

CO	STATEMENT
1	Recognize the types of normal human microflora.
2	Nature of communication of diseases and its prevention.
3	Understand the causative organisms, symptoms and prevention of Bacterial diseases.
4	Perceive the causative organisms, symptoms and control measures of Viral diseases.
5	Learn about causative organisms, symptoms, diagnosis and prevention of Fungal diseases.

UNIT – I

Introduction – History and Scope – Spontaneous generation – Germ theory of disease – Koch's postulates. General features of normal flora. Normal Human microflora of Skin, Eye, Respiratory tract, Oralcavity, Teeth, Abdomen and Urinogenital tract.

UNIT – II

Mode of transmission of diseases – Causative agent, Symptoms, Diagnosis, Prevention and Treatment of airborne diseases – Diphtheria and Chicken pox. Waterborne diseases – Amoebiasis and Cholera. Animal borne diseases – Rabies.

UNIT – III

Causative agent, Symptoms, Diagnosis, Prevention and Treatment of Bacterial diseases – Whooping cough, Pneumonia, Typhoid fever, Tetanus and Tuberculosis.

UNIT – IV

Causative agent, Symptoms, Diagnosis, Prevention and Treatment of Viral diseases – Covid-19, Small pox, Common cold, Influenza , Measles and Rubella.

UNIT – V

Diagnosis, Causative agent, Prevention and treatment of fungal diseases - Black fungus, *Dermatophytosis, Candidiasis, Aspergillosis* and *Histoplasmosis.*

UNIT – VI Current contour (Not for semester examination)

Microbial growth in natural environment, importance of Vaccination. Natural immune tolerance and Acquired immune tolerance.

Text Books

1. Rajan.S. 2007. Medical Microbiology. MJP Publishers, Chennai.
2. Sharma, P.D., 1992. Microbiology - Rastogi & Co., India.
3. Power and Daginwala., 1994. General Microbiology. Himalayan Pub. House, New Delhi.
4. Pelczar. J. Chan E.C.S and Krieg. R., 1999. Microbiology, Tata Mc. craw Hill, New Delhi.

Reference Books

1. Huge W.B. and Russell A.D.(1989). Pharmaceutical Microbiology. IV edition. Blackwell Scientific Publicaiton, Oxford, New York.
2. Collee, J. C., Duguid, J.P., Fraser, A. C., and Marimon, B.P. (1989). Mackie and Mc Carteny Practical Medical Microbiology – 13th Edition, Churchill Livingstone.
3. Topley and Wilson's (1990). Principles of Bacteriology, Virology and Immunity, VIII edition, Vol.III Bacterial Diseases, Edward Arnold, London.

CO-PO Mapping with Programme Outcomes: **Medical Microbiology**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*2*	*2*	*1*	*1*	-	-	-	-	-	*2*	-	-
2	*3*	*1*	*2*	-	-	-	-	-	-	-	-	-
3	*3*	-	-	-	-	*1*	-	-	-	-	-	-
4	*1*	-	-	-	-	-	-	-	-	*1*	-	*1*
5	-	-	*1*	*1*	-	-	-	-	-	*1*	-	-

1-Low, 2-Moderate, 3- High correlation

SEM III	NME 2	MUSHROOM CULTIVATION	22KP3BEL02	Ins. Hrs. 4	Credit: 3

Course Objectives: *To know the various types of edible mushroom and their nutritional value. To understand the methods of cultivation of mushrooms. To know the types of food prepared from mushroom and their importance in human health. Marketing of mushrooms in India and abroad*

CO	STATEMENT
1	To aware the identification of edible and poisonous mushroom
2	To understand the spawn production technique
3	To recognize the infra structure and raw materials needed for the mushroom cultivation
4	To know the storage and nutritive value of mushroom
5	To understand the food preparation and marketing of mushroom

UNIT I

Introduction - Scope of Edible mushroom cultivation - Types of edible mushroom available in India - *Calocybe indica, Volvarlella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*, Identification of Poisonous mushroom.

UNIT II

Pure culture - preparation of medium (PAD and Oatmeal Agar medium) Sterilization - preparation of test slants to store mother culture - Culturing of *Pleurotus* mycelium on petriplates, preparation of mother spawn in saline bottle and polypropylene bag and their multiplication.

UNIT III

Cultivation Technology: Infra structure: substrates (locally available) Polythene bag, vessels, Inoculation hood, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag, Mushroom bed preparation - Paddy straw, sugarcane thrash, maize straw, banana leaves. Factors affecting the mushroom bed preparation.

UNIT IV

Storage and Nutrition: Short-term storages (Refrigeration - upto 24 hrs) Long term storage (canning, pickles, papads), drying, storage in salt solutions, Nutritive Value - proteins - amino acids, mineral elements nutrition - carbohydrates, Crude fibre content - Vitamins.

UNIT V

Food Preparation:

- Types of foods prepared from mushroom; soup, cutlet, omelette, samosa, pickdes, curry, Briyani
- Research Centres - National level and Regional level
- Cost benefit ratio - Marketing in India and abroad, Export value.

UNIT VI

Medicinal value of Mushroom – cultivation, extraction, isolation and identification of active principles from mushroom – pharmacological and economical value of mushroom.

Text Books

- Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K. and Jayarajan, R., (1991), Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
- Swaminathan, M., (1990). Food and Nutrition, Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore 560 018.

Reference Books

- Tewari, Pankaj Kapoor, S.C., (1988). Mushroom Cultivation, Mittal Publications Delhi.
- Dubey. R.C., & Maheshwari, D.K., 2004, A Text Book of Microbiology. S.Chand & Company Ltd., New Delhi.

COPO Mapping with Programme Outcomes: **Mushroom cultivation**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	-	*1*	*2*	*3*	-	-	*3*	-	-	-	-	-
2	-	*3*	*2*	-	-	-	*3*	*2*	-	-	-	-
3	-	*1*	-	*3*	*2*	-	-	*2*	-	-	-	-
4	-	*3*	*2*	*3*	-	-	*3*	-	-	-	-	-
5	-	*2*	*2*	*3*	-	-	*3*	-	-	-	-	-

1-Low, 2-Moderate, 3-High Correlation

SEM III	ECC 3:1	STRESS BIOLOGY	22KP3ECCB3:1	Ins. Hrs.	Credit: 3

Course objectives: *Understand the concept of stress and resistance mechanism. Observe the role of production and scavenging mechanism of ROS.*

CO	STATEMENT
1	Acquire basic knowledge on stress, stress factors and resistance mechanisms.
2	Know the various types of stress.
3	Develop the ability for critical appraisal of various physiological mechanisms that protect the plant from environmental stress.
4	Analyze the role of production and scavenging mechanisms of ROS.
5	Acquire basic knowledge about photomorphogenetic responses of plants.

UNIT I

Stress and stress factors, Resistance Mechanisms; Tolerance, Acclimation and avoidance.

UNIT II

Water stress (Drought tolerance, Drought Avoidance) Heat stress, Salt stress, Resistance stress, Cold Stress. High light stress, Temperature stress, Hyper sensitive reaction; Pathogenesis – revealed protein (PR).

UNIT III

Signal transduction and various mechanisms, Hormonal signaling, calcium modulation and phospholipids signaling.

UNIT IV

Adaptation in plants; Changes in root and shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production. Reactive oxygen species: Production and scavenging mechanisms of ROS.

UNIT V

Phytogernotology – senescence, types and mechanism, abscission, programmed cell death.

UNIT VI: Current contour (Not for semester examination)

Photomorphogenesis, Phytochrome medicated Photomophogenesis, blue light receptors, and morphogenetic responses of plants towards red and blue light.

Text Books

1. Singh D.P.(2003), Stress physiology, New age international Pvt.Ltd.
2. Dr.Annie Ragland, K.Rajakumar, Rajarathnam, M.Jayakumar and N.Arumugam (2014), Plant physiology, Saras publication.

Reference Books

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. 4th edition Wiley and Sons. U.S.A.
2. Taiz, L., Zeiger, E., Møller, L.M. and Murphy, A (2015). Plant Physiology Development. 6 h edition. Sinauer Associates Inc. USA.

COPO Mapping with Programme Outcomes: **Stress Biology**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	-	*1*	*2*	*3*	-	-	*3*	-	-	-	-	-
2	-	*3*	*2*	-	-	-	*3*	*2*	-	-	-	-
3	-	*1*	-	*3*	*2*	-	-	*2*	-	-	-	-
4	-	*3*	*2*	*3*	-	-	*3*	-	-	-	-	-
5	-	*2*	*2*	*3*	-	-	*3*	-	-	-	-	-

1-Low, 2-Moderate, 3-High Correlation

SEM IV	CC 12	MICROBIOLOGY AND PLANT PATHOLOGY	22KP4B12	Ins. Hrs. 6	Credit: 4

Course objectives: *This course will introduce the student to the world of microbes, which are there in every possible niche. The beneficial and detrimental aspects will be taught. The principles of Plant Pathology also will be given an insight.*

CO	STATEMENT
1	Understand the History, Scope and branches of Microbiology.
2	Study the classification, structure and Reproduction of Bacteria.
3	Analyze the Structure and Replication of Viruses.
4	Recognize the host and pathogen interaction.
5	Improve to handling disease free varieties and implement the disease management.

UNIT- I: MICROBIOLOGY

History, Scope and branches of Microbiology. Classification of Microorganisms - Five kingdom concept- R.H. Whittaker (1969). and Eight kingdom concept Cavalier – Smith (1987). Prokaryotic and Eukaryotic microbes. Methods of Sterilization, Preparation of culture medium. (PDA and NA). Methods of culturing Bacteria – Isolation and Purification Techniques – Cultural Characteristics of Bacteria – Maintenance of Bacterial Culture.

UNIT- II

General characters of Bacteria - Bergey's System of Bacterial classification. Morphology, Ultrastructure, Growth, Nutrition and Reproduction. Sailent features of Eubacteria, Archaebacteria, Mycobacteria Cyanobacteria and Actinomycetes. Economic importance of Bacteria.

UNIT- III

Viruses – General characters, LTH System of Classification (Lwoff and Tournier (1962). Morphology and Ultrastructure of Virus – Plant and Animal Viruses. Replication of Viruses (lytic and lysogenic). Viroids and Prions. Cultivation of Viruses – Isolation and Purification of Viruses.

UNIT-IV: PLANT PATHOLOGY

Introduction, Organisms and Casual factor responsible for Plant diseases – Koch's Postulates - Host parasite interactions - Defence mechanisms in plants- Structural and Biochemical- Control of plant diseases – Physical, Chemical and Biological methods.

UNIT -V

Study of selected Plant diseases (Causal Organism, symptoms, disease cycle and Control measures of the plant diseases) Bacterial Diseases: Potato Wilt, Blight of Paddy. Fungal Diseases: Rust of Wheat, Foot rot of Papaya. Viral Diseases: Bunchy top of Banana, Cauliflower Mosaic Virus. Mycoplasma Diseases: Yellow dwarf disease of rice, Phyllody disease of *Sesamum*.

UNIT- VI: Current contour (Not for Semester Examination)

Role of microbes in Biogeochemical cycle - Carbon, Nitrogen, Phosphorus and Sulphur. Role of microorganisms in various ecosystems. Effect of environment on disease development.

Text Books

1. Dubey, R. C. and Maheshwari, D. K. (2007). A Textbook of Microbiology. S. Chand and Co. Ltd., New Delhi.
2. Ketchum, P. A. (1988). Microbiology: Concepts and Applications. John Wiley & sons, New York.
3. Braual NK and others(1980), Text book of plant pathology. Oxford publishing Company, New Delhi.

Reference Books

1. Sharma, P.D. (1992), Microbiology – Rastogi & Co., India.
2. Power and Daginwala (1994). General Microbiology. Himalayan Publishing House, Bombay.
3. Salle, A. J. (1974). Fundamental Principles of Bacteriology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Rangasami, G. and Mahadevan, A.(1998). Diseases of crop plants in India. Prentice Hall of India Ltd., New Delhi.
5. Pandey, B.P.(2001). Plant Pathology. S.Chand and Company Ltd., New Delhi.

CO-PO Mapping with Programme Outcomes: **Microbiology and Plant Pathology**

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	*2*	*1*	*2*	-	*2*	*1*	*3*	-	-	-	-	-
2	*3*	*1*	-	-	*2*	*1*	-	-	-	-	-	-
3	*1*	*2*	*2*	*1*	*2*	-	*2*	-	-	*1*	-	-
4	*1*	*2*	*2*	*1*	-	*2*	-	-	*1*	-	*1*	-
5	*3*	-	*2*	*1*	*2*	*1*	*2*	-	-	-	-	-

1-Low, 2- Moderate, 3- High Correlation

SEM IV	CC13	BIOTECHNOLOGY AND BIOINFORMATICS	22KP4B13	Ins. Hrs. 6	Credit: 4

Course objectives: *The aspects of Biotechnology and Bioinformatics emphasize the concepts and application of Genetic engineering. The course content also leads to develop their competency on different types of plant tissue culture and Understand the core concepts of Bioinformatics and their significance*

CO	STATEMENT
1	Understand the core concepts and fundamental functions of the enzymes and vectors in genetic engineering.
2	Develop their competency on different types of plant tissue culture and Protoplast Technology
3	Critically analyze the major concerns and applications of Transgenic technology and evaluate different methods of gene transfer.
4	Understand the core concepts and fundamentals of Computer application, Bioinformatics and their significance in the present scenario.
5	Understand the concept and execute the skills on biological databases and use of different public domain for DNA and proteins sequence retrieval.

UNIT - I: BIOTECHNOLOGY

Biotechnology - Definition, History and Scope, Branches of Biotechnology, Genetic Engineering- Tools of genetic engineering - Type of vectors - Plasmids (pBR 322), Cosmids (λ Phage), BAC and YAC, Role of Enzymes and linkers in gene cloning techniques, Gene cloning techniques - Isolation of specific DNA, Insertion of foreign DNA into a vector, Transfer of recombinant DNA into Bacterial cell.

UNIT – II

Gene cloning in Eukaryotes – *Agrobacterium* based gene transfer- Structure of Ti and Ri Plasmid, Mechanism of T-DNA transfer. Plant cell transformation – Electroporation, Liposome mediation, Particle bombardment, Microinjection. Transgenic plant- Herbicide resistance plants, Immobilization and its types, Synthetic seeds.

UNIT - III

Tissue culture techniques - Concept, Sterilization and Media Preparation. Micropropagation – Organogenesis, Embryogenesis, Meristem culture, Anther culture, Suspension culture, Protoplast Technology – Isolation, Maintenance, Plant regeneration-Applications of tissue culture, Cryopreservation.

UNIT – IV: BIOINFORMATICS

Bioinformatics - Definition, concept and application of bioinformatics, Biological Database Classification- Nucleic Acid Database- EMBL, NCBI, DDBJ; Protein sequence database- PIR, MIPS, SWISS PROT.

UNIT – V

Bioinformatics Tools – Classification of Bioinformatics tools- Homology and Similarity tools- BLAST and FASTA, Multiple Sequence alignment Tools- CLASTAL W , Sequence analysis Tools, Structural analysis Tools-PROTPARAM , Molecular modeling and Visualizing tools - Rasmol, Phylogenetic analysis tools-PHYLIP, Miscellaneous Tools-Webcutter.

UNIT – VI: Current contour (Not for semester examination)

Nano-biotechnology – Introduction – Definition – Scope – Properties of Nanomaterials. Applications of Nano-biotechnology.

Text Books

1. Dubey, R.C., 2001, Text Book of biotechnology, S. Chand & Co., New Delhi.
2. Singh, B.D., 2006, Biotechnology, Kalyani Publishers, New Delhi.
3. Gupta, P.K., 1998, Elements of Biotechnology, Rostagi Publications, Meerut.
4. Dubey & Maheshwari,2006, AText Book Of Biotechnology. S. Chand & Co., New Delhi.
5. Attwood, T.K. and Parry-Smith, D.J., 2001. Introduction to Bioinformatics, Pearson Education.

Reference Books

1. Watson ,J.D, *et al*., 2005. Recombinant DNA ,Blackwell Sciencepub.USA.
2. Mantell and Smith, S.H., 1983. Plant biotechnology, Cambridge, U.K.
3. Old, R.W. and Primose, S.B., 1994. Principles of Gene Manipulation, Blackwell, Science Ltd., London.
4. Rastogi,S.C., 2006. Bioinformatics – Concepts, Skills & Application, Rostagi Publications, Meerut.

CO-PO Mapping with Programme Outcomes: **Biotechnology and Bioinformatics**

CO/PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	*2*	-	-	*3*	*2*	*1*	-	*2*	*2*	-	-	-
2	-	*2*	*2*	-	*2*	*1*	-	*2*	*3*	-	-	-
3	-	*2*	-	*2*	-	-	*1*	-	-	*3*	-	-
4	-	*1*	-	-	*2*	*2*	-	*1*	*1*	-	-	*2*
5	-	*2*	-	-	*2*	-	-	*2*	-	-	*2*	-

1-Low, 2-Moderate, 3-High correlation

SEM IV	CC 14 (P)	PRACTICAL IV COVERING THE CORE COURSES 12 AND 13	22KP4B14P	Ins. Hrs. 6	Credit: 5

Course objectives: *To know about the various techniques involved in Microbiology, Plant pathology and Biotechnology.*

CO	STATEMENT
1	Understand the current developments of Laboratory rules and staining procedures.
2	Diagnosis the various bacterial, fungal, viral and mycoplasmal diseases.
3	Acquired knowledge on the Sterilization Techniques.
4	Understand the basic principles of plant tissue culture techniques.
5	Get to know the Bioinformatics tools.

MIROBIOLOGY

1. Laboratory Rules.
2. Preparation of Medium- Bacteria – Nutrient Agar, Fungi – PDA medium.
3. Isolation of Fungi and Bacteria from soil by Serial Dilution Techniques.
4. Isolation of Fungi and Bacteria from air.
5. Isolation of fungi and Bacteria from Sewage Water.
6. Preparation of Spread plate, Streak plate (Simple and Quadrant) and Pour plate.
7. Effect of different antibiotic sensitivity, pH and Temperature on bacterial growth.

PLANT PATHOLOGY

Study of the following diseases

Bacterial Diseases	- Potato wilt, Blight of Paddy.
Fungal Diseases	- Rust of Wheat, Foot rot of Papaya.
Viral Diseases	- Bunchy top of Banana, Cauliflower Mosaic Virus.
Mycoplasmal Diseases	- Yellow dwarf disease of rice, Phyllody disease of *Sesamum*.

BIOTECHNOLOGY

1. Tissue culture techniques - Sterilization and MS medium preparation.
2. Callus Induction
3. Sterilization and Inoculation of Root tip culture
4. Sterilization and Inoculation of Shoot tip culture
5. Sterilization and Inoculation of Leaf culture.
6. Sterilization and Inoculation of Anther culture.
7. Isolation of Protoplast and Spheroplast.
8. Isolation of DNA from Cauliflower.
9. Immobilization of Cells by using Sodium Alginate Beads

BIOINFORMATICS

1. Accessing of Genebank Website and Downloading of Files.
2. Accessing of EMBL Website and Cross-Link to Genebank.
3. Accessing PDB Website and Downloading a File of Protein Structure.
4. BLAST Similarity Search for Nucleotide Sequences.

SPOTTERS

1. Hot Air Oven
2. pH Meter
3. Laminar Air flow chamber
4. Fermentor
5. Plasmids (pBR 322)
6. Cosmids
7. PCR
8. EMBL
9. NCBI
10. DDBJ
11. PIR
12. MIPS
13. SWISS PORT
14. BLAST
15. PUBMED

CO-PO Mapping with Program Outcomes: **Practical IV Covering the Core Courses, 12 and 13.**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*1*	-	-	*2*	*2*	*1*	-	*2*	-	*2*	-	-
2	-	*1*	*1*	-	*2*	*1*	*2*	*3*	-	-	*1*	-
3	-	*2*	*2*	-	-	*1*	-	-	-	*2*	-	-
4	*2*	*1*	-	*2*	*2*	-	*1*	*1*	-	-	-	*2*
5	-	*2*	*1*	-	*1*	*2*	-	*2*	-	-	*1*	-

1-Low, 2-Moderate, 3-High Correlation

SEM IV	MBE 3:1	RESEARCH METHODOLOGY AND BIOSTATISTICS	22KP4BELB3:1	Ins. Hrs. 6	Credit: 4

Course Objectives: *To learn the basics of Biostatistics and apply the statistical principles in designing Biological experiments and solving Biological problems.*

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CO	STATEMENT
1	Acquire knowledge on Literature collection and thesis writing.
2	Analyze the ethical aspect of Research
3	Evaluate the principles of working mechanism and applications of Microscopy.
4	Acquire knowledge on basic concepts in Biostatistics.
5	Test the significance, validity and reliability of research.

UNIT- I: RESEARCH METHODOLOGY

Introduction of Research- literature collection, Methodology, Result, Tables and Figures. Discussion, Summary, Bibliography – Indexing and Abstracting – Reporting the results of research in conferences – Oral and Poster presentation.

UNIT- II

Thesis writing – Research journals – National and International –Monographs – Reprints – proof correction – Full paper – Short Communication – Review paper-Research publications, Plagiarism, Impact factor and Copyright.

UNIT-III

Principles, working mechanism and application of Microscopy - Electron Microscope (SEM & TEM), pH meter, Sonicator, Microfuge, Gas Chromatography Mass Spectrometry (GCMS), Fourier Transform Infra Red Spectroscopy (FT-IR), Atomic Force Microscopy (AFM), Differential Scanning Colorimetry (DSC).

UNIT- IV: BIOSTATISTICS

Biostatistics Definition - Collections of Data, Sampling methods, Variables, Classification, Tabulation, Graphical and Diagrammatic representation, Measures of Central Tendency – Mean, Median and Mode - Standard Deviation - Standard Error.

UNIT- V

Statistical tests of Significance, Type of Significance tests, Parametric tests (Students “t” test, ANOVA- one and two way, Correlation coefficient, Regression), Non-parametric tests (analysis of Variance, Correlation, and Chi square test).

UNIT- VI: Current Contour (Not for Semester Examination)

Analytical basis of research ethic Library research, Field research, Laboratory Research, Authors, Acknowledgements, Abbreviations and nomenclature used in scientific writing. Power point presentation - Applications of Biostatistics.

Text Books

1. Chaturvedi., B.K,(2002). Basic computer knowledge , Diamond Pocket Books Pvt.,LTD., New Delhi.
2. Rastogi, V.B. (2006). Fundamentals of Biostatistics.Ane Book India, New Delhi.
3. Gupta, S.B. (1990), Statistical Methods, S.Chand and Company Ltd., New Delhi.
4. Dutta, N. K. (2004). Fundamentals of Biostatistics, Kanishka Publishers.

Reference Books

1. Bhattacharya, D.K.(2013). Research Methodology, Excel Books, New Delhi.
2. Banerjee, P.B. (2014). Introduction to Biostatistics. S.Chand & Company Pvt. Ltd., New Delhi, India.
3. Principles of Biostatistics. Rohatgi, V.K.& Saleh, A.K.Md. (2001). an Introduction to Probability and Statistics, John Wiley & Sons.
4. Kothari,C.R.,(2004). Research Methodology-Methods, New Age International (P) Ltd, New Delhi.

CO-PO Mapping with Programme Outcomes: **Research Methodology and Biostatistics**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*1*	*1*	*3*	*2*	*2*	*1*	*2*	*1*	*1*	-	-	-
2	-	*2*	-	*2*	-	*1*	-	*2*	*1*	*1*	-	-
3	*3*	*3*	-	-	*3*	-	*2*	*1*	*1*	-	-	-
4	*1*	*3*	-	*2*	*3*	-	*1*	-	-	-	-	-
5	*2*	*2*	*1*	*2*	*1*	-	*2*	*1*	*3*	-	-	-

1-Low, 2-Moderate, 3-High Correlation

SEM IV	MBE 3:2	ENVIRONMENTAL MICROBIOLOGY	22KP4BELB3:2	Ins. Hrs. 6	Credit: 4

Course objectives: *The aspect of Environmental Microbiology highlights the relationship between microorganism and different environments and evaluate role of microbes in biogeochemical cycles. It leads to understand the microbial assessment of water quality, distribution and sources of water borne diseases and comprehend biodegradation and bioremediation process.*

CO	STATEMENT
1	Describe and comprehend the fundamental concepts of environmental microbiology and microbial life in extreme environments.
2	Understand the scope and importance of Soil microbiology and role of microbes in Biogeochemical cycles.
3	Evaluate the distribution, sources of air microflora and air borne diseases.
4	Understand microbial assessment of water quality and Distribution and sources of water borne diseases.
5	Learn about biodegradation and bioremediation process.

UNIT I: Environmental Microbiology - Scope and Importance - Concepts of Microbial Ecology - Relationship between microorganism and different environments such as land, water and air. Microorganisms inhabiting extreme environments.

UNIT II: Microbiology of Soil - Scope and Importance; Microbes and Biogeochemical cycles; Role of microbes in biogeochemical cycles - Carbon cycle, Sulphur cycle, Nitrogen cycle and Phosphorus cycle.

UNIT III: Microbiology of air – Scope and Importance - Distribution and sources. Droplet nuclei, aerosol, assessment of air quality. Brief account of air borne diseases - transmission of harmful microbes.

UNIT IV: Microbiology of water- Scope and Importance - Distribution and sources.- Potability of water – Microbial assessment of water quality - Eutrophication. Brief account of water borne diseases.

UNIT V: Biodegradation: Aerobic Vs. anaerobic Degradation; Microbial basis of Biodegradation; Biodegradation of Xenobiotics; Microbial degradation of pesticides. Types of wastes – characterization of solid and liquid wastes. Solid waste treatment – Saccharification – Gasification – Composting.

UNIT VI: **Current contour (Not for semester Examination)**
Introduction of Bioremediation - advantages and applications, Types of bioremediation, Natural (attenuation), *Ex-situ* and *In-situ* Bioaugmentation and biostimulation, Solid phase and slurry phase bioremediation – Biofiltration, Biotrickling, Filtration, Bioscrubbers, Use of microbes for Heavy metal detoxification.

Text Books

1. Subba Rao NS. 2002. Soil microorganisms and plant growth. 4th edition. Oxford and IBH publishing co Pvt. Ltd, New Delhi.
2. Chatterji 2005.AK. Introduction to Environmental Biotechnology. Prentice-Hall of India Private Limited, New Delhi.
3. Jogdand SN. 2010. Environmental Biotechnology, Himalaya Publishing House. New Delhi.
4. Alexander, A M (1974). Microbiology Ecology, John Willy & Sons.

Reference Books

1. Atlas R. M. and Bartha. R, (1992). Microbial Ecology. Fundamental and application. 3rdEd. Bengamin and Cummings.
2. Duncan Mara and Nigel Horen. 2003 The Handbook of water and waste water Microbiology. Academic press-An imprint of Elsevier.
3. Baker WC and Herson DS. . 1994. Bioremediation – McGraw Hill Inc., New York
4. Burns RC and Slater JH,1982 Experimental Microbial Ecology – Blackwell Scientific Publications, Oxford, London.
5. Christon J Hurst. 2002. Manual of Environmental Microbiology, 2nd edition. American Society for Microbiology, Washington.

CO-PO Mapping with Programme Outcomes: **Environmental Microbiology**

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12
1	*1*	*1*	-	*1*	-	-	-	-	-	*1*	-	-
2	-	*3*	-	*2*	*1*	*1*	-	*1*	-	*2*	-	-
3	-	-	*2*	-	-	-	-	*2*	-	-	-	-
4	-	-	*1*	*2*	*1*	-	-	-	-	*2*	-	*2*
5	-	-	-	*2*	*2*	*1*	-	*1*	*2*	*2*	-	*2*

1-Low, 2-Moderate, 3- High correlation

SEM IV	**PW**	**PROJECT WORK**	**22KP4B15PW**	**Ins. Hrs. 6**	**Credit: 5**