



Anekant Education Society's
Tuljaram Chaturchand College, Baramati
(Autonomous)

Two Year Degree Program in Botany
(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. (Botany) Part-II Semester -IV

For Department of Botany
Tuljaram Chaturchand College, Baramati

Choice Based Credit System Syllabus (2019 Pattern)

M.Sc. Botany
Program Outcomes (Pos) for M. Sc. Program

PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	Social competence: Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise way and help reach conclusions in group settings.
PO4	Research-related skills and Scientific temper : Infer scientific literature, build a sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	Trans-disciplinary knowledge: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	Personal and professional competence: Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	Effective Citizenship and Ethics: Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)
Course Structure for M. Sc. II (Botany)
SYLLABUS (CBCS) FOR M. Sc. Botany II (w. e. f. June, 2020)
Academic Year 2020-2021

Sem	Paper Code	Title of Paper	No. of Credits
III	BOT5301	Angiosperms and Evolution	4
	BOT5302	Developmental Botany	4
	BOT5303	Computational Botany	4
	BOT5304 (A)	Advances in Plant Physiology	4
	BOT 5304 (B)	Advances in Mycology and Plant Pathology	
	BOT 5304 (C)	Bryology	
	BOT 5304 (D)	Angiosperm Taxonomy	
	BOT5305	Practical's Based on BOT 5301,5302 and 5303	4
BOT5306 (A)	Practical's based on special paper Advances in Plant Physiology	4	
BOT5306 (B)	Practical's based on special paper Advances in Mycology and Plant Pathology		
	Practical's based on special paper Bryology		
	Practical's based on special paper Angiosperm Taxonomy		
IV	BOT5401	Plant Pathology	4
	BOT5402	Industrial Botany	4
	BOT5403	Plant Biotechnology	4
	BOT5404 (A)	Advances in Plant Physiology	4
	BOT 5404 (B)	Advances in Mycology and Plant Pathology	
	BOT 5404 (C)	Bryology	
	BOT 5404 (D)	Angiosperm Taxonomy	
	BOT5405	Practical's Based on 5401, 5402 and 5403	4
BOT5406	Research Projects, Review of Literature and Summer Training	4	

Class : M. Sc. II (Semester- IV)

Paper Code : BOT 5401

Paper : I

Credit : 4

Title of Paper : Plant Pathology

No. of lectures : 60

A) Learning Objectives:

1. To give knowledge of pathological processes occurs in plants.
2. To make aware about structure and disease development in plants.

B) Course Outcome:

- CO1. Students can be understood the details of meteorological factors and pathogens involved in disease development. So, it will help as prerequisite for avoiding the disease spreading.
- CO2. Knowledge of plant pathology will helpful to use diseases resistant varieties of crop plants and their disease management.
- CO3. Students can be start their own business related to eco-friendly management of plant diseases and its consultancy.
- CO4. Students can be confident about basic idea and comparative study of cryptogams.
- CO5. Students can be experts in identification of lower plants.
- CO6. Students can be start their own business based on applications of cryptogams.
- CO7. Get knowledge about life history of algae, fungi bryophytes.

Credit I - Introduction to Plant Pathology (15L)

1. Plant Pathology- Milestones in plant pathology **1L**
2. Plant pathology and its objectives **1L**
3. Nature and concept of plant disease, classification of plant diseases **2L**
4. Causes of plant diseases, symptoms of plant diseases, disease cycle **2L**
5. Bacterial and mollicutes diseases of plants. **2L**
6. Viral diseases of plants Diseases caused by viruses. **2L**
4. Nematodal diseases of plants **2L**
5. Plant disease epidemiology and forecasting of plant disease epidemics. **2L**
6. Effect of plant diseases on human affairs **1L**

Credit II - Pathogenesis (15L)

1. Pathogenesis: Penetration, Infection and spread of diseases **4L**
2. Effect of pathogen on plant physiological functions **4L**
3. Enzymes and toxins in plant disease **4L**
4. Pathogenicity of biotrophic and necrotrophic pathogens **3L**

Credit III–Disease Development (15 L)

1. **Environmental factors and disease development**- Effect of temperature, humidity, soil pH, soil texture, light, CO₂ and O₂ levels, nutrients and disease development **4L**
2. **Genetics of plant pathogen interactions**- Genetics of host parasitic interactions, phytoalexin and antigen hypothesis, vertical and horizontal resistance, physiological specialization, adaptation of fungi to different hosts **3L**
3. **Plant defense mechanism**- Morphological and biochemical defense, defense through induced synthesis of proteins and enzymes, detoxification of pathogen toxins and hypersensitivity of defense reactions, concept of phytoncides **3L**
4. **Molecular biology** of host pathogen interactions, pathogenesis genes, avirulence genes, host- R genes, effector molecules, miRNA **3L**
5. Concept of post-harvest diseases of fruits, vegetables and seeds **2L**

Credit IV-Disease Management and Related Aspects (15 L)

1. Diagnostic methods for detecting pathogens **2L**
2. Breeding methods for improving resistance in plants **3L**
3. Control of disease using fungicides and other chemicals **2L**
4. Bio-control agents for controlling disease **2L**
5. Disease control using biological and chemical activators of resistance **2L**
6. Plant disease assessment **2L**
7. Biotechnology and its role in plant pathology **2L**

References:

1. Plant Pathology by R. S. Mehrotra, first edition, McGraw-Hill Education publication, 1982.
2. Plant Pathology by George N Agrios, fifth edition, Academic Press, London, 2005.
3. Plant Nematode: Morphology, Systematics, Biology and Ecology by M. R. Khan, first edition, Science Publishers, 2008.
4. Plant Pathogenesis and Resistance by Jeng-Sheng Huang, first edition, Springer, Netherlands, 2001.
5. Plant Pathology by R. S. Mehrotra and Ashok Agarwal, second edition, Tata McGraw Hill Education, 2003.
6. Biocontrol of Plant Diseases by P. C. Trivedi, first edition, Aavishkar Publishers and Distributors, 2007.
7. Concise Encyclopedia of Plant pathology by P. Vidhyasekaran, first edition, CRC Press, 2004.
8. Topics in Mycology and Pathology by L. N. Nair, first edition, New Central Book Agency Kolkata, 2007.
9. Fundamentals of plant pathology by A.K. Sinha, Kalyani Publishers
10. Disease of crops plants of India by Rangswami and Mahadevan, Prentice Hall Publication

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Plant Pathology

Course Code: BOT 5401

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1	3				3				
CO 2		2		2					
CO 3						3			
CO 4	3								
CO 5		3							
CO 6	3		3				3		
CO 7								3	3

Justification for the mapping

PO1: Disciplinary Knowledge

CO1. Students can be confident about basic idea and comparative study of cryptogams.

CO4. Get knowledge about life history of algae, fungi bryophytes.

CO6. Knowledge of plant pathology will helpful to use diseases resistant varieties of crop plants and their disease management.

PO2: Critical Thinking and Problem Solving

CO2. Students can be experts in identification of lower plants.

CO5. Students can be understood the details of meteorological factors and pathogens involved in disease development. So, it will help as prerequisite for avoiding the disease spreading.

PO 3: Social competence

CO6. Knowledge of plant pathology will helpful to use diseases resistant varieties of crop plants and their disease management.

PO 4: Research-related skills and Scientific temper

CO2. Students can be experts in identification of lower plants.

PO5: Trans-disciplinary Knowledge

CO1. Students can be confident about basic idea and comparative study of cryptogams.

PO6: Personal and Professional Competence

CO3. Students can be start their own business based on applications of cryptogams.

Class : M. Sc. II (Semester- IV)
Paper Code : BOT5402
Paper : II Title of Paper : Industrial Botany
Credit : 4 No. of lectures : 60

A) Learning Objectives:

1. To give knowledge about different technologies and use in industries.
2. To make aware about methods required industrial application of subject knowledge.

B) Course Outcome:

- CO1. Preparation of different garden at personal level and to encourage people
- CO2. Hands on techniques of packaging, harvesting and hydroponics.
- CO3. Students can start their own business in cold storage, packing of flowers and fruits.
- CO4. Develop plant tissue culture industry.
- CO5. Get expertise to develop agro based industries.
- CO6. Get expertise in field of Industrial Botany.
- CO7. Understand basics of plant resource based industries.

Credit I- Algal and Bio-pesticide Technology (15L)

A. Algal Technology

1. Introduction to Algal Technology 2L

Resource potential of algae, commercial utility of algae- food and feed, pigments, pharmaceuticals and nutraceuticals, fine chemicals, fuel and biofertilizers, seaweeds extracts as biofertilizers, distribution of economically important algae in India

2. Algal Products 5L

SCP- *Spirulina* mass cultivation and its applications, biodiesel from algae, advantages over other sources of biodiesel, cultivation and extraction methods, liquid seaweed fertilizers – method of preparation and application

B. Biopesticide Technology 8L

Concept and significance of bio-pesticide; types of biopesticides and their applications,

1. Herbal- Azadiractine, rotenone and pyrethrins
2. Insect predators/parasites- Lady bird beetle, *Trichogramma*
3. Fungal- *Trichoderma*, its isolation, mass multiplication and applications
4. Bacterial- *Bacillus thurengensis*
5. Viral- Nuclear Polyhydrosis Virus (NPV), Helicoverpa Nuclear Polyhydrosis Virus

(HNPV)

Credit II - Biofuel Technology (15 L)

1. Environmental implications of fossil fuel, concept of biofuel, alternatives for fossil fuels– ethanol, vegetable oil, biodiesel **3L**

2. Bioethanol Technology 5L

Sources for bioethanol production- sugar crops, starch crops, cellulosic feed stock
bioethanol production- sugar-to-ethanol process, starch-to-ethanol process, cellulose-toethanol process, bio-ethanol from lignocelluloses, distillation to dehydration process,
technology applications of bioethanol, spark ignition engines, compression ignition engines, fuel cells, standardization of bioethanol

3. Lipid Derived Biofuels 3L

Sources - oil seed crops, microalgae, animal fats, waste oils
Fuel productions- oil extractions, oil refining, transesterification, properties and use of lipid biofuels, economy of lipid biofuels

4. Bio-hydrogen- Application and future prospects 2L

5. Methanogenesis from agro industrial residues 2L

Credit III -Fermentation Technology 15L

1. Introduction 5L

History, fermentation process, fermenters- design and construction, basic functions, types of fermenters, operation, aseptic operation and use of computer in fermenters, maintenance, types of fermentation process, batch fermentation, fed-batch fermentation, continuous fermentation, scale up of fermentations, industrial processes- upstream and down-stream processes, strain improvement of microbes

2. Alcohol and Beverage Industry 2L

Sources and methods of production of alcohol, beer and wine

3. Organic Acid Industry 1L

Sources and methods of production of vinegar, and citric acid

4. Antibiotic Industry 2L

Sources and methods of production of Penicillin, Cephalosporins, and Griseofulvins

5. Food Industry 5L

SCP - advantages and disadvantages, production of yeast biomass, production of mycoproteins, traditional fungal foods (Shoyu, Miso, Sake, Tempeh), production of Button mushroom, (*Agaricus*) Paddy straw mushroom (*Volvariella*) and Dhingri mushroom (*Pleurotus*).

Credit IV. Nutrition Garden and Entrepreneurship **2L**

1. **Need of Nutritional Garden:** Nutritional awareness, nutritional deficiencies and disorders, balanced diet and knowledge of indigenous vegetables and its nutrient content.

2. **Production technique:** **4L**

Design, layout and implementation, choice of crop species, seed source, cropping pattern, crop season, soil testing, package of practices - INM, IPM & IDM, propagation methods, present nutritional garden models in India.

2. **Quality seed production techniques** (indigenous): Genetic, agronomy and seed treatments. **2L**

Harvest and post-harvest management: Seed storage, and maintenance of seed bank. seed viability and dormancy. **2L**

Yield and economics: Bio-fortification and bio priming, recipes (season wise). **2L**

3. Entrepreneur: Concept, characteristics of entrepreneur, types and functions of entrepreneur, difference between entrepreneur and a manager. Need, objectives, course

contents and curriculum, phases and evaluation of EDPs, Meaning of project and report, project identification, project selection, contents of project reports, preparation of project report.

Commercial banks, other financial institutions- IDBI, IFSI Bank Need of institutional support, institutional support to small entrepreneurs- SIDCO, SSIB, NABARD. **4L**

References-

1. Biofuel Technologies- Recent Developments, Gupta, Vijay Kumar, Tuohy, Maria G. (Eds) Springer publication
2. Biofuel technology Handbook, Dominik Rutz, Rainer Janseen, WIP Renewable Energies, Germany
3. Biopesticides for sustainable agriculture: prospects and constraints, Editor(s): Nutan Kaushik

4. Entrepreneur Developments, S. S. Khanka, S. Chand., 2005
5. A Text Book of Microbiology, Dube and Maheshwari
6. A Text Book of Biotechnology. R C Dube
7. Insecticide control act 1985 Gazette of India
8. Fertilizer control act 1985 Gazette of India.
9. Dr. G. S. K. Swamy, Dr. J. Auxilia. Fundamentals of Horticulture.
10. Production techniques of vegetables and flowets. TNAU Coimbtore.
11. Seed production of vegetable, tuber and spice crops. Agrimoon
12. A beginners mannual on nutrition garden. Info global social service society(IGSSS) Mar2019.
13. R L Villareal, S Shanmugsundaram, M L Chadha, AVRDC. Primer in Vegetable Gardening.
14. School Gardens for Nutrition and Health- AVRDC Publication.
15. Dr. A Vadivel and Dr. M Shivanna. Soil and Plant analysis with practicals.

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Industrial Botany

Course Code: BOT 5402

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1			3						
CO 2						3			
CO 3						3			
CO 4	3								3
CO 5	3								3
CO 6	3								3
CO 7	3								

Justification for the mapping

PO1: Disciplinary Knowledge

CO4. Develop plant tissue culture industry.

CO5. Get expertise to develop agro based industries.

CO6. Get expertise in field of Industrial Botany.

CO7. Understand basics of plant resource based industries.

PO 3: Social competence

CO1. Preparation of different garden at personal level and to encourage people.

PO6: Personal and Professional Competence

CO2. Hands on techniques of packaging, harvesting and hydroponics.

CO3. Students can start their own business in cold storage, packing of flowers and fruits.

PO 9: Self-directed and Life-long Learning

CO4. Develop plant tissue culture industry.

CO5. Get expertise to develop agro based industries.

CO6. Get expertise in field of Industrial Botany.

Class : M. Sc. II (Semester- IV)

Paper Code : BOT5403

Paper : III Title of Paper : Plant Biotechnology

Credit : 4 No. of lectures : 60

A) Learning Objectives:

1. To generate awareness on recent trends in biotechnology
2. To make expertise persons in tissue culture

B) Learning Outcome:

- CO1. Learn the basic concepts, principles and techniques in plant biotechnology.
- CO2. Knowledge acquired students will be able to apply techniques in other branches such as biological, medical, agricultural etc.
- CO3. Use of bio techniques to explore plant to its molecular level.
- CO4. Get knowledge of Biopesticide and Biofertilizer.
- CO5. Acquire knowledge of organic farming with respect to Biopesticides and Biofertilizers.
- CO6. Know scope of the industrially important fungi and their applications.
- CO7. Get knowledge of Pharmaceutical Industry.

CREDIT- I

15L

Plant Physiology and basic Techniques in Plant Tissue Culture

1. Plant Nutrition: Role of microelements and micronutrients in plant metabolism. Plant Hormones: Types & Mechanism of Action, Role of Plant Hormones in growth & development of Plants.
2. Micro propagation: Organogenesis, Somatic Embryogenesis, Synthetic seeds. 2. Shoot tip culture/ Auxiliary bud culture, Embryo Culture & Embryo Rescue.
3. Design & lab setup of Plant Tissue Culture laboratory, Tissue culture Media (Composition preparation) Initiation and Maintenance of callus & Suspension culture.
4. Acclimatization of Plants, Somaclonal Variations / *In-vitro* mutagenesis Selected successful examples of Plants of Diverse Origin using Tissue Culture technology, Rescue of endangered plants.

CREDIT - II

15L

Agricultural Biotechnology

1. Plant Transformation: Basics of Tumor formation, Hairy root, features of Ti & Ri Plasmid, Mechanism of DNA transfer role of Virulence gene, Use of Ti & Ri as vectors, Multiple gene transfers vector less or direct DNA transfer methods in plants, Applications of Plant Transformation for Productivity
2. Crop improvement – Advantages of biotechnological methods over conventional methods of crop improvement. a) Homozygous plant production through anther & pollen culture b) Endosperm culture & production of triploids d) Apomixis e) Induced Polyembryony and their applications in crop improvement
3. Use of bioreactors in plant production & Scale-up Marker assisted selection – introduction to markers (RFLP, AFLP, microsatellites, RAPD, QTL)

CREDIT -III

15L

Applications of Plant Biotechnology

1. Commercial micro propagation, Metabolic engineering & Industrial products Plant secondary metabolites, control mechanisms & manipulation of Phenyl Propanol pathway, Shikimate pathway.
2. Industrial enzymes, Biodegradable plastics, Therapeutic proteins, lysosomal enzymes, Antibodies, edible vaccines, Purification strategies, oleosin partitioning technology
3. Integration of Genetic Engineering of Plants in Agriculture Diseases resistant, Biotic & Abiotic stress resistant, Enhancement of nutritional value of crop Plants & molecular farming

CREDIT- IV

15L

Introduction to Nano-world, Nanoscience and Nanotechnology

1. Nanoparticles, nanowires, thin films and multilayers, Applications in various fields viz. Physical and Chemical, Materials, Life Sciences.
Nanobiotechnology: Introduction, Biomolecules as nanostructures and their applications in nanotechnology viz. Biosensors, separation of cells and cell organelles, cancer therapy, gene therapy etc.
2. Synthesis of nanostructure:
Physical methods –mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition (CVD), electric arc deposition.

Chemical methods: Synthesis of nanoparticles by colloidal route, microemulsion, sol-gel method, chemical precipitation, pyrolysis.

Biological methods: Synthesis using microorganism, synthesis using plant extracts, use of proteins and template like DNA.

References:

1. An introduction to Plant Tissue Culture 2nd edn. Razdan, M. K, Science Publishers, USA.
2. Textbook of plant biotechnology, Chawala P.K.2002,Oxford&IBH,New Delhi.
3. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture:Theory and Practice, Elsevier Pub.
4. Chrispeels, M. J. 2002.Plant Tissue Culture:Genetical Aspects. Jones and Bortlett Publishers, International.
5. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.
6. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondary metabolism, lower Academic Publisher.
7. Agrobiotechnology and plant tissue culture, Bhojwani SS, Soh WY, Oxford & IBH Publ, India
8. Agricultural biotechnology, (2005), Kumar HD, Daya Publ House, India
9. Plant molecular breeding, (2009), Newbury HJ, John Wiley and Sons., USA.
10. Embryology of Angiosperms, (2009), S.S. Bhojwani and S.P. Bhatnagar, Vikas Publ House, India.
11. Ashwani Kumar, Shekhawat NS (2009) – Plant tissue culture and molecular markers: their role in improving crop productivity (IK International)
12. Biotechnology, 4th edition, (2010), H K Das, Wiley India Pvt. Limited, India

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Plant Biotechnology

Course Code: BOT 5403

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1		3							
CO 2	3								
CO 3		2							
CO 4	2	3							
CO 5	3								
CO 6	3								
CO 7	3								

Justification for the mapping

PO1: Disciplinary Knowledge

CO2. Knowledge acquired students will be able to apply techniques in other branches such as biological, medical, agricultural etc.

CO4. Get knowledge of Biopesticide and Biofertilizer.

CO5. Acquire knowledge of organic farming with respect to Biopesticides and Biofertilizers.

CO6. Know scope of the industrially important fungi and their applications.

CO7. Get knowledge of Pharmaceutical Industry.

PO2: Critical Thinking and Problem Solving

CO3. Use of bio techniques to explore plant to its molecular level.

PO 4: Research-related skills and Scientific temper

CO1. Learn the basic concepts, principles and techniques in plant biotechnology.

Class : M.Sc. (Semester- IV)

Paper Code : BOT 5404 (A)

Paper : IV

Title of Paper: Advances in Plant Physiology

Credits : 4

No. of lectures: 60

A) Learning Objectives:

1. To generate awareness physiological responses of plants towards different stress and phytohormones
2. To train skilled students in basic process of plant physiology.

B) Course Outcome:

- CO1. Use knowledge for improvement of agricultural yield
- CO2. Students aware about the plant to response environmental conditions.
- CO3. Students get knowledge of internal activities in plant.
- CO4. Development of expertise in plant physiology.
- CO5. Get knowledge of plant metabolism.
- CO6. Students get knowledge of plant cycle.
- CO7. Students get knowledge of biomolecules.

CREDIT- I Stress physiology

15L

Water Stress: Membranes and water stress, Stomatal response to water stress, Photosynthesis and water stress, Osmotic adjustments, physiological mechanism of drought tolerance **2L**

Waterlogging stress: Waterlogging injury, Metabolic damage, Hormonal imbalance, Soil toxins Tolerance mechanisms **2L**

Low temperature: Chilling and freezing effects on germination, Physiological mechanism of low temperature tolerance, Effect of low temperature on plant productivity **2L**

Heat Stress :Cellular response on high temperature, enzyme activities, photosynthesis ultra structural effects. Functions of HSPs, role of membrane lipids in high temperance tolerance. **2L**

Metal stress: Metal toxicity and tolerance with special reference to Alluminium, manganese, Iron, Zinc, Role of phytochelatins (heavy, metal binding proteins). **1L**

Salt Stress:Mechanism of salt stress, Effects of salts on physiology of plants. **2L**

UV stress : Plant response to UV radiation in chemical composition of plants, Effect of UV radiations on photosynthesis **2L**

Oxidative stress: reactive oxygen species (ROS) – role of scavenging systems (SOD, catalase etc.).

2L

Credit II Allelochemicals	15L
• Major Allelochemicals nature in plants: Alkaloides, phenolics, terpenoides, glucosinolates, isothiosinates .	4L
• Release and regulation of allelochemicals production and release	3L
• Mode of action of allelochemicals on physiological process.	3L
• Physiological and molecular mechanism of disease resistance in plants : Hypersensitive response, elicitors, phytoalexins, physiology of disease resistance, SAR(System Aquired Resistance)	4L
• Applications of allelochemicals.	1L

Credit III : Crop Physiology and Enzymology	15L
• Physiological basis of yield of Jowar, Pea, Maize, Soyabean Role of crop physiology in agriculture, crop growth and productivity.	5L
• Enzyme structure and properties, classification, Enzymes as biocatalysts, Importance of enzyme kinetics, factors affecting rates of enzyme mediated reaction, Michaelis-menton equation, substrate equation, Lineweaver- Burke plot, Haldane-Briggs relationship.	10L

Credit IV Experimental Plant Physiology	15L
• Preparation of solutions normal, molar, percent, ppm solutions.	
• Methods of setting of physiological experiments.	
• Physiological instruments-titrimetry, polarietry and their protocols.	
• Post-harvest physiology, ripening of fruits and its regulation, Metabolism of stored seeds and leafy vegetables.	
• Biostatistics: Graphical and diagrammatical representation of data. Measures of central tendency, t-test, Chi-square test, ANOVA.	

References:

- 1 Annual reviews of plant physiology and plant molecular biology
- 2 Aspinall D. and Paleg, L. G. (eds.) 1981. The physiology and biochemistry of drought resistance in plants, academic Press. London
- 3 Bewley, J. D. and Black, m. 1982 Physiology and biochemistry of seeds (vol 1 & 2) Springer Verlag

- 4 Buchana B. b., Gruissem, W and Jones, R. I. 2000. Biochemistry and molecular biology of plants. American Society of plant physiologists, Maryland, USA
- 5 Freifelder, D. Physical biochemistry
- 6 Goodwin, T. W. and Mercer L. E. 1989. Introductory Plant Biochemistry, Pergamon Press, New York, USA
- 7 Moore, T. C. 1989 biochemistry and physiology of plant hormones (2 nd edition), Springer Verlag, New York, USA
- 8 Salisbury, F. B and Ross, C. W. 1992 Plant Physiology (4 th edition), Wadsworth Publishing company California, USA
- 9 Co-Evolution of Secondary Metabolites, Editors: Mérillon, Jean-Michel, Ramawat, Kishan Gopal (Eds.) Springer International Publishing.
- 10 Isolation, identification and characterization of allelochemicals / Natural Products, S.S. Narwal, International Allelopathy Foundation, 101, Sector - 14, Rohtak -124 001, India.
- 11 Sergey Shabala, Plant stress physiology, 2nd edition, Boston, MA : CABI, 2017.
- 12 Narendra Tuteja and Sarvajeet S. Gill, Abiotic Stress Response in Plants, 2016 Wiley –VCH verlag GmbH and Co.
- 13 Mohd Sayeed Akhtar, Salt Stress, Microbes, and Plant Interactions: Causes and Solution, 2019, Springer Verlag, Singapore, ISBN 9789811388002.
- 14 Biochemistry and Molecular Biology of Plants. 2002. Bob Buchanan, Wilhelm Gruissem, and Russell Jones. Wiley. ISBN-13: 978-0943088396. ISBN-10: 0943088399.
- 15 Plant Physiology and Development. 2014. 6th edition. Lincoln Taiz, Eduardo Zeiger, Ian Moller, and Angus Murphy. Sinauer Associates, Inc. ISBN-13: 978-0878938667. ISBN-10: 0878938664.

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Elective Papers – Advanced Physiology - II

Course Code: BOT 5404 (A)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1	3								
CO 2	3	3							
CO 3				3					
CO 4									
CO 5	2			2					
CO 6	3			3					
CO 7	3			3					

Justification for the mapping

PO1: Disciplinary Knowledge

- CO1. Use knowledge for improvement of agricultural yield.
- CO3. Students get knowledge of internal activities in plant.
- CO5. Get knowledge of plant metabolism.
- CO6. Students get knowledge of plant cycle.
- CO7. Students get knowledge of biomolecules.

PO2: Critical Thinking and Problem Solving

- CO2. Students aware about the plant to response environmental conditions.

PO 3: Social competence

- CO1. Use knowledge for improvement of agricultural yield.

PO 4: Research-related skills and Scientific temper

- CO3. Students get knowledge of internal activities in plant.
- CO5. Get knowledge of plant metabolism.
- CO6. Students get knowledge of plant cycle.
- CO7. Students get knowledge of biomolecules.

Class : M.Sc. (Semester- IV)

Paper Code : BOT 5404 (B)

Paper : IV Title of Paper: Advanced Mycology and Plant Pathology

Credits : 4 No. of lectures: 60

A) Learning Objectives:

3. To know the primary and secondary metabolites of fungi.
4. To study industrial application of fungi.

B) Course Outcome:

- CO1. Get knowledge about cryptogams to conserve Cryptogamic diversity.
- CO2. Classify the cryptogams up to species level.
- CO3. Get aware about the importance of Cryptogams.
- CO4. Get knowledge about lifehistory of algae, fungi bryophytes.
- CO5. Explain the role of Algae, Fungi and Bryophytes in human welfare.
- CO6. Aware about plant conservation in society.
- CO7. Analyze industrial applications of algae.

Credit - I

- 1. Heterothallism, heterokaryosis and parasexual cycle (10L)**
 - a) Homothallism
 - b) Heterothallism (sexual incompatibility)
 - c) Bipolar (unifactorial) heterothallism or two-factor heterothallism
 - d) Multi-factor heterothallism
 - e) Bipolar multiple – factor heterothallism
 - f) Tetrapolar (multi-factor) heterothallism
 - g) Octopolar (trifactorial) heterothallism
 - h) Heterogenic incompatibility (semi-incompatibility)
 - i) Heterokaryosis
 - j) Parasexual cycle

- 2. Fungal hormone, physiological specialization and phylogeny (10L)**
 - a) Fungal hormones
 - b) Sirenin
 - c) Antheridiol and oogonial
 - d) Trisporic acid
 - e) Yeast a-factor
 - f) Physiological specialization
 - g) Phylogeny of fungi
 - h) Theories of algal ancestry
 - i) Protozoans ancestry of fungi
 - j) Sparrow's view with regard to the origin of lower fungi
 - k) Biochemical support for evolutionary relationships

- l) Origin of zygomycetes
- m) Origin of ascomycetes
- n) Origin of basidiomycetes
- o) Recent concept on origin and phylogeny of fungi

Credit - II

3. Role of fungi as saprotrophs (10L)

- a) Fungi as decomposers in nature
- b) Return of carbon dioxide to the atmosphere
- c) Humus formation
- d) Types of organic compounds decomposed
- e) Cellulose structure and its decomposition
- f) Hemicelluloses decomposition
- g) Decomposition of pectic compounds
- h) Decomposition of lignin
- i) Fungi in biodeterioration
- j) Fungi in bioremediation
- k) Fungi in food spoilage

4. Fungi in pathological relationships with other organisms (10L)

- a) Fungi as plant parasites
- b) Fungi as human pathogens
- c) Entomogenous fungi
- d) Fungi parasitic on other fungi
- e) Fungi parasite on lichens
- f) Allergenic fungi
- g) Poisonous fungi
- h) Toxins from fungi

Credit - III

5. Industrial and biotechnological applications of fungi (10L)

- a) Medicinal uses
- b) Transformation of steroids
- c) Enzymes from fungi
- d) Vitamins from fungi
- e) Fungi as source of organic acids
- f) Fungi in fermentation and food processing
- g) Asian and oriental foods
- h) Edible fungi
- i) Mycoproteins
- j) Fungi in cheese production
- k) Fungi in biological assay
- l) Fungi in biological control of pests
- m) Myconematicides
- n) Mycoinsecticides
- o) Other application of fungal biotechnology

6. Mushroom cultivation (10L)

- Introduction, types of edible mushrooms, nutritional values and their economic importance.
- Cultivation of oyster and button mushroom (spawn preparation, seed bed preparation, compost preparation, spawn running, mushroom development, harvesting).
- Mushroom diseases and their control

References:

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Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Elective Papers – Advanced Mycology - II

Course Code: BOT 5404 (B)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1	3								
CO 2		3							
CO 3			3						
CO 4	2								
CO 5			2						

CO 6								3	
CO 7									3

Justification for the mapping

PO1: Disciplinary Knowledge

CO1. Get knowledge about cryptogams to conserve Cryptogamic diversity.

CO4. Get knowledge about life history of algae, fungi bryophytes.

PO2: Critical Thinking and Problem Solving

CO2. Classify the cryptogams up to species level.

PO 3: Social competence

CO3. Get aware about the importance of Cryptogams.

CO5. Explain the role of Algae, Fungi and Bryophytes in human welfare.

PO 8: Environment and Sustainability

CO6. Aware about plant conservation in society.

PO 9: Self-directed and Life-long Learning

CO7. Analyze industrial applications of algae.

Class : **M.Sc. (Semester- IV)**
Paper Code : **BOT 5404 (C)**
Paper : **IV** **Title of Paper** : **Bryology**
Credits : **4** **No. of lectures** : **60**

A) Learning Objectives:

1. To understand deep knowledge of season, collection and life-cycle of plants.
2. To study vegetative, reproductive structures of plants
3. To develop In-situ and Ex-situ conservation techniques.
4. To identify the environmental and economic uses.
5. To understand the alternation of generations.
6. To understand an overview of diversifying bryophytes.
7. To understand evolution, morphology, physiology and ecology of bryophytes.

B) Learning Outcome:

- CO1. Knowledge of bryophytes at different localities.
- CO2. Understanding of practical applications of bryophytes.
- CO3. Development of Ex-situ conservation techniques.
- CO4. Protocols for In-vitro general techniques of tissue culture in bryophytes.
- CO5. Students are able to develop Ex-Situ conservation techniques of bryophytes.
- CO6. Understanding of economic importance of bryophytes.
- CO7. Understanding the alternation of generations and evolution of bryophytes.

Credit –I (15L)

1.1 Different aspects of bryophytes ecology, growth forms effects of climatic, edaphic and biotic factors, role of liverworts, hornworts and mosses in plant communities and succession in terrestrial, aquatic and epiphytic ecosystem. **15L**

Credit –II (15L)

2.1 Important elements of micro-climate as local -topography, soil surface, air temperature, wind, precipitation and humidity, micro-climate importance in the study vegetation and methods as land forms, microclimate fluctuation correlated with Beta Diversity of Epiphyllous Bryophyte Communities site preservation, factors affecting microclimate w.r.t. topography, soil, water, vegetation, erosion and artificial structures. **15L**

Credit –III (15L)

3.1 Eco-physiological and climatic adaptations in bryophytes- Ecology of bryophytes, adaptations in bryophytes- canopy, epiphytes and epiphyllous, physiology of bryophytes and water relations, oil bodies, bryophytes as indicators of altitude, air pollution and water pollution. **15L**

Credit –IV

(15L)

4.1 Morphogenesis -*In-vivo* and *In-vitro*, general techniques of tissue culture- callus, organ, free cell and protoplast, their implications. mycorrhiza in gametophytes and sporophytes, mode of penetration and establishment of mycorrhizal association, role of mycorrhiza in nutrition, germination, salt absorption and growth. **15L**

References:

1. S. R. Kashyap, 1929. Liverworts of Western Himalaya and Punjab Plain, Part-I.1932, Part-II.
2. T. T. Mahabale, 1941. On the chromosomal complex of two species of *Riccia*, *Jour. univ. Bombay*, 16: 1-16.
3. T. S. Mahabale, and Gorji, 1941. Chromosomes in *Riccia himalayensis*. *Curr. Sci.*10:28.
4. P. N. Mehra, 1967. Evolutionary trends in the Hepaticae. *Phytomorphology*. 17: 47-58
5. N. S. Parihar, 1967. An Introduction to Embryophyta. Vol. I Central Book Depot, Allahabad.
6. A. Rashid, 1998. An Introduction to Bryophyta (Diversity, Development and Differentiation)
7. G. M. Smith, 1955. Cryptogamic Botany, Vol-II Bryophytes and Pteridophytes. Edi. 2, New York.
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10. E. V. Watson, 1955. British mosses and liverworts. Cambridge, 419 p.
11. R. S. Chopra, 1975. Taxonomy of Indian mosses.
12. R. N. Chopra and P. K .Kumra, 2005. Biology of Bryophytes.
13. A. J. E. Smith, 1982. Bryophyte Ecology.

14. R. N. Chopra and S. Bhatiya, 1990. Bryophyte Development- Physiology and Biochemistry.

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. III)

Subject: Botany

Course: Elective Papers – Bryology - II

Course Code: BOT 5404 (C)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1	3								
CO 2	3								
CO 3								2	
CO 4	3			3					
CO 5	3								
CO 6						3			
CO 7	2								

Justification for the mapping

PO1: Disciplinary Knowledge

CO1. Knowledge of bryophytes at different localities.

CO2. Understanding of practical applications of bryophytes.

CO4. Protocols for In-vitro general techniques of tissue culture in bryophytes.

CO5. Students are able to develop Ex-Situ conservation techniques of bryophytes.

CO7. Understanding the alternation of generations and evolution of bryophytes.

PO 4: Research-related skills and Scientific temper

CO4. Protocols for In-vitro general techniques of tissue culture in bryophytes.

PO6: Personal and Professional Competence

CO6. Understanding of economic importance of bryophytes.

PO 8: Environment and Sustainability

CO3. Development of Ex-situ conservation techniques.

Class : M. Sc. (Semester- IV)
Paper Code : BOT 5404 (D)
Paper : IV **Title of Paper** : **Angiosperm Taxonomy**
Credits : 4 **No. of lectures** : 60

A) Learning Objective

1. To give knowledge about Origin of Angiosperms.
2. To learn about Importance and need for classification, hierarchical classification.
3. To learn about pre- and post- Darwinian systems of classification.
4. To impart the knowledge of fossil angiosperms of India.
5. To impart the knowledge of Floral Biology.
6. To idea about phytogeography.
7. To impart the knowledge about Dicotyledons and Monocotyledons families.

B) Course Outcome

By the end of the course, students will be able to:

- CO1. Origin of Angiosperms.
- CO2. Importance and need for classification, hierarchical classification.
- CO3. Pre- and post- Darwinian systems of classification.
- CO4. Fossil angiosperms of India.
- CO5. Floral Biology.
- CO6. Phytogeography.
- CO7. Dicotyledons and Monocotyledons families.

Credit I **(15L)**

1.1 Origin of angiosperms: Pre-cretaceous and Cretaceous fossil angiosperms; Time of origin of angiosperms; Cradle of angiosperms; monophyletic verses polyphyleti origin of angiosperms. **5L**

1.2 Importance and need for classification, hierarchical classification. Criteria used for classification; phases of plant classification. Overview on pre- and post- Darwinian systems of classification. Floral Biology: Evolution of flower, co-evolution of flowering plant and insects, sex distribution in flowers and plants, types of pollinations; cleistogamy and chasmogamy. **10L**

Credit II

(15 lectures)

2.1 Fossil angiosperms of India:

Brief account of fossil angiosperms of India- Palmae: Palmoxylon, Rhizopalmoxylon, Palmocarpon; Cyclanthaceae: Cyclanthodendron, Tricoccites; Pandanaceae: Viracarpon; Musaceae: Musa Gramineae: Graminocarpon; Sonneratiaceae: Sonneratiioxylon, Sahnianthus, Enigmocarpon; Guttiferae: Indocarpa, Myrtaceae: Sahnipushpam; Malvaceae: Sahnioocarpon, Chitaleypushpam. Fossil angiosperms and palaeoecology of India.

Credit III

(15 L)

3.1 Phyto geography: Geological time scale, geographical history, Continental Drift, Land Bridges, shifting of poles, theories of differentiation and natural selection, Center of origin, types and areas of natural distribution, phytogeographical regions of the World, Botanical provinces of India and their characteristic vegetation with emphasis on Vegetation and Phyto geography of the Western Ghats.

3.2 Phyto geography and speciation: Ecological variations, adaptations, plant systematics and genetic variations.

Credit IV

(15 lectures)

General Knowledge and distinguishing features of the following families:

- a) **Dicotyledons:** Bixaceae, Sterculiaceae, Agavaceae, Melastomaceae, Rubiaceae, Convolvulaceae, Gentianaceae, Podostemonaceae, Santalaceae, Scrophulariaceae, Casuarinaceae, Salicaceae and Scrophulariaceae.
- b) **Monocotyledons:** Liliaceae, Eriocaulaceae, Pandanaceae, Hydrocharitaceae, Lemnaceae and Poaceae.

References

1. M. Ahmedullah, and M. P. Nayar. 1987. Endemic Plants of the Indian Region Vol I. Botanical Survey of India.
2. T. Cooke, 1903-1908. The Flora of Presidency of Bombay, Vol. I-III.

3. P. H. Davis, and V. H. Heywood 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi.
4. Endress Peter, K. 1994. Diversity and Evolutionary Biology of Tropical Flowers. Cambridge.
5. Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy. Angiosperms. Hafner Publ. Co. New York.
6. Hutchinson, J. 1959. Families of Flowering plants.
7. K. S. Manilal, and M. S. Muktesh Kumar [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.
8. V. N. Naik, 1984. Taxonomy of Angiosperms Tata McGraw-Hill Publication Com. Ltd. New Delhi.
9. K. Paech, and M.V. Tracey. 1956. Modern Methods of Plant Analysis. Vol-I & II. Springer-Verlag.
10. R. B. Primak, 2004. A Primer of Conservation Biology. Sinauer Associates, Inc. Publishers.
11. K. R. Shivanna, and B. M. Johri 1985. The Angiosperm Pollen: structure and Function. Wiley Eastern limited, New Delhi.
12. Syngé, Hugh (ed.) 1980. The biological aspects of Rare Plant Conservation. John Wiley & Sons.
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Choice Based Credit System Syllabus (2022 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Elective Papers – Angiosperm Taxonomy - II

Course Code: BOT 5304 (D)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1	3								
CO 2	3								
CO 3	3								
CO 4	3								
CO 5	3								
CO 6	3								
CO 7				2					

Justification for the mapping

PO1: Disciplinary Knowledge

CO1. Origin of Angiosperms.

CO2. Importance and need for classification, hierarchical classification.

CO3. Pre- and post- Darwinian systems of classification.

CO4. Fossil angiosperms of India.

CO5. Floral Biology.

CO6. Phytogeography.

PO 4: Research-related skills and Scientific temper

CO7. Dicotyledons and Monocotyledons families.

Class : M.Sc. (Semester- IV)

Paper Code : BOT 5405

Paper : V

Title of Paper: Practical's Based on BOT 5401,5402,5403

Credits : 4

No. of lectures: 60

A) Learning Objectives:

1. To give hands on training plant pathological, biotechnological, gardening techniques,
2. To provide the knowledge required for setting up of nursery, labs.

B) Course Outcome:

By the end of course students will be able to

- CO1. Explain basic cell structure.
- CO2. Understand basic biological concepts.
- CO3. Get acquainted with some cytological techniques.
- CO4. Understand basic knowledge about structure of cell organelles.
- CO5. Explain mechanism of cells in plant.
- CO6. Train in different isolation techniques in cell organelle.
- CO7. Interprets cell structure and their function.

Practical's based on BOT 5401 Plant pathology

Plant Pathology

1. Study of any two each- bacterial, nematodal and viral diseases **1P**
2. Study of any six fungal diseases **1P**
3. Isolation of fungal pathogens from leaves, stem and roots by cultural methods **1P**
4. Demonstration of Koch's postulates for fungal pathogens **1P**
5. Study of pure culture of fungi by streak plate and pour plate method **1P**

Practical's based on BOT 5402 Industrial Botany

1. Qualitative tests for carbohydrates, starch, proteins, lipids, alkaloids and tannins **1P**
2. Study of any four post harvest diseases of fruits and submission of report on general postharvest technology methods followed by farmer. **1P**
3. Study of nursery media, preparation of nursery beds and raising of nursery seedlings. **1P**
4. Collection and preparation of soil samples for analysis. **1P**
5. Design and layout of Nutrition Garden. **1P**
6. Study methods of training and pruning. **1P**
7. Study of major pests and diseases vegetables and their control measures. **2P**
8. Study of threshing and seed extraction methods. **1P**

9. Study of physiological and harvest maturity for seed. 1P
10. Study of seed drying principles and methods, seed treatment and seed packing. 1P

Practical's based on BOT 5403 Plant Biotechnology

1. Preparation of M. S. Media.
2. Ex-plant Surface Sterilization, Callus Culture and Organ Culture
3. Anther Culture / Production of haploids.
4. Study of *Agrobacterium* mediated transformation.
9. Study of bacterial growth pattern.
10. Estimation of alcohol.
11. Isolation of root nodule bacteria.
13. In vitro rooting and acclimatization.
14. Protoplast isolation and culture.

Note:

Visit to Krishi Vigyan Kendra to see home garden, Olericulture practices and submission of report.

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Practical based on BOT 5401, BOT 5402 and BOT 5403

Course Code: BOT 5405

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1	3								
CO 2	3								
CO 3						3			
CO 4	2								
CO 5	2								
CO 6									3
CO 7					3				

Justification for the mapping

PO1: Disciplinary Knowledge

CO1. Explain basic cell structure.

CO2. Understand basic biological concepts.

CO4. Understand basic knowledge about structure of cell organelles.

CO5. Explain mechanism of cells in plant.

PO5: Trans-disciplinary Knowledge

CO7. Interprets cell structure and their function.

PO6: Personal and Professional Competence

CO3. Get acquainted with some cytological techniques.

PO 9: Self-directed and Life-long Learning

CO6. Train in different isolation techniques in cell organelle.

Class : M.Sc. (Semester- IV)

Paper Code : BOT 5406

Paper : VI

Credits : 4

Title of Paper: Research Projects and Summer Training

No. of lectures: 60

A) Learning Objectives:

1. To give hands on training and practical skills to the students.
2. To provide the knowledge required for writing review and case studies.

B) Learning Outcome:

- CO1. Information acquired about research work.
- CO2. Getting of awareness of innovative methodology.
- CO3. Significant conclusions and outputs.
- CO4. Information acquired about research work.
- CO5. Getting of awareness of innovative methodology.
- CO6. Significant conclusions and outputs.
- CO7. Information acquired about research work.

Credit - 1 and 2 : Research Project

30L

Projects will be allotted in third semester and students will submit project work having Introduction, review of literature, well defined material and methods, results and discussion, conclusions and references. The project should be presented at the end of fourth semester.

Credit – 3 and 4 : Summer Training

30 L

1. Report submission based on one summer training in research institutes / Laboratory / industry for atleast one month with certificate from respective authority.

Choice Based Credit System Syllabus (2019 Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M. Sc. II (Sem. IV)

Subject: Botany

Course: Practical – Advanced Mycology - II

Course Code: BOT 5406

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9
CO 1	3								
CO 2		3							
CO 3			3						
CO 4	2								
CO 5			2						
CO 6								3	
CO 7									3

Justification for the mapping

PO1: Disciplinary Knowledge

- CO1. Get knowledge about cryptogams to conserve Cryptogamic diversity.
- CO4. Get knowledge about life history of algae, fungi bryophytes.

PO2: Critical Thinking and Problem Solving

- CO2. Classify the cryptogams up to species level.

PO 3: Social competence

- CO3. Get aware about the importance of Cryptogams.
- CO5. Explain the role of Algae, Fungi and Bryophytes in human welfare.

PO 8: Environment and Sustainability

- CO6. Aware about plant conservation in society.

PO 9: Self-directed and Life-long Learning

- CO7. Analyze industrial applications of algae.