

MSU / 2021-22 / PG – Colleges / M.Sc.(Botany) / Semester-II / Ppr.no.7 / Core -7

**MANONMANIAM SUNDARANAR UNIVERSITY,
TIRUNELVELI**

PG - COURSES – AFFILIATED COLLEGES

Course Structure for M.Sc. Botany (Choice Based Credit System)(with effect from the academic year
2021- 2022 onwards)

Vision

Provision of explore the plant world and to conserve the biodiversity by sustainable utilization

Mission

- To provide the best learning experience in understanding the theoretical and experimental skill in Plant Science
- To produce academically proficient, professionally competent and socially responsible graduates in Botany.
- To develop research skills among stakeholders.
- To impart quality education in the field of Botany enabling confidently to face the competitive examinations.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	The program focuses on the all-round development of the students to face the competitive world.
PEO 2	To imbibe love and curiosity towards nature through the living plants.
PEO 3	To develop the ability of the students to transform the society through their education.
PEO 4	To acquire knowledge in the diverse life forms
PEO 5	Make students to enhance skills in handling scientific instruments, planning and executing biological research.
PEO 6	Application of moral and ethical principles to mitigate environmental issues and biodiversity conservation.

Program outcomes (PO's)

PO 1	Strong and competent knowledge in basic Plant Sciences
PO 2	Updated knowledge related to the subjects.
PO 3	To develop diversified basic professional skills through various laboratory technical training, communication and presentation skills
PO 4	ability to identify, formulate, and solve problems, related to the subject of Botany by applying reasoning and technical inputs
PO 5	Course provides wide interdisciplinary knowledge and stimulates the students to think beyond the course knowledge, apply this knowledge for solving the environmental problems, efficient use of resources by designing novel and innovative experiments.
PO 6	Impart leadership abilities to the students to lead and excel in their respective fields. The deep knowledge of the subject, analytical and scientific reasoning, effective communication and problem solving task develop special qualities in a person to attract and influence the audience,

Program Specific Outcomes (PSO's)

On completion of program students will be able to

PSO 1	Core Course of botany improve their knowledge and understanding of the subject
PSO 2	Development of understanding in the latest skills of Molecular Biology and statistical tools and their application in biological sciences
PSO 3	Understand the nature and basic concepts of cell biology, Biochemistry, Plant Physiology, Taxonomy, reproductive behavior of flowering plants and ecology.
PSO 4	Gain proficiency in laboratory techniques in the plant sciences, and be able to apply the scientific method to the processes of experimentation and hypothesis testing.
PSO 5	Student will know advance techniques in plant sciences like tissue culture, Phytoremediation, plant disease management, formulation of new herbal drugs, mushroom cultivation, biofertilizer production, fruit preservation and horticultural practices.

MSU / 2021-22 / PG - College as M.Sc. (Botany) / Semester II / Preparation / Core - 7	research investigations and result interpretations.
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COURSE STRUCTURE

Sem.	Sub No.	Subject Status	Subject Title	Contact Hrs./ Week	Credits
(1)	(2)	(3)	(4)	(5)	(6)
I	1	Core-1	Algology and Bryology	6	4
	2	Core-2	Mycology, Lichenology and Plant Pathology	6	4
	3	Core-3	Microbiology and Immunology	5	4
	4	Core-4	Phytochemistry	5	4
	5	Core-5 Practical - 1	Algology, Bryology, Mycology, Lichenology and Plant Pathology	4	2
	6	Core-6 Practical - 2	Microbiology, Immunology and Phytochemistry	4	2
	Subtotal				30
II	7	Core-7	Pteridophytes, Gymnosperms and Paleobotany	5	4
	8	Core-8	Genetics and Cell Biology	5	4
	9	Core-9	Plant Anatomy, Embryology and Morphogenesis	4	4
	10	Core-10	Entrepreneurship and Economic Botany	4	4
	11	Core - 11	Field Work	4	3
	12	Core-12 Practical - 3	Pteridophytes, Gymnosperms, Paleobotany, Plant Anatomy, Embryology and Morphogenesis	4	2
	13	Core-13 Practical - 4	Genetics, Cell Biology, Entrepreneurship and Economic Botany	4	2
Subtotal				30	23

Sem.	MSU / Subject No.	2021-22 / PG - Status	Colleges / M.Sc. (Botany) / Semester-II / Ppr.no	7 / Core	Credits
(1)	(2)	(3)	(4)	Hrs./ Week (5)	(6)
III	14	Core-14	Taxonomy of Angiosperms	6	4
	15	Core-15	Biochemistry and Biophysics	6	4
	16	Core-16	Computer Application and Bioinformatics	5	4
	17	Core-17	Research Methodology and Bioinstrumentation	5	4
	18	Core-18	Taxonomy of Angiosperms, Research Practical - 5	4	2
	19	Core-19	Biochemistry, Biophysics, Computer Application Practical - 6	4	2
	Subtotal				30
IV	20	Core-20	Plant Physiology	4	4
	21	Core-21	Plant Ecology and Conservation Biology	4	4
	22	Core-22	Applied Biotechnology	4	4
	23	Core-23	Plant Physiology and Applied Biotechnology Practical - 7	4	2
	24	Core-24	Plant Ecology and Conservation Biology + Practical - 8	4	2
	25	Elective - 1	Elective (A) – Medicinal Botany and Dietetics (or) Elective (B) - Agricultural Botany and Plant Breeding	4	3
	26	Core-25	Project	6+	8
	Subtotal				30
Total				120	90

+ Extra hours for the Project

For the Project, flexible credits are b/w 5 – 8 & Hours per week are b/w 10 - 16. Total number of credits \geq 90

: 90

Total number of Core Courses
)

: 25 (15 T + 8 P + 1 Prj. + 1 FW.

Total marks for 2021-22 / PG Course Colleges / M.Sc.(Botany) / Semester-II / Ppr.no.7 / Core -7

Total hours : 120

Total Credits

First Semester : 20 credits
Second Semester : 23 credits
Third Semester : 20 credits
Fourth Semester : 27 credits
Total number of Credits : 90
Total number of papers/courses : 26

Internal Assessment:

Internal Assessment is for 25 marks.

Internal Assessment shall be done in the following manner:

- | | | | |
|------|---|----|----------|
| i) | The average of the best two scores of the students from three tests of an hour duration shall be averaged | -- | 15 marks |
| ii) | Assignment | -- | 5 marks |
| iii) | Seminar | -- | 5 marks |
| iv) | Passing Minimum: | | 25 marks |

== There is a pass minimum of 50 for external and overall components:

- Theory – external: internal assessment = 75 : 25
- Practical - external: internal assessment = 50 : 50

Study Tour/ Laboratory Visit/ Project and Viva – Voce

For M.Sc Botany students study tour in the form of Field visit/Visit to laboratories/Libraries, algal collection trips and projects are compulsory.

Project report evaluation and Viva-Voce will be conducted by the external examiner and the guide. The break up for the project work is:

<u>Components</u>		<u>Marks</u>
Project (INTERNAL)	=	50
Viva – Voce (EXTERNAL)	=	50

Total	=	100

Note:

Scheme of valuation of thesis included, novelty of the title, purpose and importance of

Question Pattern

Section – A (10 x 1 = 10 Marks)
Answer **ALL** the Questions (Multiple choice questions)

Section – B (5 x 5 = 25 Marks)
Answer **ALL** the questions choosing either (a) or (b)

Section – C (5 x 8 = 40 Marks)
Answer **ALL** questions choosing either (a) or (b)

Total -----
= 75

Practical

Practical examinations will be conducted at the end of each semester. The scheme of valuation is to be decided by the respective board of questions setters.

Eligibility for admission:

Candidates with the B.Sc degree in Botany/Plant Biology and Biotechnology with 50 % marks are above obtained from Manonmanium Sundaranar University or equivalent to B.Sc as recognized by Manonmanium Sundaranar University in Botany/Plant Biology and Biotechnology with 50 % marks or above are eligible to be admitted into this course. However, the relaxation to 50% for SC, ST and MBC candidates is allowed as per the state government norms

Algology and Bryology

Prerequisite:

Basic knowledge in Algology and Bryology gained from Undergraduate programme

Objectives:

- To learn about classification of algae and bryophytes
- To learn about interrelationships of algae and bryophytes with other thallophytes
- To understand the role and importance of lower group plants

UNIT- I

(12 Hours)

General characters and interrelationships of Algae with other thallophytes. Classification of algae (Fritsch, 1935). A comparative study of the major groups – with special reference to their occurrence, thallus structure, reproduction and life-history of: Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Euglenophyceae, Phaeophyceae and Rhodophyceae.

UNIT- II

(12 Hours)

Comparative account of pigments, cell wall components, reserve food, flagella, chromatophores, pyrenoids, eyespot and nucleus. Range of thalli diversity- Life-cycle patterns and alternation of generations.

UNIT- III

(12 Hours)

Physiology and ecology of algae. Economic importance of algae - Role of algae in soil fertility - Laboratory and commercial cultivation of algae - Algal blooms, toxic algae and Fossil algae.

UNIT- IV

(12 Hours)

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General characters of Bryophytes and their classification (Rothmaler (1951) Smith, G.M). General characters of major orders – Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.

UNIT- V

(12 Hours)

Life cycle pattern and alternation of generations in Bryophytes. Origin of Bryophytes – Reproduction in Bryophytes. Fossil bryophytes with special reference to *Naiadita*. Ecological adaptations and economic importance of Bryophytes.

Practical

Algae

Caulerpa, Ulva, Padina, Dictyota, Turbinaria, Gracillaria, Oscillatoria, Scytonema, and Anabaena.

Bryophytes

Riccia, Plagiochasma, Anthoceros, Funaria

Record

To maintain a record note book for evaluation.

Field Trip

Algal collection trip and submission of 5 Herbarium Sheets.

Reference Books

- 1.The Algae-Chapman., V.J. & Chapman, D.J. Elbs and Macmillian, London, 1960.
- 2.Structure and Reproduction of the Algae. Vol. I & II., Fritsh, F.E. Camb. Univ. Press,1965.
- 3.The Biology of the Algae., Round, F.W. Edward Arnold Publishers, London, 1973.
- 4.Text Book of Algae., Sharma, O.P. Tata McGraw Hill Publishing Co., New Delhi, 1986.
- 5.Introductory Phycology., Kumar, H.D. Affiliated East Press, New Delhi.
- 6.The Algae – A review – Prescott, G.W. Bishen Singh & Mahendra Pal Singh, Dehra Dun and Otto Koelta Science Publishers, West Germany, 1969.
- 7.Text book of Algae – Sharma, O.P. Tata McGraw Hill Publishing Co., New Delhi, 1986.
- 8.Text Book of Botany, Algae (Revised edition), Pandey B.P., S. Chand & Co., New Delhi,2000.
- 9.Text Book of Algae, Sharma, O.P., Tata McGraw Hill Publ. Co.Ltd., New Delhi, 1992.
10. Introduction to Phycology, South, G.R. & Whittick, A. Blackwell Scientific Publ.,

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11. Botany for Degree students, Algae 9th revised edition, Vashista Sinha B.R., Singh, V.P.,2002, S. Chand & Co. Ltd., New Delhi.
12. . British Mosses and Liverworts – Watson, E.V. Cambridge, 1980.
13. Biology of Bryophytes-Chopra, R.N. and Kumar, P.K.Wiley Eastern Ltd., New Delhi,1988.
14. Bryophytes – Prem Puri. Atma Ram & Sons, Delhi, 1981.
15. An introduction to Embryophyta Vol. II, Parihar, N.S., Central Book depot, Allahabad,1967.
16. Series on Diversity of Microbes and Cryptogams : Algae, O.P Sharma, Tata McGraw- Hilleducation Private Limited, New Delhi, 2011.

Links:

1. https://www.youtube.com/watch?v=Z_4UNFjqILo
2. https://www.youtube.com/watch?v=x-K_2bHOZOk
3. <https://www.youtube.com/watch?v=1A8y1WTifYQ>
4. <https://www.youtube.com/watch?v=sEEVVCQKx68>
5. <https://www.youtube.com/watch?v=eN5ROvpx8Q>
6. <https://www.youtube.com/watch?v=FmBZGx8fkp0>
7. <https://www.youtube.com/watch?v=5Srv1c-HGXQ>

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	The course will enable students to know the earlier plant kingdom, their vegetative and reproductive structures and their importance.	K1, K2
CO2	Appreciate the diversity and evolutionary significance of lower plant groups	K3
CO3	Understand the economic and ecological importance of lower plant groups	K1 K5
CO4	Student can critically differentiate the characters of Algae and Bryophytes. Identify bryophyte and algae in the field	K4, K3
CO5	Know the importance of algae in modern research and its	K5

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K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	L	L
CO2	S	S	S	S	L	L
CO3	S	M	S	M	M	L
CO4	S	S	S	S	L	L
CO5	S	S	S	M	L	M

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Mycology, Lichenology and Plant Pathology

Prerequisite:

Basic knowledge in Mycology lichenology and Plant pathology gained from Undergraduate programme

Objectives:

- To get knowledge about fungi, lichen and pathology in detail
- To learn about role of fungi and lichen in human life
- To gain knowledge about plant diseases

UNIT - I

Classification of fungi proposed by Alexopoulos and Mims (1979). Ultrastructure of fungal cell, Cell wall composition. General characters of fungi of the following: Mastigomycotina - Zygomycotina - Ascomycotina - Basidiomycotina and Deuteromycotina.

UNIT – II

Mode of nutrition - Reproduction and life cycle patterns. Homothallism and Heterothallism in fungi. Homokaryon and Heterokaryon. Parasexuality and heterokaryosis. Economic importance of fungi. Mycorrhizae - Structure and Symbiotic association. Types - Ectotrophic - endotrophic - application of mycorrhizae in agriculture.

UNIT – III

General account of Lichens. Classification of lichens by Miller (1984). Structure, nutrition and reproduction of the three major groups. Economic importance. Lichens as pollution indicators. Microchemical tests for lichens.

UNIT – IV

Plant diseases – definition, classification, causes and symptoms, infection process –

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host parasite interaction, defence of plants, M.Sc. (Botany), Scasster-II/Period-7/Quiz-7,
Chemical, Cultural and Biological. Role of enzymes, toxins, growth regulators and
phytoalexins in plant disease management.

UNIT- V

General effects, symptoms, casual organisms, disease cycle and control measures of
the following diseases : white rust of crucifers, blast of rice, late blight of potato, black rust
of wheat, leaf spot disease of groundnut, red rot of sugarcane, citrus canker, mosaic and little
leaf of brinjal,.

Practical Fungi

Mucor / Pilobolus, Agaricus, Xylaria, Polyporus, Puccinia.

Lichens

Micropreparations of vegetative and reproductive parts of any foliose / fruticose lichens.

Mycorrhizae

Permanent microslides / photographs.

Plant pathology

Etiology of any four plant diseases from the list given in the theory syllabus

Any photographs / slides / phytochemicals relevant to pathology (host - pathogen
interactions).

To maintain a record note book for evaluation.

Reference Books

1. Introduction to Fungi. Webster, J. Cambridge University Press London, 1970.
2. Fungi., Srivastava, S., Pradeep Publications, Jalandhar, 1999.
3. The Biology of Lichens., Hale, M.E., Edward Arnold, Mayland. 1983.
4. Botany for Degree Students – Fungi, Vashista, B.R., S.C hand & Co., New Delhi, 1982.
5. College Botany Vol. I Fungi & Pathology, Pandey B.P., 1997.
6. A Text book of Plant Pathology, Bilgrami, K.S. & Dube, H.C., Vikas, New Delhi.
7. Plant diseases. Singh, R.S., Oxford & IBH, New Delhi.
8. A textbook of Fungi, Bacteria and Virus. 1978. Dube, H., Vikas Publ.,
9. Mills Dallice *et al.*, 1996. Molecular Aspects of Pathogenicity and Resistance: Requirement for Signal Transduction. APS, St Paul, Minnesota.
10. Parker, J. 2008. Molecular Aspects of plant Diseases Resistance. Blackwell Publ.

11. MSU, 2021-22, PGSSC (College of M. Sc (Botany) / Semester - II / Paper - 7 / Core - 7 Press, Florida.
12. Botany for Degree Students – Fungi, Vashista, B.R., A.K. Sinha, S.Chand & Co., NewDelhi, Revised Edition 2014.
13. Mycology and Phytopathology, Sharma, P.D. 2017. Rastogi Publications.
14. Recent advances in Lichenology, Upreti, D.K., Divakar, P.K., Shukla, V., Bajpai, R. 2015. Springer India.

Links

1. https://www.youtube.com/watch?v=VVuYGkk_I8s
2. <https://www.youtube.com/watch?v=ma9fooNnvGY>
3. https://www.youtube.com/watch?v=XQ_ZY57MY64
4. <https://www.youtube.com/watch?v=YhMG3ttCg3o>
5. <https://www.youtube.com/watch?v=xvvHUHpfQbw>

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	The course will enable students to recognize the morphology, reproduction and lifecycle pattern of Fungi and Lichen.	K1, K2
CO2	Comparative study of different fungi with special reference to evolutionary trends	K3
CO3	Identification of Fungi and Lichen included in the syllabus. Understand the economic and ecological importance of Fungi and lichen. Application of mycorrhizae.	K1 K5
CO4	Students will gain understanding of the plant diseases, causal organism, host and their relationship and control measure for plant diseases,	K4, K3
CO5	Study the mechanism of disease development by pathogens. Understand the interaction between plant and pathogen in relation to the overall environment.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

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CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L
CO2	S	S	M	M	S	L
CO3	S	S	S	M	M	L
CO4	S	S	M	S	S	L
CO5	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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Microbiology and Immunology

Prerequisite:

Basic knowledge in Microbiology and Immunology

Objectives:

- To learn about the role and importance of microbes in various fields
- To acquire ideas about microbiology
- To gain knowledge about immunology

UNIT-I

Bacteriology: Sterilization techniques- Physical and chemical methods- General characteristics - Classification (Bergey`s Manual of Systematic Bacteriology), Ultra structure of Gram positive & Gram negative bacterial cell, Bacterial staining methods-, Isolation, cultivation and preservation of bacterial culture. Bacterial growth- continuous & synchronous culture. Kinetics of growth. Determination of bacterial growth – Direct method: Haemocytometer - Viable plate count - Indirect method: Turbidity.

UNIT - II

Mycoplasma and Virology: Mycoplasma - structure and classification. Viruses - General characters, Classification, Structure, Multiplication of Caulimovirus. Plant viruses and their

UNIT III

Food and Industrial Microbiology: The role of microorganisms in foods - Spoilage of fruits, vegetables, meats, poultry, eggs, bakery products, dairy products and canned foods - Food preservation - Introduction to industrial microbiology-- Microbiology of fermented milk products (Cheese), beverages, wine and vinegar industry. Production of 1) organic acid- Acetic acid; 2) Enzyme- Amylase.

UNIT - IV

Environment and Agricultural Microbiology: Microorganisms in soil environments: Rhizosphere and Nonrhizosphere soil microorganisms and their interactions. Microorganisms in various aquatic environments: Freshwater, Brackish-water, Marine - Microbes in the extreme environments and their adaptations. Indicator organisms. Microbial inoculants in agriculture: *Rhizobium*, *Pseudomonas*, BGA - Microbial Herbicides- Bt toxins.

UNIT- V

Immunology: Cells of the Immune System - Innate and Adaptive immunity - Antigens - Antigenicity and immunogenicity - B and T cell epitopes - Immunoglobulin: Structure, Function and Immunoglobulin classes. Antigen-Antibody reaction. ELISA & RT-PCR.

Reference books

1. Pelczar J.M., Chan E.C.S. and Kreig. R.N. 2008. Microbiology. 13th Reprint, Tata McGraw Hill Publishing Company Ltd, New Delhi.
2. G. Tortora, B. Funke and C. Case. 1995. Microbiology: An Introduction. 5th ed. MenloPark, CA: Benjamin/Cummings.
3. J. Ingraham and C. Ingraham. 1995. Introduction to Microbiology. Belmont, CA: Wadsworth.
4. Mathews, R.E.F., 1957. Plant Virology. Cambridge University Press. London.
5. Atlas, R.M. 2000. Microbiology - Principles of Microbiology. Mosby Year Book Inc, Missouri.
6. Black, J. 2007. Microbiology - Principles and Explorations. 7th Edition, Prentice Hall International, Inc, New York.
7. Brock, T.D. 2000. Biology of Microorganisms. 9th edition, Southern Illinois University, Carbondale.
8. Prescott, L.M., Harley, J.P. and Klein, D.A. 1996. Microbiology. 3rd Edition,

9. Salle, A.J. 1997. Fundamental Principles of Bacteriology. 7th Edition, Tata Mc Graw Hill Publishing Company Ltd, New Delhi.
10. Vijaya Ramesh, K. Food Microbiology, MJP, Chennai Immunology.
11. Kannan, T. Immunology, MJP, Chennai.
12. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones and Bartlett, Cannada.
13. Richard, A., Godsby., Thomas, J., Kundf. Barbare A and Osborne, 2000. Kuby -Immunology W.H. Freeman and Company.
14. Rao C.V. A Text Book of Immunology, 2011. Narosa Publication House, New Delhi.
15. David Male & Stokes Peebles & Victoria Male Immunology, 9th edition, 2020, Elsevier

Links

1. <https://www.youtube.com/watch?v=Didrc3wJ3E8>
2. <https://www.youtube.com/watch?v=rXuWletgE20>
3. https://www.youtube.com/watch?v=T8_y24Wiugc
4. https://www.youtube.com/watch?v=GzuM_nfrXLk
5. <https://www.youtube.com/watch?v=6A9JFaeU7Io>

Practicals

1. Preparation of culture media agar slant - agar plate.
2. Isolation of microbes by streak and pour plate method.
3. Isolation of soil microbes by serial dilution techniques.
4. Isolation and identification of Bacteria and Fungi from spoiled food.
5. Isolation of microbes from soil and water.
6. Gram staining of Bacteria.
7. Demonstration of bacterial mobility (Hanging drop method).

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
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CO1	MSU / 2021-22 / PG ab Colleges / M.Sc (Botany) at Semester-II / Ppr. No. 7/2	Core -7
	characteristics, ultra structure of Bacteria, Mycoplasma and Virus	
CO2	Students will study the growth and different bacteriological techniques involved in microbiology.	K3
CO3	Comprehend the intricate interaction between viruses and host cells	K1 K5
CO4	Get equipped with a theoretical understanding of food and industrial microbiology. Appreciate how microbiology is applied in manufacture of industrial products.	K4, K5
CO5	Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods. Competently explain various aspects of environmental and Agricultural microbiology	K3

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L
CO2	S	S	M	M	S	L
CO3	S	M	S	M	M	L
CO4	S	S	M	S	S	M
CO5	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Phytochemistry

Prerequisite:

Basic knowledge on plant cell chemistry from undergraduate programme.

Objectives:

- To learn about phytochemistry and their components
- To understand the detailed knowledge of secondary metabolites
- To acquire the importance and the extraction techniques of various metabolites

UNIT- I

Phytochemistry – Scope and Importance in pharmaceuticals industry. Preparation of plant extracts - maceration, infusion, digestion, decoction, percolation, sonication, hot continuous extraction, aqueous alcoholic extraction, superficial fluid extraction and counter-current extraction. Parameters for selecting appropriate extraction method.

UNIT - II

Secondary metabolites - definition, classification, distribution in plants and its therapeutic functions. preliminary phytochemical screening by chemical test. Methods for separation and isolation of constituents. Synergy and polyvalent action of phytomedicines.

UNIT- III

Flavonoids: Definition, properties, classification, natural sources and therapeutic applications of flavonoids: Flavones, Flavanones Flavonols, anthocyanins. Alkaloids- Quinine, Ephedrine, Serpentine, Atrophine and Morphine. Carotenoids- Lycopene and β -carotenes

UNIT - IV

Glycosides: Definition, properties, classification, natural sources, pharmacological and toxicological effects of glycosides. Terpenoids- β -Sitosterol, Menthol and Eugenol. Phenolics - Coumarins and Tannins.

UNIT - V

wood oil, Lemon grass oil, Tulsi oil, Vetiver oil, Clove oil and Eucalyptus oil. Factors affecting volatile components production in plants. Medicinal uses of resins.

Reference Books

1. Gurdeep Chatwal, 1983. *Organic Chemistry of Natural Products*, Himalaya Publishing House, Mumbai.
2. Jean Bruneton, 1999. *Pharmacognosy*, Second Edition, Lavoisier Publishers, Inc. USA.
3. Kokate, C.K., Purohit, A. P and Gokhale, S.R. 2004. *Pharmacognosy*, Nirali Prakashan Publications, Pune.
4. Nitin Suri, 2010. *Phytochemical Techniques*, Oxford Book Company.
5. Roseline, A. 2011. *Pharmacognosy*, MJP Publishers, Chennai.
6. Runit M Shah and Rupesh T Nayak, 2012. *Pharmacognosy*, Global Academic Publishers, New Delhi. (Part I and Part II).
7. Wallis, T.E. 1985. *Text Book of Pharmacognosy*, CSB Publishers, New Delhi.
8. William Charles Evans, 2002. *Pharmacognosy*, Fifteenth edition, Harcourt Brace & Company, Asia Pvt. Ltd.
9. Andrew Pengelly, 2006. *The constituents of Medicinal Plants*, 2nd edition, Viva-Book Private Limited, New Delhi
10. Jain Usman, Jadhav, Tanvir 2017 *A text book of Phytochemistry*, S.Vikas and Company (Pvt.) Jalandhar
11. Preethi Kathirvel, 2021. *Secondary Metabolites*, Darshan Publishers, Tamilnadu

e-journals

1. Flavor and Fragrance Journal 2008 23:213-226
2. World Journal of Pharmacy and Pharmaceutical Sciences, 2015, 4(1):287-305

Links

1. <https://www.youtube.com/watch?v=9VSE3IA8Nxxw>
2. https://www.youtube.com/watch?v=_7RHYZ5x9c
3. <https://www.youtube.com/watch?v=ufG3UUUhr0M>
4. <https://www.youtube.com/watch?v=QHs8MMMZNZ6c>
5. <https://www.youtube.com/watch?v=a2DmFPvspeg>

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1. Quantification of Antioxidants in the given samples:
 - A. Estimation of flavonoids, B. Estimation of Ascorbic acid, C. Estimation of β -Carotene
2. Preliminary Phytochemical Test:
 - A. Alkaloids, B. Tannins, C. Phenols, D. Glycosides and E. Saponins
3. Spotters- Photographs/images of oil extraction, structure of : Ephedrine, Quinine, coumarins, β -Sitosterol, eugenol

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	To know the different extraction techniques.	K1, K2
CO2	Gain knowledge of common secondary metabolites in plants Explain the process of isolation, purification and identification of crude drugs	K3
CO3	Students get updated knowledge about the Flavonoids, Alkaloids, Glycosides, Terpenoids	K1 K2
CO4	Get equipped with extraction and utilization of various volatile oils	K4, K5
CO5	Knowledge about recent trends and advances in the field of Phytochemistry	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L
CO2	S	S	S	M	S	L
CO3	S	M	S	S	M	L
CO4	S	S	S	S	M	M
CO5	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

L T P C

0 0 4 2

Algology, Bryology, Mycology, Lichenology and Plant Pathology (Total : 60 hrs)

Algology and Bryology - Practicals

Caulerpa, Ulva, Padina, Dictyota, Turbinaria, Gracillaria,

Oscillatoria, Scytonema, and Anabaena.

Bryophytes

Riccia, Plagiochasma, Anthoceros, Funaria

Record

To maintain a record note book for evaluation.

Field Trip

Algal collection trip and submission of 5 Herbarium Sheets.

Mycology, Lichenology and Plant

Pathology - Practicals

Mucor / Pilobolus, Agaricus, Xylaria, Polyporus, Puccinia.

Lichens

Micropreparations of vegetative and reproductive parts of any foliose / fruticose lichens.

Mycorrhizae

Permanent microslides / photographs.

Plant pathology

Etiology of any four plant diseases from the list given in the theory syllabus

Any photographs / slides / phytochemicals relevant to pathology (host

- pathogen interactions).

To maintain a record note book for evaluation

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Acquire strong and competent knowledge in morphological and anatomical structure of Algae, Bryophytes, Mycology and	K1, K2

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CO2	To equip the students with skills related to identify the reproductive organs of Algae, Bryophytes, Mycology and Lichenology	K1, K2
CO3	Students get updated knowledge on identifying plant diseases	K1
CO4	Get equipped with identifying algae, fungi on the field	K3, K4
CO5	To create foundation for further studies in Botany	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L
CO2	S	S	S	M	S	L
CO3	S	M	S	S	S	M
CO4	S	S	S	S	S	M
CO5	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

L T P C
0 0 4 2

Microbiology, Immunology and Phytochemistry (Total : 60 hrs)

Microbiology and Immunology - Practicals

1. Preparation of culture media agar slant - agar plate.
2. Isolation of microbes by streak and pour plate method.
3. Isolation of soil microbes by serial dilution techniques.
4. Isolation and identification of Bacteria and Fungi from spoiled food.
5. Isolation of microbes from soil and water.
6. Gram staining of Bacteria.
7. Demonstration of bacterial mobility (Hanging drop method). To maintain a

record note book for evaluation

Phytochemistry - Practicals

1. Quantification of Antioxidants in the given samples:
 - A. Estimation of flavonoids,
 - B. Estimation of Ascorbic acid
 - C. Estimation of β -Carotene
2. Preliminary Phytochemical Test:
 - D. Alkaloids, B. Tannins, C. Phenols, D. Glycosides and E. Saponins
2. Spotters

Photographs/images of oil extraction,
 Structure of : Ephedrine, Quinine, coumarins, β -Sitosterol, eugenol

To maintain a record note book for evaluation

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	To get strong and competent knowledge in preparation of media, sterilization process	K1, K2
CO2	To equip the students with skills related to methods of isolation of the bacteria and fungi	K1, K3

CO3 MSU	Students gain updated knowledge on Botany techniques	K6,7 / Core -7
CO4	Students gain skills on the estimation of secondary metabolites	K3, K4
CO5	Students develop the skill on identifying the secondary metabolites from the chemical structure	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L
CO2	S	S	S	S	S	L
CO3	S	S	S	S	S	M
CO4	S	S	S	S	S	M
CO5	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

L T P C
2 4 0 4

Pteridophytes, Gymnosperms and Paleobotany

Prerequisite:

Basic knowledge on pteridophytes and gymnosperms from Undergraduate programme

Objectives:

- To learn about classification of pteridophytes and gymnosperms
- To learn about interrelationships and economic importance of pteridophytes and gymnosperms
- To understand the concept of Paleobotany

UNIT – I

General features, origin and economic importance of Pteridophytes. Classification of Pteridophytes (Smith (1955) and K.R.Sporne).

Range of morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following : *Rhynia*, *Lepidodendron*, *Calamites*.

UNIT – II

Morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following : *Angiopteris*, *Selaginella*, *Isoetes*, *Equisetum*, *Ophioglossum*, *Pteris*, *Salvinia* and *Azolla*.

UNIT – III

Stelar evolution in Pteridophytes. Telome theory – concept, significance, merits and demerits. Life cycle patterns. Apomictic life cycle. Economic importance of Pteridophytes.

7UNIT – IV

General features, origin and economic importance of Gymnosperms. Classification of Gymnosperms (Sporne 1965). Resemblances and differences between Gymnosperms and Pteridophytes. General account of *Williamsonia*

Distribution morphology, anatomy, reproduction and phylogeny of the following :
Cycas, Araucaria, Ginkgo, Taxus, Ephedra and *Gnetum*

UNIT – V

Concepts of Paleobotany. A general account on Geological Time Scale. Fossil types –compressions, incrustation, casts, molds, Pterifications, coal balls, compactions and pseudofossils. Systematic and Nomenclature of fossil plants.

Practicals

Pteridophytes :

Selaginella, Isoetes, Pteris, Salvinia and *Azolla*.

Fossil slides :

Rhynia, Lepidodendron, Calamites.

Gymnosperms :

Cycas, Araucaria, Ginkgo, Taxus, Ephedra.

Fossil slides :

Lyginopteris, Heterangium, Cordaites and *Medullosa*.

To maintain a record note book for evaluation

Reference Books

1. Arnold, C.A. 1947. An introduction to Paleobotany M C Graw Hill Book co.
2. Chamberlain, C.J. 1957. Gymnosperms structure and Evolution. University Chicago Press, New York.
3. Nikias, K.J. 1981. Palaeobotany, Palaeoecology and Evolution. Praeger Publishers, U.S.A.
4. Parihar, N.S. 1985. The Biology and Morphology of Pteridophytes. Central Book

Depot, Allahabad.

5. Rashid, A. 1986. An Introduction to Pteridophyta. Vani Educational Books New Delhi.
6. Seward, A.C. 1919. Fossil Plants vol. I, II, III and IV. Cambridge University Press, London.
7. Smith, G.M. 1971. Cryptogamic Botany vol. II. Bryophytes and Pteridophytes. Tata Mc Graw Hill, New Delhi.
8. Sporne, K.R.1972. The Morphology of Pteridophytes B.I. Publications, Madras.
9. Sporne, K.R.1974. The Morphology of Gymnosperms. B.I. Publications, New Delhi.
10. Sundararajan,S. 2007. Introduction to Pteridophytes. New Age International Publishers; New Delhi.
11. Vashishta, P.C et al; 2006. Botany for Degree Students. Gymnosperms. S.Chand and Co; Ltd., New Delhi.
12. Singh NP and R C Srivastava 2013 The Gymnosperms of India: A checklist, by Botanical Survey of India.
13. Sharma, O.P. 2017. Pteridophyta. Macmillan India Ltd., India.
14. AVSS Sambamurty 2020 A text book of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. Dreamtech Press, distributed by Wiley

Links

1. <https://www.youtube.com/watch?v=zl6Xw9aGu-s>
2. <https://www.youtube.com/watch?v=avK7hGnaRAY>
3. <https://www.youtube.com/watch?v=30dxEVDtZ20>
4. <https://www.youtube.com/watch?v=sC9iqGb94hc> 5 .
<https://www.youtube.com/watch?v=2N2Ethc-Pw8>

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Learn about the general characters and classification by K.R. Sporne, stellar evolution in Pteridophytes, heterospory and origin of seed habit.	K1, K2
CO2	Understand the economic importance of the Peridophytes and	K1, K2

	Gymnosperms	
CO3	To gain knowledge about life cycles of Peridophytes and Gymnispermous plants	K1 K4
CO4	Student can critically differentiate the characters of Pteridophytes and Gymnosperms.	K4, K3
CO5	Studied the methods of fossilization and fossil plants. To understand about geological time scale.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	L	L
CO2	S	S	S	S	L	L
CO3	S	M	S	M	M	L
CO4	S	S	S	S	L	L
CO5	S	S	S	M	L	M

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Genetics and Cell Biology

Prerequisite:

Basic knowledge in Genetics and Cell biology gained from Undergraduate programme

Objectives:

- To learn about the totipotency of cells
- To understand the synthesis of DNA and RNA
- Role of genetics and cell biology in plant diversity

UNIT – I

DNA - structure and types (A, B, C & Z), Watson and Crick model of DNA, viral DNA, bacterial DNA, Mitochondrial and Chloroplast DNA. Repetitive DNA and interspersed repeated DNA. Dissociation and re-association kinetics of DNA, cot value, rot value and its significance. The central dogma. DNA synthesis and replication (prokaryote and eukaryote).

UNIT – II

Damage and DNA repair mechanism – photo reactivation – excision repair - mismatch repair. Genetic recombination, Lysogenic and lytic cycle - Bacterial Transformation - Transduction and Conjugation.

Sex determination in plants - theories of sex determination. Sex linked, Sex-influenced and sex limited characters. Gene mutation, physical and chemical mutagens and their mode of action.

UNIT – III

RNA-synthesis - types. RNA polymerases - role. Transcription - (Prokaryote, Eukaryotes), Initiation, elongation, termination, post transcriptional changes in RNA. Genetic code, Wobble hypothesis. Translation - ribosome assembly, formation of initiation complex, initiation factors, elongation and termination, translational inhibitors.

UNIT – IV

One gene one enzyme hypothesis. Fine structure of the gene, pseudogenes, non-coding genes, overlapping genes, split genes and pseudoalleles. IS Element-transposons and

controlling elements.

Operon concept, *trp* operon, *gal* operon. Positive and negative control - Catabolite Repression, Gene Regulation in Eukaryotes. Gene silencing.

UNIT – V

Cell structure, cell theory- prokaryotic and eukaryotic, cell cycle, Cell divisions: Mitosis, Meiosis, cell communication and cell adhesion.

Ultra structure of chromosomes, Chromosome proteins –protamines, histones.

Supernaturary and Megachromosomes, specialized types – polytene and lampbrush.

Practicals

Solving problems involving:

1. Simple Molecular biology problems based on the theory syllabus.
2. Interactions of genes.
3. Chromosome mapping from test cross data.
4. Sex determination, Sex linked inheritance.
5. Identification of different stages of meiosis from suitable plant material.
6. Interpretation of micrographs.
7. Study of mitotic index from suitable plant material

Spotters

Types of DNA, Cot curve, DNA melting curve, Karyotype and idiographic analysis.

Reference Books

1. Benjamin Lewin, 2004. Genes VIII. Pearson Prentice Hall.
2. Channarayappa, 2006. Molecular Biology. Principles and Practices. Universities Press(India), Pvt. Ltd., Hyderabad.
3. Gupta, R.K. 2006. Genetics. Rastogi Publications.
4. Nicholl, DST, 2001. An Introduction to Genetic Engineering. Cambridge University Press.
5. Old, R.N. and Primrose, S.B. 2004. Principle of Gene Manipulation. Blackwell ScientificPublication, USA.
6. Power, C.B. 2007. Genetics Vols I & II. Himalaya Publishing House. Kundanlal Chandak.Industrial Estate. Ghat Road. Nagpur.
7. Satyanarayana, U. 2006. Biotechnology. Books and Allied (p). Ltd. Kolkatha.
8. Russel, P.J. 2010. iGenetics. Benjamin Cummings, Sanfransisco Boston NewYork.
9. Turner, P., A. McLennan, A. Bates, M.White, 2005. Instant notes Molecular

Biology, Third Edition, Taylor & Francis.

10. Avinash Upadhyay and Kakoli Upadhyay, 2005. Fundamentals of Molecular Biology. First edition, Himalaya Publishing House.
11. Sandhya Mitra 1994. Genetics. Tata McGraw-Hill Publishing Company Limited.
12. Ajoy Paul 2012. Text book of Genetics. Books and Applied (P) Ltd.
13. Strickberger. 2015. Genetics, Third edition, Pearson Education India
14. Siddhartha Mukherjee, 2017. The Gene: An ultimate history, Penguin Random House India
15. Verma, P.S. and V K Agarwal 2016 Cell biology, S Chand Publishing
16. Mark Harper, 2018 Plant Cell biology, Larsen and Kellar Education.

Links

1. <https://www.youtube.com/watch?v=TNKWgcFPHqw>
2. https://www.youtube.com/watch?v=2_-jSoSaaTA
3. <https://www.youtube.com/watch?v=mCOMD291oBM>
4. <https://www.youtube.com/watch?v=fOI7lrNuOnk>
5. <https://www.youtube.com/watch?v=39HTpUG1MwQ>
6. <https://www.youtube.com/watch?v=DwAFZb8juMQ>
7. <https://www.youtube.com/watch?v=jjEcHra3484>

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Recall the DNA structure and types. Distinguish the structure of prokaryotic and eukaryotic cell	K1, K2
CO2	Understanding the mechanism of sex determination in plants	K2
CO3	At the end of the course, the student has a strong foundation on the functions of the cell.	K1 K3
CO4	Students gain knowledge in gene concepts and genetic code, gene expression, gene regulation, DNA replication and also learn about polypeptide synthesis.	K1, K4
CO5	Increases interest of students to unravel mysteries regarding DNA and RNA functioning and their correlation with the protein functions in cell.	K5. K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	M	S	L
CO2	S	S	M	M	S	L
CO3	S	S	M	S	M	L
CO4	S	M	S	S	M	L
CO5	S	M	M	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Plant Anatomy, Embryology and Morphogenesis

Prerequisite:

Basic knowledge in plant anatomy and embryology gained from Under graduate programme

Objectives:

- To learn about the plant anatomical aspects
- To know the specialization of vascular tissues
- To understand the role of embryology and morphogenesis in plants

UNIT – I

Meristem – classification of meristems – Apical meristem. Organization of Shoot Apical Meristem (SAM) and Root Apical Meristem (RAM). Vascular cambium – origin, structure, seasonal activity.

UNIT – II

Xylem, Phloem and their elements – primary and secondary structures. Phylogenetic trends and specialization of xylem and phloem. Secondary growth – Periderm – structure, development of lenticels. Anomalous secondary growth.

UNIT – III

Wood anatomy – physical, chemical and mechanical properties. Defects in wood – natural defects, knots and defects due to diseases. Reaction wood – Tension and compression wood – Durability of wood. Ontogeny of dicot and monocot leaves. Kranz anatomy. Development of stomata, trichome development and Dendrochronology.

UNIT – IV

Microsporogenesis – Pollen Morphology, Pollen wall, Pollen development, Pollen dimorphism, pollen storage, Pollen allergy. Megasporogenesis - Different types of embryosac development, Fertilization, Endosperm – types and Haustoria organogenesis of dicot and monocot embryo. Apomixis and Polyembryony.

UNIT – V

Plant morphogenesis – definition – polarity – as expressed in external and internal structures and in isolated cells. Symmetry – types. Differentiation as expressed in structure - effect of environment on differentiation – factors controlling morphogenesis.

Practicals

1. Anomalous activity of Cambium in *Boerhaavia*, *Achyranthus* and *Dracaena*.
2. Wood anatomy – any 4 common timbers (T.S, T.L.S and R.L.S)
3. Leaf anatomy – C₃ (rice) C₄ – (Cynodon).
4. Dissection of globular/cordate embryo from suitable seed.
5. Any photographs/pictures of Plant Morphogenesis.

Reference Books

1. Agarwal, S.B. 1990, Embryology of Angiosperms, a fundamental approach, SahityaBhawan, Agra.
2. Bard, J. 1990. Morphogenesis. Cambridge University Press, London.
3. Bhojwani, S.S and Bhatnagar, S.P. 1981. Embryology of Angiosperms. VikasPublishing House Pvt Ltd, New Delhi.
4. Bonner, J.T. 1965 Morphogenesis. Oxford & IBH Publications, Bombay.
5. Brown et al, 1981. Text Book of Wood Technology Mc Graw Hill.
6. Bryant, J.A and Francis, D, 1985. The cell Division cycle in Plants, Cambridge University Press London.
7. Cutter, E.G.1978. Plant Anatomy, Edward Arnold Publishers Ltd; London.
8. Dwivedi, J.N, 1998. Embryology of Angiosperms; Rastogi Publications, Meerut.
9. Fahn, A. 1989. Plant Anatomy. MaxWell Pvt.Ltd; Singapore.
10. Mageswari, P, 1965. An Introduction to Embryology of Angiosperms. Internationalsociety of plant Morphologies, University of Delhi.
11. Pijush Roy, 2006 Plant Anatomy; New Central Book Agency (P) Ltd Kolkata.
12. Singh, V; Pande, P.C and Jain, D.K 1987 Anatomy of seed plants. Rastogi Publications Meerut.
13. Singh, V , Pande, P.C, Jain, D.K.2015 Plant Anatomy, Embryology of Angiosperms,Morphology and Morphogenesis; Rastogi Publications Meerut.
14. Tayal, M.S.2016 Plant Anatomy; Rastogi Publications, Meerut.
15. Pandey S N and Chadha A 2009 Plant Anatomy and Embryology, Vikas PublishingHouse Pvt Ltd.
16. Richard Crang, Sheila Lynos-Sobaski, Robert Wise 2018. Plant Anatomy – a conceptbased approach to the structure of seed plants, Springer
17. Sharma H P 2009 Plant Embryology - classical and experimental, Alpha scienceInternational

Links

1. <https://www.youtube.com/watch?v=lLnjo4Pf2JM>
2. <https://www.youtube.com/watch?v=BrkfpPQAxJE>
3. <https://www.youtube.com/watch?v=XoPMY9rPhMo>
4. <https://www.youtube.com/watch?v=uSO6Jbg8Vd8>
5. <https://www.youtube.com/watch?v=T1alaxhe7c>

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Students familiar with different types of tissues and their organization. Understand the normal and anomalous secondary growth in plants and their causes.	K1, K2
CO2	At the end of the course, students know about the reproductive organs and fertilization process in angiosperms. Students gain knowledge about the pollen and pistil interaction.	K2
CO3	Students know about the developmental patterns of trichome, stomata and leaf.	K1 K3
CO4	To gain knowledge on morphogenesis in plants	K1, K2
CO5	To make connections between plant anatomy and the other major disciplines of biology. Ability to apply skills on wood identification.	K5. K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L
CO2	S	S	S	M	S	L
CO3	S	S	M	S	M	L
CO4	S	S	M	M	S	L
CO5	S	M	M	S	S	M

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Entrepreneurship and Economic Botany

Prerequisite:

Skill based knowledge gained from Undergraduate programme

Objectives:

- To learn about role of entrepreneurship in human life
- To understand the role and economic importance of plants
- To provide the skills of various practices involved in entrepreneurship botany

UNIT - I

Gardening: History, scope and importance of gardening - Types of Gardening: Water garden (Aqua Garden), Desert and Rock Garden (Xeric Garden), Kitchen Garden, Landscape Garden. Cultivation: Topiary, Bonsai, Nursery practices, Management and Marketing of gardenplants.

UNIT - II

Olericulture : Vegetable Production, Processing and Trade in India. Major Vegetables ofTamilnadu- Onion, Cucumber, Tomato and Brinjal.

Floriculture: Aromatic flowers. Indoor cultivation of Flowers. Green, Poly and Glass Houses. Outdoor cultivation of Flowering Plants - *Rosa* and *Chrysanthemum*. Industrial uses of Flowers - Dyes preparation from flowers. Marketing Avenues.

UNIT - III

Mushroom Cultivation: Brief History - Scope of Mushroom Cultivation of Paddy straw and Oyster mushroom - Medicinal and Nutritional value of mushrooms. Pathology of Mushrooms. Harvesting and Post harvesting technology - Marketing, Packing, Storage and recipes.

UNIT – IV

Organic Farming: Historical Account of Organic Farming - Impact of organic farming in the current scenario. Bio Composting - *Azolla* Cultivation. Vermicomposting - methods – Vermiwash, Vermi Marketing.

Entrepreneurship - funding agencies (NABARD), Rural Banking, FAO, TNAU - STEP (Science & Technology Entrepreneurship Programme) - Govt and NGO's, Yojana Schemes. Entrepreneurship Development Programme (EDP). Need and their significance.

UNIT – V

Economic Botany - Utilization of selected crop plants - Cereals- (Rice, Millets- Ragi); Spices and Condiments - (Cardamom, Pepper); Commercial crops - Fibre (Jute); Timbers (Teak, Red Sander); Resins and Gums (*Asafoetida*, Gum Arabic); Fixed oils (Gingelly, Sunflower); Volatile oils - (Rosemary); Beverages (Tea, Coffee); Natural dyes (Indigo, Henna) and Drug yielding plants (Nilavembu and Ginseng).

Reference Books

1. Don Ellison, 2002. Garden Plants of the world. New Holland Publishers. V.K.
2. Valerie Bradley, 2006. The complete guide to House Plants. Readers Digest, New York.
3. Geoff Hamilton, 1993. Gardens of World - Practical Gardening Course, BCA London.
4. Collin Levis 1997. Bonsai - A Care Manual. Chancellor Press London.
5. Anna Pavord, 1996. The New Kitchen Garden. Dorling Kindersley London.
6. Jane Fearnley 1995. Gardening Made Fast, Wedenfeld London.
7. Vijaya Ramesh, K. 2007. Food Microbiology, MJP Publisher, Chennai.
8. Sumathi R. Mudambi, Shalini Roa, M.V. Raja Gopal, 2006. Food Science New AgeInternational (P) Ltd., New Delhi.
9. N.K. Jain 2011. Fundamentals of Food Science Technology Processing and Preservation. Cyber Tech Publications.
10. Mukund Joshi, 2012. New Vistas of Organic Farming. Scientific Publishers Bangalore.
11. Singh, J.K. 2012. Mushroom Diseases and its control. Emkay Publishing House, New Delhi.
12. Suman 2005. Mushroom Cultivation Processing and Uses. IBH Publishers and Distributors, New Delhi.
13. Pathal, V.K.N. Yadav and Gaur, M. 2000. Mushroom Production and Processing Technology.
14. Sharma, V.P. 2006. Disease and Pests of Mushrooms, IBH Publishers and Distributors, New Delhi.
15. Geeta Sumbali, 2010. The Fungi, Narosa Publishing House, Chennai.
16. Rais AHMAD, 2009. WTO and Indian Agriculture - Opportunities and Challenges (1-3 Vols) Mittal Publications, New Delhi.
17. Joshi, S.R. 2006. Biopesticides - A Bio Technological Approach New Age International

(P) Ltd. N.D.

18. Subba Rao, N.S. 1988. Bio Fertilizer in Agriculture, Oxford & IBH, New Delhi.
19. ICAR, 1987. Hand Book of Agriculture, New Delhi.
20. Rana M K 2014 Olericulture in India. Kalyani Publishers.
21. Pandey, B.P. 1999. Economic Botany. S.Chand Publishing, New Delhi.
22. Beena Nair, Krishnan Pal Singh, Prem Chand 2014 Fundamentals of Vegetable Crop Production, Scientific Publishers, India
23. Rajan Kumar Biswas 2014 Organic Farming in India. ND publishers.
24. Desh Raj 2017 Floriculture at a glance. Kalyani Publishers
25. Singh, V., Pande, P.C., Jain D.K. Economic Botany 2018 Rastogi Publications, Shivaji Road Meerut
26. Ravinder Singh Rana and Isha slathia, 2020. Mushroom Cultivation and its Diseases, Sankalp Publication.

Note :

1. Students may be encouraged to visit TNAU / ICAR Research Stations.
2. Visiting websites.
3. Referring News Letter / Booklets of CSIR, TNAU, DBT.
4. Recommended Readings:- Velan Ulagam / Naveena Velanmai, Pasumai Vikadan, Tholil Nutpu, Thottakkalai, Herbal Bio Tech., and Hindu Survey of Agriculture.

Practical:(spotters)

1. Kitchen garden/water garden/Rockery
2. Green house/Polyhouse/Glass house
3. Organic farming- Azolla cultivation/Vermicompost/Vermiwash
4. Mushroom cultivation- Paddy straw/Oyster mushroom
5. Note on Funding agencies – EDP/NABARD
6. Spotters for Economic Botany - binomials of economically important plants, family, their parts and economic importance.

Links

1. https://www.youtube.com/watch?v=YaPW_c2ANVg
2. <https://www.youtube.com/watch?v=9u-UEqiUZtk>
3. <https://www.youtube.com/watch?v=UznYV181dig>
4. https://www.youtube.com/watch?v=X_hnfG2T5UY
5. <https://www.youtube.com/watch?v=UA-lqWd7fPE>

<https://www.youtube.com/watch?v=QTDVI99qLoo&t=649s>

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Graduates will understand the value of economically important plants	K1, K2
CO2	Familiarization with principles and practices of landscaping, ornamental gardening, vegetable Production and floriculture.	K1, K2
CO3	Develop understanding of organic farming system including Good Agricultural Practices	K3
CO4	Communicate effectively within the discipline and also be able to transmit knowledge and skills to lay-persons in the general public.	K4, K5
CO5	Acquisition of knowledge in various skills to help become entrepreneur	K5, K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	L
CO2	S	S	S	S	S	L
CO3	S	S	S	S	M	L
CO4	S	M	M	M	S	M
CO5	S	M	M	M	S	M

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Field Work

Prerequisite:

The students should be able to interpret the scientific ideas

Objectives:

- To provide training in scientific skills.
- To prepare students for professional training programmes

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Acquire skills related to design, analyse and execute an experiment	K1, K2
CO2	Acquisition of graduate attributes and descriptors with demonstrated abilities through field work training.	K3
CO3	Ability to express thoughts and ideas effectively, and present complex information in a clear and concise manner to different groups.	K3, K4
CO4	Analyze and synthesize data from a variety of sources and draw valid conclusions.	K4, K5
CO5	Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of problems and taking up challenges in unforeseen challenges.	K6

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	M	S	L
CO2	S	S	M	M	S	L
CO3	S	S	S	S	S	L
CO4	S	M	S	S	S	S
CO5	S	M	S	M	S	S

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Pteridophytes, Gymnosperms, Paleobotany, Plant Anatomy, Embryology and Morphogenesis

(Total : 60 hrs)

Pteridophytes, Gymnosperms and Paleobotany (Total : 30 hrs) Practicals

Pteridophytes :

Selaginella, Isoetes, Pteris, Salvinia and Azolla.

Fossil slides :

Rhynia, Lepidodendron, Calamites.

Gymnosperms :

Cycas, Araucaria, Ginkgo, Taxus, Ephedra.

Fossil slides :

Lyginopteris, Heterangium, Cordaites and Medullosa.

To maintain a record note book for evaluation

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Acquire strong and competent knowledge in morphological and anatomical structure of Pteridophytes and Gymnosperms	K1, K2
CO2	To equip the students with skills related to identify the reproductive organs of Pteridophytes and Gymnosperms	K1, K2
CO3	Student gets knowledge to describe the fossil specimens	K1
CO4	The students will gain ability to apply the acquired knowledge and skills in the field of plant diversity	K3, K4
CO5	To create foundation for further studies in Botany	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L

C02	S	S	S	M	M	L
C03	S	S	S	S	M	L
C04	S	S	S	S	M	L
C05	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Plant Anatomy, Embryology and Morphogenesis (Total : 30 hrs)

Practicals

1. Anomalous activity of Cambium in *Boerhaavia*, *Achyranthus* and *Dracaena*.
2. Wood anatomy – any 4 common timbers (T.S, T.L.S and R.L.S)
3. Leaf anatomy – C₃ (rice) C₄ – (Cynodon).
4. Dissection of globular/cordate embryo from suitable seed.
5. Any photographs/pictures of Plant Morphogenesis.

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Acquire strong and competent knowledge in identification of wood	K1, K2
CO2	To equip the students with skills related to identify the anomalous structure in stem	K1, K2
CO3	Student gets knowledge to compare the leaf anatomy of C ₃ and C ₄ plants.	K1
CO4	The students will gain ability to dissect the embryo from the seed	K3, K4
CO5	To facilitate students for taking up research projects in Plant Anatomy	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	M	S	L
CO2	S	S	S	M	M	L
CO3	S	S	S	S	M	L
CO4	S	S	S	S	M	L
CO5	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

Taxonomy of Angiosperms

Prerequisite:

Basic knowledge in Plant Morphology and Taxonomy gained from Undergraduate programme

Objectives:

- To learn about identification and classification of plants
- To learn about preparation of herbarium and Plant Systematics
- To understand the role of taxonomy and importance of plants in day to day life

Outcome:

- ✓ Graduates will easily identify common and economically important plants
- ✓ Acquisition of knowledge about conservation of plants
- ✓ Herbal remedy knowledge acquisition

UNIT- I

Principles - Classification - (a) Artificial - Linnaeus (b) Natural -Bentham and Hooker (c) Phylogenetic - Cronquist and APG System. Taxonomic hierarchy - Species concept.

Herbarium Preparation – methods and importance, Digital/Virtual herbaria, role of regional, national and international herbaria. BSI

UNIT- II

International Code of Botanical Nomenclature : History of different codes – Botanical congress – ICBN to ICN. Principles of ICN – Priority of publication, Typification, Effective and Valid Publication. Rejection of names, Author citation – Botanical naming (Polynomial, Trinomial, Binomial)

UNIT – III

Modern Plant Systematics: Cladistics and Biosystematics, Numerical taxonomy, Molecular systematic, Chemotaxonomy, Serotaxonomy

Taxonomic Literature – Monographs, Floras, Catalogues, Revisions, Checklist

UNIT – IV

A detailed study with special reference to the following families:

Polypetalae : Magnoliaceae, Menispermaceae,

Zygophyllaceae,

Combretaceae, Lythraceae and Mimosaceae

Gamopetalae : Asclepiadaceae, Asteraceae, Pedaliaceae, Boraginaceae,
Bignoniaceae, Scrophulariaceae, and Verbenaceae.

UNIT – V

A detailed study with special reference to the following families:

Monochlamydeae : Euphorbiaceae, Amaranthaceae,
Nyctaginaceae,

Polygonaceae, Piperaceae

Monocotyledons: Commelinaceae, Orchidaceae, Cyperaceae and Poaceae.

Reference books

- 1) Ahmedullah, M., and M.P. Nayar. 1987. Endemic Plants of the Indian Region. Vol. I. Botanical Survey of India. Howrah.
- 2) Cronquist, A. (1981). An Integrated System of Classification of Flowering Plants. Columbia University Press, New York.
- 3) Davis, P.H. and Heywood, V.H. 1973. *Principles of Angiosperms Taxonomy*. Robert E. Kreiger Pub. Co., New York.
- 4) Gamble, J.S., and C.E.C. Fischer. 1967. *Flora of the Presidency of Madras*. Vols. I - III. Botanical Survey of India. Calcutta.
- 5) Grant, W.F. 1984. Plant Biosystematics. Academic Press, London.
- 6) Greuter, W, (Ed.). 2000. International Code of Botanical Nomenclature. (St.Louis Code). Koeltz Vesentific Books. Germany.
- 7) Harrison, H.J.1971. New Concepts in Flowering Plant Taxonomy. Hieman Educational Books Ltd., London.
- 8) Henry, A.N., M.Chandrabose. 1980. *An Aid to International Code of Botanical Nomenclature*. Today & Tomorrow's Printers and Publishers. New Delhi.
- 9) Heywood, V.H. and Moore, D.M. 1984. *Current Concepts in Plant Taxonomy*. Academic Press, London.
- 10) Jain, S.K. and R.R. Rao. 1977. *A Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers and Publishers, New Delhi.
- 11) Jeffrey, C. 1982. *Introduction of Plant Taxonomy*, Cambridge University Press, Cambridge.

- 12) Lawrence, G.H.M. 1951. *Taxonomy of Vascular Plants*. The Macmillan Company. New York.
- 13) M.P. Nayar 1996. "*Hot Spots*" of endemic plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Thiruvananthapuram, India.
- 14) M.G. Simpson, 2010. *Plant Systematics*, Elsevier Academic Press, California, USA
- 15) S.N. Pandey and S.P. Misra 2008. *Taxonomy of Angiosperms*, Ana Books Pvt Ltd, New Delhi.
- 16) Gurcharan Singh 2018. *Plant Systematics*, Oxford & IBH Publishing Co., New Delhi.
- 17) B.P. Pandey, 2001. *Taxonomy of Angiosperms*, S.Chand (G/L) Company Ltd., New Delhi.
- 18) O.P. Sharma 2004. *Plant Taxonomy* Tata-McGraw-Hill Publishing Company.
- 19) Pandey Arun, Kasana Shruti 2020 *Plant Systematics*, Jaya Publishing House
- 20) Judd, Campbell, Kellogg, Donoghue 2015 *Plant systematics : A phylogenetic Approach*, 4th edition, OUP USA.

Links

1. <https://www.youtube.com/watch?v=TWQhP5IAgWU>
2. <https://www.youtube.com/watch?v=jak-Bfw8w4M>
3. <https://www.youtube.com/watch?v=woFRd76OWUo&t=189s>

Practicals

1. Identification of plants mentioned in the syllabus
2. Preparation of dichotomous key.
3. Identification of Binomial using flora (J.S.Gamble).
4. Dissection and technical description of plants from locally available plants.
5. Workout nomenclatural problems regarding priority and author citations.
6. A study tour of Taxonomic interest (any area) – Submission of an album with 10 photographs of and 10 herbarium plant specimens from the prescribed families and field note book.

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Acquire strong and competent knowledge in plant nomenclature and importance of classification in Angiosperms	K1, K2
CO2	To know the role of Numerical taxonomy, Molecular	K1, K2

	systematic, Chemotaxonomy, Serotaxonomy	
CO3	Understand various angiosperm families emphasizing their morphology, distinctive features and biology.	K1
CO4	The students should be in a position to understand and use Floras, Revisions and Monographs. Should be able to apply nomenclatural rules	K3, K4
CO5	To gain proficiency in the use of keys and identification manuals for identifying any unknown plants to species level.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	M	S	L
CO2	S	S	S	M	M	L
CO3	S	S	M	S	S	M
CO4	S	S	S	S	S	L
CO5	S	S	S	M	S	L

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2 4 0 4

Biochemistry and Biophysics

Prerequisite:

Basic knowledge on structure and role of biomolecules - gained from undergraduate programme.

Objectives:

- To gain advanced knowledge about plant biomolecules
- To understand different metabolic pathways occurring in a cell
- To provide an advanced integral knowledge and understanding of topics in Biochemistry and Biophysics

UNIT -I

Biomolecules: Carbohydrates - properties of mono, oligo and polysaccharides. Structure and properties of trioses, tetroses, pentoses, hexoses, maltose, sucrose, starch and pectinglycosidic linkage, isomerism and mutarotation. Glycoproteins, amino sugars.

UNIT- II

Amino acids – Structure, classification, properties, functions and ionic forms. Zwitterion, isoelectric pH, optical isomers of aminoacids.

Proteins - primary, secondary, tertiary, quaternary protein - super secondary structures, properties, functions - denaturation and folding of proteins. Biologically important peptides.

UNIT – III

Lipids - Classification, structure, properties and functions - Fatty acids - saturated and unsaturated fatty acids - Structure of fatty acids and glycerol - phospholipids, glycolipids, amphipathic lipids, steroids, lipoproteins. Biosynthesis and Oxidation of fatty acid - Gluconeogenesis.

UNIT - IV

Enzymes - Properties - Nomenclature and Classification. Coenzymes and isoenzymes, Enzyme kinetics - active sites - mechanism of enzyme action. Enzyme inhibition –reversible, irreversible and allosteric inhibition. Enzyme specificity and regulation..

UNIT – V

Properties of light - Different components of electromagnetic radiation. Emission - Excitation - Fluorescence and Phosphorescence - Bioluminescence. Laws of Thermodynamics, free energy, Redox potential, activation energy. High energy compounds

in biology and their significance.

Text books:

1. J.L. Jain, Fundamentals of Biochemistry. S. Chand and Company, New Delhi, 2005.
2. U. Satyanarayana, Biochemistry. Books and Allied (P) Ltd, Kolkatta, 2005.

Reference Books

1. R.L.P. Adams, Burdon, R.H., Campbell, A.M., Leader, D.P. and Smile, R.M.S. The Biochemistry of Nucleic acids. Chapman and Hall Ltd. New York, 1981.
2. O.P. Agarwal, Chemistry of organic natural products. Goel Publishing House, New Delhi, 1989.
3. J. Bonner and J. E. Varner, Plant Biochemistry. Academic Press, New York, 1976.
4. A.C. Deb, Fundamentals of Biochemistry. New Central Book Agency (P) Ltd., Kolkatta, 2011.
5. E.E. Conn and P.K. Stumpf, Outlines of Biochemistry. John Wiley and Sons, New York, 1987.
6. J. Jayaraman, Laboratory Manual in Biochemistry, Wiley Eastern Limited, New Delhi, 1995.
7. D.T. Plummer, An introduction to Practical Biochemistry. Tata Mc Graw Hill publishing Company, New Delhi, 1990.
8. J. M. Berg, J. L. Tymoczko and L. Stryer Biochemistry, W.H. Freeman Company, New York, 2012.
9. S. Palanichamy and M. Shanmugavelu, Principles of Biophysics. Palani Paramount Publications. 1996.
10. P. Narayanan, Essentials of Biophysics. New Age International Publishers, New Delhi, 2008.
11. David L. Nelson, Michael M. Cox. Lehninger Principles of Biochemistry. Seventh Edition, Macmillan UK, 2017.
12. Bhutani, S.P. 2019. Chemistry of Biomolecules. 2nd edition, CRC Press.
13. Bowsheer, C. and A. Tobin 2021. Plant Biochemistry. CRC Press.

Links

1. <https://www.youtube.com/watch?v=CcN8NnGGPhs>
2. <https://www.youtube.com/watch?v=D5RdWVbAN1c>
3. <https://www.youtube.com/watch?v=Ia4dkXg0C78>
4. <https://www.youtube.com/watch?v=c5j6ExHLFD8>

5. <https://www.youtube.com/watch?v=htHmxjEh4SQ>

Practicals

1. Determination of neutralization point of acid-base mixture by titration method using pH meter.
2. Estimation of sugars by anthrone method - Colorimeter /Spectrophotometer.
3. Estimation of aminoacids by ninhydrin method - Colorimeter / Spectrophotometer.
4. Estimation of proteins (Lowry's method).
5. Extraction and separation of known and unknown amino acids - Paper Chromatographymethod.
6. Determination of saponification value of any two vegetable oils.
7. Determination of Km value of Nitrate Reductase enzyme.

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Understand in detail about structure of carbohydrates, proteins, amino acids and types of carbohydrates, proteins, amino acids	K1, K2
CO2	Recognize the structural levels of organization of proteins, 3D structure of proteins, its functions, denaturation	K1, K2
CO3	Describing structure, functions and the mechanism of action of enzymes. Learning kinetics of enzyme catalysed reactions and enzyme inhibitions and regulatory process.	K1, K2
CO4	Gives a clear understanding about the classifications and biological significance of lipids. Get familiar with biosynthesis and oxidation of fatty acid.	K3, K4
CO5	Relating entropy to law of thermodynamics and free energy and its relation to chemical equilibria. Detail description of coupled reactions and their role in metabolism and chemiosmotic hypothesis of ATP synthesis.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	L
CO2	S	S	S	M	M	L
CO3	S	S	M	S	S	L
CO4	S	S	S	S	S	L
CO5	S	S	S	M	S	L

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3 2 0 4

Computer Application and Bioinformatics

Prerequisite:

Basic knowledge in Computer Operations and techniques

Objectives:

- To learn the basic applications of computer and internet
- To gain a working knowledge on computer and search strategies
- To understand the scope and application of bioinformatics

UNIT - I

Computer - Definition, Need for computers, Characteristics of computer- detail of input units, output units and storage devices. Classification of computers - Knowledge about windows and its scientific applications - MS Word, Power Point, Excel

UNIT – II

Internet – introduction and history, world wide web – URL – e-mail. Internet protocols – Internet service provider- Internet Browsers - Search Engines - e-books, e-journals applications of internet.

UNIT - III

Introduction to Bioinformatics - Definition, Need and Potential of Bioinformatics - Genomics and Proteomics – Human Genome Project and medically relevant genes – Pharmaco-informatics

UNIT - IV

Bioinformatics Databases: Nucleic acid sequence Databases - GenBank, EMBL, DDBJ, GSDB. Protein Sequence Databases - SwissProt, TrEMBL, PIR. Structure Databases – SCOP, PDB, CATH, CSD. Literature Databases - PubMed, Scopus.

UNIT – V

Techniques in Bioinformatics: FASTA - BLAST - Types. Pairwise and Multiple Sequence Alignment methods and significance. Molecular Visualization - JS Mol / RasMol. Prediction of Activity Spectra - PASS.

Text Books :

1. Alexis Leon and Mathews Leon, Computer Applications in Business, Vijay Nicole Imprints, Chennai, 2013.
2. S. Ignacimuthu, Basic Bioinformatics, Narosa Publishing House. New Delhi-3, 2012.
3. P. Narayanan, Bioinformatics - A Primer, New Age International Publishers, New Delhi, 2005.
4. K. Teresa, Attwood and David J. Parry-Smith, Introduction to Bioinformatics Dorling Kindersley Pvt. Ltd. India, 2006.

Reference Books:

1. Alexis Leon and Mathews Leon, 2013. Computer Applications in Business, Vijay Nicole Imprints, Chennai.
2. Bryan Bergeron, Bioinformatics Computing, Prentice Hall of India, New Delhi, 2006.
3. N. Gautham, "Bioinformatics - Databases and Algorithms" Narosa Publishing House, Chennai, 2006.
4. P. Mohan, Fundamentals of Computers, Himalaya Publishing House, New Delhi, 2009.
5. P. Narayanan, Bioinformatics - A Primer, New Age International Publishers, New Delhi, 2005.
6. Neeru Mundra Renu Vashisth, Introduction to Information Technology, Himalaya Publishing House, New Delhi, 2011.
7. S.C. Rastogi, Mandiratta Namita and Rastogi Parag, Bioinformatics - Concepts, Skill Applications, CBS Publications, 2003.
8. S. Ravishankar and P.V. Raphael Computer Awareness and Applications, Himalaya Publishing House, New Delhi, 2004.
9. Saxena Sanjay, MS office for everyone, Vikas Publishing House, New Delhi, 2002.
10. T.K. Attwood and D.J. Parry-Smith, Introduction to Bioinformatics Dorling Kindersley Pvt. Ltd. India, 2006.
11. Douglas E. Comer. The Internet Book, Chapman and Hall /CRC Press. 2018.

Links

1. <https://www.youtube.com/watch?v=Q4z7pPyNGos>
2. https://www.youtube.com/watch?v=RX_6nM11wGs
3. <https://www.youtube.com/watch?v=4TF7VC4-4nQ>
4. <https://www.youtube.com/watch?v=IrHDOEDtwD4>
5. <https://www.youtube.com/watch?v=jV2eABoog1w>

Practicals:

1. Working knowledge with computer in preparing word document, construction of line and bar graphs in Excel for the Botanical sample data provided
2. E-mail creation.
3. Searching data bases prescribed in the syllabus.
4. Sequence alignment technique – FASTA and BLAST
5. Molecular Modeling

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Acquire strong and competent knowledge in basics of computer	K1, K2
CO2	To understand the importance and applications of computational methods in Biology	K1, K3
CO3	Acquire knowledge and awareness on basic informatics tools and to extract or retrieve information from Biological databases	K1, K3
CO4	Describe features that can be annotated on a DNA sequence of interest. Appreciate different levels and organization of protein structures and their prediction	K3, K4, K5
CO5	Should be able to understand the concept of different forms of sequence alignment methods and selection of appropriate alignment method	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	L
CO2	S	S	M	S	M	L
CO3	S	S	M	S	S	S
CO4	S	S	S	S	S	S
CO5	S	S	S	M	S	S

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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Research Methodology and Bioinstrumentation

Prerequisite:

Basic knowledge in biological and related informations to be useful for research and development during undergraduate programme

Objectives:

- To understand the basic aspects in research
- To learn mathematical and statistical technique for research
- To acquire basic knowledge about various instruments and techniques in biological research

UNIT – I

Research Methodology: Choosing the problem for research - Review of Literature - Primary, Secondary and Tertiary sources - Bibliographs - Indexing and abstracting - Reference collections - Planning and preparation of thesis. Thesis format, Journal format- Editing & Proof correction, Abstract and keywords, Full paper, Short Communication, Monographs, Review Articles, Citation, Impact Factor, Plagiarism – peer reviewed publication, Oral and Poster presentation

UNIT- II

Biostatistics: Scope, Collection and classification of data, Tabulation, Graphical and diagrammatic representation, Histograms. Standard deviation and standard error, Chi-square test-T test, F test, ANOVA - Application software - SPSS.

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UNIT – III

Microscopy - Principles and application - Light - Dark field - Phase contrast - Fluorescence - Polarization - Scanning and Transmission Electron Microscopy, Photomicrography.

Cytochemical and histochemical methods- Microtomes: rotary, wood and cryo types. Microtome techniques: fixation, dehydration, clearing, embedding, sectioning staining, mounting,. Cytochemistry and detection of nucleic acids, carbohydrates, proteins and lipids in plant cells/tissue.

UNIT – IV

Study the principle and the applications of Centrifugation (High speed and Ultra),

Spectroscopy (UV-Vis Spectrophotometer, AAS) and Chromatography (TLC, Column, GLC and HPLC)

UNIT –V

Electrophoresis: Basic principles, theory and applications of starch gel, agarose, PAGE, AGE.

Introduction to IPR, Types – Patent, Copyright, Trademark, Design and Trade Secret, IPR in India.

Text Books

- N. Gurumani 2009 An introduction to Biostatistics, MJP Publishers, New Delhi.
- N. Gurumani 2011 Research methodology in biological sciences, MJP Publishers, New Delhi

Suggested References

1. Daniel WW, 1995. Biostatistics. 7th edition, John Wiley and Sons, New York, USA.
2. Green, M. R. and Sambrook, J. 2012. *Molecular Cloning: A Laboratory Manual*. 4th Edition, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
3. Khan, I.A. and Khanum, A. 1994. *Biostatistics*. Vikas Publishing House Pvt. Ltd. New Delhi.
4. Panse, V.G. and Sukhatme, P.V. 1967. *Statistical Methods for Agricultural Workers*. ICAR, New Delhi.
6. Plummer, D.T. 1988. *An Introduction to Practical Biochemistry*. Tata McGraw Hill Publishing Company. New Delhi.
7. Raghuvanshi. 1995. *Practical Exercises in Cytology, Genetics, Plant Breeding and Biostatistics*. CBS Publishers & Distributors, New Delhi.
8. Sandhu, G.S. 1990. *Research Techniques in Biological Sciences*. 1st Edition. Anmol Publications, New Delhi.
9. Steel, R.G.D. and Torrie, J.H. 1960. *Principles and Procedures of Statistics with special reference to Biological Sciences*. McGraw-Hill.
10. Wilson, K. and Walker, J. 2000. *Principles and Techniques of Practical Biochemistry*. Cambridge University Press, London.
11. Balagurusamy, E. 2009. *Fundamentals of Computers*. Tata McGraw-Hill Education Pvt. Ltd., New Delhi.
12. Gupta, A. 2009. *Instrumentation and bioanalytical techniques*, Pragati Prakashan, Meerut
13. Thomas, A.P. 2009. *Biology – Perspectives and methods*, Green leaf Publishers, TIES. Kottayam
14. Veerakumari, L. *Bioinstrumentation*. 2006, MJP Publishers, Chennai
15. Uwe Flick, 2011. *Introducing Research Methodology*. SAGE publications.

16. Kothari C R and G.Garg 2019 Research Methodology: Methods and Technologies. New Age International Publishers.

17. Vitha M.F. 2016. Chromatography : Principles and Instrumentation. Wiley publications

Links:

1. <https://www.youtube.com/watch?v=a0G7iyz4McM>
2. <https://www.youtube.com/watch?v=saJIWFUGebw>
3. <https://www.youtube.com/watch?v=t4hhdgJADE8>
4. <https://www.youtube.com/watch?v=avSdoMz6OuA>
5. <https://www.youtube.com/watch?v=ZN7euA1fS4Y>

Practicals

1. Demonstration of microscopes (Light and Dark field, phase-contrast, fluorescence, SEM, TEM). centrifugation (Ultra, high speed). TLC, UV-Vis Spectrophotometer
2. Demonstration Microtomy: preparation of thin sections and permanent slides.
3. Histochemical localisation of soluble components in plant cells - proteins, sugars, polysaccharides, lipids, nucleic acids, tannins, phenols, etc.
4. Demonstration of statistics software to analyse field data.
5. Study on Bioinstruments and Biological techniques
6. Manuscript preparation for research journal
7. Problems from Biostatistics – SD & SE , Chi-square test, T – test, F-test

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	To lay a strong foundation for the students to understand the basics of research and report preparation	K1, K2
CO2	Understand the sampling techniques and interpret the data based on the measures of the central tendency. Learn deviations of the variable based of measures of dispersion	K1, K3
CO3	to know the principles and application of Microscopy and plant micro technique	K1, K2
CO4	Exhibit a knowledge base in handling different chromatographic techniques and learn fundamental principles behind centrifugation and electrophoresis and apply them practically.	K4, K5

CO5	Capable to choose and apply suitable separation techniques to identify different biomolecules.	K5
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K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	L
CO2	S	S	S	S	M	L
CO3	S	S	M	M	S	L
CO4	S	S	S	S	S	M
CO5	S	S	S	M	S	M

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

MSU / 2021-22 / PG – Colleges / M.Sc.(Botany) / Semester-III / Ppr.no.18 / Practical 5

Taxonomy of Angiosperms and Research Methodology and Bioinstrumentation (Total: 60 hrs)

L T P C
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Taxonomy of Angiosperms (30 hrs.)Practicals

1. Identification of plants mentioned in the syllabus
2. Preparation of dichotomous key.
3. Identification of Binomial using flora (J.S. Gamble).
4. Dissection and technical description of plants from locally available plants.
5. Workout nomenclatural problems regarding priority and author citations.
6. A study tour of Taxonomic interest (any area) – Submission of an album with 10 photographs of and 10 herbarium plant specimens from the prescribed families and field note book.

Research Methodology and Bioinstrumentation (30 hrs.)Practicals

1. Demonstration of microscopes (Light and Dark field, phase-contrast, fluorescence,SEM, TEM). centrifugation (Ultra, high speed). TLC, UV-Vis Spectrophotometer
2. Demonstration Microtomy: preparation of thin sections and permanent slides.
3. Histochemical localisation of soluble components in plant cells - proteins, sugars, polysaccharides, lipids, nucleic acids, tannins, phenols, etc.
4. Demonstration of statistics software to analyse field data.
5. Study on Bioinstruments and Biological techniques
6. Manuscript preparation for research journal
7. Problems from Biostatistics – SD & SE , Chi-square test, T – test, F-test

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	The objective of this course is to familiarize students with the basic concepts and applications of performing taxonomic studies	K1, K2
CO2	To enable the students to develop skill in the preparation of taxonomic key.	K1, K3
CO3	To gain practical knowledge on the application of biostatistics in research	K1, K2
CO4	To identify the instruments, their parts and applications	K4, K5
CO5	The objective of this laboratory course is to provide the students practical skills in discipline centric electives.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	L
CO2	S	S	S	S	M	L
CO3	S	S	S	S	S	L
CO4	S	S	S	S	S	M
CO5	S	S	S	M	S	M

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

MSU / 2021-22 / PG – Colleges / M.Sc.(Botany) / Semester-III / Ppr.no.19 /

Practical 6 Biochemistry, Biophysics, Computer Application and Bioinformatics

(Total : 60 hrs)

L	T	P	C
0	0	4	2

Biochemistry and Biophysics (30 hrs.)

Practicals

1. Determination of neutralization point of acid-base mixture by titration method using pH meter.
2. Estimation of sugars by anthrone method - Colorimeter /Spectrophotometer.
3. Estimation of aminoacids by ninhydrin method - Colorimeter / Spectrophotometer.
4. Estimation of proteins (Lowry's method).
5. Extraction and separation of known and unknown amino acids - Paper Chromatographymethod.
6. Determination of saponification value of any two vegetable oils.
7. Determination of Km value of Nitrate Reductase enzyme.

Computer Application and Bioinformatics (30 hrs.)Practicals:

1. Working knowledge with computer in preparing word document, construction of line and bar graphs in Excel for the Botanical sample data provided
2. E-mail creation.
3. Searching data bases prescribed in the syllabus.
4. Sequence alignment technique – FASTA and BLAST
5. Molecular Modeling

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	To estimate various biochemical parameters in plants	K2, K3

CO2	To enable the students to develop skill in the preparation of graph and solve statistical problems in Excel.	K2, K3
CO3	To gain practical knowledge on the application of bioinformatics in research	K1, K2
CO4	the student gets practical knowledge in order to preparation of molar, normal and percentage solutions and their dilutions	K4, K5
CO5	The laboratory courses help the student to understand and learning principles of laboratory.	K4, K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	L
CO2	S	S	S	S	M	M
CO3	S	S	S	S	S	L
CO4	S	S	S	S	S	L
CO5	S	S	S	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

MSU / 2021-22 / PG – Colleges / M.Sc.(Botany) / Semester-IV / Ppr.no.20 / Core -20UNIT – IV

L T P C
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Plant Physiology

Prerequisite:

Basic knowledge of plant physiology gained in undergraduate programme

Objectives:

- To develop understanding in the mechanisms of functioning of plant cells
- To acquire basic knowledge in physiological processes
- To acquire knowledge on impact of environmental factors on physiological process

UNIT – I

Water and Plant relations – Water potential, solute potential, pressure potential, soil water relationship. Absorption and transport of solutes (Active and Passive). Translocation of organic solutes. Phloem loading and unloading. Importance of Macro and Micronutrients. Transpiration

– mechanism of stomatal movement - starch sugar interconversion theory and K^+ ion transport and stomatal regulation.

UNIT – II

Photosynthesis – Photosynthetic pigments – Light harvesting complexes PS I and PS

II. Photo oxidation of water. Mechanism of electron and proton flow through photosynthetic transport chain - 'Z' – scheme. Mechanism of ATP synthesis. C_3 , C_4 and CAM Pathways.

UNIT – III

Plant respiration – Glycolysis, citric acid cycle and mitochondrial electron transport oxidative phosphorylation. Beta oxidation – Glyoxylate cycle. Nitrogen metabolism – Biological nitrogen

– mechanisms of nitrate uptake and reduction – ammonia assimilation

Physiological role and mechanism of action of cytokinins, ethylene and abscisic acid. Growth retardants – Morphactins and Brassinosteroids. Photoperiodism and vernalizations – flower induction and development. Phytochrome - structure, properties and physiological role. Physiological role and biochemical change of senescence and Abscission.

UNIT – V

Stress physiology – classification of stress – biotic and abiotic stress factors. Stress effects – morphological, biochemical, physiological changes associated with stress due to salinity, water, radiation, heavy metals, drought. Heat shock proteins – stress resistance.

Reference Books

1. Bidwell, R.G.S. 1980, Plant Physiology. Academic Press, New York.
2. Datt, S.C. 1989, Plant Physiology. Central Book depot, Allahabad – 48.
3. Develin, R.M. 1990. Plant Physiology. Reinhold Publishers Corp, New York.

4. Jacob, W.P, 1979, Plant Hormones Plant Development.
5. Noggle, G.R and Fritz, G.J, 2002 – second edi. Introductory Plant Physiology PHIlearning Pvt Ltd., New Delhi.
6. Salisbury, F.B and Ross, C. 2000, Plant Physiology John Wiley & sons, New Delhi.
7. Sinha, R.K. 2007, Modern Plant Physiology. Narosa Publishing House Pvt,Ltd. NewDelhi.
8. Srivastava, H.S. 2013, Plant Physiology. Rastogi Publications, Meerut, India.
9. Verma,V. 2007, A Text Book of Plant Physiology. Ane Books, New Delhi.
10. Jain, V.K. 2017. Fundamentals of Plant Physiology. S Chand and Company Limited.
11. Park S Nobel 2020 Physicochemical and Environmental Plant Physiology, ElsevierScience
12. Kochhar, S.L. and S.K. Gujral 2020 Plant Physiology. Cambridge University Press.

Links

1. https://www.youtube.com/watch?v=c72_Xbj-Jpw
2. <https://www.youtube.com/watch?v=AQf3gKTCffs>
3. <https://www.youtube.com/watch?v=la92f3Lh55Y>
4. <https://www.youtube.com/watch?v=oG7WNO5vM3I>
5. <https://www.youtube.com/watch?v=dg9ZUT2cIL0>

Practicals

1. Determination of water potential by gravimetric method.
2. Estimation of Photosynthetic pigments with reference to age (young and mature)
3. To determine the Chl.a/ Chl.b ratio in C₃ and C₄ plants.
4. Estimation of proline in normal and stressed leaves.
5. Effect of pH on membrane permeability.
6. Effect of temperature on membrane permeability.
7. Effect of detergents on membrane permeability.

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Understand the physiology of plants with reference to water relations, mineral nutrition and transport of ions, solutes and other macromolecules. A fair knowledge on deficiency of minerals and their related diseases.	K1, K2
CO2	The students will be able to explain various physiological and	K1, K2

	metabolic processes unique to plants	
CO3	To enable the students to learn or to know the biological, physiological activities of various organs.	K2, K3
CO4	Understand the role of hormones in plant development and to understand how the plant system works and explains the mechanisms.	K4, K5
CO5	Analyze the role of external factors in plant development and stress induction	K3, K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	L
CO2	S	S	M	S	M	L
CO3	S	S	M	M	S	L
CO4	S	S	S	S	M	L
CO5	S	S	M	M	S	M

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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L T P C

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Plant Ecology and Conservation Biology

Prerequisite:

Basic knowledge in Environmental science gained from undergraduate programme

Objectives:

- To gain advanced knowledge about plants and their environment
- To acquire wide knowledge about environmental issues
- To understand and implement effective measures in biodiversity conservation programmes

UNIT- I

Aim and scope of Ecology - Methods of studying plant community, Ecosystem: Types - Terrestrial - Cropland and Aquatic ecosystems - fresh water, marine, estuarine and mangroves with special reference to trophic structures. Succession - causes, patterns -

xeroseres and hydroseres

UNIT - II

Environmental resources – natural – forest resources with special reference to TamilNadu and India. Land resources – water and wild life, Major biomes of the world.

Energy resources: utilization - Renewable and Non-renewable energy resources. Environmental Laws and Education.

UNIT - III

Environmental issues - pollution - Causes, consequences and control measures of Air, water, soil and thermal pollution.

Soil erosion, deforestation, conservation and disaster management - Floods, Earth quake, Cyclones, Tsunami and Landslides.

UNIT - IV

Biodiversity - definition, scope and constraints, Levels of biodiversity (genetic, species and ecosystem), measures, values use and loss of biodiversity, threats to biodiversity.

Phytogeography: Dispersal and migration barriers hypothesis, Continental drift hypothesis, Land - Bridges hypothesis, Age and Area hypothesis,

UNIT - V

Conservation Biology: current practices in conservation - Ecosystem approaches - Species based approaches–Social approaches - Chipko Movement, Narmada Bacho Andolan. *In situ* conservation (Protected area, Afforestation, Social Forestry, Agro Forestry, Biosphere Reserves, National Parks, Sanctuaries and Sacred Groves) and *ex situ* conservation (Botanical Gardens, Cryopreservation, Gene Banks, Seed Banks, Pollen Banks, DNA Banks). Role of organizations in Biodiversity management - IUCN, BSI, NBPGR and WWF.

Text Books

1. Agrawal, K.C. 1987. Environmental Biology. Agro-botanical Publications, India.
2. Ignacimuthu, S. 2013. Environmental studies. MJP Publishers, India.
3. Sharma, P.D. 2019. Ecology and Environment 13th edition, Rastogi Publications.

References

4. Ambasht, R. S. 1974. A Textbook of Plant Ecology. 3rd ed. Students' FriendsCo. Varanasi, India.
5. Billings, W. B. 1965. Plants and the Ecosystem. Wardsworth Publishing Co. Inc., Belmont.
6. Kershaw, K. A. 1973. Quantitative and Dynamic Plant Ecology. Edward

Arnold Publishers Ltd., London.

7. Kormandy, E. J. 1978. Concepts of Ecology. 2nd ed. Prentice Hall of India Pvt.Ltd., New Delhi.
8. Krishnan Kannan, 1997. Fundamentals of Environmental Pollution. S. Chandand Co. Ltd., New Delhi.
9. Levitt, J. 1980. Responses of Plants to Environmental Stresses. Acad. Press, New York.
10. Odum, E. P. 1971. Fundamentals of Ecology. W. B. Saunders & Co., Philadelphia, USA.
11. Odum, E. P. 1975. Ecology. 2nd ed. Oxford & IBH Publications, New Delhi.
12. Puri, G. S. 1960. Indian Forest Ecology. Vol. I & II. Oxford & IBH Publications, Delhi.
13. Vashista, P. C. 1974. A Textbook of Plant Ecology. Vishal Publications, Jullunder.
14. Cain, S. A. 1944. Foundation of Plant Geography. Harper & Brothers, New York.
15. Mani, M. S. 1974. Ecology and Biogeography of India. Dr. W. Junk Publishers, theHague.
16. Frankel, O. H., Brown, A. H. D. and Burdon, J. J. 1995. The Conservation of Plant Diversity. Cambridge University Press, London.
17. Heywood, V. H. 1995. Global Biodiversity Assessment. UNEP, Cambridge University Press, London.
18. Cardinale, B.J., Primack, R.B., Murdoch, J.D. 2019. Conservation Biology, Oxford University Press
19. Sharma P D 2017. Ecology and Environment, Rastogi Publications.
20. Tony Juniper 2019 The ecology book – big ideas simply explained. Dorling Kindersley Limited.
21. Begon, M and CR Townsend 2020 Ecology : from individuals to ecosystem, Wiley

Links

1. <https://www.youtube.com/watch?v=lqxNQpajdpQ>
2. https://www.youtube.com/watch?v=_5q8hzF9VVE
3. <https://www.youtube.com/watch?v=8ceDE01iWLE>
4. https://www.youtube.com/watch?v=b6Ua_zWDH6U
5. <https://www.youtube.com/watch?v=3juNzNiWt00>
6. <https://www.youtube.com/watch?v=Ic-J6hcSKa8>

Practicals

1. Vegetation Analysis (Quadrats and line transects) - Raunkaier's frequency diagram dominance and density in a given area and Shannon - Weaver's measures of species diversity index.

2. Water analysis - Dissolved oxygen - Carbonate and bicarbonate. Water hardness –Calcium and Magnesium, Chemical Oxygen Demand and Primary productivity (Winkler’s method).
5. Estimation of oxidized organic matter in the soil by Walkle Black method.
6. Study the Interpretations of the following
 1. Ecosystem types
 2. Different seric stages.
 3. Endemism
 4. Conservation of biodiversity
 5. Vegetation types of India.
 6. Environmental pollution impact study

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Understand the importance of ecosystem, biodiversity and energy flow	K1, K2
CO2	understand the population ecology and community ecology system in the world	K1, K3
CO3	get meticulous knowledge in ecological succession and phytogeography	K1, K2
CO4	To understand the correlation of different environmental/ ecological parameters with living systems and their protection & sustenance.	K4, K5
CO5	get knowledge in environmental pollution, global environmental problems, their mitigation and remedies and to acquire knowledge about the importance of biodiversity conservation	K3, K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	M	S	M	L
CO2	S	S	M	S	M	L
CO3	S	S	M	M	S	L
CO4	S	S	M	S	S	L
CO5	S	S	M	M	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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Applied Biotechnology

Prerequisite:

Basic knowledge on biotechnology and its applications gained during undergraduate programme.

Objectives:

- To train the students in advanced level of biotechnological principles and techniques.
- To understand the process, development of tissue culture through micropropagation and impact of transgenic plants.
- To develop the skill in pollution abatement through Biofuel production

UNIT –I

Biotechnology – scope, types, potentialities and constraints. Tissue Culture: Single cell and suspension culture, Production of haploids, detection and identification, and uses of haploids. Micropropagation - virus elimination, secondary metabolite production, encapsulated seeds - Application of plant tissue culture in agriculture and crop improvement.

UNIT – II

Outline of Genetic engineering - transposons as vectors - gene cloning - cloning in eukaryotes. Promoters and terminators - *Agrobacterium* derived promoters - 35S promoters of CaMV, inducible and tissue specific promoters. Importance of promoters. Amplification of genes by PCR. Gene transfer methods in plants - vectors - Ti and Ri plasmids of *Agrobacterium*.

UNIT – III

Transgenic plants resistant to Virus, Fungi, Bacteria, Pest, Insects and Herbicides - Transgenic plants with improved quality traits - Flavr Savr tomato, Golden rice, Arctic apple. Improved varieties in Floriculture. Transgenic plants for molecular pharming. Biodegradable plastics.

UNIT – IV

Biomining – Bioleaching, Biorecovery of metals, Biodegradation, Biosensors and Biochips, Bioremediation types - *In situ* and *ex situ*, future strategies and challenges. Enzyme technology - large scale production of fungal enzymes - extraction and purification methods involved - application of fungal enzymes in different industries. Immobilization of enzymes – applications.

UNIT – V

Bio-fuels from all kinds of plants. Biotechnology and healthcare- Gene therapy – types, methods and applications. Genetically engineered Humulin. Production of antibodies, vaccines and monoclonal antibodies - applications.

Text Books

1. Dubey, R.C. 2006. Text Book of Biotechnology. S. Chand and Company Ltd.
2. Satyanarayana, U. 2008. Biotechnology. Books and Allied (P) Ltd, Kolkata.
3. Vijaya Ramesh, K. 2004. Environmental Microbiology, MJP Publishers

References

4. Chawla, H.S. 2002. Introduction to Biotechnology. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
5. Razdan, M.K. 2003. An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Company Pvt. Ltd., New Delhi.
6. Das, H.K. 2005. Text book of Biotechnology. Wiley Dream tech India Pvt. Ltd., Delhi.

7. Slater, A., N.W. Scott, and Flower, M.R. 2010. Plant Biotechnology: The genetic manipulation of plants. Second edition, Oxford University Press.
8. Kumar, V. 2012 “Biodiesel from Algae” LAP Lambert Academic Publishing
9. Thieman, W.J and M.A. Palladino 2009 Introduction to biotechnology, second edition, Dorling Kindersley India Pvt. Ltd.
 10. Isil Aksan Kumaz 2015 Techniques in Genetic Engineering, CRC Press.
 11. Marcel Kuntz 2018 Transgenic Plants and Beyond Elsevier Science
 12. Hasanuzzaman, M, MNV Prasad 2020 Handbook of Bioremediation – Physiological, Molecular and Biotechnological Interventions. Elsevier Science.

Links

1. <https://www.youtube.com/watch?v=dg9ZUT2cIL0>
2. <https://www.youtube.com/watch?v=JtkhHIG3nx4>
3. <https://www.youtube.com/watch?v=xuwV3ywCxW8>
4. <https://www.youtube.com/watch?v=T-q1BaFci5I>
5. <https://www.youtube.com/watch?v=gJd0MeECLHA>
6. <https://www.youtube.com/watch?v=wPwQYHrTC8A>

Practicals:

1. Preparation of MS medium.
 2. Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of Tobacco, *Datura*, *Brassica*.
 3. Study of Anther, Embryo and Endosperm culture, Micropropagation, Somatic embryogenesis and artificial seeds
 4. Study of methods of gene transfer. Isolation of Plasmid DNA, Restriction digestion and gel electrophoresis of plasmid DNA, *Agrobacterium* - mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
 5. Study of steps of genetic engineering for production of Golden rice, Arctic apple.
 6. Production of biofuels from algae, Mass cultivation of algae, *Spirulina*- SCP production.
- Compulsory visit to institution(s) related in the field of Biotechnology

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
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CO1	Learn the basic concepts, principles and processes in plant biotechnology. Understand the role of vectors, plasmids in gene technology	K1, K2
CO2	The student will learn about the applications of Biotechnology in agriculture like micro-propagation, haploid plants, embryo culture, hybrids, cybrids etc.	K1, K3
CO3	Students would have learnt the basics of gene cloning, construction of various libraries and gene identification.	K1, K2
CO4	Explain the general principles of generating transgenic plants. its pros and cons.	K3, K4
CO5	To apply the knowledge of tissue culture in the commercial and industrial field of agriculture.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	M	L
CO2	S	S	M	S	M	L
CO3	S	S	S	M	S	L
CO4	S	S	S	S	S	L
CO5	S	S	M	S	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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L T P C
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Plant Physiology and Applied Biotechnology (Total : 60 hrs)

Plant Physiology (30 hrs.)

Practicals

1. Determination of water potential by gravimetric method.
2. Estimation of Photosynthetic pigments with reference to age (young and mature)
3. To determine the Chl.a/ Chl.b ratio in C₃ and C₄ plants.
4. Estimation of proline in normal and stressed leaves.
5. Effect of pH on membrane permeability.
6. Effect of temperature on membrane permeability.
7. Effect of detergents on membrane permeability.

Applied Biotechnology (30 hrs.)Practicals

- 1 Preparation of MS medium.
- 2 Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of Tobacco, *Datura*, *Brassica*.
- 3 Study of Anther, Embryo and Endosperm culture, Micropropagation, Somatic embryogenesis and artificial seeds
- 4 Study of methods of gene transfer. Isolation of Plasmid DNA, Restriction digestion and gel electrophoresis of plasmid DNA, *Agrobacterium* - mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
- 5 Study of steps of genetic engineering for production of Golden rice, Arctic apple.
- 6 Production of biofuels from algae, Mass cultivation of algae, *Spirulina*- SCP production.
Compulsory visit to institution(s) related in the field of Biotechnology

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	To estimate various physiological parameters in plants	K1, K2
CO2	Provide essential knowledge and cutting edge practical methodologies that are fundamental to the physiological study	K2, K3
CO3	Provide students an insight of the non - conventional methods of plant propagation. This laboratory course is to provide the students practical skills in basic Plant Tissue culture	K1, K4
CO4	Know about equipment's required in Tissue culture Lab. Media preparation techniques and sterilization techniques for media as well as for explants.	K3, K5
CO5	Demonstrate practical skills in different laboratory equipment's	K4

	and their handling	
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K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	L
CO2	S	S	M	S	S	L
CO3	S	S	S	S	S	L
CO4	S	S	S	S	S	L
CO5	S	S	M	S	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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L T P C

0 0 4 2

Plant Ecology and Conservation Biology + Elective (Total :60 hrs)

- 1 Vegetation Analysis (Quadrats and line transects) - Raunkaier's frequency diagram dominance and density in a given area and Shannon - Weaver's measures of species diversity index.
2. Water analysis - Dissolved oxygen - Carbonate and bicarbonate. Water hardness –Calcium and Magnesium, Chemical Oxygen Demand and Primary productivity (Winkler's method).
3. Estimation of oxidized organic matter in the soil by Walkle Black method.
4. Study the Interpretations of the following
 1. Ecosystem types
 2. Different seric stages.
 3. Endemism
 4. Conservation of biodiversity
 5. Vegetation types of India.
 6. Environmental pollution impact study

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Knowledge and skills to use practical and analytical techniques to examine population size and structure and quantify population dynamics	K1, K2
CO2	Understand the quadrat techniques	K2, K3
CO3	Students get knowledge about the local flora	K1, K4
CO4	To get in-depth knowledge about the analysis of soil and water	K4, K5
CO5	Demonstrate practical skills in different laboratory equipment's and their handling	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	L
CO2	S	S	M	S	S	L
CO3	S	S	S	S	S	L
CO4	S	S	S	S	S	L
CO5	S	S	M	S	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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L T P C

4 0 0 3

Medicinal Botany and Dietetics

Prerequisite:

Basic knowledge on Medicinal plants and its applications gained during undergraduate course.

Objectives:

- To promote good health by teaching the students about diet and nutrition.
- To educate the science of nutrition in preventing the development of disease.
- To educate on the nutritional standards and specifications for the healthy person and patient to

ensure and prevent mortality due to malnourishment.

Unit –I

Medicinal Botany – definition, history and importance, Indian system of Medicine. Study of the following plants with reference to their Habitat, Habit, Systematic position, Morphology of their useful parts and uses of: *Tinospora cordifolia* (Root), *Acorus calamus* (Rhizome), *Tylophora asthmatica* (leaf), *Terminalia chebula* (fruit), *Plantago ovata* (seed), *Holarrhena antidysenterica* (bark) and *Aloe vera* (dried juice).

Unit – II

Source, properties and medicinal uses of some phyto oils resources - Olive oil, Castor oil, Neem oil, Coconut oil, Mentha oil and Lavender oil.

Unit - III

Dietetics - Study the vernacular names, botanical sources, morphology, chief constituents and the therapeutic value of Indian plant foods - a) rice b) wheat; c) green gram, black gram, d) banana, Guava, e) Ginger, Turmeric, f) Cumin and Pepper.

Unit – IV

Plant nutraceuticals - definition and sources. Study of plant foods (food as medicine) in the treatment and nutritional care of some selected diseases – anorexia, arthritis, constipation, diarrhoea, diabetes, psoriasis, hypertension and memory loss.

Unit- V

Plant foods as Antioxidants - Definition - types, PUFA, Probiotics, Prebiotics, Dietary fibers, Omega-3 fatty acids. Cosmeceuticals – Definition, Retinoic acid. Recommended dietary allowances – significance.

Text books:

1. S.G. Joshi, “Medicinal plants”, Oxford and IBH Company Private Ltd., New Delhi, 2000.
2. J.L. Raymond, “Krause’s Food, Nutrition and Diet therapy”, Saunders publishers, 2003.
3. Harbans Lal, “Food and Nutrition”, 2nd edition, India Binding House, U.P. 2013

References

1. K. K. Purohit and Gokhale, "Pharmacognacy", Nirali Publications, 1999.
2. A.K. Srivatsava, "Medicinal plants", International Book Distributors, Dehradun, 2006.
3. S.N. Yoganarashimman, "Medicinal Plants India", Vol.2 TamilNadu, Inderline Publishing Private Ltd., Bangalore, DehraDun and Michigan, 2000.
4. S.K. Bhattachariya, Handbook on medicinal plants, pointer publishers Jaipur, 2004.
1. A. Farooqi and B.S. Sreeramu, Cultivation of medicinal and aromatic Crops, Universities Press, 2001.
2. R. T. Laga and V.S. Claudio, "Nutrition and diet therapy Reference dictionary" 4th edition, Jones & Barlett Learning, 1995.
3. B. Thomas and J. Bishop, "Manual of Dietetic Practice" Edited by Jone Gandy, 4th edition, Wiley Blackwell Publishing, Oxford, UK, 2007.
4. B. Srilakshmi, "Dietetics", New Age International publishers, 2007.
5. D.A. Vattem and V. Maitin, "Functional foods, Nutraceuticals and Natural Products DEStech Publications, INC, 2016.
6. John Shi "Functional Food Ingredients and Nutraceuticals Processing Technology", CRC Taylor and Francis Publishers, 2006
7. M.M. Pandey, Subha Rastogi and AKS Rawat Indian Traditional Ayurvedic System of Medicine and Nutritional Supplementation, Evidence based Complementary and Alternative Medicine, <http://doi.org/10.1155/2013/376327>. 2013
8. Rachen Hartley Gentle Nutrition – A non-diet approach to healthy eating. Victory Belt Publishing. 2021.

Links

1. <https://www.youtube.com/watch?v=Kt0Lgy17I78>
2. <https://www.youtube.com/watch?v=wPwQYHrTC8A>
3. <https://www.youtube.com/watch?v=Y2I1Ld8W4eE>
4. <https://www.youtube.com/watch?v=5EGQ6XVGPm0>
5. <https://www.youtube.com/watch?v=0z47wLZ4-O4>

6. <https://www.youtube.com/watch?v=FXjVa5g8x8g>
7. <https://www.youtube.com/watch?v=8XMN0MhmoAM>
8. <https://www.youtube.com/watch?v=9zwBGmcAZ8U>

Practicals

Spotters

Identification of medicinal plants/products described in the syllabus

1. Any four medicinally important plants/ products described in the syllabus
2. Any five Indian plant foods described in the syllabus
3. Prebiotics/Probiotics/Omega-3 fatty acids

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Know about history and relevance of herbal drugs in Indian system of medicine	K1, K2
CO2	Understand the constituents of plant based oils	K1, K2
CO3	Occurring knowledge to identify the major chemical components of food	K1, K3
CO4	Familiarize nutritional assessment, RDA and Recommendations & Guidelines.	K3, K4
CO5	Acquire the skills and techniques involved in the planning and preparation of therapeutic diets for various ailments.	K4

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	L
CO2	S	S	M	S	M	L
CO3	S	S	M	M	S	L
CO4	S	S	S	M	S	L
CO5	S	S	M	S	M	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No

Correlation

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Agricultural Botany and Plant Breeding

Prerequisite:

Basic knowledge on agriculture and plant breeding applications gained during undergraduate course.

Objectives:

- To enhance the knowledge of agricultural botany and plant breeding.
- To educate the basic ideas and concepts of crop improvement
- To understand the breeding techniques and hybridization

UNIT –I

Agroclimatic zones of India. **Cropping system in India** – Kharif, Rabi, and Zaid. Concepts of multiple cropping, multistorey, relay and inter-cropping. Types of Farming in India. Soil profile - physical and chemical properties of soil - soil biota - classification of Indian soils - soil erosion - causes and effects - acid and sodic soils. Classification of essential plant nutrients - nutrient deficiency symptoms.

UNIT –II

Tillage- Primary and Secondary tillage - Conventional tillage - Minimum tillage – Stubble mulch tillage. Weed and their management- Harmful effects of weeds- Classification of weeds – Propagation and Dissemination of weed, Methods of weed control- Mechanical, Cultural, Chemical, Biological. Integrated weed management. Herbicide – Classification - Mode of action.

Water, its properties and role in plants – Irrigation - Classification of soil water - methods of irrigation. Fertilizers - Nitrogenous, Phosphatic, Potassic. Biofertilizers - Compost and farmyard manure. Biopesticides - Types of biocontrol agents – applications.

UNIT – IV

Plant breeding - Centre of origin and domestication of crop plants. Plant introduction – Quarantine measures. Selection methods - for self, cross pollinated and vegetative

propagate plants. Backcross method of breeding. Hybridization- types, advantages and limitations. Seed technology, its importance. Different kinds of seeds and their seed production and processing techniques.

UNIT –V

Genetic basis of inbreeding depression, heterosis. Mutation and Polyploidy in crop improvement. Distant hybridization - Role of **Biotech** in crop improvement. Development of resistant varieties in drought. Cytoplasmic sterility in hybrid seed production. Antisense technology and its role in crop improvement. Somoclonal variation in crop improvement.

References

1. Kanwar, J.S. (1985) Theory and Practice of Soil Fertility. ICAR Pub.
2. Pierzinsky GM, Sims TJ & Vance JF. 2002. Soils and Environmental Quality. 2nd Ed. CRC Press.
3. Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. Soil Fertility and Fertilizers. 5th Ed. Prentice Hall of India.
4. Troeh FR & Thompson LM. 2005. Soils and Soil Fertility. Blackwell.
5. Chand, S. (2008). Integrated Nutrient Management for Sustainable Crop Production and Soil Health, International Book Distributing Co., Lucknow, UP
6. Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.
7. Sehgal J. 2002. Introductory Pedology: Concepts and Applications. New Delhi.
8. Das. P.C. 2003 Manures and Fertilizers, Kalyani Publishers
9. SubbaRao, N.S. 2004 Soil Microbiology Oxford & IBH.
10. Magdoff F & Weil RR 2004. Soil Organic Matter in Sustainable Agriculture. CRC Press
11. A.M. Michael, 1987. Irrigation – Theory and Practice, Vikas Publishing House Pvt. Ltd., New Delhi
12. S.S. Parihar and B.S. Sandhu, 1978. Irrigation of field crops – Principles and Practices, ICAR, New Delhi
13. Lenka, 1999. Irrigation and Drainage. Kalyani Publishers, New Delhi.
14. G.H. Sankara Reddy and T. Yellamanda Reddy. 1995. Efficient use of irrigation water. Kalyani Publishers, New Delhi.
15. Gupta, O. P. 1998. Modern Weed Management. Agro Botanica Bikaner, India.
16. Subramanian, S. A. Mohammed Ali and R. Jayakumar. 1991. All about Weed Control. Kalyani Publishers, New Delhi.
17. Jaganathan.R., & R.Jayakumar. 2003. Weed Science Principles, Kalyani

Publishers, NewDelhi.

18. Ashton FM & Crafts AS. 1981. Mode of Action of Herbicides. 2nd Ed. Wiley Inter-Science. Mandal RC. 1990. Weed, Weedicides and Weed Control - Principles and Practices. AgroBotanical Publ.
19. Rao VS. 2000. Principles of Weed Science. Oxford & IBH.
20. Jain, K & Kharkwal, M.C. 2004. Plant Breeding – Mendelian to Molecular Approaches. Narosa Publishing House, New Delhi.
21. Chandrasekaran, S.N. & Parthasarathy. S.V. 1975. Cytogenetics and plant breeding (Revised Edition) Eds. Krishnaswamy. P. Varadachary & Co., Madras.
22. Backcock., E.B. 2001 Genetics and Plant breeding. Agrobios (India), Jodhpur.
- 23, V. L. 2000. Plant Breeding. Theory and Practicals (2nd edition), Oxford & IBH Publ. Co.Pvt.. Ltd., New Delhi.
24. Sharma, J R. 1994 Principles and Practice of Plant Breeding, Tata-McGrawHill Publ. Co.Ltd, New Delhi.
25. Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS New Delhi.
26. Singh P. 2006. Essentials of Plant Breeding. Kalyani Publishers, New Delhi.

Practical/Demo/Spotters

1. Compare texture, porosity, capillarity of different types of soil
2. Determination of moisture and organic matter content from manures samples.
3. Emasculation and Pollen viability test
4. Soil Profile/Biofertilizers

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	understand cropping system in India and physical and chemical properties of soil and their effect on plant's health	K1, K2
CO2	Acquire the skills and techniques in tillage, weeding and irrigation methods	K1, K3
CO3	Learn the techniques of Hybridization. Learn about the selection methods for self pollinated, cross pollinated plants	K2, K3
CO4	Students understand the introduction to plant breeding, domestication, plant introduction and acclimatization.	K3, K4

CO5	Student knows about the mutant breeding, Polyploidy in plant breeding, Breeding for nutritional quality.	K5
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K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	L
CO2	S	S	S	M	M	L
CO3	S	S	S	S	S	L
CO4	S	S	S	M	S	L
CO5	S	S	S	S	S	L

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation

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Project

Prerequisite:

The students should be able to understand and interpret the literature in their areas of research.

Objectives:

- To provide training in scientific skills.
- To prepare students for professional training programmes or entry level jobs in any area of Botany

Course outcomes

After the completion of this course, the student will be able to

CO Nos	CO Statement	Cognitive Level
CO1	Students should have increased their capacity to think critically	K1, K3
CO2	students should have increased their ability to design, analyze and execute an experiment	K2, K3
CO3	Students should have increased their confidence and ability in communication skills (in writing and oral).	K3, K4

CO4	in acquiring the literature collection methods and interpreting the data of their scientific experiments etc.	K3, K4
CO5	Developing research skills in nutrition field through Dissertation/Project.	K5

K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 - Create

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S	S	S	S	S	L
CO2	S	S	M	S	S	L
CO3	S	M	S	M	S	S
CO4	S	S	S	S	S	S
CO5	S	S	S	S	S	S

S – Strongly Correlated, M – Moderately Correlated, L – Weakly Correlated, N – No Correlation