

405 - M.SC. BOTANY

Programme Structure and Scheme of Examination (Under CBCS)
(Applicable to the Candidates admitted from
the Academic year 2022-2023 onwards)

Course Code	Study Components & Course Title	Hours / Week	Credit	Maximum Marks		
				CIA	ESE	Total
SEMESTER-I						
22PBOTC11	Core Course - I : Phycology, Mycology and Bryology	5	4	25	75	100
22PBOTC12	Core Course - II : Microbiology and Plant Pathology	5	4	25	75	100
22PBOTC13	Core Course - III : Pteridology, Gymnosperms and Palaeobotany	5	4	25	75	100
22PBOTP14	Core Practical - I : Core Practical-I (covering Papers - I,II & III)	10	7	40	60	100
22PBOTE15	Core Elective - I	3	3	25	75	100
22PBOTO16	Open Elective - I	2	2	25	75	100
Total		30	24			600
SEMESTER-II						
22PBOTC21	Core Course - IV : Anatomy and Embryology of Angiosperms	5	4	25	75	100
22PBOTC22	Core Course - V : Cytogenetics, Plant Breeding and Evolution	5	4	25	75	100
22PBOTC23	Core Course - VI : Plant Tissue culture	5	4	25	75	100
22PBOTP24	Core Practical - II : Core Practical-I (covering Papers - IV,V & VI)	10	7	40	60	100
22PBOTE25	Core Elective - II :	3	3	25	75	100
22PHUMR27	Compulsory Course : Human Rights	2	2	25	75	100
Total		30	24			600

List of Core Elective (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	H / W	C	CIA	ESE	Total
I	22PBOTE15-1	Mushroom Cultivation	3	3	25	75	100
	22PBOTE15-2	Sylviculture and Seed Technology	3	3	25	75	100
	22PBOTE15-3	Industrial Microbiology	3	3	25	75	100
II	22PBOTE25-1	Marine Botany	3	3	25	75	100
	22PBOTE25-2	Techniques in Botany	3	3	25	75	100
	22PBOTE25-3	Pharmacognosy	3	3	25	75	100

List of Open Elective (Choose 1 out of 3 in each Semester)

Semester	Course Code	Course Title	H /W	C	CIA	ESE	Total
I	22PBOTO16-1	Organic Farming and Bio-fertilizers	3	2	25	75	100
	22PBOTO16-2	Herbal Botany	3	2	25	75	100
	22PBOTO16-3	Mushroom Cultivation	3	2	25	75	100

SEMESTER - I CORE - I	22PBOTC11: PHYCOLOGY, MYCOLOGY AND BRYOLOGY	CREDITS: 3 HOURS: 75
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COURSE OBJECTIVES

1. To understand the General Characters, Economic importance of Algae
2. To understand the diversity, structure and Life cycle of Algae.
3. To understand the General features, diversity, reproduction and of Fungi
4. To acquire the knowledge of General Characters, diversity, reproduction and of Lichens.
5. To understand the General Characters, diversity, reproduction and of Bryophytes

Unit I: Phycology

Introduction-general character – Classification of algae)Fritsch, 1945(life cycle patterns in algae. Algae as biofuel, bioremediation, aquaculture, bioactive compounds in algae and algal culturing techniques-algal blooms-algae in soil fertility-algae as pollution indicators -fossil algae and Economic importance of algae.

Unit II: Phycology

General features-range of vegetative structure-reproduction-life cycle and evolutionary trends in Cyanophyceae)*Microcystis*, *Oscillatoria Anabaena*, *Scytonema* and *Stigonema* Chlorophyceae)*Chlamydomonas*, *Hydrodictyon*, *Ulva*, *Cladophora*, *Chaetophora*, *Halimeda* and *Chara*(Xanthophyceae)*Botrydium* and *Vaucheria*(Bacillariophyceae)*Navicula* and *Pinnularia*(Phaeophyceae)*Ectocarpus*, *Dictyota*, *Padina*, and *Sargassum*(Rhodophyceae)*Polysiphonia* and *Gracilaria*)

Unit III: Mycology

General Characters -Classification of fungi)Alexopoulos and Mims 1979(- Cell wall composition, mode of nutrition, vegetative structure, reproduction, and life cycle of Myxomycetes)Physarum, Stemonites(Zygomycetes)Mucor, Rhizopus, Pilobolus(Oomycetes)Cystopus, Phytophthora, Pythium(. Ascomycetes)Aspergillus, Xylaria ,Morchella ,Taphrinia(Basidiomycetes)Lycoperdon, Auricularia, Polyporus, Pleurotus(and Deuteromycetes)Alternaria, Colletotrichum, Fusarium(. Heterothallism, Ecology of fungi. Parasexuality in fungi. Mycorrhiza, ectorphic, endophytic and VAM fungi. Economic importance of fungi.

Unit IV: Lichenology

General character and Classification of Lichens)Hale, 1969(– Origin and Evolution of Lichens. Occurrence and Inter-relationship of Phycobionts and Mycobionts - Structure and Reproduction in Ascolichens, Basidiolichens and Deuterolichens – Lichens as pollution indicator Economic importance and ecological significance of lichens.

Unit V : Bryology

Introduction, general characters, classification)Rothmaler,1951(, origin and evolution of bryophytes. Alternation of generation in bryophytes .Comparative morphological account of sporophytes and gametophytes and life cycle of Hepaticapsida)Marchantia, Lunularia, Reboulia, Dumortiera, Targionia, Pallavicinia, Porella(. Anthocerotopsida)Anthoceros(Bryopsida)Sphagnum and Bryum(. Evolution of gametophytes and sporophytes. Fossil bryophytes, Methods to conserve bryophytes at national level. Economic importance of bryophytes.

COURSE OUTCOMES

On the completion of this paper, students will be able to

1. Learn about Thallus organization, Reproduction, and Lifecycles in Algae.
2. Knowing cultivation of important seaweeds, mass culture of microalgae and their use in waste land reclamation, Bio-fouling and Bio-remediation.
3. Learn about detailed study about some fungal forms belong to different classes of fungi
4. Acquiring general characters, Morphology, reproduction and Life history of Lichens
5. Understanding general character of Bryophytes and Conduction in bryophyte.

Text Books

1. Kumar, H.D. 1985. Introductory Phycology East West Press, New Delhi.
2. Sharma, O.P. 2011. Diversity of microbes & Cryptogams – Algae, Tata McGraw Hill Education Private Limited, New Delhi.
3. Alexopoulos, C.J. Mims, C.W. 1979. Introductory Mycology, Wiley Eastern Ltd., New Delhi
4. Dube, H.C 1983. Introduction of Modern Mycology. Blackwell Science Publication. Oxford
5. Dube, H.C. 1990. An Introduction of Fungi. Vikas Publication House Ltd, New Delhi.
6. Chopra.R.N. 1998. Biology of Bryophytes. New Age International Pvt. Ltd., New Delhi.
7. Gangulee, H.C. and Kar. A.K. 1989. College Botany. Vol. II. New Central Book Agencies Ltd., Kolkata.
8. Reddy, S.M. 1996. University Botany. I: Algae, Bryophyta and Pteridophyta. New Age International Publishers, New Delhi.
9. Singh, S.K. 2006. Text Book of Bryophyta, Campus Books, New Delhi.
10. Vashishta, B.R., Sinha, A.K. and Kumar, A. 2005. Botany for degree Students, Bryophyta. S.Chand and Co. Ltd, New Delhi.
11. Alain Vanderpoorten and Bernard Griffin, 2009. Introduction to Bryophytes. Cambridge University Press. London.

12. Foster, A.S. and Gifford, E.M. 1973. Comparative Morphology of Vascular Plants. W.H. Freeman and Co.
13. Frank Cavers. 1981. The Inter Relationship of the Bryophyta. S.R.Technico Book house.
14. Tuba, Z. Nancy, G. Slack and Lloyd, R. Stark. 2011. Cambridge University Press. New York.

Supplementary Readings

1. Chapman, V.J and Chapman. 1973. The algae – ELBS & MacMillan, London.
2. Fritsch, F.E. 1935. The Structure & Reproduction of The Algae)Vol1&2(Cambridge University press, England.
3. Lee, R. E. 2008. Phycology IV Edition, Cambridge University Press, New Delhi.
4. Bessey, E.A 1979. Morphology and Taxonomy of fungi, Vikas publishing House Pvt. Ltd, New Delhi.
5. Mehrotra, R. S. and Aneja K.R. 1990. An Introduction to Mycology, New Age International Pub, New Delhi.
6. Dharani DharAwasthi. 2000. A Handbook of Lichens. Vedams eBooks)P(Ltd. New Delhi.
7. Hale, M.E. 1983. The Biology of Lichens. Edward Arnold, London.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2			
CO2	3		3	3	2
CO3	3		3	3	3
CO4	3	2	2	2	3
CO5	3	3	3	3	3

SEMESTER - I CORE - II	22PBOTC12: MICROBIOLOGY AND PLANT PATHOLOGY	CREDITS: 4 HOURS: 75
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COURSE OBJECTIVES

1. To study the different types of microorganisms and their activities
2. This course is introduced to make the students understand and appreciate the fundamental principles of basic and applied microbiology.
3. To understand and realize the classification, structure, reproduction and economic importance of Bacteriology and Virology
4. To study the mechanism of infection and colonization of plant diseases
5. To study disease cycle and control measures of various plant diseases.

Unit I : General Microbiology

General classification of microorganisms: Five kingdom concept of Whittaker classification – General characters of Archaeobacteria, Cyanobacteria, Eubacteria - Sterilization Methods: Physical and Chemical methods of microbial control – Culture media – types and culture techniques: – Maintenance of cultures

Unit II : Bacteriology

General Characters of bacteria – Classification by Bergey's)1994(– Bacterial morphology – Ultra structure of bacterial cell – Bacterial growth: Growth curve, measurement of bacterial growth: Measurement of cell mass and cell number – Simple and Differential staining: Gram's staining – Nutrition of bacteria – Reproduction of bacteria: Asexual and Para sexual methods - Economic importance of bacteria and its role in agriculture and industry.

Unit III: Virology

Viruses – History and development of virology - General features, Classification, Morphology and Structure of virus: Physical, chemical and structural Properties of viruses. Replication of viruses - Bacteriophages – Classification – Lytic and lysogenic cycle. Viroid and Prions – SARS, EBOLA, Corona virus – properties, epidemiology, symptoms, diagnosis)RT-PCR(, treatment, prevention and control.

Unit IV: Plant Pathology

Koch's postulates and Inoculum potential – Parasitic and Non-Parasitic causes of diseases – Disease symptoms: Necrotic, Hypoplastic and Hyperplastic – Plant-microbe interactions – mutualism, Mycoparasitism, Antagonism, Commensalism – Entry and Invasion of the pathogen to the host plant and damage to host Tissues - Toxins in pathogenesis – Defense Mechanism in Plants – Mechanical and Chemical Mode.

Unit V : Plant Pathology

Epidemiology – The causes of epidemics, environment and pathogenic factors – Plant protection and protective methods - Integrated Pest Management)Physical, Chemical and Biological(– Detailed account on Diseases in Rice) Blast disease, Bacterial leaf blight, Tungro disease(, Sugarcane)Red rot, Sugarcane Mosaic(, Cotton)Wilt of cotton, Angular leaf spot(, Banana)Panama disease and Bunchy Top(& Groundnut)Tikka disease(.

COURSE OUTCOMES

On the completion of this paper, students will able to

1. Understand the classification and culture techniques of microbes.
2. Students will also study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.
3. Students will learn about the biomolecules by studying their structures and types.
4. Identify common plant diseases and their control measures.
5. Know about microbes and their life to draw inspirations to hire them in applications

Text Books

1. Dubey RC, Maheswari DK 2014. A text book of Microbiology, S.Chand & company, New Delhi.
2. Powar, C.B. and Dagniwala, H.F. 2008. General Microbiology. Himalaya Publishing House, Bombay
3. Sharma, P.D. 2012. Microbiology – Rastogi & Co, Meerut
4. Alexopoulos. C.J. Mims C.H and Black well, M., 2007. IntroductoryMicrobiology. 4 th edition John Wiley and Sons, New York.
5. Bilgrami, K.S. &H.C. Dube 2010A text book of Modern Plant Pathology – VikasPublishing House (P)Ltd., New Delhi

Supplementary Readings

1. Carpenter, P.L. 1977. Microbiology, W.B. Saunders Co., London.
2. Ketchum, Paul, A. 1988. Microbiology: Concepts and application, John Wiley andSons, New York
3. Mandahar, C.L. 1978. An Introduction to Plant Viruses. S. Chand & Co., New Delhi.
4. Mehrotra R.S. and Ashoka Agarwal. 2010. Plant Pathology. TATA McGraw
5. Pelezar,J.M., chan E.C.S and Kreig, R.N. 2008. Microbiology. 13 th Tata Mc.Graw Hill Publishing Company Ltd, New Delhi.
6. Pandey, B.P. 1982. A Textbook of Plant pathology, Pathogen and Plant Diseases.Chand and Co. Ltd., New Delhi.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	3
CO2	3		3	3	3
CO3	2	3		3	3
CO4	2	3	3		
CO5	2	2	2	3	3

SEMESTER - I CORE - III	22PBOC13: PTERIDOLOGY, GYMNOSPERMS AND PALAEOBOTANY	CREDITS: 4 HOURS: 75
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COURSE OBJECTIVES

1. To understand the diversity, structural organization, reproduction and evolution of organs of Pteridophytes & Gymnosperms.
2. To understand the diversity, structural organization, reproduction and evolution of organs of Gymnosperms
3. To acquire the knowledge of the paleobotany.
4. To understand the Geological time Scale
5. To develop the skill on studying of fossil Specimens

Unit I: Pteridophytes

General characters and classification of Pteridophytes (Sporne, Telome and Enation theories, Stelar evolution. Monophyletic and polyphyletic origin of pteridophytes, pteridophytic life cycle with reference to alternation of generations, Eusporangiate and leptosporangiate development of sporangium. Soral evolution.. Apomictic life cycle, apogamy, apospory, heterospory and seed habit. Spore structure, pattern of spore germination in ferns, Structure and reproduction in fossil forms - *Rhynia*, *Asteroxylon*, *Lepidodendron*, *Lepidocarpon*, *Sphenophyllum* and *Calamites*.

Unit II: Pteridophytes

Structure and evolution of sporophytes of the forms Psilopsida (*Psilotum*), Lycopsida (*Isoetes*), Sphenopsida (*Equisetum*), Pteropsida (*Osmunda*, *Angiopteris*, *Adiantum*, *Dicranopteris*, *Marsilea*, *Salvinia*)

Unit III: Gymnosperms

General characters of Gymnosperms, Classification of gymnosperms (Sporne 1965). Morphology, structure and reproduction of Progymnosperms: Cycadofilicales (*Lyginopteris*, *Medullosa*, *Heterangium* and *Lagenostoma*), Glossopteridales (*Glossopteris*), Pentoxylales (*Pentoxylan*), Cordaitales (*Cordaites*), Cycadales (*Cycas* and *Zamia*)

Unit IV: Gymnosperms

Coniferales - *Cupressus*, *Podocarpus* and *Araucaria*, Taxales - *Taxus*, Ginkgoales - *Ginkgo*, Ephedrales - *Ephedra*, Gnetales - *Gnetum*. Evolutionary tendencies in gymnosperm, organography and life cycle with particular reference to male and female sporophylls, cones, ovules and seeds, Pollination mechanisms, Economic importance of Gymnosperms.

Unit V: Palaeobotany

Introduction, scope and objectives of Palaeobotany, Geological time scale. Radiocarbon dating. Fossilization - method of fossilization; types of fossils. Techniques to study fossils - Ground thin section, Film or Peel technique, Maceration technique and Transfer technique. Fossil nomenclature. Contribution of Birbal Sahni to palaeobotany, Economic importance of fossils.

COURSE OUTCOMES

On the completion of this paper, students will able to

1. Understand the diversity, structural organization, reproduction and evolution of organs of Pteridophytes
2. Knowledge about ferns
3. Understand the diversity, paleoclimate and early fossil members of Gymnosperms
4. Understand the diversity, structural organization, reproduction and evolution of organs of Gymnosperms
5. Understand the Geological time Scale, Develop the skill on studying of fossil Specimens

Text Books

1. Bhatnagar, S.P., and Moitra, A. 1996. Gymnosperms. New age International, Private Limited.
2. Biswas, C., and Johri, B.M. 1997. Gymnosperms. Narosa Publishing House, New Delhi.

Supplementary Readings

1. Arnold, C.A. 1947. An Introduction to Palaeobotany. McGraw Hill Book Company, New York.
2. Brown, H.P. 1989. An Elementary Manual of Indian Tree Technology, Dehradun
3. Chamberlain C.J. 1935. Gymnosperms: Structure and Evolution CBS Publishers and Distributors, N. Delhi.
4. Coulter, J.M., and Chamberlain, C.J. 1917. Morphology of Gymnosperms)Reprinted(Central Book Dept. Allahabad.
5. James, W. 2015. The Gymnosperms Hand Book, Plant Gateway Ltd.
6. Sporne, K.R. 1965. The Morphology of Gymnosperms, Published by Hutchinson University Library.
7. Stewart M. 2007. Classification of Life, Published by Twenty First Century Books

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3		2
CO2	3	-	2	2	3
CO3	3	3	2		3
CO4	3	2	3		3
CO5	3	2	2	3	3

SEMESTER - I CORE PRACTICAL- I	22PBOTP14: (COVERING PHYCOLOGY, MYCOLOGY, BRYOLOGY, MICROBIOLOGY, PLANT PATHOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PALAEOBOTANY)	CREDITS: 7 HOURS: 150
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Phycology

Morphological, reproductive and anatomical study of representative members of the bryophytes studied in theory using cleared whole mount preparation and sectioning) *Oscillatoria, Anabaena, Ulva, Halimeda, Chara, Vaucheria, Dictyota, Padina, Sargassum, Gracilaria.*

Mycology

1. Morphological, reproductive and anatomical study of representative members of the bryophytes studied in theory using cleared whole mount preparation and sectioning) *Stemoites, Pilobolus, Phytophthora, Aspergillus, Morchella, Polyporous, Alternaria, Colletotrichum*
2. Morphological, reproductive and anatomical study of representative members of the lichens *Parmelia, Usnea*

Bryology

Morphological, reproductive and anatomical study of representative members of the bryophytes studied in theory using cleared whole mount preparation and sectioning) *Riccia, Reboulia, Targinonia, Lunularia, Marchantia, Porella, Pellia, Funaria, Sphagnum, Polytrichum.*

Microbiology

1. Staining of microorganisms: Simple staining
2. Gram staining spore and acid fast staining,
3. Preparation of culture media – Synthetic and Non-synthetic.
4. Growth of microorganisms.
5. Serial dilution technique.
6. Hanging Drop method.

Plant Pathology

1. Verification of Koch's postulates.
2. Identification of plant diseases included in the syllabus.

Pteridology

Study of External morphology and reproductive structures and T.S. or L.S. of Leaf, Stem, Cone of the following species - *Psilotum, Isoetes, Equisetum, Osmunda, Angiopteris, Adiantum, Dicranopteris, Marsilea, and Salvinia*

Gymnosperms

Study of External morphology and reproductive structures and T.S. or L. S of Leaf, Stem, Cone of the following species - *Cycas, Cupressus, Podocarpus, Araucaria, Ephedra and Gnetum.*

Palaeobotany

1. Study of fossils in Pteridophytes and Gymnosperms mentioned in the theory.
2. Compression, Impression, Petrified Fossils, Cast and mold, Amber and coal ball

OUTCOME MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	1
CO2	2	3	2	2	1
CO3	2	2	1	1	2
CO4	2	2	2	3	2
CO5	2	2	2	2	3

22PBOTP14: Core Practical - 1

(Covering Papers-I, II & III)

**Phycology, Mycology, Bryology, Microbiology, Plant Pathology,
Pteridology, Gymnosperms and Paleobotany**

Time; 4 Hours

Max. Marks: 100

External Practical: 60

Internal: 40

Question

1. Cut the transverse/ longitudinal sections of the given material A and B. Identify by giving reasons. Draw labeled sketches. Submit the slide for valuation.

(2x5= 10)

2. Take transverse/ longitudinal sections of the given materials C, D and E stain it and mount in glycerin. Submit the slides for valuation. Identify by giving reasons. Draw labeled sketches.

(3x5=15)

3. Identify the fossil slides F and G. Give reasons. Draw labeled diagrams.

(2x3=6)

4. Identify the given pathological specimen H. Write the causal organism, Symptoms and control measures. Draw labeled diagrams.

(5)

5. Write critical notes about the given spotters I, J, K, L, M and N. Identify and Draw label sketches.

(6x4 = 24)

22PBOTP14: Core Practical - 1
(Covering Papers-I, II & III)

**Phycology, Mycology, Bryology, Microbiology, Plant Pathology,
Pteridology, Gymnosperms and Paleobotany**

Key

Q. NO	Material	Identification	Reason	Diagram	Slide	Total
1.	A. Algae	1	2	1	1	5
	B. Fungi	1	2	1	1	5
2.	C. Bryophytes	1	2	1	2	6
	D. Pteridophytes	1	2	1	2	6
	E. Gymnosperms	1	2	1	2	6
3.	Fossil slides	Identification	Era	Reason	Diagram	Total
	F. Pteridophytes	1	1	1/2	1/2	3
	G. Gymnosperms	1	1	1/2	1/2	3
4.	Pathological Specimen	Name of the Disease	Causal organism	Symptoms	Control Measures	Total
	H	1	1	2	1	5
5.	Spotters	Identification	Reason	Diagram		
	I. Algae/Fungi	1	2	1	-	3
	J. Bryophytes	1	2	1	-	3
	K. Pteridophytes	1	2	1	-	3
	L. Gymnosperms	1	2	1	-	3
	M. Lichens	1	2	1	-	3
	N. Bacteria	1	2	1	-	3
External Total Marks						60

SEMESTER - I CORE ELECTIVE-I	22PBOTE15-1: MUSHROOM CULTIVATION	CREDITS: 3 HOURS: 45
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COURSE OBJECTIVES

1. To study the morphology and types of Mushrooms.
2. To Identify edible types in mushroom, Selection of appropriate cultivation sites
3. To know the nutrient value of mushroom
4. To aware the identification of edible and poisonous Mushrooms.
5. Designing and construction of Mushroom Farm, Packaging, storing and grading of Mushrooms.

Unit I : Introduction

Mushroom – introduction, Life cycle of Mushrooms. Types and identification - edible and poisonous Mushrooms - external factors for growth. Economic importance of Mushrooms as food.

Unit II : Mushroom Cultivation Methods

History and scope of mushroom cultivation-early cultivation- domesticated mushrooms today- other domesticated fungi. - selection - 'starter' - preparation of spawn - preparation of Compost)outdoor and indoor beds(- incubation - Harvesting and marketing

Unit III : Spawn preparation

Spawn production - grain, powder and granular spawn - mother spawn - planting spawn-spawn preparation-spawning techniques-environmental conditions for spawn runpreparation of culture)Tissue culture and spore culture(, preservation and storage of culture - various media)PDA, malt extract, Wheat extract, compost extract(

Unit IV : Different types of Mushrooms

Cultivation of white Button Mushrooms)*Agaricus bisporus*(and Oyster Mushrooms)*Pleurotus spp*(- materials - sterilization - spawning and fruiting - house design for Pleurotus- preservation, canning drying, Cultivation of paddy straw Mushrooms - Preparation, Spawn making - Methods of Cultivation. Mushrooms are different types in Tamil Nadu: a(Button Mushroom b(Oyster Mushroom c(Milky Mushroom and their main income source is agriculture. Primary data was collected through questionnaires and secondary data from online.

Unit V : Mushroom harvesting technology

Mushroom technology - nutritive value of edible Mushrooms Protein, carbohydrate, fat, mineral, and vitamin - Medicinal value of Mushrooms, Advantages of Mushrooms Cultivation - Harvesting & Marketing)Local, National and International level(.

COURSE OUTCOMES

On the completion of this paper, students will able to

1. Understanding of prospects of Mushroom cultivation
2. The students will gain the knowledge of cultivation of different types of edible Mushroom.
3. The students will gather concepts on the methods of harvesting of Mushroom and methods of grading, packing and storing of Mushroom
4. Students will be able produce spawn on their own.
5. Learned the prospects and scope of mushroom cultivation in small scale industry.

Text Books

1. Shubhrata R.Mishra, 2014. Techniques of Mushroom Cultivation. Discovery Publishing House Pvt. Ltd.New Delhi.
2. Kannaiyan.S and Ramasamy, K, 1980. A Handbook of Edible Mushroom. Today and Tomorrows. Printers and Publishers, New Delhi, 104 p.
3. Tewari,S.C.and Pankaj Kapoor,2018, Mushroom Cultivation Mittal Publication New Delhi.

Supplementary Readings

1. Pathak V.N, Nagendra Yadav and Maneesha Gaur. 1998.
2. Mushroom Production and Processing Technology. Agrobios)India(Jodhpur,
3. Suman, B.C. and Sharma, V.P.2007, Mushroom cultivation in India. Daya Publishing House New Delhi.
4. Chauhan,M., Gajre.K. andPrajapati.P.2013, Scientific Cultivation of Mushroom. Biotech Books New Delhi

OUTCOME MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	3
CO3	3	2	3	2	2
CO4	3	3	3	3	2
CO5	3	2	3	2	2

SEMESTER - I CORE ELECTIVE - I	22PBOTE15-2: SILVICULTURE AND SEED TECHNOLOGY	CREDITS: 3 HOURS: 45
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COURSE OBJECTIVES

- 1) Understanding of key ecological concepts related to forest stand development and the response of forest vegetation to silvicultural practices.
- 2) Students will demonstrate a familiarity with silvicultural terminology and be able to discuss practical application of regeneration techniques, intermediate treatments, and alternative silvicultural systems.
- 3) To develop the skill of Silviculture Systems.
- 4) Students will be able to develop a silvicultural prescription to accomplish identified ownership objectives.
- 5) To understand the Germination, Viability and Storage of Seed.

Unit I : Fundamentals of Forestry

Definition, history, classification and branches of forest and forestry. Status of forests in India and their role. Major forest types of India-forest composition and structure. Locality factors influencing forest growth and distribution in India. Plant succession, competition and tolerance. Methods of studying forest area-Aerial survey-Photographic method. Remote sensing and GIS in forestry. Forest floor-canopy-sholas and its importance. Forest mensuration. Use of wedge prism.

Unit II : Regeneration and Plantation of forests

Natural regeneration: Definition, advantages and disadvantages. Steps involved in artificial regeneration. Plantation of forests-Plantation establishment-site selection, site preparation and planting. Choice of species on ecological aspects-afforestation of dry land, wet land, other adverse sites. Intercultural operations. Plantation maintenance. Nursery techniques, silvicultural management of stands, Protection and utilization of some important conifer and broadleaved tree species of India.

Unit III : Silviculture Systems

Silviculture-Definition, objectives and scope. Relation of silviculture with forestry and its branches. Silviculture system: coppice, selection, clear felling, shelter wood, regular and irregular. silviculture of some of the economically important species: *Tectonagrandis*, *Casuarina equisetifolia*, *Eucalyptus*, *Bamboosa species*, *Santalum album*. Barks-Nature and types. Forest conservation: objectives, scope and methods.

Unit IV: Type of seeds and Seed dormancy.

Classification of seeds, Recalcitrant seeds, Albuminous and Ex-Albuminous seeds. Seed reserves. External and internal structures of seed-their functional significance, Seed certification. Types of dormancy-Physical, Physiological, Morphological, Chemical and Mechanical. Primary and secondary dormancy, Photo

and Skoto dormancy. Methods to overcome dormancy. Artificial induction of dormancy and release. Dormancy breaking-principles and methods. Ecological significance of seed dormancy.

Unit V: Germination, Viability and Storage of Seed

Seed germination-types and phases of germination; imbibition-pattern and water kinetics-events of germination-physical, physiological, biochemical changes. Brief account of germination value, rate and percentage. Influence of light and temperature on germination and seedling development. Vigour and viability test)Tetrazolium test(. Critical role of seed moisture content and environmental factors on viability. Methods of seed storage-modified atmospheric storage-ultra dry storage-vacuum storage-cryopreservation-germplasm storage. Static conservation of seeds. seed banks, Gene pool..

COURSE OUTCOMES

On the completion of this paper, students will able to

- 1) Understand the importance of forests
- 2) Acquire the knowledge of Regeneration and Plantation of Forests
- 3) Develop the skill of Silviculture Systems
- 4) Understand the process and principles of Seed technology
- 5) Understand the Germination, Viability and Storage of Seed

Text Books

- 1) Agarwal, R.L. (1997). Seed Technology, Scientific Publishers, Jodhpur.
- 2) Archana Sharma (2014), Seed Technology and Seed Pathology: Pointer Publishers.
- 3) Dwivedi A.P. (1993). A Text Book of Silviculture. International Book Distributors, Dehradun.
- 4) Khanna L.S. (1996). Principle and Practice of Silviculture. International Book Distributors.
- 5) Negi, S.S. (1985). General Silviculture, Natraj Publication, Dehra Dun.

Supplementary Readings

- 1) Agarwal, P.K and Dadlani, M. (1992). Techniques in seed science and technology, Scientific Publisher, Jodhpur.
- 2) Champion , H.G and Griffith. (1967). Manual of General silviculture for India, 3rd edition, New Delhi.
- 3) Dwivedi, A.P. (1992). Agroforestry: Principles and Practices. Oxford and IBH.
- 4) Prakesh, R. and Khanna, L. S. 1979. Theory and Practice of Silvicultural Systems. International Book Distributor, Dehra Dun.
- 5) Sanjeev Kumar (2014). Principles of Seed Technology: Sonali Publications.
- 6) Shrivastava, M.B. (1998). Introduction to Forestry. South Asia Books; 1 edition, New Delhi.

- 7) Smith, D.M, Larson, B.C, Ketty, M.J. and Ashton, P.M.S. (1997). The Practices of Silviculture-5.Applied Forest Ecology. John Wiley & Sons.
- 8) Vinod Kumar(1995). Nursery and Plantation practices in Forestry, Jodhpur.Scientific publishers.

OUTCOME MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3		3
CO2	3	2	2	2	3
CO3	3	3	3	2	3
CO4	3	3	3	2	3
CO5	3	3	3	3	3

SEMESTER - I CORE ELECTIVE - I	22PBOTE15-3: INDUSTRIAL MICROBIOLOGY	CREDITS: 3 HOURS: 45
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COURSE OBJECTIVES

1. To acquire the knowledge of scope of industrial microbiology
2. To understand the importance of microbes, basics of a sterilization, fermenter design and types.
3. To study the avenues of exploiting microbes in bioconversion technology.
4. To study the industrial production, product recovery and commercial application in fermentation.
5. To develop the skill on production of Microbial metabolites

Unit I : Industrial Biotechnology

Introduction - Historical account - development - scope of industrial microbiology, source and characters of industrially important microbes - Microorganisms in industry Sterilization - preparation of media - isolation methods for microorganisms - culture and preservation and stability. Principles of storage of microbes at low temperature in liquid nitrogen, Preparation of inoculum - Screening methods and methods for strain improvement.

Unit II : Industrial Fermentations Techniques

Types of fermentation - components of fermentation process - factors involved in fermenter design, differences between biochemical and chemical processes; biochemical reactions, operational consideration. Fermenter configuration and different types of fermentors; Principle of operation characteristics of fermentors, Methods used for down stream processing and product recovery - filtration, centrifugation, cell disruption, extraction, dialysis, purification, drying, packing and labeling, Manufacturing practices and Fermentation economics.

Unit III : Methylootrophs

Methanogens and methylootrophs, Mechanism of methane production - Economic importance of methylootrophs. Hydrogen fuel, Microbial leaching. Sulphur utilizing, sulphate reduction pathway - use of nucleotides as nitrogen source for growth of certain microorganisms)pathway of nucleic acid breakdown(. Immobilization of microbial cells and enzymes methods and applications - Biofuel, ethanol, biogas, biodiesel and hydrogen production, Microbial polyesters, biosurfactants and recombinant products.

Unit IV : Microbial production of food

Microbes in food production and food poisoning, microbial single cell protein)SCP(. Fermented dairy products, fermented meats, leavening of breads, microbiology and production of ethanol and alcoholic beverages - beer, manufacturing and production of distilled beverages, wines, vinegar, Baker's yeast production - food and fodder yeast production, fermented vegetables, pickles, olives, soy source, mushroom, algae and cheese.

Unit V : Microbial production of Metabolites

Microbial production of primary and secondary metabolite, commercial production of antibiotics with special reference in penicillin, streptomycin and their derivatives. Vitamins and growth stimulants – Vitamin A, Vitamin B12; Organic acids – citric acid, fumaric acid, Bacterial gluconic acid and - Ketoglutaric acid. Amino acid – L – glutamic acid, Lysine. Enzymes – Amylase and proteases. Microbial transformation of steroids and alkaloids production. Large scale production of recombinant molecules interferon, human protein, insulin, somatostation, vaccines and anticancer agents.

COURSE OUTCOMES

On the completion of this paper, students will able to

- 1) To acquire the knowledge of scope of industrial microbiology
- 2) Students will gain knowledge about the different cell organelles of microorganisms and their detailed functions.
- 3) Students will understand the importance of microbes, basics of a sterilization, fermenter design and types.
- 4) To study the avenues of exploiting microbes in bioconversion technology.
- 5) To study the industrial production, product recovery and commercial application in fermentation.
- 6) To develop the skill on production of Microbial metabolites.

Text Books

- 1) Ndukaokafor, 2007. Modern Industrial Microbiology and Biotechnology. Ist Editions. Science Publishers.
- 2) Waiter, M.J., organ, N.I., Rockey., I.S and Higton, G., 2002. Industrial Microbiology – An Introduction, Black well science Publisher.
- 3) Patel, A.H., 2010. Industrial Microbiology 4th edition. Macmillan Publisher, India.
- 4) Casida, JR L.E., 2009. Industrial Microbiology. New Age International (P) Ltd., Publishers, New Delhi.
- 5) Okafor, 2007. Modern industrial microbiology and Biotechnology. Scientific publisher. Enfield, USA.
- 6) Demain, A.I, 2001. Industrial Microbiology and Biotechnology. 2nd Edition, ASSIPress, Washington.
- 7) Ndukaokafor, 2007. Modern Industrial Microbiology and Biotechnology. Ist Editions. Science Publishers.
- 8) Waiter, M.J., organ, N.I., Rockey., I.S and Higton, G., 2002. Industrial Microbiology – An Introduction, Black well science Publisher.

Supplementary Readings

- 1) Patel, A.H., 2010. Industrial Microbiology 4th edition. Macmillan Publisher, India.
- 2) Casida, JR L.E., 2009. Industrial Microbiology. New Age International (P) Ltd., Publishers, New Delhi.
- 3) Okafor, 2007. Modern industrial microbiology and Biotechnology. Scientific publisher. Enfield, USA.
- 4) Demain, A.I, 2001. Industrial Microbiology and Biotechnology. 2nd Edition, ASSIPress, Washington.
- 5) DanialForciniti. 2008. Industrial Bioseparations– principles and practice, Wiley Black well.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	2
CO2	2	2	2		2
CO3	3	3	3	2	2
CO4	3	3	2	2	3
CO5	3	2	3	3	3

SEMESTER - II CORE - IV	22PBOTC21: ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS	CREDITS: 4 HOURS: 75
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COURSE OBJECTIVES

1. To provide an insight into the internal structure and reproduction of the most evolved group of plants, the Angiosperms;
2. To get an insight into the histochemistry with special reference to various stains and staining procedures
3. To study and understand morphological, internal structure of diverse plant groups for the evolution of structure-functions and their application
4. To understand the origin, structure, growth, development and reproduction of angiosperms.
5. To understand the development of Dicots and Monocots

Unit I : Anatomy- Tissue System

Introduction and Detailed study of Cell wall. Tissue system-dermal tissue, simple and permanent tissue systems. Primary and secondary structure of root and stem of dicots and monocots, structure of shoot and root apices.

Unit II : Anatomy- Meristems

Meristems origin, structure, types, theories. Vascular and cork cambium origin, structure and functions, dendrochronology and rhytidome. Periderm, lenticels, tylosis, wound healing and grafting. Secretory tissue. Wood properties - porous and non-porous wood, heart wood and sap wood.

Unit III : Anatomy- Stem and leaf anatomy

Anomalous secondary thickening of dicot and monocot stem. Nodal anatomy- uni, tri and multilacunar nodes and their evolution. Leaf ontogeny and anatomy, stomata types, hydathodes, histogenesis of bifacial and unifacial leaf, Kranz anatomy. Vascular anatomy of flower and fruits. Application of anatomy in detecting food adulteration and contamination.

Unit IV : Embryology- Sporogenesis and fertilization

Introduction of Embryology, Microsporangium, microsporogenesis, male gametophyte- structure and development. Megasporangium, megasporogenesis, female gametophyte, monosporic, bisporic and tetrasporic embryo sac. Structure and nutrition of embryo sac. Types of ovule. Pollination and its types. pollen-stigma interaction and sexual incompatibility. Fertilization, and post fertilization changes. Dicot and monocot embryo development.

Unit V: Embryology- Endosperm and Polyembryony

Endosperm, types- nuclear, cellular, helobial, ruminant, endosperm haustoria and its functions. Polyembryony, apomixis, apospory and apogamy, parthenogenesis and parthenocarpy and its applications.

COURSE OUTCOMES

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

- 1) Acquire knowledge about the structure and functional development of cells and tissues
- 2) Are able to apply the concepts of Plant Anatomy to better understand the structural organization and functions of various tissue systems of plant body.
- 3) Understand the difference between normal and anomalous secondary growth in dicots and monocot plants
- 4) Learn the process of micro and megasporogenesis to embryo formation in seeds.
- 5) Improving knowledge about parthenocarpy to indroduce new varieties in Horticulture.

Text Books

- 1) Pandey,B.P. 2016. Plant Anatomy. S.Chand & Co(P)Ltd. New Delhi.
- 2) Pandey,S.N & Chada,A. 2020. Plant Anatomy & Embryology. S.Chand & Co.Ltd New Delhi.
- 3) Bhojwani,S.S. & Bhatnagar,S.P. 2011. The Embryology of Angiosperms. Vikas Publ House (P). Ltd., NewDelhi.
- 4) Agarwal,S.B. 1990. Embryology of Angiosperms- A fundamental Approach. Sahatiya Bhawan, Agra.
- 5) Dwivedi,J.N,1998.Embryology of Angiosperms.Rastogi & Co.Meerut.

Supplementary Readings

- 1) Fahn,A. 1989. Plant Anatomy. Maxwell Pvt. Ltd. Singapore.
- 2) Pandey,B.P. 2005. Plant Anatomy. S.Chand & Co.Ltd. New Delhi.
- 3) Katherine Esau,.,2006. Anatomy of seed plants. John Willey & Sons, Newjersy.
- 4) Paula J.Rudall,2007. Anatomy of Flowering Plants.Cambride University Press.
- 5) Raghavan,V,1976. Experimental embryogenesis in vascular plants. Academic Press. London.
- 6) Maheswari,P. 2016. An Introduction to Embryology of Angiosperms.Scholar Select Publishers. New Delhi.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	2		3	3	3
CO2	3	3		2	3
CO3	3	2	3		3
CO4	3		3		3
CO5	2	2	2	2	3

SEMESTER - II CORE - V	22PBOTC22: CYTOGENETICS, PLANT BREEDING AND EVOLUTION	CREDITS: 4 HOURS: 75
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COURSE OBJECTIVES

- 1) To understand the structure of prokaryotic and eukaryotic cell and Cell organelles.
- 2) To Understand the Principles of Mendelian Genetics.
- 3) To acquire knowledge about Mutation and Mutagens
- 4) To understand the Principle and significance of Plant Breeding
- 5) To understand the Process and theories of Evolution.

Unit I: Cell Biology

Structural variations of chromosomes – Deletions, duplications, inversions and translocations, meiotic behavior in the above types, Karyotype analysis, Karyogram and Idiogram. Chromosomal aberrations- Bridge, Laggard, Precision, Succession and Catenation. Numerical variation in chromosomes- euploidy and aneuploidy and its role in Horticulture.

Unit II: Mendelian Genetics

General account of genetics, Laws of inheritance, Mendelian Genetics. Quantitative genetics: Polygenic inheritance)kernel colour in wheat, ear head length in maize. Self-incompatibility in Nicotiana. Population genetics; Hardy-Weinberg Equilibrium. Extra-chromosomal or Cytoplasmic inheritance: male sterility in plants.

Unit III: Mutation

Nature of Mutations, types of mutations and mutagens, methods of detection of mutation: Ames test, CIB method and attached-X method, Molecular mechanism of spontaneous and induced mutations, Mutagenic effects of food additives and drugs. Nucleic acid as genetic material-types of nucleic acids, Replication of DNA, DNA damage and repair. Homeotic mutants in *Arabidopsis* and *Antirrhinum*. Transposons and types.

Unit IV: Plant Breeding

General account on plant breeding, Breeding methods - sexual, asexual and apomitic reproduction. Selection-Mass selection, Pureline selection and Clonal selection, Hybridization: Objectives, Choice of parents, problems and causes of failure of hybridization, types and process of hybridization, Bulk method, pedigree and backcross method of selection. Role of interspecific and intergeneric hybridization in plant improvement. Heterosis. And Hybrid vigor. Role of CSIR, CIMAP organizations for crop improvement. Modern methods of plant breeding.

Unit V: Evolution

Theories of evolution- Lamarckism, Darwinism, Modern synthetic theory, Germplasm theory and De Vries theory. Variation within and between populations. Speciation and reproductive isolation. Sequencing techniques and meta-genomics, adaptive variation. Process of origin of life, Molecular evolution.

COURSE OUTCOMES

On the completion of this paper, students will be able to

- 1) Understand the structure of prokaryotic and eukaryotic cell and Cell organelles.
- 2) Understand the Principles of Mendelian Genetics
- 3) Acquire knowledge about Mutation and Mutagens
- 4) Understand the Principle and significance of Plant Breeding
- 5) Understand the Process and theories of Evolution

Text Books

- 1) Shukla, RS and Chandel, PS. 1980. Cytogenetics and Evolution. Chand and company, New Delhi
- 2) Klug, WS and Cummings, MR. 2003. Concepts of Genetics. Peterson Edu.

Supplementary Readings

- 1) De Robertis and De Robertis 1998 Cell and Molecular Biology. B.I. Waverly Pvt Ltd. New Delhi.
- 2) Strickberger, M. W. 1985. Genetics. Macmillan India, New Delhi.
- 3) Gerald Karp. 1984. Cell Biology. McGraw Hill, New Delhi.
- 4) Jurgen Schulz-Scaffer, 1985. Cytogenetics- Plants Animals and Humans. Springer Verlag, Berlin.
- 5) Cooper, G. M. 1997. The Cell –A Molecular approach. ASM Press, Washington.

OUTCOME MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	3
CO2	3	2			3
CO3	3	3	3		3
CO4	3	2	3		3
CO5	3	2	3	2	2

SEMESTER - II CORE - VI	22PBOTC23: PLANT TISSUE CULTURE	CREDITS: 4 HOURS: 75
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COURSE OBJECTIVES

- 1) To understand and the production of exact copies of plants that produce particularly good flowers, fruits, or have other desirable traits.
- 2) To quickly produce mature millions of plants.
- 3) To acquire knowledge on the production of multiples of plants in the absence of seeds or necessary pollinators to produce seeds.
- 4) To improve the state of health of the planted material and to increase the number of desirable germplasms available to the plant breeder.
- 5) To develop Skill on plantlet generation by using tissue culture techniques

Unit I : Basics of Tissue culture

Concepts of Totipotency – Conditions of aseptic culture – Laboratory equipment – Culture vessels and different types of culture - Sterilization methods: Physical and chemical – Sterilization of Tools, Water, Vessels, Nutrient Media, Working Area, Methods of the surface disinfections - Inoculation and initiation of tissue culture – Acclimatization

Unit II : Methods and media Preparations

Explant preparation, callus initiation, growth and maintenance, Multiplication and Organogenesis – Media preparation: MS and Root media - Embryogenesis, Somaclonal variation, Germiclonal variation establishment, growth and maintenance of cell suspension culture, Methods of sub culturing and transfer of regenerated plants to the field.

Unit III : Micro Propagation

Tissue and organ culture; Cellular differentiation and regulation of Morphogenesis- Somatic embryogenesis - Control of organogenesis and embryogenesis - Single cell culture - Establishment of suspension cultures - Meristem and Nodal culture – Synthetic seed technology. Micro propagation advantages and disadvantages- application of techniques in crop improvement.

Unit IV : Haploids and variation in Tissue culture

Haploid production – Androgenesis: Anther and microspore culture - Gynogenesis: Embryo culture - Protoplast isolation: Culture – regeneration - Somatic hybrid-cybrids In *vitro* selection of mutants – mutants for salts, disease, cold, drought, herbicide and other stress conditions - Meristem culture and virus elimination - Shoot tip culture.

Unit V : Application of Tissue culture

Industrial application: Secondary metabolite production and single cell proteins by cell culture – Bioreactors – Genetic transformation using Ti plasmid Manipulation of gene expression in plants – Tissue culture as a tool for Biotechnology: Production of marker free transgenic plants- Developing insect-resistance, disease-resistance,

herbicideresistance; stress and senescence tolerance in plants – Rapid propagation of Banana, Roseand orchids.

COURSE OUTCOMES

On the successful completion of this course the students will able to

- 1) Understand the Concepts of plant tissue culture
- 2) Acquire the knowledge on plant cells, tissues or organs under sterile conditions on anutrient culture medium of known composition.
- 3) Develop the skill on as micropropagation.
- 4) Improve the state of health of the planted material and to increase the number of desirable germplasms available to the plant breeder.
- 5) Develop Skill on planlet generation by using tissue culture techniques

Text Books

- 1) Bhojwani, SS. and MK Razdan. 1996. Plant tissue Culture: Theory and Practice (arevised edition). Elsevier science publishers, New York.
- 2) Satyanarayana, U 2008. Biotechnology, Books & Allied Ltd.
- 3) Razdan M K 2019 Introduction to Plant Tissue Culture 3rdEdn. Oxford & IBH Publishing
- 4) Oberta Smith. 2012. Plant Tissue Culture - Techniques and Experiments, Elsevier, 3rd Edn.
- 5) Timir Baran Jha and Biswajit Ghost. 2005. Plant tissue culture (Basic and Applied). University Press, Hyderabad.
- 6) Thorpe, T.A. 1981. Plant tissue culture methods and application in agriculture, Elsevier.

Supplementary Readings

- 1) Reinert. J and Yeoman, M.M. 1983. Plant cell and Tissue culture - Laboratory manual, Narosa publishing house, New Delhi.
- 2) Razdan.M.K. 2003. Introduction to Plant Tissue Culture. Oxford & IBH Publishing C.Pvt.Ltd, New Delhi.
- 3) Kalyan Kumar D.E.1992. Plant tissue culture, Agrobios, New Delhi.
- 4) T. Pullaiah, 2009. Plant Tissue Culture: Theory and Practicals, Scientific Publishers Journals Dept.
- 5) Timir Baran Jha and Biswajit Ghosh, 2016. Plant Tissue Culture.Basic and Applied, Platinum Publishers; 2nd Edn.
- 6) Anis Mohammad and AhmadNaseem. 2016. Plant Tissue Culture: Propagation, Conservation and Crop Improvement, Springer.

OUTCOME MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3		3
CO2	3	3	3	2	2
CO3	3	3	3	3	2
CO4	3	3		2	3
CO5	3	3	3	3	3

SEMESTER - II CORE PRACTICAL- II	22PBOTP24: COVERING ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS, CYTOGENETICS, PLANT BREEDING AND EVOLUTION, PLANT TISSUE CULTURE	CREDITS: 7 HOURS: 150
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Anatomy

- 1) Examination of root and shoot apices;
- 2) Maceration, clearing and peeling techniques;
- 3) Primary and secondary structure of dicot, monocot stem;
- 4) Transverse sectioning and observation of Anomalous secondary thickening in Bougainvillea, Boerhaavia, Nyctanthes, Bignonia, Aristolochia, Strychnos and Dracaena.
- 5) Nodal anatomy – different types of nodes.
- 6) Peeling techniques and study of different types of stomata,
- 7) Wounding of young stem and study of the wound healing response

Embryology

- 1) Different stages of anther, embryo sac, endosperm and embryo development
- 2) Pollen germination and viability test
- 3) Ovule types
- 4) Endosperm types
- 5) Dissection of embryo – Tridax, Crotalaria and Cleome
- 6) Endosperm and endosperm haustoria – Cucurbitaceae members

Cytogenetics

- 1) Squash and smear techniques
- 2) Study of cell division – mitosis)Allium cepa, Rhoeco, Urgenia, Scilla(
- 3) Study of meiosis -)Allium cepa, Helianthus, Tredescantia flower buds(
- 4) Study of chromosomal aberrations and polyploidy
- 5) Karyotype analysis – Idiogram preparation
- 6) Study of special types of chromosomes
- 7) Genetics problems in Mendelian inheritance, gene interaction, quantitative inheritance, multiple alleles, sex linkage and genetic maps

Plant breeding

- 1) Methods of vegetative propagation – Layering, Budding and Grafting
- 2) Intergeneric hybrids.
- 3) Hybridization techniques including Emasculation, Bagging.

Evolution

- 1) Charts – Evidences of evolution, Lamarckism, Darwin and DeVries

Plant Tissue Culture

- 1) Preparation of stock solutions for tissue culture
- 2) Preparation of solid and liquid media for test tube cultures and petri plate culture
- 3) Preparation of plant tissue culture media

- 4) Induction of callus culture and suspension culture
- 5) Encapsulation of embryos using sodium alginate
- 6) Callus induction and maintenance *in vitro*
- 7) Micropropagation of plants using nodal explants and shoot apex
- 8) Culture of ovary and ovule *in vitro*.

OUTCOME MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	2	1
CO2	2	3	2	2	1
CO3	2	2	1	1	2
CO4	2	2	2	3	2
CO5	2	2	2	2	3

22PBOTP24: Core Practical - 2
(Covering Papers-IV,V & VI)

**Anatomy and Embryology of Angiosperms, Cytogenetics ,
 Plant Breeding and Evolution, Plant Tissue culture**

Time: 4 Hours

Max. Marks: 100

External Practical: 60

Internal: 40

Question

1. Cut the transverse/longitudinal section of the given material **A**. Identify by giving reasons. Draw labeled sketches. Submit the slide for valuation. (6)
2. Take the transverse section of the given material **B**. Stain it and mount in glycerin. Submit the slides for valuation. Identify by giving reasons. Draw labeled sketches of ground plan and a sector enlarged. (6)
3. Dissect and display any one developmental stage of **C**. Leave the slide for valuation. Draw labeled sketches (6)
4. Make a suitable Squash preparation of **D**. Show any two phase of the mitosis. Draw labeled diagrams and leave the slide for valuation. (6)
5. Write the Protocol for **E** and describe the procedure (8)
6. Find out the solution for the Genetics problem **F**. Find out the ratio. (6)
7. Work out the Genetic problem **G**. Find out the order of genes and the distance between them. Construct a chromosome map (10)
8. Write critical notes about the given spotters **H, I, J** and **K**. Identify and Draw labeled sketches.
 (4x3=12)

22PBOTP24: Core Practical - 2
(Covering Papers-IV,V & VI)
Anatomy and Embryology of Angiosperms, Cytogenetics ,
Plant Breeding and Evolution Plant Tissue culture.

Key

Q. NO	Material	Identification	Reason	Diagram	Slide	Total
1.	A Anatomy	1	2	1	2	6
2.	B Anatomy (Anamolous)	1	2	1	2	6
3.	C Embryology	-	-	3	3	6
4.	D Cell Biology	1	1	2	5	6
		Aim	Requirements	Procedure	Result	
5.	E Molecular Biology	1	1	5	1	8
6.	F Genetics	4		4	2	6
7.	G Genetics	2		6	2	10
8.	Spotters	Identification	Reason	Diagram		
	H Anatomy	1	1	1	-	3
	I Embryology	1	1	1	-	3
	J Cell Biology	1	1	1	-	3
	K Plant breeding	1	1	1	-	3
				Total Marks		60
				External Total Marks		60

SEMESTER - II CORE ELECTIVE-II	22PBOTE25-1: MARINE BOTANY	CREDITS: 3 HOURS: 45
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COURSE OBJECTIVES

- 1) To study the Introduction, concepts and Significance of marine Biology
- 2) To understand Marine environment, Ecosystem and its Biodiversity.
- 3) To acquire the knowledge about Microalgae, Macro algae, Sea grasses and Mangroves
- 4) To Understand the economic importance of Microalgae, Macroalgae, Sea grasses and Mangroves
- 5) To apply the skill on Identifying the sources, impact and control of Marine Pollution.

Unit I : Marine Biology

Introduction to Marine Biology, Concepts and scope of Oceanography, physical and chemical properties of sea water, differences between freshwater and seawater. Marine resources.

Unit II : Marine Environment

Marine environment – ecological factors– light, temperature, salinity, pressure.–Marine Ecosystem. Food Chain, food web, Ecological Pyramids. Current status of marine biodiversity – biodiversity conservation.

Unit III : Microalgae

Microalgae, Phytoplankton, Diatom,)Dinoflagellate, Silicofagellate(, Cyanobacteria, General features, Classification, Distribution, Influence of Physico-Chemical properties of sea water on diversity and population of phytoplankton. Economical and Medicinal values of Microalgae.

Unit IV : Macro algae, Seaweeds and Mangroves

Seaweeds – occurrence and distribution- economic importance. Interaction between reefs and seaweeds. Sea grasses –adaptations and their ecological role. Mangrove Plants-Salt Marshes-Distribution, types, adaptations-morphological, physiological- ecological role, Biomedical values of Seagrasses and Mangroves.

Unit V : Marine Pollution

Major pollutants – sources, transport path, sewage; industrial, agricultural and domestic discharges. Heavy metal pollution –, Oil pollution – Thermal pollution, Radioactive pollution, - Plastics and litter- impact on marine environment. Control methods.

COURSE OUTCOMES

On the completion of this paper, students will able to

- 1) Understand the Introduction, concepts and Significance of marine Biology

- 2) Understand Marine environment, Ecosystem and its Biodiversity.
- 3) Acquire the knowledge about Microalgae, Macroalgae, Seagrass and mangroves
- 4) Understand the economic importance of Microalgae, Macroalgae, Seagrass and Mangroves
- 5) Apply the skill on Identifying the sources, impact and control of Marine Pollution.

Text Books

- 1) Munn, C.B. 2004. Microbial ecology: ecology and applications. BIOS Sci., Pub., US., 282pp.
- 2) Kirchman, D.L., 2008. Microbial ecology of the oceans John Wiley & sons US 593pp
- 3) Kui Hong, An-Hui Gao, Qing-Yi Xie, Hao Gao, Ling Zhuang, Hai-Peng Lin, Hai-Peng Lin, Hai-Ping Yu, Jia Li, Xin-Sheng Yao, Michael Goodfellow Michael Goodfellow, 2009. Actinomycetes for Marine Drug Discovery Isolated from Mangrove Soils and Plants in China Mar. Drugs. 7, 24-44 pp.
- 4) Sverdrup, H.U., M.W. Johnson and R.H. Flemming 1958. The Oceans – their Physics, Chemistry and General Biology. Prentice – Hall Inc. New Jersey, 1087 pp.
- 5) Strickland, J.D.H. and T.R. Parsons, 1972. A Practical Handbook of Seawater Analysis. Fisheries Board of Canada, Ottawa, Bulletin, 167:311pp.
- 6) McCormick, J.M. and J.V. Thiruvathakal, 1976. Elements of Oceanography. 2nd edition, W.B. Saunders, Philadelphia, 346 pp.
- 7) Fergusson, J.E., 1990. The Heavy Elements: Chemistry, Environmental Impact and Health Effects. Pergamon Press, London 612 pp
- 8) Fernando, Olivia J, 1999. Sea Water Properties and Dynamics, Dhanesh Publications, Thanjavur
- 9) Stowe, K, 1996. Exploring Ocean Science. John Wiley Sons Inc, New York 426 pp.
- 10) Chapman, V.J., 1976. Mangrove Vegetation. J. Gramer, Berlin, 292 pp
- 11) Kathiresan, K and S.Z. Qasim, 2005. Biodiversity of Mangrove Ecosystems. Hindustan Lever Limited, India, 251 pp
- 12) Jeffrey S. Levinton, 2008. Marine Biology: Function, Biodiversity, Ecology, 3rd ed., Oxford University Press, USA 640pp

Supplementary Readings

- 1) Heike K. Lotze, Hunter S. Lenihan, Bruce J. Bourque, Roger H. Bradbury, Richard G. Cooke, Matthew C. Kay, Susan M. Kidwell, Michael X. Kirby, Charles H. Peterson, Jeremy B. C. Jackson, 2006. Depletion, Degradation, and Recovery Potential of Estuaries and Coastal Seas. Science. 1806-1809 pp.
- 2) Cara Wilson, Victoria J. Coles, 2005. Global climatological relationships between satellite biological and physical observations and upper ocean properties. Journal of Geophysical Research.

- 3) Hurd, C.L., Et Al.,2014. Seaweed Ecology and Physiology (551 pp).
- 4) William M. Sackett, Walter R. Eckelmann, Michael L. Bender, Allan W. H. Be, 1965. Temperature Dependence of Carbon Isotope Composition in Marine Plankton and Sediments. Science. 235-237 pp.
- 5) Shing Yip Lee, Jurgene H. Primavera, FaridDahdouh-Guebas, Karen McKee, Jared O.Bosire, Stefano Cannicci, Karen Diele, Francois Fromard, Nico Koedam, CyrilMarchand, Irving Mendelssohn, Nibedita Mukherjee and Sydne Record, 2014. Ecologicalrole and services of tropical mangrove ecosystems: a reassessment. A Journal ofMacroecology. 726-743 pp.

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3				
CO3	3	3	3	2	
CO4	3	3	3		3
CO5	3	3	3	3	3

SEMESTER - II CORE ELECTIVE-II	22PBOTE25-2: TECHNIQUES IN BOTANY	CREDITS: 3 HOURS: 45
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COURSE OBJECTIVES

- 1) To understand working principle, and applications of Microscopy
- 2) To provide knowledge about Micro and Spectroscopic techniques
- 3) To understand the working Principle of Spectroscopy
- 4) To understand the Molecular biology tools and techniques
- 5) To acquire the knowledge on Tissue culture techniques

Unit I : Microscopy

Principle, structure, image formation and applications of Light, Dark field, Bright Field, Phase Contrast, Confocal, Fluorescence, Scanning and Transmission Electron microscopy. Material preparation for Electron microscopy. Microscopic measurements: Micrometers– Ocular and Stage; Haemo-cytometer and Camera Lucida.

Unit II : Micro-techniques

Fixatives: Properties and composition of important fixatives. Dehydrating and clearing agents. Dehydration Methods: Tertiary-butyl alcohol and Alcohol-xylol method. Embedding: Paraffin embedding. Sectioning: Free hand sections–rotary and sledge microtome. Classification of stains. Staining-Single, Double and Triple. Whole mounting-TBA/Hygrobuto and Glycerine-xylol method. Techniques of Smear, squash and maceration. Common mounting media. Histochemical localization of starch, protein, lipid and lignin.

Unit III : Spectroscopic techniques

Principle and applications of Colorimetry, UV-Visible and Atomic Absorption Spectrophotometry, IR, NMR and Mass Spectrophotometry and X-Ray Diffraction analysis. Flow Cytometry.

Unit IV : Molecular and separation Techniques

Blotting techniques- Southern, Northern and Western; ELISA, RIA and PCR)Real Time PCR(. DNA finger printing; RFLP, RAPD and FISH techniques. Concentration of the purified protein- Lyophilisation and Crystallization. Electrophoresis–General principles–Agarose gel, SDS–PAGE. Gel Documentation. Chromatography–Principles and applications of Paper, Thin layer, Column, Ion exchange, HPLC and GC. Centrifugation: Principles and applications of clinical, refrigerated and ultra centrifuge.

Unit V : Tissue Culture techniques

Introduction - tissue culture techniques - laboratory organization – preparation of nutrient media)MS and B5 media(. Methods of sterilization–Chemical and Physical methods. Preparation of explants–callus initiation, subculture and hardening. Concepts of totipotency and redifferentiation. Cell suspension culture – callus culture, Anther and pollen culture – haploids and their significances. Embryo culture - Meristem culture for virus-free clones.

COURSE OUTCOMES

On the completion of this paper, students will be able to

- 1) Understand working principle, and applications of Microscopy
- 2) Acquire knowledge about Micro and Spectroscopic techniques
- 3) Understand the working Principle of Spectroscopy
- 4) Understand the Molecular biology tools and techniques
- 5) Understand the techniques in Tissue culture

Text Books

- 1) Ananta Swargiary (2017). Biological tools and Techniques. Kalyani Publishers, New Delhi.
- 2) Johansson, D.A. (1975). Plant Microtechnique. McGraw Hill.
- 3) Prasad and Prasad, (2000). Outlines of Micro technique. Emkaypubl, New Delhi.
- 4) Rana, S.V.S. (2005). Biotechniques Theory and Practice, Rastogi Publication. Meerut.
- 5) Sadasivam, S. and Manickam, A. (1992). Biochemical Methods for Agricultural Sciences. (1st Ed). Wiley Eastern Limited, New Delhi.

Supplementary Readings

- 1) Berlyn, G.P. and Miksche, J.P. (1976). Botanical Microtechnique and Cytochemistry. (1st Ed). The Iowa State University Press. Ames, U.S.A.
- 2) Keith Wilson and John Walker (2010). Principles and Techniques of Biochemistry and Molecular biology. Cambridge University Press, New York.
- 3) Palanichamy, S. and Shunmugavelu, M. (1997). Research methods in Biological Sciences. Palani Paramount Publications, Palani.
- 4) Sharma, R.K. and Sangha. S.P.S. (2009). Basic Techniques in Biochemistry and Molecular Biology. I.K. International Pvt. Ltd, New Delhi.
- 5) Susan carson, Heather B. Miller and Scott, D. (2012). Molecular biology techniques, Elsevier.
- 6) Bajpai, P.K. (2006). Biological instrumentation and Methodology. S Chand Publishers, New Delhi.
- 7) Sabari Ghosal and Srivastava, A. K. (2009). Fundamentals of Biological Techniques and Instrumentation. PHI Learning Private Ltd. New Delhi.
- 8) Yadav, P.R. and Rajiv tyagi (2006). Biological Techniques, Discovery Publishing House, New Delhi.

OUTCOME MAPPING

CO/ PO	PO1	PO2	PO3	PO4	PO5
CO1	3				
CO2	3		2		2
CO3	3	3	3	3	2
CO4	3	3	3	3	3
CO5	3	3	3	3	3

SEMESTER - II CORE ELECTIVE-II	22PBOTE25-3: PHARMACOGNOSY	CREDITS: 3 HOURS: 45
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COURSE OBJECTIVES

1. To acquire the knowledge of Pharmacognosy
2. To understand the diversity, isolation, identification of plant phytochemicals
3. To acquire the knowledge of Therapeutic Uses of Plants and Drugs
4. To understand the application of medicinal Plants
5. To acquire the knowledge of Crude Plant Drugs

Unit I : Introduction

Definition. History and scope of Pharmacognosy. Indigenous system of medicine: Ayurveda, Homeopathy, Unani, traditional Chinese Medicine, Naturopathy, Yoga and Siddha. Classification of drug of natural origin. Adulteration/Substitution and drug evaluation. Significance of Pharmacopeial standards.

Unit II : Plant constituents

Plant Phytochemicals-Occurrence, distribution, classification, isolation, identification test and pharmaceutical applications: plant metabolites, carbohydrate lipids, protein and amino acids, nucleic acids, glycosides, terpenoids, flavonoid, Phenols, volatile oil / essential oil / resin and tannins.

Unit III : Therapeutic Uses of Plants and Drugs

Occurrence, distribution, organoleptic evaluation, chemical constituents including tests wherever applicable and therapeutic efficacy of following categories of drugs.)a(Laxatives: Aloes. Rhuburb. Castor Oil. Ispaghula.)b(Cardiotonic-Digitalis Arjuna.)c(Carminatives and G.I. regulators. Umbelliferous fruits, Coriander, Cardamom, Ginger, Black pepper, Asafoetida, Nutmeg and Clove.)d(Astringents: Catechu)e(Drugs acting on nervous systems - Belladonna, Aconite, *Withaniasomnifera*, *Ephedra* and Opium.)f(Anti diabetics- *Pterocarpus*, *Gymnemasylvestre*.

Unit IV : Industrial uses of Medicinal Plants

Perfumes and flavorings agents- peppermint oil, Lemon oil, Orange oil, Lemon grass oil and Sandal wood. Pharmaceutical aids- honey. Arachis oil, Starch, Kaolin, Pectin, Olive oil, Lanolin, Bees wax, Acacia, Sodium alginate, Agar, Guar gum and Gelatin. Miscellaneous- liquorice, Garlic, Picrorhiza, Dioscorea, Linseed, Shatavari, Shankhapushpi, Pyrethrum and Tobacco.

Unit V : Crude Plant Drugs

Collection and preparation of crude drug for the market as exemplified by ergot, Opium, Rauwolfia, Digitalis and senna. Gross anatomical studies of Senna, Datura, Cinnamon, Cinchona, Fennel, Clove, Ginger, Nuxvomica and Ipecacuanha.

COURSE OUTCOMES

On the completion of this paper, students will able to

1. Acquire the knowledge of Pharmacognosy
2. Understand the diversity, isolation, identification of plant phytochemicals
3. Acquire the knowledge of Therapeutic Uses of Plants and Drugs
4. Understand the application of medicinal Plants
5. Acquire the knowledge of Crude Plant Drugs

Text Books

1. Trease. G.E. and Evans W.C. 2009. Pharmacognosy. 16th Edn. Elsevier
2. Wallis T. E. 2005. Textbook of Pharmacognosy, 5th Edn. CBS publishers
3. Gokhale. .S. B. 2008. Pharmacognosy, Pragati Books Pvt. Ltd.
4. Kokate, C. K. 2008. Pharmacognosy 53rd Edn. Nirali publisher.
5. Mohammed Ali. 2019. Textbook of Pharmacognosy 2Edn. CBS Publisher.

Supplementary Readings

1. Horborne. J.B. 1983. Phyto chemical methods. Chapman and Hall. London.
2. Biren Shah and A.k. Seth 2010. Textbook of pharamcognosy and Phytochemistry.
8th Edn. Reed Elsevier India Pvt. Ltd.
3. Pharmacopoeia of India. Govt. of India. Ministry of health 1955 and 1966

OUTCOME MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3				
CO2	2		2		2
CO3	3	2	3	3	2
CO4	3	2	3	3	3
CO5	3	2	2	3	3

SEMESTER - II COMPULSORY COURSE	22PBOTC33 : HUMAN RIGHTS	CREDITS: 3 HOURS: 30
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COURSE OBJECTIVES

- 1) To understand the Human Rights and concern for its protection
- 2) To acquire the knowledge about the role of UN in protecting and promoting awareness of Human Rights and National legislations enforcement
- 3) To trace the development of regional instruments drafted aiming at protection of Human Rights and its enforceability.
- 4) To understand the Indian perspective of protection of Human Rights vide its Legislations, the Constitution of India Fundamental rights, Duties and Directive Principles of the State Policy
- 5) To aware about Special legislations and the enforcement machineries of Human Rights in India.

Unit- I: Human rights- Concepts & Nature

Human Rights: Meaning, Definition, Nature, Content- Legitimacy of Human Rights- Origin and Development of Human Rights- Theories – Principles of Magna Carta – Modern Movements of Human Rights – The Future of Human Rights.

Unit- II: Human Rights – The International Perspective

International human rights – Human Right concepts Prior and after World War II – UNO, UDHR, ICCPR, ICESCR.- Optional Protocols- Human Right Declarations – Role of United Nation Commissions – CEDAW, UNCAT, CRC or UNCRC- Conventions on the Protection of the Rights of Migrant Workers and Disabled.

Unit- III: Regional Human Rights

European Human Rights System- African Human Rights System – International Human Rights – Enforceability before Domestic Courts.

Unit- IV: Human Rights in India

The Constitution of India – Fundamental Rights – Right to Life and Liberty – Directive Principles of State Policy – Fundamental Duties – Individual and Group Rights – Other facets of Human Rights – Measures for Protection of Human Rights in India.

UNIT-5: Human Right Violations and Redressal Mechanism

Human Rights – Infringement of Human Right by State Machinery and by Individual – Remedies for State action and inaction – Constitutional remedies – Public Interest Litigation (PIL) - Protection of Human Rights Act, 1993 – National Human Rights Commission–State Human Rights Commissions – Constitution of Human Right Courts.

COURSE OUTCOMES

On the successful completion of this course the students will be able to

- 1) Know the nature of human rights its origin, the theories, the movements in the march of human rights and the facets of future of human rights.
- 2) Understand the international dimension of human rights, the role of UN and the global effort in formulating conventions and declarations.
- 3) Perceive the regional developments of human rights in Europe, Africa and Asia and the enforceable value of human rights in international arena.
- 4) Acquire the knowledge on the human rights perspectives in India, more developed by its constitution and special legislations.
- 5) Know the redressal mechanism made available in case of human rights violation confined to India.

Text Books

1. Lalit Parmar, 1998. Human Rights Anmol Publications Pvt. Limited.
2. David P. Forsythe, Human Rights in International Relations. Cambridge University Press.
3. Alston, Philip, And Frederic Megret, 2014. The United Nations and Human Rights: A Critical Appraisal. Second Edition. Oxford University Press.
4. Kruckenber, Lena J. 2012. The Unreal World of Human Rights: An Ethnography of the UN Committee on the Elimination of Racial Discrimination. Nomos Publishers.
5. Rebecce Wallace, M.M. 1982. International Human Rights.
6. A.H. Robertson & J.G. Merrils, 1993.. Human Rights in Europe: A Study of The European Convention On Human Rights, 386-413 (3d Ed.).
7. Francisco Forrest Martin, 1997. International Human Rights Law And Practice
8. Inha, R.K. S. 1997. Human Rights of the World, African Commission On Human Rights And Peoples Rights.
9. Evelyn A Ankumah, 1996. The Constitution of India Human Rights Bharatiya Values, Mandagadde Rama Jois, Bharatiya Vidya Bhavan.
10. Bhargave, G S and R. M. Pal, 1999. Human Rights of Dalit Societal Violation.
11. Gerald Van Bueren, 1995. International Law and The Rights of the Child. Martinus Nijhoff Publishers, London
12. Tirpathi, P. C. 1999. Crime Against Working Women. Ashish Publishers.

Supplementary Readings

1. Protection of Human Rights Act, 1993.
2. Seervai H.M 2015. Constitutional Law of India (3 Volumes) The Human Rights Watch Global Report on Women's Human Rights 2000 Oxford Publication.
3. Sharma, R.S.1988. Perspectives in Human Rights Development. Julies Stone Human Law and Human Justice 2000 Universal Publication. Research Handbook On International Human Rights Law, Edited By Sarah Joseph & Edited By Sarah Joseph, Edward Elgar Publishing Limited USA.

OUTCOME MAPPING

O/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	-	3
CO2	3	3	-	2	2
CO3	3	3	-	3	3
CO4	3	3	-	2	3
CO5	3	3	3	3	3