Syllabus for I M. Sc. Botany

I and II Semesters

(2022 onwards)

Department of Botany

Name of the Program: M. Sc. Botany

Duration of the course: Two years

Intake: 15 Admission

Eligibility: Candidate must have secured 40% in aggregate and studied Botany as one of the cognate subjects at B.Sc. level.

COURSE CREDITS

SEM. I

Paper Code	Title of the Paper	Theory (Hrs/Week)	Practical (Hrs/Week)	Total No. of Hrs/Semester	Duration of Examination (Hrs)	Max. Marks examination	Internal Assessment	Total Marks	Credits
HCT-101	SYSTEMATICS AND BIODIVERSITY	4	-	52	3	70	30	100	4
HCT-102	DIVERSITY OF LOWER GROUPS – ALGAE, FUNGI AND BRYOPHYTES	4	-	52	3	70	30	100	4
HCT-103	DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS	4	-	52	3	70	30	100	4
HCT-104	ECOLOGY AND ENVIRONMENTAL BIOLOGY	4	-	52	3	70	30	100	4
SCT-105	PHYTOGEOGRAPHY AND EVOLUTION	3	-	39	3	70	30	100	2
HCP-106	PAPER – HCT 101	-	4	52	4	70	30	100	4
	PAPER – HCT 102	-	4	52					
HCP-107	PAPER – HCT 103	-	4	52	4	70	30	100	4
	PAPER – HCT 104	-	4	52					

SEM. II

Paper Code	Title of the Paper	Theory (Hrs/Week)	Practical (Hrs/Week)	Total No. of Hrs/Semester	Duration of Examination (Hrs)	Max. Marks examination	Internal Assessment	Total Marks	Credits
HCT-201	PLANT ANATOMY AND PALYNOLOGY	4	-	52	3	70	30	100	4
HCT-202	PLANT MORPHOGENESIS AND REPRODUCTION	4	-	52	3	70	30	100	4
HCT-203	CELL BIOLOGY AND GENETICS	4	-	52	3	70	30	100	4
HCT-204	PLANT BREEDING AND PROPAGATION	4	-	52	3	70	30	100	4

SCT-205	BIOCHEMISTRY AND BIOPHYSICS	3	-	39	3	70	30	100	2
HCP-206	PAPER – HCT 201	-	4	52	4	70	30	100	4
	PAPER – HCT 202	-	4	52					
HCP-207	PAPER – HCT 203	-	4	52	4	70	30	100	4
	PAPER – HCT 204	-	4	52					

Scheme for Continuous Evaluation

Theory Paper (each)

Attendance: 05 Marks

Tests*: 15 Marks

Assignment: 05 Marks

Seminar/Presentation: 05 Marks

Total: 30 Marks

*Two tests will be conducted and average of marks from two tests shall be computed for continuous evaluation

Practical (each)

Attendance: 05 Marks

Practical Tests*: 20 Marks

Record: 05 Marks

Total: 30 Marks

*Two tests shall be conducted and average of marks from two tests shall be computed for continuous assessment.

BOT HC 101: SYSTEMATICS, VIROLOGY, BACTERIOLOGY AND PLANT PATHOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Acquaint with the concept of Systematic Botany and various methodologies employed in the study.
- Comprehend the diversity of lower cryptogams (Bacteria, Phytoplasma and viruses).
- Recognize the morphology, anatomy, physiology, reproduction and lifecycle pattern. Their diversification and familiarize with various ecological niche. Positive and negative values.
- Understand to identify plant diseases, causal organisms and the defense mechanism by the host.

UNIT I Fundamental of Systematics: **13 hrs**

Biological classification, hierarchy of categories and higher taxa. Taxonomical characters — Procedures and keys. Species concepts: varieties, subspecies, sibling species and race. International code of Botanical nomenclatures.

Methodologies in Systematics:

Morphology based taxonomy, numerical taxonomy, cytotaxonomy and chemotaxonomy. DNA fingerprinting and markers - detection/evaluation of polymorphism.

Modern concepts: Genomic DNA: nuclear, chloroplast and mitochondrial genomes, DNA and RNA based taxonomy in plants representative genes in modern taxonomy (COI, cyt-b, 16S, 185, 28S rRNA, mat K, ITS1, ITS2, rDNA and trnl-F). Key features of DNA based phylogeny.

Genomic Data Bases: Genetic Diversity-Assessing biodiversity. Primary nucleotide, nucleotide sequence databases: Gene Bank, EMBL, DDBJ and BOLDS. DNA barcoding.

UNIT II Virology: **13 hrs**

Origin and evolution of viruses; Classification of viruses- Methods of cultivation of viruses; Purification and detection of viruses; Transmission of viruses; Mechanism of replication of DNA and RNA viruses; Viroids - Structure and multiplication; Prions - structure and multiplication; **Prions**.

UNIT III: Bacteriology: **13 hrs**

Introduction and classification of Bacteria by Bergey's Manual of Determinative and Systematic

Bacteriology; C. R. Woese- Three domain classification of Bacteria; Archaebacteria and Eubacteria - diversity and evolution; Nutritional types of bacteria; Bacterial growth; Recombination in bacteria (conjugation, transformation, and transduction); Brief account on actinomycetes; Structure and multiplication of Mycoplasma and Phytoplasma; Economic importance of bacteria.

UNIT IV Plant Pathology: **13 hrs**

Concepts and scope of plant pathology; Plant diseases and crop losses; classification of plant diseases; Parasitism and disease development; Effect on physiology of host; Host range of pathogens; Defense Mechanisms in Plants; Plant Disease epidemics and plant disease forecasting; Methods of plant disease management; Study of plant diseases- Sandal Spike, Citrus Canker, Bacterial Blight of Paddy, Bacterial Blight of Pomegranate, Late Blight of Potato, and Sugarcane gumming disease. Tobacco mosaic, Yellow mosaic of beans, Tomato leaf curl, Cauliflower mosaic, Cucumber mosaic and Tomato spotted wilt. Phloem Necrosis of Coffee, Root Knot Disease of Mulberry.

BOT HCP 101: SYSTEMATICS, VIROLOGY, BACTERIOLOGY AND PLANT PATHOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. Construction of dichotomous key
2. Construction of Cladogram
3. Determining total count of microbes using Haemocytometer.
4. Culturing of Bacteria. Preparation of media (NA & NB), Sterilization and inoculation.
5. Direct / Indirect staining of Bacteria.
6. Plant pathology – Bacterial and Viral diseases.
7. Estimation of total phenols in diseased and healthy plant tissues.
8. Field activities: Field visits, survey arid forests/GKVK.

REFERENCES:

1. Biodiversity Conservation and Phylogenetic Systematics. Pelleus R and Gandcolas P(2011) Springer N.Y.
2. Biodiversity: Perception, Peril and Preservation. Prabodh Maiti and Paulain Maiti (2011). PHI Learning. New Delhi
3. Plant Systematics. Balfour A (2016). Syrawood Pub. House. London
4. Morphology and General Properties of Viruses. The National Institute of Open Schooling
5. Edward K. Wagner & Martinez J. Hewlett. 2003. Basic Virology Paperback. Blackwell publishing.
6. P.C. Trivedi, Sonali Pandey & Seema Bhadauria. 2010. Textbook of Microbiology. Aavishkar Publishers, Distributors, India.
7. Tina M. Henkin, & Joseph E. Peters. 2020. Molecular Genetics of Bacteria (5^{th} ed.).

BOT HC 102: DIVERSITY OF LOWER GROUPS –FUNGI, ALGAE AND BRYOPHYTES

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Familiarize the morphology, anatomy, physiology, reproduction and lifecycle pattern of fungi, algae and bryophytes. Their diversification and application.
- Explore the economic importance of algae and culturing methodology.
- Understand the evolution of bryophytes, its significance and morphological adaptation.

UNIT I - FUNGI: 13 hrs

Introduction: History and scope of Mycology. General Characteristics, Structure, reproduction and classification of fungi with emphasis on criteria used in classification of different groups and introduction to Molecular Classification.

Evolution of sex in fungi; Heterothallism and parasexuality; Structure and mode of reproduction in Plasmodiophoromycetes: *Plasmodiophora*, Oomycetes: *Pythium*, Zygomycetes: Mucor, Ascomycetes: *Aspergillus*, Basidiomycetes: *Agaricus* and Deuteromycetes: *Colletotrichum*.

Economic importance of Fungi. The role of fungi in biotechnology.

UNIT II - ALGAE: 13 hrs

Classification and Diversity: A comparative study of traditional and modern systems of classification, Significance of pigments and cell wall in the classification of algae.

Habitat, thallus organization, cell structure, reproduction and life cycle patterns with reference to Cyanobacteria, Chlorophyceae, Charophyceae, Bacillariophyceae, Xanthophyceae, Euglenophyceae, Phaeophyceae, and Rhodophyceae.

UNIT III - CULTURING AND APPLICATIONS OF ALGAE: 13 hrs

Cultivation of microalgae - *Spirulina* and *Dunaliella*; Media, seeding, cultivation systems, harvesting; processing, drying methods, packaging, marketing; Algal cultivation and production in India; Cultivation of macroalgae- *Porphyra*.

Applications of algae/products: Treatment of wastewater plants, phyco-remediation; Biofouling and biofuel production. Algal products as sources of nutraceuticals; Food colorants; Aquaculture feed; Therapeutics and cosmetics; Medicines; Dietary fibres from algae and uses.

Bio - fuels from Algae: Bio diesel, ethanol, mass culturing of algae for biofuel – production, extraction and refinement.

Economic importance of algae- Algal fertilizers and Algal Biotechnology (Biotechnological applications of algal silica and oils); Algae as food and carbon sequestration.

UNIT IV - BRYOPHYTES: 13 hrs

Introduction, general characteristics, classification and phylogeny of Bryophytes; Distribution, habitat, external and internal morphology and reproduction: Hepaticae – Marchantiales, Jungermanniales, and Sphaerocarpales. Anthocerotae – Anthocerotales. Musci − Sphagnales, Funariales, Polytrichales, Comparative account on gametophytes and sporophytes of bryophytes. Ecological and economic importance of Bryophytes.

Conservation of Bryophytes.

Fossil Bryophytes.

BOT HCP 102 DIVERSITY OF LOWER GROUPS – ALGAE, FUNGI AND BRYOPHYTES

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

FUNGI

1. Fruiting bodies of fungi: Acervuli, pycnidia, fruiting body
2. Staining of AM Fungi
3. Fruiting bodies of macro fungi: *Pythium, Albugo, Rhizopus, Mucor, Aspergillus, Penicillium, Trichoderma, Curvularia, Alternaria* and *Agaricus*.
4. Mushroom Culturing Technique
5. Preparation of Wine from grapes.

ALGAE

1. Cyanobacteria: *Microcystis*, *Spirulina*, *Rivularia, Gloeotrichia*, *Nostoc*, *Anabaena* and *Scytonema*.

2. Chlorophyceae: *Pediastrum, Zygnema, Desmids, Cladophora, Draparnaldiopsis, Bulbochaete, Oedogonium, Ulothrix, Ulva lactuca, Ulva reticulata, Enteromoropha, Caulerpa, Codium* and *Halimeda.*
3. Charophyceae: *Chara* and *Nitella*.
4. Xanthophyceae: *Vaucheria*
5. Bacillariophyceae: Centric and Pennate Diatoms.
6. Phaeophyceae: *Ectocarpus*, *Dictyota*, *Sargassum* and *Turbinaria*.
7. Rhodophyceae: *Gracillaria, Batrachospermum* and *Polysiphonia*

BRYOPHYTES

1. Study of morphology, anatomy, reproductive structures and sporophytes of the following: *Marchantia, Lunularia, Dumortiera, Porella, Anthoceros, Notothylos, Sphagnum, Funaria and Polytrichum.*
2. Botanical tour - Field trips to identify and collect fresh water, marine algae and bryophytes.

REFERENCES

FUNGI

1. Bruns, T. D. White, T. J. and Taylor, J.W. 1991. Fungal molecular systemtics. Annu. Rev. Ecol. Syst, 22: 525-64.
2. Burnell, J. H. and Trinci, A. P. J. 1979. Fungal walls and hyphal growth, Cambridge University Press. Cambridge.
3. Chandhniwala, 1996. K.M. Infectious fungi, Anmol Publications, Pvt. Ltd.,

ALGAE

1. Andersen, R. A. 1992 and Bhatia, K. N. 1984. Photosynthetic apparatus among green, A treatise on algae, S. Chand and Company, New Delhi.
2. Bold and Wynee. 1985. Introduction to algae – Structure and reproduction. Prentice – Hall, India,
3. Desikachary, 1959, Cyanophyta, ICAR. New Delhi.
4. Dixon. 1973. Biology of Rhodophyta. Oliver and Boyd, London.
5. Dodge, J.D. 1973. The Fine Structure of Algal Cells, Academic Press, INC. London.
6. Fritsch, F. E. 1961, Structure and reproduction in algae, Vol- I, II Cambridge University Press, London.
7. Kumar, H. D. 1990. Introductory phycology, Affiliated East West Pvt Ltd., Bangalore, India.
8. Kumar, H. D. 1984, Algal Cell Biology, East West Private Ltd., India

9. Round, F. E. 1973, Biology of algae. Edward Arnold Publishers, London.
10. Smith, G. M. 1951, Manual of Phycology, Chronica Botanica, Publishers, Waltham, Mass.
11. Smith, G. M. 1972. Cryptogamic Botany, Vol – 1 Tata McGraw Hills Publishers, New Delhi.
12. Trivedi, P. C. 2001. Algal Biotechnology, Pointer Publishers, Jaipur India.

BRYOPHYTES

1. Bernard Goffinet and Jonathan Shaw, A. 2009. Bryophyte Biology. Cambridge University Press, New York.
2. Chopra, R. N and Kumar, P. K. 1988. Biology of Bryophytes. New Age International Publishers, New Delhi.
3. Parihar, N. S. 1970. An Introduction to Embryophyta. Vol. I Bryophyta, Central Book Depot, Allahabad.
4. Rashid, A. 1998. An Introduction to Bryophyta. Vikas Publishing House, Pvt. Ltd., New Delhi.
5. Smith, G. M., Cryptogamic Botany, Vol. I McGraw Hill Book Company, New Delhi.
6. Vasishta, B. R., Sinha, A. K. and Adarsh Kumar, 2005. Botany for degree students Bryophyta. S Chand and Company, New Delhi.
7. Watson, E. V. 1971. The structure and life of Bryophytes. Hutchinson and Co. London.

BOT HC 103: DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Expertise the morphology, reproduction and lifecycle pattern of various classes of Pteridophytes, and Gymnosperms. Their diversification and application.
- Understand the stelar evolution and seed formation habit in pteridophytes.
- Explain about fossils and fossilization.
- Develop the art of preparing sections of wood (as by means of a microtome) for microscopic examination

PTERIDOPHYTES

UNIT I **13 hrs**

Introduction: General characters, Distribution and classification. Diversity in morphology and reproduction: Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales

Fossil Pteridophytes: Psilophytales, Lepidodendrales and Calamitales.

UNIT II **13 hrs**

Diversity in morphology and reproduction of Ferns Eusporangiate Ferns: Ophioglossales, Marattiales, Leptosporangiate Ferns: Osmundales, Filicales (Adiantaceae, Cyatheaceae, Hymenophyllaceae, and Dryopteridaceae), Marsileales and Salviniales.

Heterospory and seed habit, stelar evolution, origin of Pteridophytes (Telome theory) and economic importance of Pteridophytes.

Evolutionary significance of Pteridophytes.

GYMNOSPERMS

UNIT III **13 hrs**

Introduction: Distribution and Systems of Classification, Fossil Gymnosperms: Types of Fossils, techniques to study fossils. Pteridospermales, Bennettitales, Pentoxylales, Caytoniales, Ginkgoales and Cordaitales

UNIT IV **13 hrs**

Diversity in morphology, anatomy and reproduction: Cycadales Coniferales, Ginkgoales, Taxales and Gnetales.

Economic importance of Gymnosperms; Xylotomy.

BOT HCP 103: DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

PTERIDOPHYTES

1. **Study of morphology and anatomy of vegetative and reproductive structures of:** *Psilotum, Lycopodium, Selaginella, Isoetes, Equisetum, Ophioglossum, Angiopteris, Osmunda, Adiantum, Hymenophyllum, Trichomanes, Cyathea, Marsilea, Salvinia* and *Azolla*. (Specimens and Images)
2. **Study of Fossil Pteridophytes:** *Rhynia, Lepidodendron, Lepidostrobus Lepidocarpon, Calamites* and *Sphenophyllum.* (Slides and Images).

GYMNOSPERMS

1. **Types of Fossils and Fossiliferous rocks:** Impressions, Petrificatations, Coal & lignite.
2. **Study of representative genera of:** *Lygenopteridaceae, Medullosaceae, Cycadeoideaceae, Williamsoniaceae, Glossopteridaceae, Pentoxylaceae, a*nd *Cordaitaceae.* (Slides and Images).
3. **Study of morphology anatomy and reproductive structures:** *Zamia, Encephalartos, Ginkgo, Cedrus, Araucaria, Podocarpus, Thuja, Biota, Cupressus Taxodium, Juniperus, Cryptomeria, Gnetum, Ephedra* and *Welwitschia.* (Specimens and Images)

REFERENCE

PTERIDOPHYTES

1. Eames, A. J. 1936. Morphology of Vascular Plants (Lower groups), McGraw Hill Publisher. New York.
2. Gifford, E. M. and Foster, A. S. 1989. Morphology and Evolution of Vascular Plants. (3 Edition) W. H. Freeman and Company, New York.
3. Kubitzki, K. 1990. The Families and Genera of Vascular Plants: Vol - I Pteridophytes and

Gymnosperms. Springer-Verlag and Gymnosperms.

4. Parihar, N. S. 1977. The Morphology of Pteridophytes. Central Book depot Allahabad, India.
5. Sporne, K.R. 1962 The morphology of Pteridophytes: the structure of ferns and allied plants. Hutchinson & Co.(https://archive.org/details/morphologyofpter00spor)
6. Rankel, T.A. and Hanfler. C. H, 2008 The Biology and Evolution of Ferns and Lycophytes Cambridge University press.

GYMNOSPERMS

1. Andrews, H. N. 1961. Studies in Paleobotany, John Wiley, New York.
2. Bhatnagar, S. P. and Moitra, A. 1996. Gymnosperms. New Age International Ltd., New Delhi.
3. Biswas. C. K. Johri, B. M. 1997. The Gymnosperms Springer- verlag.
4. Coulter. J. M. and Chamberlain. C. J. 1910. Morphology of Gymnosperms, University of Chicago press.
5. https://www.biodiversitylibrary.org/item/116878#page/7/mode/1up.
6. Harris, T. M. 1973. Cycas and the Cycadales, Central Book Depot, Allahabad.
7. Sporne, N. E. 1965. The Morphology of Gymnosperms. Hutchinson and Co.

BOT HCT 104: ECOLOGY AND ENVIRONMENTAL BIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Expertise the concept, types, development and functions of various ecosystems and their communication.
- Understand the various environmental factors governing these ecosystems.
- Analyze the factors leading to Environmental degradation, their reasons and their impact on the Environment.
- The knowledge to form strategies for conservation and sustainable management.

UNIT I Concept of Ecology and Ecosystem: 13hrs

Evolutionary ecology, environmental concepts-laws and limiting factors, Ecological models. Nature of ecosystem, production, food webs, energy flow through ecosystem, bio-geochemical cycle, resilience of ecosystem, ecosystem management.

Limiting Factors: Concept of limiting factors-Liebig's law of the minimum, Shelford's law of Tolerance. Population and community ecology. Natality, mortality, growth rate as factors determining the population density-population interactions. Types of community-structure, ecological succession and homeostasis.

UNIT II Habitat Ecology: 13 hrs

Types of ECOSYSTEMS: Freshwater, marine, estuarine, terrestrial habitat. Biodiversity hot spots of the world. Eco-tourism.

Resource Ecology and Management:

Concept-classification; non-renewable and renewable resources conventional and non-conventional source and energy. Conservation of natural resources. use alternate energy sources.

Climate change:

Environmental stresses and their management- global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations. El-Nino Effect.

UNIT III Environmental Pollution: 13 hrs

Air, water, soil and land pollution. Impact of pollutants on flora and ecosystem. Factors influencing environmental concentration of toxicants and toxicity. Environmental monitoring of pollutants. Major conventions and agreements for environmental protection. Rehabilitation of lakes in and around Bangalore.

Toxicology: Principles of Toxicology and types of Toxins, sources, metabolism and biological monitoring of Arsenic, Mercury, Zinc, and Lead.

UNIT IV Bioremediation: 13 hrs

Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants. Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemicals in agriculture, industry hygiene and their disposal. Impact of chemicals on biodiversity of microbes, and plants. Bio indicator and biomarkers of environmental health. Biodegradation and bioremediation of chemicals. Rehabilitation of degraded water bodies, mangroves, rural landscape and unbalanced soils.

BOT HCP 104: ECOLOGY AND ENVIRONMENTAL BIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. Estimation of chloride, sulfide in water samples.
2. Estimation of the B.O.D. and C.O.D
3. Thermal lag studies in habitat.
4. Study of vegetation by quadrat method.
5. Study of terrarium.
6. Estimation of soil biomass. (Wet and dry methods)
7. Ecological instruments: Thermometers (Wet and dry), Aerometer, Altimeter, Barograph, Thermograph and Rain gauge.

REFERENCES:

1. Fundamentals of Ecology. Eugene P. Odum (1972). W.B. Saunders company, London
2. Environmental Biology, Michael Reiss and Penny Chapman, (2000) Cambridge Press, UK
3. Environment and Ecology. Majid Husain (2015) Access Publishing.UK
4. Cunningham and Saigo (1999), Environmental Science. McGown Hill, 5th Edition. London.

5. A primer of Conservational Biology. Primark (2001) Sinauer, 2nd Ed.
6. Process of Organic evolution. Stebbins, G.L. (I 989). Prentice Hall of India, New Delhi
7. Evolutionary Biology. Douglas, J. Futuyma. (1997). Sinauer Associates.
8. Evolution: Making Sense of Life. Zimmer C and Elmen D J. (2013). Roberts & Co. NY.

SCT 105: PYTOGEOGRAPHY AND EVOLUTION

Total Contact Hours:	30 Hrs
Number of Credits:	02
Formative Assessment Marks:	30

Summative Assessment Marks:	70

COURSE OUTCOME

- Understand the division of geographical regions based on the distribution of plants.
- Apply the factors governing the distribution of plants in relation to evolution and migration of plants.
- Gain insight into theories governing origin, evolution and distribution of plants.

UNIT I **10 hrs**

Introduction and History: Physical features of the world (climate, deserts) Aims, methods and principles of plant geography. Islands of botanical interest. Continental drift and evidence in its favour. Biogeographical regions of the world phytochoria of Indian sub-continent. Floristic regions of the world; Hansen classification and Ronald Good's classification

UNIT II **10 hrs**

Continuous, discontinuous, Centre of origin, endemism, age and area hypothesis, bathymetric distribution.

Evolution and Plant Migration: Dispersal, isolation, and barriers. Vicarious species, Relict species, isofloras, polytopy, centers of origin of crop plants.

UNIT III **10 hrs**

Theories on origin of life: prebiotic environment, panspermia. Theories on evolution: Lamarkism, Darwinism and Neo Darwinism. Natural selection: Models of Natural selection Variations: Causes and consequences of variations, polymorphism. Isolation mechanism and speciation: Geographical and reproductive isolation, parapatric and sympatric speciation.

Micro and macroevolution.

REFERENCES:

1. Cain, S.A. 1944. Foundations of Plant Geography. Harper & Bros, NY
2. Futuyama, D. J. 2003. Evolution. Sinaur Associates, Inc.
3. Good, R. D. 1 974. The Geography of Flowering Plants. edn. 3, Long Mans, London.
4. Hall, B. K. and Hallgrimsson. B, 2008. Strickberger's Evolution. Jones and Barlett pub.
5. I.awrence. G.H M. I 965. Taxonomy of vascular plants, The McMillan Company, New York.
6. Strickberger, M.V. 2002. Evolution. Jones and Barlett Publishers. Sudbury.
7. Valentine, D.H. 1972. Taxonomy, Phytogeography and Evolution. Academic Press, London.

New York.

8. Webber, P and Punnett, N. 1999. Physical geography and people Stanley. Thomas.

BOT HCT 201: PLANT ANATOMY AND HISTOCHEMISTRY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Understand the internal organization of various parts of the plants.
- Describe the morphological and anatomical adaptation of plants in relation to their surroundings.
- Understand the various cell types and their functions.
- Understand the process of microscopy

UNIT I: **13 hrs**

Root anatomy: Primary structure of root, variations in number of vascular Strands. Velamen and Trichoblast. Leaf anatomy: Dicot, Monocot and Variations, Venation pattern Stomatal types and distribution. Nodal anatomy: Types of nodes and origin of bud traces. Internodal anatomy: Herbaceous dicot, woody and monocot stem, medullary bundles, bicollateral bundles and internal phloem. Floral Anatomy: Ontogeny and vascularization.

UNIT II: **13 hrs**

Primary xylem: Concepts of Protoxylem and metaxylem, vascular differentiation in shoot apex and leaf primordia. Diversity in structure of wood: Heart and sapwood, Growth rings, Ring porous wood, Porous wood, diversity in axial parenchyma distribution and diversity in ray system.

Anatomical Variations: Ecological and anatomical adaptations in Hydrophytes, Xerophytes, Halophytes, Parasites and Epiphytes.

Concepts of Protoxylem and metaxylem, vascular differentiation in shoot apex and leaf primordia.

UNIT III: **13 hrs**

Phloem tissue: Ultra structure and development of sieve tube element. Vascular

cambium: Structure and activity, uniseriate / multiseriate nature, Fusiform ray initials and Cambium zone. Variations in Vascular Cambium - *Gnetum* and Magnoliales. Unusual Secondary Growth: *Serjania clematidifolia* and *Passiflora* spp.

UNIT IV **13 hrs**

Plant Histochemistry: Tests for minerals, carbohydrates, lignins, polyphenols, proteins, lipids and nucleic acids; Study of instruments: (a) Microscopy (b) Camera lucida (c) Micrometry (d) Microtome.

Principles of histo-chemical stains; Killing, fixing and staining of plant tissues; Double staining - TBA method.

BOT HCP 201: PLANT ANATOMY AND HISTOCHEMISTRY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. Study of instruments
2. Study of epidermal appendages and Stomatal types.
3. Double staining technique
4. Root Anatomy.
5. Stem Anatomy
6. Leaf Anatomy.
7. Flower bud Anatomy.
8. Ecological Anatomy.
9. Maceration (Study of types of elements).

REFERENCES

PLANT ANATOMY

1. Abraham, F. 1982. Plant anatomy 3 editions, Pergaon Press, Oxford.
2. Carlquist, S. 1967. Comparative Plant Anatomy, Holt Reinert and winston, New York.
3. Chand, S. 2005. Plant Anatomy. S. Chand and Company Ltd., New Delhi.

4. Cutter, E. G. 1971. Plant Anatomy — Part I & II, Cell and Tissues. Edward Arnold, London.
5. Fahn, A. 1985. Plant anatomy, Pergaon Press, Headington Hill Hall, Oxford.
6. Katherine Easu, 1996. Anatomy **of Seed Plants.** First wiley Reprint, New Delhi.

BOT HCT 202 PLANT MORPHOGENESIS AND REPRODUCTION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Understand the various aspects of plant floral parts, development and reproduction
- Comprehend the various aspects of embryology and apomixis.
- Deliberator the development and regeneration from lower to higher plants.

UNIT I **13 hrs**

Introduction, History, aim and scope of plant morphogenesis; Totipotency: Free cell and its significance.

Polarity: Contemporary understandings at different levels of organization; *Fucus* egg and *Equisetum* spores

Symmetry: Radial, bilateral and dorsiventral symmetry. Differentiation: Patterns of differentiation, vascular differentiation, role of growth hormones in vascular differentiation.

Regeneration: Lower and higher plants.

UNIT II **13 hrs**

Organogenesis in plants: Differentiation of plant body, organization of shoot and root apical meristem, activity of the shoot and root apical meristems, formation of lateral roots and leaves, transformation of vegetative apex into reproductive apex.

Flower: Morphogenetic concept of flower development (the initial, steady state, stimulus and transition to flowering), genetic analysis of floral development (Arabidopsis) and flower regulatory genes.

UNIT III **13 hrs**

Microsporogenesis: Ultra structure and physiology - a brief account. Male gametophyte: Pollen wall morphogenesis during tetrad and post tetrad phases, origin, structure and differential behaviour of generative and vegetative cells, formation of

spores and ultra-structure of 3-celled pollen grain, culture of anthers and meiocytes. Nemec phenomenon.

Palynology: Brief account on branches of Palynology. General account of pollen / Spore morphology: Dicot, monocot, Gymnosperms and Pteridophytes, Chemical composition of pollen ornamentation, Palynological techniques. General account on aeropalynology and melittopalynology.

UNIT IV **13 hrs**

Ovule: A general account of ontogeny and diversity in structure.

Megasporogenesis: Ultra structure and physiology.

Female Gametophyte: Diversity in organization and ultra-structure of female gametophyte (In cotton), Embryosac haustoria - a general account.

Fertilization: Structure of stigma and style, pollen germination in vivo, pollen tube entry into the stigma, pollen tube growth, entry of pollen tube into female gametophyte, double fertilization, hetero fertilization and single fertilization.

Endosperm: Development, cytology and physiology, reserve materials, embryo – endosperm relationship.

Embryo: Structure, composition and polarity of zygote, early embryogenesis (2 celled, proembryonal tetrad, quadrant and octant stages), octant to mature embryo in *Capsella bursa* (Dicot) and *Najas lacerata* (Monocot).

BOT HCP 202 PLANT MORPHOGENESIS AND REPRODUCTION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. Study of Shoot apices by dissections using aquatic plants (Hydrilla).
2. Study of cytohistochemical zonation in the shoot apical meristem in sectioned and double stained micropreparation of a suitable plant.
3. Study of development of bisected shoot apices.

4. Examination of rosette plants (Raphanus) and induction of bolting under natural condition as well as by GA treatment.
5. Diagrammatic representation to show the polarity in higher and lower plants. Experiment to cause alternations in polarity, Regeneration experiment with stem cuttings to show polarity.
6. Study of the following stages from permanent micropreparation;

a) Anther wall, Microsporogenesis.
b) Male gametophyte in general and in Cyperaceae.
c) Types of ovules and ovular parts.
d) Megasporogenesis and female gametophyte (Polygonum type).
e) Endosperm – Three types (Cellular, Nuclear and Helobial).
f) Embryo – Globular, Cordate stages; mature dicot and monocot embryo.

REFERENCE

1. Bhojawani, S. S. and Bhatnagar, S. P. 1979. **The Embryology of Angiosperms**. VikasPublication, New Delhi.
2. Davis, G. L. 1966. Systemic embryology of Angiosperms. John Wiley & Sons, Inc. New York.
3. Easu, K. 1977. **Anatomy of Seed Plants**. Wiley Eastern, New Delhi.
4. Fosket, D. E. 1989. **Plant growth and developments**. Academic Press, New York.
5. Johansen, D. A. 1950. **Plant embryology**. Chronica Botanica Co., Witham, Mass.
6. Johri, B. M. 1984. **Embryology of Angiosperms**. Spinger – Verlag, Berlin.
7. Lyndon, R. F. 1990. **Plant development** – The **cellular basis**. Unwin Hyman, London.
8. Maheshwari, P. 1963. **Recent advances in embryology. International Soc. Plant Morphol,** New York.
9. Maheshwari, P. 1950. **An introduction to the embryology of Angiosperms**. McGrawHill, New York.
10. Pullaiah, T. Lakshminarayana, K. and Hanumatha Rao, K. 2001. **Textb o o k of Embryology of Angiosperms**, Regency Publication, New Delhi.
11. Raghava, V. 1979. **Experimental embryogenesis of Vascular Plants**, Cambridge University Press, Cambridge. U.K.
12. Sinnott, E. W. 1960. **Plant morphogenesis**. Mc Graw Hill Book Company, INC, NewYork.
13. Steeves, T. A. and Sussex, I. M. 1989. **Patterns in Plant development**. Cambridge University Press, Cambridge. U. K.
14. Steward, F. C. 1968. **Growth and organization in plants**. Addison Wesley Publishingcompany, U. S. A.

BOT HCT 203: CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Analyze the cellular components and how it is used to generate and utilize energy in cells
- Understand causal relationships between molecule/cell level phenomena ("modern" genetics) and organism-level patterns of heredity ("classical" genetics) .
- Application in a variety of genetic problem-solving situation.
- Understand the process of Mapping and sequencing of genome.

UNIT I **13 hrs**

Structural organization: Phospholipid bilayer, integral proteins and fluid mosaic model; transport across cell membrane.

Cell organelles: Structure, functions and biogenesis of ER, Golgi bodies, Mitochondria, Chloroplast, Plastids, Lysosomes, Nucleus.

Protein Sorting and Targeting: Processing through endomembrane system, synthesis and targeting of mitochondrial and chloroplast and peroxisomal proteins. Insertion of membrane proteins into ER, receptor mediated endocytosis, exocytosis and molecular mechanism of vesicular traffic.

UNIT II **13 hrs**

Cell growth, division and differentiation, mechanism regulating mitotic events checkpoints, role of Cyclins, Protein kinases and Maturation Promoting Factor (MPF) Regulation of Cell Cycle and Cytokinesis. Meiosis and fertilization. DNA damage and repair mechanisms. Gene: Fine structure of r II locus, Present concept, Split genes. Genetic Code Cell free system, use of synthetic RNAs, Poly-U experiments. Overview of gene expression, central dogma, structure and function of different RNAs.

Chromosomes: Organization, structure in Prokaryotes and Eukaryotes, Centromere,

Kinetochore complex, centromere Proteins (CENPs), Sister chromatid cohesion, Telomeres and their role in chromosome segregation. Histone code and role of non-histones. Chromosomal packaging and Gene activity Structural variations in chromosomes: Cytogenetic implications of Deletion, Duplication, Inversions and Translocations. Secondary messengers. Apoptosis; mitochondrial dependent and independent pathway, factors influencing apoptosis. Necrosis and necroptosis.

UNIT III **13 hrs**

Mendelian Principles: Extension, Codominance, Multiple alleles and linkage, inheritance of complex traits, Chromosomal theories of inheritance. Nondisjunction as proof, Sex linked inheritance and non mendelian inheritance in organelle Genomes.

Genetics of Bacteria and Viruses: Bacterial mutants, genetic transformation, conjugation and transduction in bacteria, Genetic recombination, mapping of bacterial genome, Bacterial phage genetics, Plaque formation and Phage mutants, Recombination- lytic, lysogenic cycle and specialized transduction. Evolutionary significance of genetic exchange in Bacteria.

Population Genetics: Hardy-Weinberg concept and its application, Allele frequency, genotype frequency, amino acid variation, Molecular drive, genetic variability in population and factors responsible for variation.

UNIT IV **13hrs**

Proteomics, Genomics and Bioinformatics: Structural and functional genomics, Comparative Genomics- biochemical, evolutionary, physiological and phylogenomics. Tools to study functional genomics: Proteomics- functional and comparative proteomics. Protein distribution, characterization and identification, differential display proteomics, detection of functional linkages, pharmacogenomics. Bioinformatics- tools of bioinformatics, data bases and data base management, Bioinformatics in taxonomy, biodiversity, agriculture. Bioinformatics in drug design and drug discovery.

BOT HCP 203: CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30

Summative Assessment Marks:	70

1. Vital staining of mitochondria
2. Squash and smear preparation of mitotic and meiotic chromosomes (*Allium cepa* and *Rhoeo* sp.)
3. Karyotype study (at least two species)
4. Preparation of polytene chromosomes
5. Preparation of semi-permanent slides
6. Genetic problems.
7. Bioinformatics

REFERENCES:

1. Cell Biology. Karp, G. (2016). McGraw Hill book Co. NY, 16th Edition.
2. The Cell: Molecular approach. Cooper G.M. (2009) ASM press, USA
3. Molecular Biology of the Cell. Alberts M, Johnson A, Raff M, Bray D and Lewis J. (2008) 6th edition. Garand Sciences NY.
4. Molecular Biology. Lodish, Berk, Zipursky, Matsudaira, Baltimore and Darnell. (2006). Freeman Press, London.
5. Modern Genetic analysis: Integrating Genes and Genomes. Griffiths A.J.G. Gilbert W.M. and Miller J.H. and Lewontin R.C. (2003). Freeman Co NY.

BOT HCT 204: PLANT BREEDING AND PLANT PROPAGATION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Acquire knowledge on floral biology and selection of proper breeding method.
- Cultivate skill in emasculation and pollination of various crop plants.
- Know the requirements in breeding for biotic and abiotic stress tolerant varieties.
- Comprehend the various methods of vegetative propagation and sees propagation.

PLANT BREEDING

UNIT I **13hrs**

Introduction: History and scope of plant breeding

Reproduction: Modes of reproduction, Mechanism of pollination control in crop plants (self-incompatibility and male sterility).

Hybridization: Conventional breeding methods, Hybridization methods in self- and cross-pollinated crop plants, selection in self, cross and vegetative propagated crop plants. Backcross method and its importance in crop plants. Plant Introduction, Domestication and Acclimatization,Patterns of Evolution in crop plants, Plant Genetic resources and its importance, Sources of Germplasm utilization and conservation. Role of Global and National Organizations for crop Improvement.

UNIT II **13hrs**

Heterosis: History, Genetic basis of Heterosis, Homozygous and Heterozygous balance inbreeding depression and its effects.

Resistance Breeding: Breeding for resistance to Abiotic stresses – drought resistance, breeding methods and genetics of drought resistance. Breeding for resistance to biotic stresses - diseases resistance, disease development and escape, breeding methods, genetics of disease resistance. Insect resistance - Breeding methods and genetics of insect resistance.

Distant Hybridization: Introduction, barriers, techniques for the production of distant hybrids, sterility in distant hybrids, Importance of distant hybridization in crop

improvement.

Quality Seeds: Classes, production, maintenance, development of seed industry, Indian seed act and Plant protection Act.

PLANT PROPAGATION

UNIT III **13 hrs**

Basic concepts and principles of plant propagation: Propagating structures: Green house, Shade house, Net house, nurseries, containers for growing plants. Media for propagation, treatment of soil and soil mixtures. Fertilizers and sanitation.

Vegetative Propagation: Sources, selection and management, advantages and limitations of the vegetative propagation.

Source, production, viability & maintenance and genetic variability. Types of cutting, layering, grafting, budding. Hydroponics.

UNIT IV **13 hrs**

Seed propagation: Seed production, types of seed sowing, harvesting, drying and thrashing, storage, types of storage, pathogens in storage and their control. Seed health, purity, vigour, and tests to check.

Dormancy: types, factors affecting dormancy, methods to overcome dormancy, advantages of dormancy. Seed germination and viability tests seed protectants; priming. Coating, pelleting, Classes of seeds; breeder seeds, nuclear seeds, founder seeds, certified seeds and cultivar seeds, seed act 1966, seed certification.

Liner production and hardening of seedlings.

BOT HCT 204: PLANT BREEDING AND PLANT PROPAGATION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

PLANT BREEDING

1. Reproductive biology, Self, Cross, pollinated plants, Vegetative reproduction.
2. Emasculation, bagging, pollination biology and pollen fertility.
3. Origin, distribution and centres of diversity of crop plants, Wheat, Sorghum, Rice, Chilly, Sugarcane, Cotton, Potato, Coffee, Sunflower and Groundnut.

4. Visit to GKVK and IIHR (Hesaraghatta).

PLANT PROPAGATION

1. Preparation of types of soil, soil mixtures and Soil bed
2. Breaking of seed dormancy and growing seedlings after treatment with hormones and light.
3. Propagate the bulbs (*Allium*), tubers (Potato, *Begonia*) corms (*Gladiolus, Amorphophalus*) rhizomes (*Canna)* and suckers (Banana).
4. Different types of layering (Simple layering, tip layering, serpentine layering, Air layering, mound layering).
5. Grafting – Whip (or splice), side and bark grafting,
6. Budding − T-budding, Inverted T-budding and chip budding.
7. Demonstrate the experiments on the propagation of succulents by cutting and Cacti by grafting.
8. Visit to Lalbagh Botanical Garden, Bengaluru.

REFERENCE

PLANT BREEDING

1. Chaudhari, H.K. 1983. **Elementary Principles of Plant Breeding.** TM.H. Publisher, Comp. New Delhi.
2. Frankel, R. and Bet Dagan. 1983. **Heterosis.** Springer verlag. Berlin.
3. Jain, H.K and Kharkwal, M.C. 2004. **Plant breeding mendelian to molecular approaches.** Narosa Publishing House, New Delhi.
4. Poehlman, J.M. and Brothukar, I.B.H. 1998. **Breeding of Asian Plant.** Oxford and I.B.H, New Delhi.
5. Poehlman, J.M. and Sleper, D.A. 1999. **Breeding Field Crops.** Panima Publisher, New Delhi.
6. Ram, H. 1998. **Vegetable Breeding Principles and Practices.** Kalyani Publishers, New Delhi.
7. Russel, E.G. 1978. **Plant breeding for pest and disease resistance.** Butter worth, London.
8. Sharma, J.R. 1994, **Principles and practice of Plant Breeding.** TATA McGraw – Hill Publisher. Co. New Delhi.
9. Singh, B.D. 2003. **Plant Breeding.** Kalyani Publication, New Delhi.
10. Sneep, J and Hendriksen. 1979. **Plant breeding preparations.** Puduo, Wageningn,

Netherlands.

11. Stalker, H.T and Murthy, J. P (Eds) **Plant breeding in the 1990's.** C.A.B. International walling ford U.K

PLANT PROPAGATION

1. Hartman, H.J. 1990. **Plant Propagation – Principles and practices.** Prentice Hall, New Delhi.
2. Sadhu, M.K. 2000. **Plant Propagation.** New Age Publication, New Delhi.
3. Schwalz, M. 1975. **Guide to commercial hydroponics.** Israel University, Jerusalem.
4. Sharma, V.K. 1996. **Plant nurseries. Techniques, production and management.** Indian Pub. New Delhi.

BOT SCT 203: BIOCHEMISTRY AND BIOSTATISTICS

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Comprehend bioenergetics: Laws of thermodynamics and its application in biological systems, concept of entropy and enthalpy.
- Understand the various biomolecules and their types.
- Knowledge on quantifying the biological data through mathematics.
- Learn the methods of central tendency: Mean, Median and Mode, Measures of dispersion: Standard deviation, Standard error, Mean deviation, Test of significance: Chi-square test and t- test

UNIT I: Molecules and their characteristic futures: 08 hrs

Review of basic concepts of solution chemistry — acid, base, ionic strength, principles of thermodynamics: chemical potential, free energy, entropy, enthalpy, heat capacity; dimensions of atoms, bonds: covalent and non- covalent bonds and molecules. Dihedral angles, steric conflict, classes of organic compounds and functional groups.

Amino acids, peptides and polypeptides:

Chemical reactions and physical properties, three dimensional structures of proteins, the Ramachandran plot, α helix, β sheet. Structure of collagen, conformational map, tertiary structure, quaternary structure.

UNIT II: Carbohydrates and Lipids: 08 hrs

Sugars and polysaccharides: chemistry, classification and function; glycoproteins: structure and function. Fatty acids- Saturated, unsaturated and eicosanoids; phosphor and sphingolipids- structure, classification, lipoprotein, liposomes and prostaglandins.

Nucleic acids: Nucleotides, single and double - stranded DNA structures, types of DNA, RNA word.

Enzymology: Classification, specific activity, coenzymes. Kinetics of enzyme reactions, regulation of enzymatic activity. Isoenzymes: structure and function.

UNIT III: Light and Biomolecules: 08 hrs

Properties of light and laser light, Polarization of light, linear and circular dichroism (CD). CD spectra of protein and nucleic acids.

Spectrometry and X-ray diffraction: Principles of spectroscopy, ionization, protein mass determination, MALDI-MS, ESI-MS. Methods of glowing crystals, theory of x-ray diffraction, Bragg's law, x-ray scattering in reciprocal space, low-angle x- ray scattering, fibre diffraction of helices. Fluorescence resonance energy transfer (FRET)

and its biological applications. Electron Spin Resonance (ESR) and Nuclear Magnetic Resonance (NMR) Spectroscopy.

UNIT-IV Biostatistics: 08 hrs

Importance and scope of Biostatistics. Sample and sampling, Collection and representation of date-tabulation, graphical, diagrammatic. Measures of Central tendency Measures of dispersion: range, mean deviation, Standard deviation, Variance, Deviation. Tests of significance: Significance and difference in means, Standard error of mean, Standard error of SD, Students 't' test, Chi-square test. Analysis of variance (ANOVA). Correlation and regression - Meaning, kinds of correlation, coefficient of correlation, methods of studying correlation. Aims of regression analysis. Kinds of regression analysis.

REFERENCES:

1. Gilbert H.E. 2002. Basic concepts of Biochemistry. McGraw Hill Professional. New Work.
2. Lippincott William & Wilkins. Biochemistry. Down M.B. 1999. London.
3. Annadurai Pillai. 2007. A text book of biostatistics. New Age International Publishers

MODEL QUESTION PAPER

I Semester M.Sc. Examination

HCT:

Time: 3 Hours **Max. Marks: 70**

A. Answer any ten of the following (10x2=20)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

B. Explain/Describe/Write critically on any four of the following (4x5=20)

13.
14.
15.
16.
17.
18.

C. Give a comprehensive account of any three of the following (3x10=30)

19.
20.
21.
22.
23.

BOT HCT 201: PLANT ANATOMY AND HISTOCHEMISTRY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Understand the internal organization of various parts of the plants.
- Describe the morphological and anatomical adaptation of plants in relation to their surroundings.
- Understand the various cell types and their functions.
- Understand the process of microscopy

UNIT I: 13 hrs

Root anatomy: Primary structure of root, variations in number of vascular Strands. Velamen and Trichoblast. Leaf anatomy: Dicot, Monocot and Variations, Venation pattern Stomatal types and distribution. Nodal anatomy: Types of nodes and origin of bud traces. Internodal anatomy: Herbaceous dicot, woody and monocot stem, medullary bundles, bicollateral bundles and internal phloem. Floral Anatomy: Ontogeny and vascularization.

UNIT II: 13 hrs

Primary xylem: Concepts of Protoxylem and metaxylem, vascular differentiation in shoot apex and leaf primordia. Diversity in structure of wood: Heart and sapwood, Growth rings, Ring porous wood, Porous wood, diversity in axial parenchyma distribution and diversity in ray system.

Anatomical Variations: Ecological and anatomical adaptations in Hydrophytes, Xerophytes, Halophytes, Parasites and Epiphytes.

Concepts of Protoxylem and metaxylem, vascular differentiation in shoot apex and leaf primordia.

UNIT III: 13 hrs

Phloem tissue: Ultra structure and development of sieve tube element. Vascular cambium: Structure and activity, uniseriate / multiseriate nature, Fusiform ray initials and Cambium zone. Variations in Vascular Cambium - *Gnetum* and Magnoliales. Unusual Secondary Growth: *Serjania clematidifolia* and *Passiflora* spp.

UNIT IV

13 hrs

Plant Histochemistry: Tests for minerals, carbohydrates, lignins, polyphenols, proteins, lipids and nucleic acids; Study of instruments: (a) Microscopy (b) Camera lucida (c) Micrometry (d) Microtome.

Principles of histo-chemical stains; Killing, fixing and staining of plant tissues; Double staining - TBA method.

BOT HCP 201: PLANT ANATOMY AND HISTOCHEMISTRY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

10. Study of instruments
11. Study of epidermal appendages and Stomatal types.
12. Double staining technique
13. Root Anatomy.
14. Stem Anatomy
15. Leaf Anatomy.

16. Flower bud Anatomy.
17. Ecological Anatomy.
18. Maceration (Study of types of elements).

REFERENCES

PLANT ANATOMY

7. Abraham, F. 1982. Plant anatomy 3 editions, Pergaon Press, Oxford.
8. Carlquist, S. 1967. Comparative Plant Anatomy, Holt Reinert and winston, New York.
9. Chand, S. 2005. Plant Anatomy. S. Chand and Company Ltd., New Delhi.
10. Cutter, E. G. 1971. Plant Anatomy — Part I & II, Cell and Tissues. Edward Arnold, London.
11. Fahn, A. 1985. Plant anatomy, Pergaon Press, Headington Hill Hall, Oxford.
12. Katherine Easu, 1996. Anatomy **of Seed Plants.** First wiley Reprint, New Delhi.

BOT HCT 202 PLANT MORPHOGENESIS AND REPRODUCTION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Understand the various aspects of plant floral parts, development and reproduction
- Comprehend the various aspects of embryology and apomixis.
- Deliberator the development and regeneration from lower to higher plants.

UNIT I

13 hrs

Introduction, History, aim and scope of plant morphogenesis; Totipotency: Free cell and its significance.

Polarity: Contemporary understandings at different levels of organization; *Fucus* egg and *Equisetum* spores

Symmetry: Radial, bilateral and dorsiventral symmetry. Differentiation: Patterns of differentiation, vascular differentiation, role of growth hormones in vascular differentiation.

Regeneration: Lower and higher plants.

UNIT II **13 hrs**

Organogenesis in plants: Differentiation of plant body, organization of shoot and root apical meristem, activity of the shoot and root apical meristems, formation of lateral roots and leaves, transformation of vegetative apex into reproductive apex.

Flower: Morphogenetic concept of flower development (the initial, steady state, stimulus and transition to flowering), genetic analysis of floral development (Arabidopsis) and flower regulatory genes.

UNIT III **13 hrs**

Microsporogenesis: Ultra structure and physiology - a brief account. Male gametophyte: Pollen wall morphogenesis during tetrad and post tetrad phases, origin, structure and differential behaviour of generative and vegetative cells, formation of spores and ultra-structure of 3-celled pollen grain, culture of anthers and meiocytes. Nemec phenomenon.

Palynology: Brief account on branches of Palynology. General account of pollen / Spore morphology: Dicot, monocot, Gymnosperms and Pteridophytes, Chemical composition of pollen ornamentation, Palynological techniques. General account on aeropalynology and melittopalynology.

UNIT IV

13 hrs

Ovule: A general account of ontogeny and diversity in structure.

Megasporogenesis: Ultra structure and physiology.

Female Gametophyte: Diversity in organization and ultra-structure of female gametophyte (In cotton), Embryosac haustoria - a general account.

Fertilization: Structure of stigma and style, pollen germination in vivo, pollen tube entry into the stigma, pollen tube growth, entry of pollen tube into female gametophyte, double fertilization, hetero fertilization and single fertilization.

Endosperm: Development, cytology and physiology, reserve materials, embryo – endosperm relationship.

Embryo: Structure, composition and polarity of zygote, early embryogenesis (2 celled, proembryonal tetrad, quadrant and octant stages), octant to mature embryo in *Capsella bursa* (Dicot) and *Najas lacerata* (Monocot).

BOT HCP 202 PLANT MORPHOGENESIS AND REPRODUCTION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

7. Study of Shoot apices by dissections using aquatic plants (Hydrilla).
8. Study of cytohistochemical zonation in the shoot apical meristem in sectioned and double stained micropreparation of a suitable plant.
9. Study of development of bisected shoot apices.
10. Examination of rosette plants (Raphanus) and induction of bolting under natural condition as well as by GA treatment.
11. Diagrammatic representation to show the polarity in higher and lower plants. Experiment to cause alternations in polarity, Regeneration experiment with stem cuttings to show polarity.
12. Study of the following stages from permanent micropreparation;

a) Anther wall, Microsporogenesis.
b) Male gametophyte in general and in Cyperaceae.
c) Types of ovules and ovular parts.
d) Megasporogenesis and female gametophyte (Polygonum type).
e) Endosperm – Three types (Cellular, Nuclear and Helobial).
f) Embryo – Globular, Cordate stages; mature dicot and monocot embryo.

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15. Bhojawani, S. S. and Bhatnagar, S. P. 1979. **The Embryology of Angiosperms**. VikasPublication, New Delhi.
16. Davis, G. L. 1966. Systemic embryology of Angiosperms. John Wiley & Sons, Inc. New York.
17. Easu, K. 1977. **Anatomy of Seed Plants**. Wiley Eastern, New Delhi.
18. Fosket, D. E. 1989. **Plant growth and developments**. Academic Press, New York.
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20. Johri, B. M. 1984. **Embryology of Angiosperms**. Spinger – Verlag, Berlin.
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23. Maheshwari, P. 1950. **An introduction to the embryology of Angiosperms**. McGrawHill, New York.
24. Pullaiah, T. Lakshminarayana, K. and Hanumatha Rao, K. 2001. **Textb o o k of Embryology of Angiosperms**, Regency Publication, New Delhi.
25. Raghava, V. 1979. **Experimental embryogenesis of Vascular Plants**, Cambridge University Press, Cambridge. U.K.
26. Sinnott, E. W. 1960. **Plant morphogenesis**. Mc Graw Hill Book Company, INC, NewYork.
27. Steeves, T. A. and Sussex, I. M. 1989. **Patterns in Plant development**. Cambridge University Press, Cambridge. U. K.
28. Steward, F. C. 1968. **Growth and organization in plants**. Addison Wesley Publishingcompany, U. S. A.
29. Wardlaw, 1968. **Morphogenesis in Plants**, Methuen, London.

BOT HCT 203: CELL BIOLOGY, GENETICS AND MOLECULAR

BIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Analyze the cellular components and how it is used to generate and utilize energy in cells
- Understand causal relationships between molecule/cell level phenomena ("modern" genetics) and organism-level patterns of heredity ("classical" genetics) .
- Application in a variety of genetic problem-solving situation.
- Understand the process of Mapping and sequencing of genome.

UNIT I

13 hrs

Structural organization: Phospholipid bilayer, integral proteins and fluid mosaic model; transport across cell membrane.

Cell organelles: Structure, functions and biogenesis of ER, Golgi bodies, Mitochondria, Chloroplast, Plastids, Lysosomes, Nucleus.

Protein Sorting and Targeting: Processing through endomembrane system, synthesis and targeting of mitochondrial and chloroplast and peroxisomal proteins. Insertion of membrane proteins into ER, receptor mediated endocytosis, exocytosis and molecular mechanism of vesicular traffic.

UNIT II

13 hrs

Cell growth, division and differentiation, mechanism regulating mitotic events checkpoints, role of Cyclins, Protein kinases and Maturation Promoting Factor (MPF) Regulation of Cell Cycle and Cytokinesis. Meiosis and fertilization. DNA damage and repair mechanisms. Gene: Fine structure of r II locus, Present concept, Split genes. Genetic

Code Cell free system, use of synthetic RNAs, Poly-U experiments. Overview of gene expression, central dogma, structure and function of different RNAs.

Chromosomes: Organization, structure in Prokaryotes and Eukaryotes, Centromere, Kinetochore complex, centromere Proteins (CENPs), Sister chromatid cohesion, Telomeres and their role in chromosome segregation. Histone code and role of non-histones. Chromosomal packaging and Gene activity Structural variations in chromosomes: Cytogenetic implications of Deletion, Duplication, Inversions and Translocations. Secondary messengers. Apoptosis; mitochondrial dependent and independent pathway, factors influencing apoptosis. Necrosis and necroptosis.

UNIT III

13 hrs

Mendelian Principles: Extension, Codominance, Multiple alleles and linkage, inheritance of complex traits, Chromosomal theories of inheritance. Nondisjunction as proof, Sex linked inheritance and non mendelian inheritance in organelle Genomes.

Genetics of Bacteria and Viruses: Bacterial mutants, genetic transformation, conjugation and transduction in bacteria, Genetic recombination, mapping of bacterial genome, Bacterial phage genetics, Plaque formation and Phage mutants, Recombination- lytic, lysogenic cycle and specialized transduction. Evolutionary significance of genetic exchange in Bacteria.

Population Genetics: Hardy-Weinberg concept and its application, Allele frequency, genotype frequency, amino acid variation, Molecular drive, genetic variability in population and factors responsible for variation.

UNIT IV

13hrs

Proteomics, Genomics and Bioinformatics: Structural and functional genomics, Comparative Genomics- biochemical, evolutionary, physiological and phylogenomics. Tools to study functional genomics: Proteomics- functional and comparative proteomics. Protein distribution, characterization and identification, differential display proteomics, detection of functional linkages, pharmacogenomics. Bioinformatics- tools of bioinformatics, data bases and data base management, Bioinformatics in taxonomy, biodiversity, agriculture. Bioinformatics in drug design and drug discovery.

BOT HCP 203: CELL BIOLOGY, GENETICS AND MOLECULAR BIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

8. Vital staining of mitochondria
9. Squash and smear preparation of mitotic and meiotic chromosomes (*Allium cepa* and *Rhoeo* sp.)
10. Karyotype study (at least two species)
11. Preparation of polytene chromosomes
12. Preparation of semi-permanent slides
13. Genetic problems.
14. Bioinformatics

REFERENCES:

6. Cell Biology. Karp, G. (2016). McGraw Hill book Co. NY, 16th Edition.
7. The Cell: Molecular approach. Cooper G.M. (2009) ASM press, USA
8. Molecular Biology of the Cell. Alberts M, Johnson A, Raff M, Bray D and Lewis J. (2008) 6th edition. Garand Sciences NY.
9. Molecular Biology. Lodish, Berk, Zipursky, Matsudaira, Baltimore and Darnell. (2006). Freeman Press, London.
10. Modern Genetic analysis: Integrating Genes and Genomes. Griffiths A.J.G. Gilbert W.M. and Miller J.H. and Lewontin R.C. (2003). Freeman Co NY.

BOT HCT 204: PLANT BREEDING AND PLANT PROPAGATION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Acquire knowledge on floral biology and selection of proper breeding method.
- Cultivate skill in emasculation and pollination of various crop plants.
- Know the requirements in breeding for biotic and abiotic stress tolerant varieties.
- Comprehend the various methods of vegetative propagation and sees propagation.

PLANT BREEDING

UNIT I

13hrs

Introduction: History and scope of plant breeding

Reproduction: Modes of reproduction, Mechanism of pollination control in crop plants (self-incompatibility and male sterility).

Hybridization: Conventional breeding methods, Hybridization methods in self- and cross-pollinated crop plants, selection in self, cross and vegetative propagated crop plants. Backcross method and its importance in crop plants. Plant Introduction, Domestication and Acclimatization,Patterns of Evolution in crop plants, Plant Genetic resources and its importance, Sources of Germplasm utilization and conservation. Role

of Global and National Organizations for crop Improvement.

UNIT II

13hrs

Heterosis: History, Genetic basis of Heterosis, Homozygous and Heterozygous balance inbreeding depression and its effects.

Resistance Breeding: Breeding for resistance to Abiotic stresses – drought resistance, breeding methods and genetics of drought resistance. Breeding for resistance to biotic stresses - diseases resistance, disease development and escape, breeding methods, genetics of disease resistance. Insect resistance - Breeding methods and genetics of insect resistance.

Distant Hybridization: Introduction, barriers, techniques for the production of distant hybrids, sterility in distant hybrids, Importance of distant hybridization in crop improvement.

Quality Seeds: Classes, production, maintenance, development of seed industry, Indian seed act and Plant protection Act.

PLANT PROPAGATION

UNIT III

13 hrs

Basic concepts and principles of plant propagation: Propagating structures: Green house, Shade house, Net house, nurseries, containers for growing plants. Media for propagation, treatment of soil and soil mixtures. Fertilizers and sanitation.

Vegetative Propagation: Sources, selection and management, advantages and limitations of the vegetative propagation.

Source, production, viability & maintenance and genetic variability. Types of cutting, layering, grafting, budding. Hydroponics.

UNIT IV

13 hrs

Seed propagation: Seed production, types of seed sowing, harvesting, drying and thrashing, storage, types of storage, pathogens in storage and their control. Seed health, purity, vigour, and tests to check.

Dormancy: types, factors affecting dormancy, methods to overcome dormancy, advantages of dormancy. Seed germination and viability tests seed protectants; priming.

Coating, pelleting, Classes of seeds; breeder seeds, nuclear seeds, founder seeds, certified seeds and cultivar seeds, seed act 1966, seed certification.

Liner production and hardening of seedlings.

BOT HCT 204: PLANT BREEDING AND PLANT PROPAGATION

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

PLANT BREEDING

5. Reproductive biology, Self, Cross, pollinated plants, Vegetative reproduction.
6. Emasculation, bagging, pollination biology and pollen fertility.
7. Origin, distribution and centres of diversity of crop plants, Wheat, Sorghum, Rice, Chilly, Sugarcane, Cotton, Potato, Coffee, Sunflower and Groundnut.
8. Visit to GKVK and IIHR (Hesaraghatta).

PLANT PROPAGATION

9. Preparation of types of soil, soil mixtures and Soil bed
10. Breaking of seed dormancy and growing seedlings after treatment with hormones and light.
11. Propagate the bulbs (*Allium*), tubers (Potato, *Begonia*) corms (*Gladiolus, Amorphophalus*) rhizomes (*Canna)* and suckers (Banana).
12. Different types of layering (Simple layering, tip layering, serpentine layering, Air layering, mound layering).
13. Grafting – Whip (or splice), side and bark grafting,
14. Budding − T-budding, Inverted T-budding and chip budding.
15. Demonstrate the experiments on the propagation of succulents by cutting and Cacti by grafting.
16. Visit to Lalbagh Botanical garden, Bengaluru.

REFERENCE

PLANT BREEDING

12. Chaudhari, H.K. 1983. **Elementary Principles of Plant Breeding.** TM.H. Publisher, Comp. New Delhi.
13. Frankel, R. and Bet Dagan. 1983. **Heterosis.** Springer verlag. Berlin.
14. Jain, H.K and Kharkwal, M.C. 2004. **Plant breeding mendelian to molecular approaches.** Narosa Publishing House, New Delhi.
15. Poehlman, J.M. and Brothukar, I.B.H. 1998. **Breeding of Asian Plant.** Oxford and I.B.H, New Delhi.
16. Poehlman, J.M. and Sleper, D.A. 1999. **Breeding Field Crops.** Panima Publisher, New Delhi.
17. Ram, H. 1998. **Vegetable Breeding Principles and Practices.** Kalyani Publishers, New Delhi.
18. Russel, E.G. 1978. **Plant breeding for pest and disease resistance.** Butter worth, London.
19. Sharma, J.R. 1994, **Principles and practice of Plant Breeding.** TATA McGraw – Hill Publisher. Co. New Delhi.
20. Singh, B.D. 2003. **Plant Breeding.** Kalyani Publication, New Delhi.
21. Sneep, J and Hendriksen. 1979. **Plant breeding preparations.** Puduo, Wageningn, Netherlands.
22. Stalker, H.T and Murthy, J. P (Eds) **Plant breeding in the 1990's.** C.A.B. International walling ford U.K

PLANT PROPAGATION

5. Hartman, H.J. 1990. **Plant Propagation – Principles and practices.** Prentice Hall, New Delhi.
6. Sadhu, M.K. 2000. **Plant Propagation.** New Age Publication, New Delhi.
7. Schwalz, M. 1975. **Guide to commercial hydroponics.** Israel University, Jerusalem.
8. Sharma, V.K. 1996. **Plant nurseries. Techniques, production and management.** Indian Pub. New Delhi.

BOT SCT 203: BIOCHEMISTRY AND BIOSTATISTICS

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

- Comprehend bioenergetics: Laws of thermodynamics and its application in biological systems, concept of entropy and enthalpy.
- Understand the various biomolecules and their types.
- Knowledge on quantifying the biological data through mathematics.
- Learn the methods of central tendency: Mean, Median and Mode, Measures of dispersion: Standard deviation, Standard error, Mean deviation, Test of significance: Chi-square test and t- test

UNIT I: Molecules and their characteristic futures:

08 hrs

Review of basic concepts of solution chemistry — acid, base, ionic strength, principles of thermodynamics: chemical potential, free energy, entropy, enthalpy, heat capacity; dimensions of atoms, bonds: covalent and non- covalent bonds and molecules. Dihedral angles, steric conflict, classes of organic compounds and functional groups.

Amino acids, peptides and polypeptides:

Chemical reactions and physical properties, three dimensional structures of proteins, the Ramachandran plot, α helix, β sheet. Structure of collagen, conformational map, tertiary structure, quaternary structure.

UNIT II: Carbohydrates and Lipids:

08 hrs

Sugars and polysaccharides: chemistry, classification and function; glycoproteins: structure and function. Fatty acids- Saturated, unsaturated and eicosanoids; phosphor and sphingolipids- structure, classification, lipoprotein, liposomes and prostaglandins.

Nucleic acids: Nucleotides, single and double - stranded DNA structures, types of

DNA, RNA word.

Enzymology: Classification, specific activity, coenzymes. Kinetics of enzyme reactions, regulation of enzymatic activity. Isoenzymes: structure and function.

UNIT III: Light and Biomolecules:

08 hrs

Properties of light and laser light, Polarization of light, linear and circular dichroism (CD). CD spectra of protein and nucleic acids.

Spectrometry and X-ray diffraction: Principles of spectroscopy, ionization, protein mass determination, MALDI-MS, ESI-MS. Methods of glowing crystals, theory of x-ray diffraction, Bragg's law, x-ray scattering in reciprocal space, low-angle x- ray scattering, fibre diffraction of helices. Fluorescence resonance energy transfer (FRET) and its biological applications. Electron Spin Resonance (ESR) and Nuclear Magnetic Resonance (NMR) Spectroscopy.

UNIT-IV Biostatistics:

08 hrs

Importance and scope of Biostatistics. Sample and sampling, Collection and representation of date-tabulation, graphical, diagrammatic. Measures of Central tendency Measures of dispersion: range, mean deviation, Standard deviation, Variance, Deviation. Tests of significance: Significance and difference in means, Standard error of mean, Standard error of SD, Students 't' test, Chi-square test. Analysis of variance (ANOVA). Correlation and regression - Meaning, kinds of correlation, coefficient of correlation, methods of studying correlation. Aims of regression analysis. Kinds of regression analysis.

REFERENCES:

4. Gilbert H.E. 2002. Basic concepts of Biochemistry. McGraw Hill Professional. New Work.
5. Lippincott William & Wilkins. Biochemistry. Down M.B. 1999. London.
6. Annadurai Pillai. 2007. A text book of biostatistics. New Age International Publishers

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MODEL QUESTION PAPER

I Semester M.Sc. Examination

HCT:

Time: 3 Hours **Max. Marks: 70**

D. Answer any ten of the following (10x2=20)

24.

25.

26.

27.

28.

29.

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31.

32.

33.

34.

35.

E. Explain/Describe/Write critically on any four of the following (4x5=20)

36.

37.

38.

39.

40.

41.

F. Give a comprehensive account of any three of the following (3x10=30)

42.

43.

44.

45.

46.

BOT HCT 301: PLANT PHYSIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

COURSE OUTCOME

UNIT I: **13 hrs**

Cell Structure: Ultra structure of Plasma membrane, Mitochondria, Endoplasmic reticulum, Chloroplast, Golgi bodies, Ribosomes, Glyoxysomes, Peroxisomes, Cytoskeleton.

Water relations and Mineral Nutrition: Water potential, its role in water movement from soil through plant into the air. Importance of nutrients, deficiency disorders and treatments.

Passive and Active transport, Membrane transport proteins and Ion transport in roots.

UNIT II: **13 hrs**

Plant Growth regulators: Types (Auxin, Gibberellins, Cytokinin, Ethylene, Abscisic Acid), physiological effects and mechanism of action of hormones and their applications in Agriculture and Horticulture. Physiology and biochemistry of flowering and senescence.

Seed physiology: Seed dormancy- significance, types, methods of breaking dormancy, physiology and biochemistry of seed germination.

UNIT III: **13 hrs**

Photosynthesis: General concepts of photosynthesis, Photosynthetic pigments and LHCs and Photosystems, Photooxidation of Water, mechanism of electron & proton transport, Photophosphorylation. A brief description of C3, C4 and CAM plants, photorespiration.

Respiration: General aspects, Glycolysis, TCA Cycle, Electron transport and ATP synthesis and alternate Oxidase system. Pentose Phosphate pathway and its significance.

UNIT IV: **13 hrs**

Nitrogen and Lipid Metabolism: Mechanism of Biological Nitrogen Fixation, Nitrogenase- Properties and mechanism of action.

Structure and functions of Lipids, Synthesis and Degradation of fatty acids, Glyoxylate pathway and Gluconeogenesis.

Stress Physiology: Plant responses and adaptations to abiotic stresses (Freezing stress, heat stress, salinity stress, water deficit and oxygen Deficiency), Osmotic adjustments and its role in tolerance to drought and salinity.

BOT HCP 301: PLANT PHYSIOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. Determination of Water potential of the tissue by falling drops method.
2. Determination of Catalase activity by Permanganate Titration method.
3. Determination of alpha-amylase activity in germinating grains.
4. Estimation of reducing sugars by 3,5-Dinitrosa1icylic acid method.
5. Estimation of Superoxide dismutase.
6. Estimation of Carbohydrates by Anthrone method.
7. Estimation of total leghaemoglobin in the nodules.
8. Estimation of total chlorophyll content and **Chl a / Chl b** ratio.
9. Estimation of proline.
10. Separation of amino acid and Phenolic mixture by TLC.
11. Effect of temperature on Water potential of potato tuber

REFERENCES

1. Buchanan, B.B. Gruissem, W. and Jones, R.L. 2004. Biochemistry and **Molecular** Biology of plants.
2. Conn, E.E. Stumpf. Bruenning, G. and Doi, R.H. 1987. **Outlines of** Biochemistry. John Wiley and Sons, New York.
3. Hall, D.O. and Rao, K.K. 1999. Photosynthesis. 6'h edition, published in association with the Institute of Biology, Cambridge University Press, Cambridge, U.K.
4. Hopkins, W.G. 1995. Introduction to Plant Physiolop•y. John Wiley & Sons. Inc., New York, USA.
5. Moore, T.C. 1989. Biochemistry and physiology of Plant Hormones. 2nd edition. Springer — Verlag, New York, USA.
6. Stumpf, P.K. and Conn, E.E. (eds.) 1988. The Biochemistry of Plants- A c**omprehensive treatise.** Academic Press, New York.
7. Taiz, L. and Zeiger, E. 1998. Plant Physiology. 2"d edition. Sinauer Associates, Inc.,

Publishers, Massachusetts, USA.

8. Taiz, L. and Zeiger, E. 2003. **Plant** Physiology. 3'd edition. Panima Publishing Corporation, New Delhi/Bangalore.
9. Wilkins, M.B. 1989. Advanced Plant Physiology. Pitman publishing Ltd., London. I.K. International Pvt., New Delhi

BOT HCT 302 - RESEARCH METHODOLOGY AND INSTRUMENTATION

UNIT I **13 hrs**

Introduction to Research: Meaning of Research, Types of Research, Research and Scientific Method, Research Process, Criteria of Good Research, Research Problem - Identification and defining a research problem.

Research Design: Collection and review of research literature, Sources of literature and their evaluation. Designing research methodologies, Framing the objectives, Formulation of hypothesis, execution of designed experiments.

UNIT II **13 hrs**

Research Process & Report: Analysis of data, Presentation of research findings. General strategies for report writing. Organization of the research report, Contents of report, Bibliography, Appendices, Style manuals, Criteria for the evaluation of the research report.

Research Ethics: Preparation and Presentation of proposal to the ethical committee for approval. Causes of unethical acts, Research Databases and indexing, Impact factor, Cite Score, i10.

Intellectual property rights: Patenting and the procedures involved in the application for patents and granting of a patent, Compulsory licenses, Patent search, Patent Cooperation Treaty (PCT), Examples of patents, Legal implications, Patent exploitation and protection.

UNIT III **13 hrs**

Separation Technique I: Centrifugation – Principles, types, and theory of centrifugation; Chromatography – introduction, principle, types of chromatography – paper chromatography, thin layer chromatography, HPTLC, column chromatography - HPLC, gas chromatography.

Separation Technique II: Electrophoresis – Introduction, principle, buffers, detection and assay, recording and storage, safety and applications, factors affecting electrophoresis; types of electrophoresis – moving boundary electrophoresis, paper electrophoresis, gel electrophoresis - polyacrylamide gel electrophoresis (PAGE), agarose electrophoresis; iso electric focusing electrophoresis, immuno electrophoresis, capillary electrophoresis.

UNIT IV **13 hrs**

Spectroscopic techniques- General principles, Types of spectra and their biochemical usefulness, visible and UV spectrophotometry, Infra-red (IR) Circular Dichroism (CD), and mass spectroscopy, Spectro-fluorimetry, Luminometry, Atomic/Flame spectrophotometry, Atomic absorption and plasma emission spectroscopy, ICP-MS. Detection and measurement of different types of radioactive isotopes normally used in biology-– Geiger-Muller, Liquid Scintillation Counting, ionization chamber, Pocket dosimeters-film badge. Radioactive material, safety guidelines. Application of radioisotopes in biological research, radioisotope tracer technique and autoradiography.

BOT HCP 302 - RESEARCH METHODOLOGY AND RESEARCH METHODOLOGY

1. Proposal writing
2. Report writing
3. Study of instruments – Spectrophotometer, HPLC, PAGE
4. Preparation of buffer.

REFERENCE

1. C. R. Kothari. Research Methodology: Methods and Techniques, 2nd Edition, New Age International Publishers.
2. Das, D.J. (1987). Biophysics and Biophysical Chemistry. Academic Publishers. Calcutta.
3. Deb, A.C. (2015). Fundamentals of Biochemistry. New central Book Agency Pvt Ltd. Kolkata.
4. Garg, A.S., and Garg, N. (2017). Biochemical Test Principles and Protocols. Viva Books Pvt. Ltd.
5. Joseph Gibaldi (2000). MLA Handbook for writers of research papers. Affiliated EastWest Press Pvt. Ltd.
6. Purohit, S.S. (2010). Biochemistry- Fundamentals and Application. Student edition Jodhpur.
7. Victoria E McMillan (1997). Writing papers in the biological sciences (II Edn). Bedford books.www.opengate.com

HCT-303: TAXONOMY OF ANGIOSPERMS

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

UNIT I: **13 hrs**

Introduction: Brief historical development — Ancient — Medieval and Modern. General account: Aims, aspects and phases of development of Taxonomy. Role of Botanical Gardens, Herbarium (techniques for succulents, aquatic and underground stem), Virtual herbarium; E-flora. Botanical Survey of India. A comparative study of Bentham and Hooker, Hutchinson and Takhtajan systems of Classification and APG IV with respect to principles, outlines and phylogenetic implications.

UNIT II: **13 hrs**

Nomenclature: Historical development — Principles of International Code of Botanical Nomenclature, ICBN articles and recommendations. ICN - rules and recommendations. Type concept (Typification), Rule of priority, Author citation, valid publication, rejection of names, principle of priority and its limitations. Brief account of SHENZAN code.

Names of hybrids/cultivated species.

Biosystematics — Introduction, Principle and Methods. Numerical and experimental Taxonomy.

Phylogenetic Systematics: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades, synapomorphy, symplesiomorphy, apomorphy, lineage sorting, serial homology etc).

Molecular taxonomy: Respect to DNA sequences of chloroplast genes (atpB, rbcL, ITS, trnL

etc) and one nuclear gene (nuclear ribosomal 18s DNA).

UNIT III: 13 hrs

Taxonomic Evidences: Study of characters from Anatomy, Cytology, Embryology, Morphology, Molecular, Palynology and Phytochemistry in relation to Taxonomy. Field inventory.

Species concept: Principles employed in grouping, relationship and delimitation of species, genera, family, order and classes.

UNIT IV: 13 hrs

Diagnostic and salient features of the following families: Study of important taxonomic character and popular examples of the following natural order of Benthem and Hooker classification –Magnoliaceae, Nymphaeceae, Sterculiaceae, Lythraceae, Rubiaceae, Asteraceae, Sapotaceae, Asclepiadaceae, Solanaceae, Convolvulaceae, Scorphulariaceae, Bignoniaceae, Lamiaceae, Verbenaceae, Nyctaginaceae, Piperaceae, Loranthaceae, Amaryllidaceae, Lilliaceae, Araceae, Cyperaceae.

BOT HCP 303: TAXONOMY OF ANGIOSPERMS

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. Description and derivation of a taxon to Polypetalae families of Bentham and Hooker's systems.
2. Description and derivation of a taxon to Gamopetalae families of Bentham and Hooker's systems.
3. Description and derivation of a taxon to Monochlamydeae and Monocotyledons families of Bentham and Hooker's systems.
4. Preparation and uses of dichotomous and Polyclave keys
5. Construction of plant phylogenetic trees using various loci (atpB, rbcL, ITS, trnL etc) with various phylogenetic methods (Neighbor Joining, Maximum Likelihood etc).
6. Study of significant characters viz., Pollinia, Thalloid angiosperms.

7. Taxonomic uses of primary and secondary metabolites — micro and macro molecules.
8. Mounting of a properly dried and pressed specimen of any wild plant on herbarium sheet. (The 10-herbarium sheets and and 10 Virtual Herbarium) shall be submitted with record book at the time of examination).
9. Field survey. (Note: Field trip of 2-3 days to a floristically rich area is compulsory)

REFERENCES

1. Chrispeels, M. J. and Sadava, D. 1977. Plants, Food and **People.** W.H. Freeman & Co., San Francisco.
2. Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia, University press, New York.
3. Cronquist, A. 1988. **The Evolution and Classification of Flowering** Plants. 2nd edition. New York Botanical Garden, New York.
4. Carlquist, S. 1961. **Comparative Plant Anatomy** - a guide to taxonomic and evolutionary application of anatomical data in angiosperms. Columbia Unix. Press. New York
5. Davis, P.H. and Heywood, V.H. 1973. **Principles** of **Angiosperm** Taxonomy. Robert E Kriegen Publ. Co., New York.
6. Erdtman, 1952. Pollen **Morphology &** Plant **Taxonomy.** Chronica Botanica, Wa1tham, Mass.
7. Heywood, V.H. and Moore, D.M. (eds.). 1984. **Current concepts in Plant Taxonomy.** Academic, Press, London.
8. Huber, H. 1977. **The treatment of Monocotyledons in an** evolutionary system of classification. Pl. Syst. Evel. suppl.
9. Hutchinson, J. 1973. **The Families of Flowering** Plants **arranged according to a new system based on their phylogeny.** Oxford University Press, Oxford.
10. International **Plant** Names Index. A list of Current Plant names from three source; the index kewensis (IK), the gray card index (GCI) and the Australian Plant names Index.
11. Lawerence, G. H. M. 195l. Taxonomy of Vascular Plants. Macmillan, New York.
12. Mc. Neill, J et al (eds) 2006. International code of Botanical Nomenclature. Regnum Vegetabite 146.
13. Michael. G. Simpson 2010. **Plant** Systematics. Academic Press, USA.
14. Mondal. A. K. 2005, Advanced Plant Taxonomy. New central Book Agency Pvt. Ltd.,

Kolkata.

15. Pimetel, D. and Hall, C.W. (eds.). 1989. Food **and Natural Resources.** Academic Press, London, New York.
16. Radford *et al* 1974. **Vascular Plant Systematics.** Harpen and Row New York.
17. Sambamurty, A.V.S. S 2005. **Taxonomy of Angiosperms**. IK International Pub., New Delhi.
18. Singh, G. 2010. Plant Systematics. An Integrated Approach 3 eds. Science Publishers Enfield. N.H.
19. Sneath and Sokal, R. R. 1973. Numerical Taxonomy. The Principles and Practice of Numerical Classification. WH Freeman, San Francisco.
20. Sreenath. K. P. 2009. Angiosperms Classification Systems; An analytical approach. Annadani Byrava Prakashana, Bangalore.
21. Turrill, W.B. (eds.) 1964. Embryology in relation to Taxonomy. Vistas in botany. Vol. IV Pregamon press, Oxford.
22. Wendy B. Zomlefer 2006. **Guide** to **Flowering Plant Families.** Overseas press, (India) Pvt. Ltd., New Delhi.
23. Young, D.A. and Siegler, D.S. (eds.) Phytochemistry and Angiosperm. Phytochemistry. Praeger Scientific, New York

OET- 304: ETHNOBOTANY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

UNIT I **13 hrs**

Introduction of Botany: Overall structures of the plants, its parts and various terminologies. Bacteria, Viruses, Fungi, Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

Ethnobotany: History and importance of ethnobotany, ethnomedicobotany, ethnozoology, ethnoveterinary, ethnomusicology and ethnoagriculture and methods of studies. Tribals of Karnataka and their socio - cultural practices.

UNIT II **13 hrs**

Indigenous Phytotheraphy: Jaundice, skin, nervous disorders, respiratory and intestinal disorders and rejuvenation; scientific validation of folk claims.

Traditional plants: Cereals, pulses, vegetables, spices, and mushrooms. Edible fruits and seeds. Plants in folk songs and proverbs.

UNIT III **13 hrs**

Conservation and management: Sacred groves, impact of modernization, a case study Sholiga tribes of B. R hills and Khani tribals of Kerala.

UNIT IV **13 hrs**

Traditional systems: Basic concepts and development of Ayurveda, Siddha, Unani and Tibetian systems of medicine.

A general account on the traditional uses of plants and animals with reference to Karnataka State tribals.

REFERENCES

1. Cotton, C.M. 1996. Ethnobotany - **Principles** and Applications, Century School Book by service Film setting Ltd.
2. Dahlgren. R. H., Clifford, T and P. F Yeo 1985. The **families** of the **monocotyledons; structure, Evolution and Taxonomy.** Spinger Verlag, NY.
3. Gary J, Martin, 2004. Ethnobotany - A Methods Manual, Chapman and Hall. UK.
4. Jain S. K. 1981. **Glimpses of Indian Ethnobotany.** Oxford and IBH, NewDelhi
5. Jain S.K.1987. A manual **of ethnobotany.** Scientific publisher Jodhpur.
6. Jain S.K and Mundgal, 1999. Handbook of ethnobotany. London.
7. Rao, P. 1996. Sacred groves and conservation. WWF — India, Quartely 7; 4 -8
8. Trivedi, P. C. 2006. Medicinal plants: Ethanobotanical Approach, Agriobios, India.
9. Trivedi, P. C. 2002. Enthnobotany. Aavishkar publishers and Distributors, Jaipur.
10. Yoganarasimhan, S.N. Medicinal Plants of India -Vol I- Karnataka, Interline Publishing Pvt. Ltd.

BOT HCT-401: ECONOMIC BOTANY AND PHYTOCHEMISTRY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

ECONOMIC BOTANY

UNIT I **13 hrs**

Introduction: Plants in commerce and industry.

General account: Introduction, origin, distribution, botanical name, family, part used and methods of cultivation and uses - Rice, Wheat, Ragi, Maize; Beverages: Tea and Coffee, Oils and fats: classification, extraction methods; Sunflower, Safflower, Groundnut, Lin seed, Fibres: Cotton, Jute, Coconut & Agave, Wood: features and properties of Teak, Mahogany. Brief account of Vegetable sponges.

UNIT II **13 hrs**

Family, useful parts and Chemical constituents: Cardamom, Cinnamom, Clove, Asafoetida, Ginger, Pepper, Coriander, Fennel, Henna, Indigofera, Butea, Arecanut, Beetle Leaf, Tobacco, Turmeric and Vanilla, Rubber- processing of rubber; gums and resins- gum Arabic, copals, turpentine. Sugars- sugarcane, preparations of sugar; stevia and beet sugar.

PHYTOCHEMISTRY

UNIT III **13 hrs**

Extraction, Isolation and purification of herbal drugs: General methods of extraction, Isolation, Characterization and Identification of selected herbal drugs (Vincristine, Camptothecin and Curcumin). Herbal drugs: Roots, stem, wood, leaves, flowers, fruits and seed (Two from each).

UNIT IV **13 hrs**

Phytochemical screening: Classification and structures of Alkaloids, phenols, saponins, terpenes, flavonoids, cyanogenic compounds, gums and mucilages.

Biotechnology in herbal drugs: Current trend in herbal medicine, types of DNA markers in plant genome analysis (with respective to adulterant).

BOT HCP-401: ECONOMIC BOTANY AND PHYTOCHEMISTRY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

ECONOMIC BOTANY

1. Field Survey for collection of economically important plants of the region.
2. Study of locally available economic products of plant origin.

PHYTOCHEMISTRY

1. Qualitative phytochemical screening of
   a) Phenolics
   b) Tannins
   c) Saponins

REFERENCE

1. Kocchar, H. L. 1998. Economic Botany of the tropics, 2 Edn. Macmillan India Ltd.
2. Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. AF Hill, Adopted by O. P Sharma)' Tata Mc Graw Hill Co. Ltd., New Delhi.
3. Rashtra Vardhana, 2009. Economic Botany, Super Book Publishers Pvt. Ltd., New Delhi.
4. Pandey, B.P. 2000. Economic Botany, S. Chand and Company Pvt. Ltd., New Delhi.
5. Pandey, S.N. and Chandha, A. 1999. Economic Botany, Vikas Publishing House Pvt. Ltd., New Delhi.
6. Bhushan Patwardhan, 2007. Drug Discovery and Development, New India Publishing Agency, New Delhi.
7. Raman, N. 2006. Phytochemical Techniques, New India Publishing Agency, New Delhi.
8. Wagner, H. and Bladt, S. Plant Drug Analysis, Pharma book Syndicate, Hyderabad, India.
9. Biren Shah and Seth, A. K. 2010. Text Book of Pharmacognosy and Phytochemistry. Reed Elsevier India Pvt. Ltd., Haryana, India.

BOT HCT-402: PLANT CELL, TISSUE AND ORGAN CULTURE

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

UNIT I **13 hrs**

History and applications of Plant Tissue Culture: Concept and development of tissue culture, role of auxins and cytokinins, improvement of media and recent advances in plant tissue culture.

Requirement for Tissue Culture: Basic laboratory organization, instruments and equipment, culture media.

Aseptic Manipulation: Composition of media, media preparation, selection of media, sterilization of culture vessels, instruments, media, explants and transfer to media.

Concept of Cellular Totipotency: Vascular and organogenic differentiation, dedifferentiation, redifferentiation, totipotency of epidermal and crown gall cells.

UNIT II 13 hrs

Clonal Propagation: Technique, multiplication by axillary, apical and adventitious shoots, factors influencing shoot multiplication and rooting and acclimatization of plants transferred to soil.

Organ, tissue and cell culture:

- **Organ Culture:** Leaf, Root, Flower, Anther, Pollen, Ovary, Ovule and Embryo.
- Tissue Culture: Meristem, Nucellus and Endosperm.
- Cell Culture: General account of single cell culture.

UNIT III

13 hrs

Somatic Embryogenesis: Types, embryo maturation and plantlet development, factors affecting somatic embryogenesis and practical applications of somatic embryogenesis.

In vitro Pollination and Fertilization: Methodology, factors affecting seed setting after in vitro pollination and applications of in vitro pollination.

Protoplast Culture: Isolation of protoplast, methods, source, culture, media, regeneration and protoplast fusion, somatic hybrids, cybrid production and their practical application.

Somaclonal and Gametoclonal Variations: Source of materials, culture conditions, molecular basis of variation, isolation of variants, disease resistant, herbicide resistant and stress tolerant lines.

UNIT IV 13 hrs

Role of Tissue Culture in Germplasm conservation: Need for in vitro conservation, modes of conservation, cryopreservation, low pressure and low oxygen storage, multiplication through callus cultures, artificial seed.

Industrial application with particular reference to secondary metabolites: Techniques of selecting cell lines for high yields of compounds of secondary metabolites, mass cultivation of plant cells, Bioreactors, Elicitor — induced accumulation of products, factors limiting large scale production of useful components, application of tissue culture for synthesis of useful compounds.

BOT HCP-402: PLANT CELL, TISSUE AND ORGAN CULTURE

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. In vitro morphogenetic studies on any one plant system (Seed culture, multiplication of shoots, rooting and hardening)
2. Isolation of explants, establishment, subculture and maintenance of callus.
3. Morphology of callus cells (callus smear preparation) and histological aspects (microtomy).
4. Preparation of synthetic seeds.

REFERENCE

1. Bajaj, Y.P.S. (Ed.). **Biotechnology in agriculture** and **forestry.** Various Volumes published time to time. Springer-Verlag, Berlin

2. Bhojwani, S.S. 1990. **Plant tissue culture: Applications and limitations.** Elsevier Publishers, Amsterdam.
3. Bhojwani, S.S., and Razdan, M K. 1996. **Plant tissue culture: Theory and Practice.** Elsevier Publishers, Amsterdam.
4. Dixon, R.A. and Gonzales, R.A. (Ed.) 1994. Plant cell culture, a practical approach. 2nd edition. Oxford University Press, Oxford. U.K.
5. Evans, D.A., Dharp, D.R., Ammirato, P.V. and Yamuda, Y. (Ed.). Handbook of Plant cell culture series. Vol. 1-6, McGraw Hill Publishing Company, New York.
6. Gamborg, O.L. and Phillips, G.C. 1995. Plant cell, tissue and organ culture, fundamental methods. Springer International student edition. New Delhi.
7. George, E.F. 1993 / 1996. Plant **propagation by Tissue culture Part** 1 & 2, Exegetics Ltd. Great Britain, U.K.
8. Maheshwari, P. and Rangaswamy, N.S. (Eds.) 1963. **Plant, Tissue and organ culture** — A symposium, Intern. Soc. Plant Morphologists, New Delhi.
9. Razdan, M.K. 1993. **An introduction** to **plant tissue culture.** Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
10. Reinert, J.R. and Bajaj, Y.P.S. 1977. **Applied and fundamental aspects of plant cell, tissue and organ culture**. Springer-Verlag, Berlin.
11. Sen, S.K. and Giles, K.L. (Ed.) 1983. **Plant cell culture in crop improvement.** Plenum Press, New York.
12. Street, H.E. 1977. **Plant tissue and** cell **culture.** Academic Press, Berkeley, University of California. USA.
13. Thorpe, T.A. (Ed.) 1995. Embryogenesis in plants. Kluwer Academic Publishers, Netherlands.
14. Vasil, I.K. (Ed.). **Cell culture and** somatic **cell genetics of** plants, **various** volumes. Academic Publishers, Orlando.

BOT HCT-403: BIOTECHNOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30

Summative Assessment Marks:	70

UNIT I **13 hrs**

Introduction, scope and importance of Biotechnology, Biotechnology scenario in India. Recombinant DNA - I: Enzymes used in genetic engineering: Restriction Endonucleases, Ligases, Polymerases, Kinases and Phosphatases, DNA Methylases and Topoisomerases.

Use of vectors in cloning: Plasmids, Phages, Cosmids, ssDNA vectors, BAC, YAC, MACs. Expression Vectors, Sequencing vectors, Vectors for cloning PCR products, Binary and Shuttle Vectors. Improved Agrobacterium based Vectors and Virus based vectors for plants.

UNIT II **13 hrs**

Recombinant DNA - II: Methods of DNA delivery: PEG mediated DNA uptake, electroporation, Biolistic transfer, Microinjection, organelle transformation, Mechanism of integration of foreign DNA into plant genomes.

Genomic and cDNA libraries: Construction, size, full length cDNA cloning, RT-PCR, RACE. Nucleic acid hybridization- Southern and Northern blotting techniques.

UNIT III **13 hrs**

Plant Biotechnology - I: Transgenic plant technology. Insect resistant plants- Cry- genes of Bt., their proteins and target insects, cry genes expression in plants, insect resistance to cry proteins.

Bt cotton and Bt brinjal issues in India. Virus resistant transgenic plants. Herbicide resistance and stress-and senescence-tolerant plants.

Modification of seed protein quality. Suppression of indigenous genes by antisense (delaying ripening). Genetic modification of flower pigmentation. Terminator technology, production of vaccines by transgenic plants.

Problems in gene transfer in plants. Ethics of genetically engineered crops.

UNIT IV **13 hrs**

Enzyme Biotechnology: Isolation, purification, immobilization and uses of enzymes. Production of amylases, proteases and lipases.

Microbial Biotechnology: Production of organic compounds by fermentation: ethanol, acetone and butanol. Production of antibiotics – Pencillin.

Production of Single Cell Proteins - Spirulina and Chlorella. Production of Biofertilizers - Azatobactor and Rhizobium Production of Bioinsecticides - Bacillus thuringiensis and NPV Safety, social, moral and ethical consideration, IPR.

BOT HCP 403: BIOTECHNOLOGY

Total Contact Hours:	52 Hrs
Number of Credits:	04
Formative Assessment Marks:	30
Summative Assessment Marks:	70

1. Study of fermentation by wine production.
2. Isolation of genomic and plasmid DNA.
3. PCR based amplification of DNA.
4. Agarose gel electrophoresis of restriction fragments.
5. Isolation of amylase producing bacteria.

REFERENCE

1. Bajaj, Y.P.S. (Ed.) 1978. Biotechnology in agriculture and forestry. Various volumes published time to time. Springer-Verlag, Berlin
2. Bernard. R Glick and Jack J. Pasternak, 2000. Molecular Principles and Applications. 2nd edition, ASM Press, Washington: DC.
3. Bhojwani, S.S. 1990. Plant tissue culture: Applications and limitations. Elsevier Publishers, Amsterdam.
4. Bhojwani, S.S., and Razdan, M.K. 1996. Plant tissue culture: Theory and Practice. Elsevier Publishers, Amsterdam.
5. Brown, T.A. 1994. Gene cloning. Chapman and Hall Pub. New York.
6. Christopher, H. 1995. Gene cloning and manipulation. Cambridge University press. Cambridge, U.K.
7. Dixon, R.A. and Gonzales, R.A. (Ed.) 1994. Plant cell culture, a practical approach. 2"d edition, Oxford University Press, Oxford.
8. Evans, D.A., Dharp, D.R., Ammirato, P.V. and Yamuda, Y. (Ed.). Handbook of Plant cell culture series. Vol. 1-6, Mc Graw Hill Publishing Company, New York.

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10. George, E.F. 1993 / 1996. Plant propagation by Tissue culture. Part 1 & 2, Exegetics Ltd. Southampton, England.
11. Glick B.R. and Pasternak, J J. 1994. Molecular Biotechnology: Principles and Applications of recombinant DNA. American society of microbiology. Washington DC.
12. Greene, J.J. and Rao, V.S. 1998. Recombinant DNA — Principles and Methodologies. Marcel Dekker, New York. 1998.
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18. Reinert, J.R., and Bajaj, Y.P.S. 1977. Applied and fundamental aspects of plant cell, tissue and organ culture. Springer-Verlag, Berlin.
19. Sen, S.K. and Giles, K.L. (Ed.) 1983. Plant cell culture in crop improvement. Plenum Press, New York.
20. Street, H.E. 1977. Plant tissue and cell culture. Academic Press, Berkeley, University of California.
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23. Yeoman, M.M. 1985. Practical Cell culture technology. Blackwell Scientific Pub.