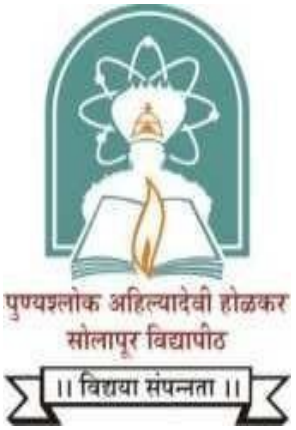
Punyashlok Ahilyadevi Holkar Solapur University, Solapur



NAAC Accredited-2022
'B^{++}'Grade (CGPA 2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Botany

Name of the Course: M. Sc. II (Sem. III &IV)

(Syllabus to be implemented from June 2024)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
M. Sc. II Choice Based Credit System (CBCS)
Course Structure (NEP 2020)
M.Sc. II Botany w.e.f. 2024-25

Sr. No	Paper Code	Course/Title	Nature	Credit	Marks	
Semester III						
1.	**DSC-5** Theory 2314301	**Major mandatory course I** Plant Embryology & Palynology	Theory	4	40	60
2	**DSC-6** Theory 2314302	**Major mandatory course II** Cytogenetics & Crop Improvement	Theory	4	40	60
3	**DSC-5 Practical** 2314304	**Practical based on Major mandatory course I**	Practical	2	20	30
4	**DSC-6 Practical** 2314305	**Practical based on Major mandatory course II**	Practical	2	20	30
5	**DSE-3** Theory 1. 2314306 2. 2314307 3. 2314308	**Major elective course I** (Select One) 1) Advances in plant metabolism & Biochemistry 2) Recent Trends in Angiosperm Taxonomy 3) Plant Biotechnology	Theory	4	40	60
6	**DSE-3** **1.** 2314309 **2.** 2314310 **3.** 2314311	**Practical Based on Major elective course I**	Practical	2	20	30
6	**RP** 2314303	**Research Project**	Practical	4	40	60
		Total credits with marks		**22**	**220**	**330**
Semester IV						
7	**DSC-8** Theory 2314401	**Major mandatory course II** Phytogeography & plant ecology	Theory	4	40	60
8	**DSC-7** Theory 2314402	**Major mandatory course I** Plant Tissue culture, Green house Technology & Hydroponics	Theory	4	40	60
9	**DSC-7** Practical 2314404	**Practical Based Major mandatory course I** Plant Tissue culture, Green house Technology & Hydroponics	Practical	2	20	30

10	**DSE-4** Theory 1. 2314405 2.23144046 3. 2314407	**Major elective course I** (Select One) 1) Environmental Plant Physiology 2) Industrial Botany 3) Industrial and Environmental Biotechnology	Theory	4	40	60
11	**DSE-4** Theory 1. 2314408 2.2314409 3. 2314410	**Practical Based on Major elective course II**	Practical	2	20	30
11	**RP** 2314403	**Research Project**	Practical	6	60	90
		Total credits with marks		**22**	**220**	**330**
		Total Credits Sem III & IV		**44**	**440**	**660**

Revised Syllabus for the Master of Science in Botany, Punyashlok Ahilyadevi HolkarSolapur University, Solapur

(National Education Policy 2020)

General guidelines:

1) There shall be at least a short tour (up to 3 days) and a long tour (not exceeding 10 days) per year for all M. Sc. I and M. Sc. II students. The long tour may be arranged to a region out of the state covering various Botanical Regions/ Research Institutes/ Centers and Universities. Tours are the part of curriculum and are obligatory to each student, failing which they will not be considered eligible to appear for the practical examination. Under unavoidable circumstances, if the student fails to attend the tour, he/ she have to produce justifiable evidence for not attending the tour. However, in lieu of tour the candidate will have to complete thework assigned by the Department.
2) If there are female students in a batch of sixteen, one additional lady teacher is permissible for excursion. T.A. and D.A. for teachers and non-teaching staff participating in the excursions should be paid as per the rules.
3) Following documents will have to be produced by each student at the time of practical examination (at the end of each Semester):
   a. Submission of a laboratory journal of practical records.
   b. Submission of a tour report (in his / her own handwriting) duly signed by the concerned teacher and head of department is mandatory.

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***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course was designated to understand basic concepts in plant embryology, techniques used in plant embryology. Somatic hybridization. This course gives an idea about developmental stages of anther, ovary, fertilization, pollen structure, use of Palynology in taxonomic identifications.

Course objective: During this course, the student is expected to:

1. Get knowledge about different concepts like microsporogenesis, megasporogenesis, process of fertilization & embryo development.

2. Get knowledge about somatic embryogenesis.

3. Get knowledge about developmental stages & pollen structure.

4. Get knowledge about different branches of Palynology & its use if different fields.

Course Outcomes: At the end of this course students will be able to:

1. Understand about microsporogenesis & megasporogenesis
2. Understand about development process of male & female gametes
3. Understand about apomixes & polyembryony
4. Understand about Current trends of research in plant embryology & palynology.

M. Sc. II Botany Semester-III

Major Mandatory Course I
DSC-5 Plant Embryology and

PalynologyLectures-60 (Credits: 4)

Unit-1: Embryology **15L- 23Marks**

Gametophytes in Angiosperms- Brief outline of development of Male and Female Gametophyte. Ultra structure of Male Gametophyte- Vegetative Cell, Generative Cell, Pollen Wall, Pollen Tube; Abnormal Male Gametophytes and their features. Ultra-structures of Female Gametophyte: Synergids, Egg, Antipodals, Central Cell.

Unit-2: Pollen - Pistil Interaction and Incompatibility **15L- 23Marks**

Pollen - Pistil Interaction and its Significance, Structure of Stigma and Style, Pollen Tube Growth, Chemotropism, Incompatibility, Pollen Wall Proteins, Stigma Surface Proteins, Fertilization, Methods to Overcome Incompatibility, Apomixis- Diplospory, Apospory, causes, consequences and significance of Apomixes.

Polyembryony- Classification, Causes, Experimental Induction and Practical importance

Unit-3: Introduction of Palynology and its branches **4L- 06Marks**

Introduction, Pollen Morphology and Plant Taxonomy with reference to Gymnosperms and Angiosperms branches and scope.

Unit 4: Melit to palynology **6L - 09Marks**

Introduction, Bee colony, foraging behavior of bees, unifloral & Multifloral honey, plication incrop productivity, Methodology in forensic study: potential pollen/spore forensic sample collections pollen preservation and controlling factors, Pollen- expressed and pollen specific genes.

Unit 5: Aeropalynology **10L- 15Marks**

Introduction, Principles, techniques, pollen analysis, pollen and spore Allergy, plants causing pollen allergy, allergic properties of pollen, pollen calendar and importance

Unit: 6: Palaeo palynology and Agropalynology **10L- 15Marks**

Palaeo palynology**:** Principles, microfossil recovery, theory and techniques, Microfossils and oil exploration.

Agropalynology: Pollen banks and their role in agriculture and plant breeding, Pollen storage, viability and pollen germination and their significance.

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***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

DSC-5 Plant Embryology & Palynology
Practical Course
Credit 2

1. Study of Development and Ultra structure of Male Gametophyte with the help of Microphotographs.
2. Study of Development and Ultra structure of Female Gametophyte with the help of Microphotographs.
3. Study of types of styles - Solid, Hollow, Filamentous. Types of Stigmas- Dry and Wet Stigmas and their sub types.
4. Study of apomicts (any two) and polyembryony.
5. Study of different types of embryos (monosporic, bisporic and tetraspopric).
6. Pollen germination in situ condition.
7. Determination of Percentage of Pollen Germination in Vitro conditions.
8. Study of Pollen Morphotypes and their significance in Taxonomy. (at least six examples)
9. Honey Analysis. (Unfloral and multifloral).
10. Study of Allergic Plants and their Pollens.
11. Study of Pollen Fertility by TTC or Acetocarmine Methods.
12. Intra –ovarian pollination; Test tube pollination through photographs.

Reference:

Embryology and Palynology

Bhojawani, S.S. And S.P. Bhatnagar, 1998. The Embryology of Angiosperms.

Johri, M.B. 1984. Embryology of Angiosperms.

Maheshwari, P. 1950. An Introduction to the Embryology of Angiosperms.

Maheshwari, P. 1963. Recent Advances in the Embryology of Vascular Plants.

Johri, B.M. 1963. Experimental Embryology of Vascular Plants.

Shivanna, K.R. And B. M. Johri, 1989. The Angiosperm Pollen; Structure and Function.

Stanley, R. G & F.L. Linkens, 1974.Pollenl; Biology, Biochemistry Management

Shivanna K.R. and N. S. Rangaswamy, 1992. Pollen Biology, a Laboratory Manual.

Cunningham, D.D.1873. Microscopic Examination of Air.

Erdtman, G. 1988. Pollen Morphology and Plant Taxonomy.

Fageri, K. And J. Inversen, 1964. Text Book of Pollen Analysis.

Gregory, P.H. 1973. Microbiology of Atmosphere.

Heslop-Harrison, Y.1971.Pollen Development and Physiology.

Moor, P.D. et.al. 1989. Pollen Analysis.

Nair P.K.K.1996. Essentials of Palynology.

Nair P.K.K. 1964 Advances In Palynology.

Tilak, S.T.1989. Airborne Pollen and Fungal Spores.

Malik C.P Physiology of sexual reproduction in flowering plants.

Mulcamy D.L. et.al, Biotechnology and ecology of pollen.

Davis, G.L Systematic embryology of angiosperms.

Nair, P.K. Recent advances in pollen spore research vol I, II and III.

Raghavan, V. Experimental embryogenesis in vascular plants.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M. Sc. (Botany) Semester-III** **Vertical: DSC** **Course Code: 2314302** **Course Name: Cytogenetics and Plant improvement**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course was designated to understand genetics, cytological genetics, chromosomes, plant tissue culture methods, Intellectual property Rights. This course will provide knowledge of plant cytogenetics, Karyotype analysis, isolation techniques of DNA, RNA, Electrophoresis methods.

Course objective: During this course, the student is expected to:

1. Get knowledge about concepts in plant cytogenetics & bioinformatics
2. Get knowledge about ultrastructure & properties of cell orgenells.
3. Get knowledge about methods of replication
4. Get knowledge about techniques of isolation, gene transfer

Course Outcomes: At the end of this course students will be able to:

1. Understand molecular methods used in cytogenetics & bioinformatics
2. Understand use of bioinformatics in life sciences
3. Understand cellular organizations & ultra structures
4. Understand iimportance of Cytogenetics & bioinformatics methods in research with IPR

Major Mandatory Course II

DSC-6 Cytogenetics and Plant improvement

Lectures-60 (Credits: 4)

Unit 1: Genome organization in prokaryotes and eukaryotes 15L- 23marks

Organization of genome in prokaryotes and eukaryotes- structure and organization of the gene inplasmid, viruses, bacteria and eukaryotes Architectural differences of the genome. Geneconversion, amplification, mobile genetic elements and their significance. Gene families.

Unit 2: Genetic Recombination and Genetic Mapping 15L- 23marks

Independent Assortment, linkages and Crossing Over, Molecular Mechanism of Recombination, Site Specific Recombination, Role of Rec A,B,C,D Enzymes. Proteins Involved in EukaryoticRecombination, Recombination Nodules in plants, Chromosome Mapping, Genetic Markers:Conventional and Molecular Markers used in construction of Molecular Maps. Correlation ofGenetic and physical maps, somatic cell genetic an alternative approach to gene mapping.

Unit 3: Modern methods of plant improvement 10L- 15 marks

Introduction, Somaclonal variations, Somatic hybridization protoplast isolation, fusion andregeneration, hybrids. Hybridoma technology, transgenic plants

Unit 4: IPR (Intellectual property right) 05L- 6 marks

Domains of IPR Copyright, Trade Mark, Trade Secrete, Patent concept, importance, ecologicalrisk, biopirecy and ethical concerns application form for patenting

Unit 5: Bioinformatics 15L- 23 marks

Introduction, Proteomics and genomics, Major Bioinformatics Resources on Internet: National Centre for Biotechnology Information (NCBI) The knowledge of various databases and bioinformatics tools available at NCBI resource. The major content of the NCBI data bases purpose and applications in life sciences Protein data bank (PDB) and Nucleic acid sequence database (Gene Bank) The Basic Local Alignment Search Tool (BLAST), Use of bioinformatics in biological research

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M. Sc. (Botany) Semester-III** **Vertical : DSC** **Course Code: 2314305** **Course Name: Cytogenetics and Plant improvement**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credit**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

DSC-6 Cytogenetics and Plant improvement

Practical Course

1. Karyotype analysis in any two plant species.
2. Banding Studies- "O" Banding in *Allium cepa.*
3. Separation of DNA by Gel electrophoresis / Estimation of DNA
4. Meiotic Studies in Structural Hybrids.

5&6. Genetic Problems based on gene mapping

7. Study of methods of Genes transfer through photographs – physical, chemical and biological.
8. Study of GM plants Bt-Cotton, Golden Rice Flavrsavr Tomato through photographs/samples.
9. Practical based on IPR – Procedural information about patenting.
10. Practical based on bioinformatics

11&12. Protoplast isolation, viability testing, Fusion, and Regeneration

Reference Books

Benjamin Lewin- Genes -VIII
James Darnell, Harvey Lodish and David Baltimore- Molecular Cell Biology.
Albert et. al-Cell Molecular Biology.
C. J. Avers-Genetics.
Strick Berger Genetics.
E. J. Gardner- Principles of Genetics. J.
Jahier- Techniques of Plant Cytogenetic.
Sharma A.K. & Sharma A – Chromosome: Theory and Practice.
Genetics – P. K. Gupta 2010
Genetics classical to modern - – P. K. Gupta 2008
Genetics – Verma and Agrawal -2008
Cytogenetics evolution biostatistics and Plant Breeding – Shukla and Chandel
Cell Biology, Genetics, Molecular biology, evolution and ecology – Verma and Agrawal 2008
The world of cell – Backer and Klein Smith (Pearson publication)
Biotechnology - Satyanarayana.
Biotechnology –R. C. Dubey
Biotechnology – P. K. Gupta.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSC** **Course Code: 2314306** **Course Name: Advances in Plant Metabolism & Biochemistry**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course was designated to understand different physiological processesin plants like, photosynthesis, respiration, different cycles, enzymes needed, phosphorous & sulphate metabolism, this concept & techniques will be helpful to apply in various centers & institutes working on crop physiology & crop improvement.

Course objective: During this course, the student is expected to:

1. Learn different concepts in plant metabolism
2. Learn different cycles in plant physiology
3. Learn different enzymes & their role in plant metabolism
4. Learn sulphate & phosphate metabolism in plants.

Course Outcomes: At the end of this course students will be able to:

1. Understand concepts in plant metabolism & apply their knowledge for improvement of plants.
2. Understand different metabolic cycles in plant their use in plant metabolism.
3. Understand importance of enzymes their catalytic actions.
4. Understand importance of sulphate & phosphate in plant metabolism.

DSE 3 Major Elective Course I
Advances in Plant Metabolism & Biochemistry
Lectures-60 (Credits: 4)

Unit: 1 Integration of major metabolic pathways in plants, an overview 2L

Unit: 2 Photosynthesis 13L- 21 marks

Introduction, definition, Ultra structure of chloroplast and light harvesting complexes, Energy transduction in photosynthesis, photosynthetic electron transport, ATP synthesis, photosynthetic pathway C3, C4 and CAM and their subgroups, C3 & C4 intermediates, regulation of Rubisco, PEP case and PCR cycle, photorespiration and its significance. Photosynthetic carbon partitioning, regulation of sugar and starch biosynthesis and significance of Photosynthesis.

Unit: 3 Respiration 15L- 23 marks

Introduction, definition, regulation of glycolysis, Acetyl CoA formation, and TCA cycle, modern concept of electron transport chain in plant mitochondria, pentose phosphate pathway, alternate oxidase, respiratory inhibitors, Gluconeogenesis. Organic acid metabolism – metabolism and role of malic acid,

Unit: 4 Secondary metabolism 15L- 23 marks

Introduction of secondary metabolism, shikimic acid pathway, biosynthesis of aromatic amino acids.

Unit: 5 Phosphorus and Sulphur metabolism 15L- 23 marks

Phosphorus Metabolism: Introduction, Forms of phosphate in soil and plants, mechanism of Puptake, factors controlling P uptake, role of pyrophosphates in plant metabolism. AM and Pnutrition.
Sulphur Metabolism- Forms of Sulphur in soil and plants, sulphate uptake and reduction, biosynthesis of Sulphur containing amino acids (cysteine and methionine) and their role.

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***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Practicals: DSE 3: Advances in Plant Metabolism & Biochemistry (Credit 2)

1. Estimation of Chlorophyll and Carotenoids,
2. Study of leaf anatomy from C_3 and C_4 plants.
3. Estimation of TAN from CAM plants
4. Measurement of Rate of Respiration (In Germinating Seeds).
5. Study of Enzyme Glycolate Oxidase.
6. Determination of CO_2 Compensation Point.
7. Estimation of Ascorbic Acid.
8. Estimation of Polyphenols.
9. Estimation of Phosphorus in Different Plants Parts.
10. Study of AM in plants
11. Estimation or detection of Phosphate or Sulphate in Soil
12. Detection and estimation of secondary metabolites.

References:

Sinha S. K. Sane P.V. Bhargava S.C. and Agraval P.K 1990. Proceedings of International congress of plant
physiology vol I& II.
Smith H. 1975. Phytochrome and Photomorphogenesis.
Steward F.C. 1976. Growth and Organization in Plants.
Stumpf P.K. & Conn. E. 1980. The Biochemistry of Plants: A Comprehensive Treatise.
Tiaz L. And Zieger, F. 1998. Plant Physiology.
Wilkins M.B. 1976. Physiology of Plant Growth and Development.
Annual Reviews of Plant Physiology and Molecular Biology.
Indian Journal of Plant Physiology.
Journal of Experimental Botany.
Physiologic Plantarum Sweden.
Plant Physiology (Bethedsa U.S.A
Bidwell R.C.S. 1979. Plant physiology.
Boner J. and Varner J. E. 1976. Plant Biochemistry.
Edwards G. Walker D.W. 1983. C3-c4 mechanism and cellular environmental regulation of photosynthesis.
Govindjee 1982. Photosynthesis vol I & II.
Hopkins W.C. 1995. Introduction to plant physiology.
Krishnamoorthy H.N. 1992. Physiology of plant growth and development.
Marschner, H.W. 1986. Mineral nutrition of higher plants.
Miller P. 1973. Phyto chemistry vol I, II & III.
Moore T.C. 1974. Research experiences in plant physiology, a laboratory manual.
Mukherjee, S.P. and Ghosh A.N. 1996. Plant physiology.
Noggle G.R. & G.J. Fritz. 1990. Introductory plant physiology II Ed.
Randhir Singh & Sawhney S.K. 1988. Advances in frontier areas of Plant Biochemistry.24
Sadasivan and Manikkam 1996. Plant Biochemical methods.
25 Salisbury F.B. & Ross C.W. 1992. Plant physiology IV Ed

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSC** **Course Code: 2314307** **Course Name: Recent Trends in Angiosperm Taxonomy**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This subject gives knowledge to the students of basic understanding of recent trends in angiosperm taxonomy. Different branches of taxonomy like chemotaxonomy, serotaxonomy, numerical taxonomy & its applications in identification of plants.

Course objective: During this course, the student is expected to:

1. Learn basic concepts in angiosperm taxonomy
2. Learn use of chemicals, proteins, numbers used in identification of plant.
3. Learn methods of herbarium preparation
4. Learn modern systems in taxonomy for classification of plants.

Course Outcomes: At the end of this course students will be able to:

1. Understand plant material using numerical, cytological and physiological aspect.
2. Student can prepare e herbaria
3. Understand about angiospermic plant with respect to numerical, cytological and physiological aspects.
4. Apply their knowledge in identification of plants.

DSE 3: Recent Trends in Angiosperm Taxonomy

(Total Lecture 60)

Unit I: Numerical Taxonomy (12L) 21 marks

Phenetic methods in taxonomy (taximetrics), principles, Construction of taxonomic groups, OUTs, unit character, Measurement of resemblances, cluster analysis, phenons and ranks, discrimination, Nomenclature and numerical taxonomy, applications, merits and demerits, clad as tics and cladogram, clad as tics and classification.

Unit II: Cytotaxonomy (12L) 21marks

Introduction, Chromosome number, Ploidy in relation to taxonomy, Karyotype, Chromosome banding, Meiotic analysis, Scope and Limitation.

Unit III: Chemotaxonomy (12L) 21marks

Introduction, Origin of chemotaxonomy, classes of compounds and their biological significance, stages in chemotaxonomic investigations, techniques, uses of chemical criteria in planttaxonomy, protein and taxonomy, seed proteins

U**nit IV: Ultra-structural Systematics and e-herbaria (12L) 21 marks**

Introduction, SEM and plant surface structure, TEM and dilated cisterneae of endoplasmic reticulum and sieve element plastids, Applications of data in the classification of higher taxa, e- herbaria: preparation and application

Unit V: Modern System of Classification (12L) 21 marks

Introduction, APG III System Outline, Salient features, Merits and demerit

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Botany) Semester-III** **Vertical : DSC** **Course Code: 2314310** **Course Name Recent Trends in Angiosperm Taxonomy**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

DSE 3 Practical

1. Practical based on Numerical Taxonomy
2. Karyotypic study of given plant material
3. Chemotaxonomic studies of plant genera.
4. Study of surface attributes with the help of SEM photograph
5. Study of sieve tube, plastid and dialated cisterneae of ER with the help of TEMphotograph
6. Preparation of e-herbarium

7-12 Study of plant families as per APG system

References:

Cronquist, A. (1988). The Evolution and Classification of Flowering Plants (2nd ed.) AllenPress, U.S.A.

Davis, P. H. and V. H. Heywood (1991). Principles of Angiosperm Taxonomy. Today andTomorrow Publications, New Delhi, India.

Naik, V. N. (1984). Taxonomy of Angiosperms. Tata McGraw-Hill Publication Com.Ltd. New Delhi, India.

Quicke, Donald, L. J. (1993). Principles and Techniques of Contemporary Taxonomy.Blakie Academic & Professional, London, U.K.

Taylor, D. V. and L. J. Hickey (1997). Flowering Plants: Origin, Evolution and Phylogeny.CBS Publishers & Distributers, New Delhi, U.K.

Lawrence George H. M. (1951). Taxonomy of Vascular Plants. Oxford and IBH Publ.Co. Pvt. Ltd. New Delhi, India.

Shivanna, K. R. and B. M. Johri (1985). The Angiosperm Pollen: Structure and Function.Wiley Eastern Limited, New Delhi, India.

Endress Peter, K. (1994). Diversity and Evolutionary Biology of Tropical Flowers,Cambridge, U.K.

Richard, A. J. (1997). Plant Breeding Systems. (2nd ed.) Chapman and Hall.

Rao, R. R. (1994). Biodiversity of India (Floristic Aspects). Bishen Singh Mahendra PalSingh, Dehra Dun, India.

Judd Walter S., Campbell C. S., Kollogg, E. A., Stevens P.F. and M. J. Donoghue (2008)Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur niversity, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSC** **Course Code:** 2314308 **Course Name** Plant Biotechnology
***TeachingScheme** Lectures:**04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course was designated to clear the concepts of plant biotechnology which is an developing science, techniques used for propagation of plants in plant biotechnology, development of new plant varieties & production of disease free plant with helpof plant biotechnology.

Course objective: During this course, the student is expected to:

1. Learn concepts in plant biotechnology
2. Learn techniques used in plant biotechnology.
3. Learn sterilization techniques required in plant biotechnology
4. Learn to develop new plants by using plant biotechnology

Course Outcomes: At the end of this course students will be able to:

1. Understand different hybridization techniques and basics of embryogenesis.
2. They will be able to learn about different gene delivery techniques.
3. Identify different biotechnological techniques used in plant research and breeding.
4. Critically assess the scientific validity and reliability of research studies in plantio technology.

DSC-3: Plant Biotechnology

Lectures-60 (Credits: 4)

UNIT 1: Plant Regeneration technologies 15L 23 marks

- Organogenesis, Somatic Embryogenesis, Synthetic seeds.
- Shoot tip culture/Auxiliary bud culture, Rapid clonal propagation.
- Embryo Culture & Embryo Rescue. Acclimatization of Plants.
- Soma clonal Variations/*Invitro* mutagenesis Selected successful examples of Plants ofDiverse Origin using
- Tissue Culture technology,
- Rescue of endangered Plants.

UNIT 2: Protoplast Culture, Anther Culture and Cryopreservation 15L 23 marks

- Protoplast Isolation, Culture, Fusion, Selection of Hybrid
- Symmetric and Asymmetric hybrids.
- Anther, Pollen and Ovary culture for production of Haploid Plants and Homozygous lines.
- Cryopreservation, Slow growth & DNA Banking for germ plasma Conservation.

UNIT 3: Plant Transformation Technology 15L 23 marks

- Basics of Tumor formation, *Agrobacterium* mediated transformation, Hairy root,Features of Ti & Ri Plasmid and their uses.
- Mechanism of DNA transfer role of Virulence gene, Binary vectors
- Use of 35s & other promoters, genetic markers, viral vectors & their applications
- Multi plegene transfers: vector lessor direct DNA transfer, Use of report ergene,
- Methods of gene transfer in plants: Particle bombardment, electroporation, Microinjection, transformation in monocots, Transgene stability & genesilencing in Plant transformation.

UNIT 4: Application soft Plant Biotechnology 15L 23 marks

- Commercial micro propagation. Metabolic engineering & Industrial products
- Plant secondary metabolites, Industrial enzymes, Biodegradable plastics
- Therapeutic proteins: lysozomal enzymes. Antibodies and edible vaccines.
- Agriculture Diseases resistant plants, Biotic & Abiotic stress resistant plants
- Enhancement of nutritional value of crop Plants & molecular farming
- Applications in Bio-diver site conservation.

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M. Sc. (Botany) Semester-III** **Vertical : DSE** **Course Code: 2314311** **Course Name:** Plant Biotechnology
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Practical Course based on

ME-3-Plant Biotechnology

CREDITS -2

1. Tissue culture lab and its organization. (1 practical weightage)
2. Preparation of solutions and media in plant tissue culture laboratory. (1 practical weightage)
3. Study of sterilization technique: surface sterilization, steam sterilization, flame sterilization, chemical sterilization, fume sterilization, UV sterilization etc. (1 practical weightage)
4. Callus induction and culture using suitable explant (1 practical weightage)
5. Another culture using Dhatura/Convolvulus/any suitable plant material (1 practical weightage).
6. Ovule culture using Cucumis species / suitable plant material (1 practical weightage)
7. Embryo culture using peanut / citrus / suitable plant material (1 practical weightage).
8. Proto plasti solation and culture (1 practical weightage).
9. Protoplast fusion techniques (2 practical weightage)
10. *Invitro* rooting and acclimatization (1 practical weightage).
11. Synthetic seed preparation (1 practical weightage)
12. Agrobacterium mediated genetic transformation. (3 practical weightage)
13. Plasmid Isolation (2 practical weightage).

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पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University,Solapur** **Second Year M. Sc. (Botany) Semester-III** **Vertical: Research** **ProjectCourse Code:** **2314303** **Course Name Research Project:**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M. Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 2314402** **Course Name: Plant tissue culture, Greenhouse technology andhydroponics**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credit**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course preamble: This course was designated to get knowledge about concepts in plant tissue culture, green house technology & hydroponics which is an immerging science for huge production of plant varieties with minimum scale. This course gives idea to develop plants without soil, with disease resistant ability & maximum yield.

Course objective: During this course, the student is expected to:

1. Learn different concepts in plant tissue culture, green house technology & hydroponics.

2. Learn preparation & composition of media used for growth of plants.

3. Learn hydroponics & greenhouse technology techniques of plant growth.

4. Learn growing conditions & maintenance in plant tissue culture, green house technology & hydroponics

Course Outcomes: At the end of this course students will be able to:

1. Understand & apply concepts in development of plant tissue culture
2. Understand techniques & procedure for tissue culture
3. Understand about maintenance & types of Greenhouses.
4. Understand hydroponics, types of media used in hydroponics.

M.Sc. II Botany Semester- IV

DSC 7: Plant tissue culture, Green house technology and hydroponics

Lectures-60 (Credits: 4)

Unit 1: Introduction **15L 23 marks**

Plant tissue culture- Objectives and goals of plant tissue culture, laboratory design and development, operation and management. Tissue nutrition- Basic principles of in vitro culture, factors influencing morphogenesis, Sterilization methods, equipment and apparatus, procedures of media preparation and stock solutions.

Unit 2: Regeneration of Plants **15L 23 marks**

Plant regeneration and plant propagation: Meristem culture / axillary Bud culture, protocols and schedules of observation. Callus culture- somatic embryogeny, cell suspension culture, cell line and bioreactors

Unit 3: Organ culture **10L 15 marks**

Anther culture, Isolation of haploids & its significance. Embryo culture. embryo rescue.
Synthetic seed- Concept method and applications.

Unit 4: Greenhouse technology **10L 15 marks**

Construction, operation, maintenance and Management.
Management- light, temperature, Fertilization, humidity, pest and disease control.

Unit: 5: Hydroponics- Definition, technique, applications **10L 10 marks**

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 23143404** **Course Name: Plant tissue culture, Green house technology andhydroponics**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

DSC 7: Practical's
Credits -2

1. Designing of plant tissue culture laboratory.
2. Preparation of culture media.
3. Sterilization techniques.
4. Callus culture, organogenesis and suspension culture.
5. Meristem culture.
6. Somatic embryogenesis.
7. Techniques of hardening.
8. Encapsulation of embryos.
9. Green house design sketching.
10. Demonstration of watering and nutrient supply system in greenhouse. Drip irrigationsprinklers etc.

11& 12. Study of technique of Hydroponics.

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पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 2314401** **Course Name: Phytogeography and Ecology**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course was designated to get knowledge about phytogeographical regions of India & Maharashtra, biodiversity, RET plants, endemic plants their conservation strategies plant ecology, concept in ecology& factors affecting, Intensification of agriculture and forest policies & green belt.

Course objective: During this course, the student is expected to:

1. Learn concepts in Phytogeography
2. Learn biodiversity of India & conservation strategies.
3. Learn green belt concepts & its applications.
4. Learn different forest & wild animals conservation acts.

Course Outcomes: At the end of this course students will be able to:

1. Understand biodiversity of India with phytogeographical distribution.
2. Understand conservation strategies for wild life & plants
3. Understand importance of green belt
4. Understand different acts, their rules for conservation

DSC 8: Phytogeography and Ecology

Lectures-60 (Credits: 4)

Unit 1: Phytogeography **15L 23 marks**

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation

Unit 2: Biodiversity **15L 23 marks**

Introduction, measures of biodiversity (alfa, beta and gama), Age and area hypothesis, endemism, RET plants, hotspots, Western Ghat vegetation, mangrove vegetation of India,

Unit 3: Greenbelt **15L 23 marks**

Introduction and significance of green belt, Plants and mitigation of pollution, Modeling of greenbelt and plantation design. Nursery and propagation of greenbelt plants. Tree legislation-importance and Maharashtra Tree Act 1975 and 2016 with reference to tree census.

Unit 4: Green Credit Program me **15L 23 marks**

Introduction, objectives and Mechanism, Tree Plantation, Water and Sustainable Agriculture based Green Credit, Waste Management and Air Pollution Reduction based Green Credit. Mangrove Conservation and Restoration based Green Credit. Ecomark based Green Credit: Sustainable building and infra based Green Credit

Unit 5: Intensification of agriculture and forest policies **15L 23 marks**

Biological diversity act 2002, forest conservation act, wildlife protection act with recent amendments, international conventions- Washington convention on trade of flora and fauna (1933), international biodiversity year 2010, role of NGO's in conservation of Biodiversity.

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Principles& Practices.
Mishra &Singh – Flora of India Series- 4, Endemic & Threatened Flowering Plants of Maharashtra.16 M.P. Nayar,
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Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Second Year M. Sc. (Botany) Semester-III

Vertical: DSE

Course Code: 2314405

Course Name: Environmental Plant Physiology

*TeachingScheme	*Examination Scheme
Lectures:04 Hours/week, 04 Credits	UA:60 Marks CA: 40 Marks

Course preamble: This course was designated to understand environmental impact on crop growth how plants tolerate various stress conditions like salt, drought along with various institutes working in area of stress management of plants.

Course objective: During this course, the student is expected to:

1. Learn different types of stress

2. Learn plant physiological changes in stress conditions

3. Learn techniques to overcome stress conditions in plant.

4. Learn different institutes working on stress management of plants.

Course Outcomes: At the end of this course students will be able to:

1. Understand physiological changes & morphological changes during stress conditions.

2. Understand the techniques used under stress management

3. Understand maximum yield production during stress conditions

4. Understand the strategies taken by different research centers on plant stress.

DSE-4 Environmental Plant Physiology

Lectures-60 (Credits: 4)

Unit 1: Introduction to environmental plant physiology (5L) 7 marks

Introduction- Concept of stress & types of stress, plastic strain & elastic strain, stress injury, avoidance, resistance, endurance, & escape.

Unit 2: Water and salt stress (20L) 26 marks

a) **Water stress:** Introduction, Effect of water stress on plant metabolism, drought resistance mechanisms in plants, role of pralines and other osmolites, induction of drought resistance.

b) **Salt stress:** Introduction, Salinity and sod city, types of salinity, causes of soil salinization, a brief account of distribution of salt affected soils in India, effect of salt stress on plant Metabolism, mechanism of salt tolerance in higher plants, reclamation of saline soils. Water logging- Causes of water logging, nature of water logging injury, mechanism of flooding tolerance.

Unit 3: Inorganic element and physical stress (15L) 23 marks

a. Introduction, Heavy metal toxicity, iron, manganese and zinc stress, effects of soil acidity on plants and phytoremidation.

b. Temperature and Radiation Stress: High and low temperature stress on plant metabolism, Radiation stress- Effect of ultraviolet radiations on plants, photo inhibition and Mechanisms of. UV tolerance

Unit 4: Pollution stress (15L) 23 marks

Introduction, Effect of air pollutants (SO2, NOx and Ozone) on plant metabolism, Oxygen toxicity in plants- Free radicals and their scavenging Effect of elevated CO_2 concentration on plant metabolism & productivity.

Unit: 5: Biotic stress (5L) 7 marks

Introduction, Effect of fungal infection on plant metabolism and mechanism of Disease resistance, allelopathy-concept, plant-plant interactions, auto toxicity & allelochemicals.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 2314408** **Course Name: Environmental Plant Physiology**
***TeachingScheme** **Lectures:04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

DSE-4 Practical's

Credits 2

1. Measurement of relative water content and osmotic potential.
2. Determination of chlorophyll stability index.
3. Study of effects of Fe/Zn/Mn toxicity on plant growth and development.
4. Study of proline in plants under stress condition.
5. Study of effect of fungal infection on peroxidase activity.
6. Screening of germplasm for biotic and abiotic stresses
7. Effect of UV radiations on anthocyanin production.
8. Study of free radical scavenging enzymes catalase / SOD.
9. Study of free proline accumulation in plants under stress.
10. Study of effect of waterlogged condition on plants.
11. Study of allelopathic effect on plant growth and development (allelochemicals)
12. Study of chloride and sulphate salinity stress on plant growth and development.

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पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical : DSE** **Course Code: 2314406** **Course Name: Industrial Botany**
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course preamble: This course was designated to understand role of plants in medicines along with economic & medicinal importance of fungi, different photochemical used in medicines so that students will learn herbal drug development strategies.

Course objective: During this course, the student is expected to:

1. Learn use of algae & fungi in industry
2. Learn crude drug preparation methods.
3. Learn various plants used in medicines.
4. Learn techniques of extraction, crude drug preparation & photochemical screening

Course Outcomes: At the end of this course students will be able to:

1. It is helpful to know algal and fungal technology
2. It gives knowledge about medicinal plants
3. This syllabus helpful to know various plants used as a decoction and for juice.
4. This syllabus helpful to understand various extraction and separation techniques and photochemical screening.

DSE-4 Industrial Botany

(Total Lectures: 60)

Unit: I (12L) 19 marks

Algal and Fungal Technology

a. Algal Technology: Introduction, Algae culture system, algae products, cultivation, biomass harvesting, biofuel, SCP

b. Fungal Technology: Role of fungi in industries with reference to the production of alcohol, organic acids, antibiotics and enzymes.

Unit II Pharmacognosy (10L) 15 marks

Introduction, Definition, History, Scope and Development of Pharmacognosy: Pharmacognosy and modern medicine. Classification of drugs. Plant origin, animal origin and synthetic. Sources of crude drugs – roots, rhizome, bulb, corm, tubers, leaves, stems, wood, gum resins, flowers, fruits, seeds and whole plant. Adulteration and drug evaluation; significance of Pharma copoeial standards

Unit III Important Indian Medicinal Plants (14L) 26 marks

a. Plant parts used as Powder:

Identification and utilization of Amla (*Embelica officinalis*), Behra (*Terminalia bellerica*), Harad (*Terminalia chebula*), Turmeric (*Curcuma longa*), Garlic (*Allium sativum*), Bitter guard (*Momordica charantia*), Black plum (*Syzygium cumini*), Fenugreek (*Trigonella foenumgraecum*), Cinnamon (*Cinnamomum verum*), Sarpgandha (*Raulfia serpentina*), Black pepper (*Piper nigrum*), Ashwagandha (*Withania somnifera*), Psyllium husk (*Plantego ovata*)

b. Plant parts used as juice/ decoction:

Identification and utilization of Amla (*Embelica officinalis*), Ginger (*Gingiber officinalis*), Onion (*Alium cepa*), Bottle guard (*Lagenaria siceraria*), Basil (*Oscimum santum*), Arjun (*Terminalia arjuna*), Neem (*Azadirecta indica*), Gwarpatha (*Aloe vera*), Brahmi (*Bacopa monnieri*), Giloy (*Tinospora cordifolia*), Shankhpushpi (*Convolvulus prostrate*), Bael (*Aegle marmelos*)

Unit IV: Extraction and separation techniques: (08L) 7 marks

Maceration, Infusion, Percolation, Decoction, Soxhlet extraction, Microwave assisted extraction (MAE), Supercritical fluid extraction (SFE), Ultrasound assisted extraction, Enzyme assisted extraction.

UNIT V: Phytochemical screening (14L) 21 marks

Occurrence, general structure and properties, classification, structure and functions; medicinal properties of Steroids, Sugars (Total sugar, Reducing and Nonreducing), Terpenoids, Alkaloids, Phenolics, Flavonoids, Saponins, Tannins and Glycosides

Detailed study of the following natural products with special reference to the source, chemical nature and its medicinal properties. 1. Caffeine 2. Curcumin 3. Quinine 4. Digitalis 5. Vincristine & Vinblastine 6. Aspirin 7. Morphine 8. Digoxin 9. Taxol 10. Lysergic Acid Diethylamide (LSD)

	Punyashlok Ahilyadevi Holkar Solapur University, Solapur **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 2314409** **Course Name: Industrial Botany**
***TeachingScheme** **Lectures:04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Practical:

1.	Isolation and culture of *Spirulina*
2.	Identification of commercially important algae.
3.	Identification of mushroom and its cultivation
4.	Identification of medicinal plants
5-9	Preparation of Jam, jelly, pickles, juice and Sauce
10	Preparation of Standard solutions
11	Qualitative and Quantitative analysis of natural products given in syllabus
12	Industrial Visit

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पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ॥ विद्यया संपन्नता ॥ NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 2314407** **Course Name:** Industrial and Environmental Biotechnology
***TeachingScheme** **Lectures:04 Hours/week, 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Preamble: This course was designated to understand industrial applications in botany, Bioprocess Engineering, Downstream processing, ethanol, amino acids production, and bioremediation techniques.

Course objective: During this course, the student is expected to:

1. Learn process of fermentation & biotransformation.

2. Learn process of making of ethanol & amino acids.

3. Learn process of downstream processing.

4. Learn technique of bioremediation.

Course Outcomes: At the end of this course students will be able to:

1. Understand components of plant tissue culture media and their functions.
2. Understand significance of aseptic techniques in plant tissue culture.
3. Understand proficiency in using aseptic techniques for culturing plant tissues.
4. Understand commercial applications and benefits of plant tissue culture in various industries

DSC4: Industrial and Environmental Biotechnology

(Lectures-60Credits: 4)

UNIT-1: Introduction to Bioprocess Engineering 15L 23 Marks

- Introduction to bioprocess, Bioreactors: design, types (Air lift, Bubble column, packed bed, fluidized bed, Photobioreactor), sterilization.
- Fermentation medium: formulation and sterilization. Air sterilization.
- Types of fermentation processes: (Batch, fed batch, continuous, submerged, and solidstate). Bio-transformation. Analysis of mixed microbial population.
- Isolation and preservation of industry ally important microorganisms.
- Microbialgrowthkinetics.ApplicationsofComputerinbioprocessengineering.
- Measurement and control of bio-process parameters (Physical, chemical and biological).

UNIT-2: Upstream processing 15L 23 marks

- **Upstream process:** Industrial production of chemicals: Ethanol, Organic acids (citric acid, acetic acid and gluconic acid), Solvents (glycerol, acetone, and butanol), Antibiotics (Penicillin, Streptomycin and Tetracycline), Amino acids (lysine and glutamic acid). Vitamin (B12)
- Single cell protein and Single cell oil. Fermented food products (Bread, Idli, Dairy products and Alcoholic beverages).

UNIT-3 Downstream processing 15L 23 marks

- **Downstream process**: Introduction, Solid liquid separation (flotation, flocculation, sedimentation, filtration and centrifugation), Celllys is (physical, chemical and biological methods) Concentration (Evaporation, solvent extraction, membrane filtration, precipitation and adsorption), Purification by chromatography, Formulation (dehydration, crystallization and use of stabilizing agents).
- Distillery and pharmaceutical industrial Effluent treatment (Physical, chemical and biological methods)

UNIT 4: Bio-remediation 15L marks

- Biomaterials as substitutes for non-degradable materials (bio-plastics, biofuel, bioinsecticide, and biofertilizer)
- Molecular mechanisms for heavy metal tolerance (Biosorption, bioaccumulation bio-assimilation, bioprecipitation, bioleaching, and biotransformation), Bioindicators (Bacteria, plant and animal)
- Bio-sensors for detection of pollution, Air-Pollution Control

- Solid Waste Management (Hazardous & non- hazardous)
- Biotreatment of textile Effluent, Xenobiotics,
- Biological Detoxification of PAH.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 2314410** **Course Name:** Industrial and environmental biotechnology
***TeachingScheme** **Lectures:04 Hours/week, 02 Credits**	***Examination Scheme** **UA:30 Marks** **CA: 20 Marks**

Practical Course based on

ME-4 Industrial and environmental biotechnology

CREDITS -2

1. Necessity and procedure of writing SOPs for instruments/equipments to be used in scale up and/or largescale production.
2. Culturing and char act erization of micro or ganismsused in Dairy and Bakery.
3. Culturing and characterization of fungi/actinomycetes used in pharmaceutical industry.
4. Production and estimation of organics olvents: Ethanol /Acetone /Butanol /Glycerol.
5. Production and estimation of Alcoholic beverages: Beer/Wine.
6. Production and estimation of Phenylalanine/L-lysine/VitaminB12.
7. Preservation of industrial microorganisms (short term and long term).
8. Degradation of xenobiotic/textile ebyusing bacteria/fungi.
9. Determination of COD for the given effluent sample.
10. Determination of BOD for the given effluent sample.
11. Demonstration of detection of antibiotics from fungal biomass.
12. Production of ergot alkaloid by using fungal elicitors.
13. Culture and Mass Production of Fungi used as Biofertilizers
14. Culture and Mass Product ionfungi as a biocontrol of plant pathogens
15. Production of alcohol by fermentation technique.

REFERENCEBOOKS:

- Sullia S. B & Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd .
- Glaser A. N & Nilaido. H (1995) Microbial Bio-technology, W. H Freeman & Co.

- Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
- Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India)Publishers.
- Crueger W & Crueger A.(2000)A text of IndustrialMicrobiology,2ndEdition, Panima Publishing Corp.
- Stanbury P.F, Ehitaker H, Hall S.J (1997) Principles of Fermentation Technology., AdityaBooks(P) Ltd.
- S.N.Jogdan(2006) Industrial Biotechnology, Himalaya Publishing House
- Amann, R. I. Stromley, J. Stahl: Applied & Environmental Microbiology
- Dash: Concept so f Ecology
- Chattergy: Environmental Biotechnology
- Varma & Agarwal: Environmental Biology
- B. K. Sharma: Environmental Chemistry
- Peavy & Rowe: Environmental Pollution
- Asthana & Asthana: Environment Problems & Solution

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **Second Year M.Sc. (Botany) Semester-III** **Vertical: DSE** **Course Code: 2314407** **Course Name:** Research project
***TeachingScheme** **Lectures:04 Hours/week, 06 Credits**	***Examination Scheme** **UA:90 Marks** **CA: 60 Marks**