Savitribai Phule Pune University

(Formerly University of Pune)

Two Year Degree Program in Botany

(Faculty of Science & Technology)

Revised Syllabi for

M.Sc. (Botany) Part-II

(For Colleges Affiliated to Savitribai Phule Pune University)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2020-2021

Title of the Course: M.Sc. Botany

Structure for M. Sc. Botany Second Year:

Year	Semester	Course Type	Course code	Course Name	Credits
2	3	Core Compulsory Theory paper	BOUT 231	**Botany Theory Paper 1- Computational Botany**	4
			BOUT 232	Botany Theory Paper 2- **Developmental Botany**	4
			BOUT 233	Botany Theory Paper 3- **Plant Physiology-**	4
		Choice Based optional paper	BODT 234 (Any one)	Botany Theory Paper 4 **a. Mycology** b. **Angiosperm Taxonomy-** c. **Plant Ecology** d. **Plant Biotechnology** e. **Genetics and Plant breeding** f. **Seed science**	2
			BODP 234	Botany Practical Paper based on BODT 234	2
		Core Compulsory practical paper	BOUP 235	Botany Practical Paper **based on BOUT 231, BOUT 232, BOUT 233**	4
2	4	Core Compulsory Theory paper	BOUT 241	Botany Theory Paper 1- **Botanical Techniques**	4
			BOUT 242	Botany Theory Paper 2- **Advanced Ecology**	4
		Choice Based optional paper	BODT 243 (Any one)	Botany Theory Paper 3- **a) Applied Mycology** **b) Advanced Medicinal Botany** **c) Advanced Plant Physiology** **d) Industrial Biotechnology-** **e) Seed Technology**	2
			BODP 243	Botany Practical paper based on BODT 243	2
			BODT 244 (Any one)	Botany Theory Paper 4- **a) Plant Tissue culture Technology** b) **Herbal Technology** c) **Research Methodology**	2

			BODP 244	Botany Practical Paper based on BODT 244 Or PG Dissertation	2
		Core Compulsory practical paper	BOUP 245	Botany Practical paper based on BOUT 241 and BOUT 242	4

BO 4.1 Computational Botany (60 L)

Credit I-Basic Biostatistics (15 L)

1. Introduction to Statistics : 9L
   Measures of central tendency – mean, mode, median and their properties Measures of dispersion – variance, standard deviation, coefficient of variance Symmetry and skewness, measures of skewness, kurtosis Sampling and sampling distributions – concept of sample and population, statistic, standard error, methods of sampling
2. Correlation and regression 6L
   Bivariate correlation, positive correlation, negative correlation Measures of correlation – Scatter diagram, Karl-Pearson's coefficient of correlation, Spearman's rank correlation coefficient Regression – Equations of regression lines using least square method, regression estimate and its standard error

Experimental Statistics (15 L)

1.1 Statistics using R, SPSS and Excel : Introduction , features, installation, starting and ending of the sessions, R commands and case sensitivity (08L)

a. Data types: Logical and Numerical
b. Vectors and vector arithmetic
c. Data frames: Creation using data, frame, subset and transform commands
d. Statistical methods using R : Sampling methods, Diagrams, graphs:
   : Measures of central tendency, Dispersion, Skewness and Kurtosis
e. Probability Distributions: Hypergeomertric distribution, Binomial. Normal and poison distribution
f. Correlation and Regression

1.2. SPPS (Statistical Package for the Social Sciences) Software: Concept and applications in Means, t – test, ANOVA and Correlation and linear regression

1.3 Excel : concept and applications on Biology

2. Testing of Hypothesis : critical difference for pairs of treatments Tukey's test for pairwise comparison of treatments Dunnet's test for comparison of treatment means with control Duncan's multiple range test Mann–Whitney U test

3. Testing of hypothesis 7L
Hypothesis, statistical hypothesis, critical region, level of significance, p-value, normal distribution T-test: t-test for mean, equality of two means, paired t-test, unpaired t-test, chi-square test: chi square test for goodness of fit, independence of attributes, non-parametric test

Credit III – Scientific Communication (15 L)

1. Importance of scientific communication Types of scientific communications Logical organization of scientific data and documentation
2. Different modes of scientific communication Details of – Steps involved in Proposal writing, Research paper writing, Thesis writing
3. Oral forms of scientific communication Popular and Scientific talks, Poster presentations
4. Legal forms of communication of science 4 Ethics in scientific communication IPR, patent submissions

Credit IV: Bio-analytical techniques & Bioinformatics (15L)

1. Making solutions – moles and molarity, stock solutions and dilutions, making media and reaction mixtures (4 L)

2. pH measurements and preparation of buffers (2L)

3. Measuring concentrations using spectrophotometry, Cell counting using serial dilutions, haemocytometry (2L)

4. Bioinformatics: What is Bioinformatics, What is database, Classification of database, Sequences and nomenclature, IUPAC symbols, Types of sequences used in Bioinformatics, Information sources: NCBI, the GDP, MGD. (4L)

5. Data Retrieval tools – ENTREZ, OMIM, PubMed, Taxonomy Browsers, LocusLink, SRS. Database Similarity Searching – BLAST, FASTA, Resources for Gene Level Seqoences, Use of Bioinformatics tools in analysis (3L)

NOTE – Emphasis be given on methodology and numerical problem solving rather than derivations and proofs.

Suggested Reading:

1. P.N. Arora and P.K. Malhan (2002) Biostatistics, Himalaya publishing House.
2. Rama Krishnan, P. (1995) Biostatics, Saras publication A.R.P. camp Road, Periavilai, Kottar, po. Nagercoil, Kanyakumari- Dist. Pin- 629 002.
3. Banerjee, P.K. (2005) Introduction to Biostatics' S. Chand and Company Ltd. Ram Nagar, New Delhi- 110 055.
4. Norman T.J. Bailey (2004), Statistical methods in biology (Third Edition) Cambridge University press (Low price Editions).
5. Dr. Mungikar A.N. (1997) an introduction to Biometry, Saraswati publication, Aurangabad.
6. Mungikar, A. M. (2003) Biostatistial Analysis. Saraswati Printing Press. Aurangabad.

7. Lab Math – Adams, D.S. I.K. InternationsPvt Ltd. New Delhi, 2004
8. T. M. Apostol: Mathematical Analysis (Narosa publishing house)

BOUT 232 Botany Theory paper 2

BOUT 232 Developmental Botany (4 Cr - 60 L)

Credit I: Basic concepts of Plant development (15L)

1. Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development, 7L

2. Polarity & Symmetry 2L

3. Difference between Plant and Animal development 2L

4. Factors for development- intrinsic and extrinsic 2L

5. Juvenility -Characteristics,Transition to Adult phase. 2L

Credit II: Embryology (15L)

1. Reproductive structure in plant 1L

2. Gametophyte development- Stamen and Microsporogenesis, Male gametophyte or male germ unit development, Carpel and Megasporogenesis, Female gametophyte or female germ unit development 4L

3. Fertilization-Pollen tube growth and its path,it sentry into embryo sac, gametic fusion, significance of double fertilization, abnormalities in fertilization. 2L

4. Development of embryo in dicots and monocot 2L

5. Development of Endosperm 2L

6. Polyembryony- concept and classification of polyembryony, special cases and causes of polyembryony. 2L

7. Apomixis - concept, categories- agamospermy and vegetative reproduction apospory, parthenogenesis 2L

Credit III: Physiological & Molecular Basis of Plant Development (15L)

1. Physiology of plant development - Photo-morphogenesis, Light mediated development, Photoreceptors, Hormonal Signaling in development 4L

2. Molecular and Cellular Events in –

a. Embryogenesis 1L

b. Leaf development 2L

c. Stomatal development 2L

d. Root development 2L

e. Root Hair Development 2L

f. Shoot development 2L

Credit IV: Molecular and Cellular Events in – 15L

g. Inflorescence development 2L

h. Flower development 2L

3. Mutants in Developments 3L

4. Genetic and Epigenetic Mechanisms Underlying Vernalization 4L

5. Radial and Axial Pattern of development 2L

6. Process of Senescence 2L

References:

1. Embryology of Angiosperm by Maheswari
2. Embryology of Angiosperm by BhojwaniandBhatnagar
3. Plant Physiology by Taize and Zeiger
4. Arabidopsis Book
5. Current Trends in the Embryology of Angiosperms by SS Bhojwani
6. Developmental Biology of Flowering Plants by V. Raghavan
7. Flowering Plant Embryology By Nels R. Lersten

Semester III

M Sc Syllabus, 2020-2021

BOUT 233 Theory Paper 3-Plant Physiology (4 Credit)

Credit I: Plant Nutrition: 15L

- Soil- Formation, structure, composition, classification and role 2L.
- Essential elements- Mineral and nonmineral, criteria of essentiality, role-structural, catalytic osmotic and others; influence of pH, mineral elements interaction and microbes on availability of essential elements 3L
- Mechanism of absorption of mineral elements; mechanism of assimilation of sulfur, phosphorus and nitrogen 2L
- Active and passive transport, Transporters, role of ATPase and PPase 2L
- Merits and demerits of use of natural and chemical fertilizers, conventional and modern methods of application of fertilizers 2L
- Properties of water, water potential and factor influencing transport of water 2L
- Mechanism of opening and closing of stomata, transpiration ratio and water conservation strategies in plants 2L

Credit II: Photosynthesis: 15L

- Photosystem I and II (composition, light harvesting mechanism and functioning). 2L
- Organization of Photosynthetic electron transport system(evidence from Membrane chemical composition, electro-potential gradient and use of ETS Component inhibitors) 3L
- Photo-oxidation of water 2L
- Mechanism of establishment of proton gradient across the thylakoid membrane. Production of assimilatory powers of photosynthesis (ATP and NADPH) 3L
- Fixation of CO2: Calvin (C3), steps and regulation, Photorespiration-mechanism and significance 3L
- Fixation of CO2: C4 cycle, Kranz anatomy, biochemical sub-types, Single cell C4 Photosynthesis.
- CAM pathway 2L

Credit III: Respiration and lipid metabolism: 15L

- Schematic presentation of Glycolysis, TCA cycle and PPP (Home assignment). Release of energy in Glycolysis, TCA cycle and PPP and their significance 7L
- Organization of respiratory electron transport system(evidence from membrane chemical composition, electro-potential gradient and use of ETS component inhibitors) 2L

- Mechanism of NADPH and NADH oxidation, establishment of proton gradient across the membrane and ATP formation 1L
- Cyanide resistance pathway 1L
- Fatty acid biosynthesis 1L
- Synthesis of membrane lipids 1L
- Catabolism of storage lipids 1L
- Significance of lipids(energy storage, defense, structure and others) 1L

Credit IV: Solute transport, Growth and development: 15L

- Seed dormancy, types of dormancy, causes, and methods of break dormancy. 1L
- Growth- Relative growth rate and net assimilation rate, IRGA 1L
- Physiology of flowering- photoperiodism, mechanism of vernalization. 4L
- Physiological organization phloem element for transport (Home assignment), Loading and unloading of phloem and mechanism of transport of solutes (Munch hypothesis); Source and sink relationship 3L
- Plant growth regulators-types and the physiological roles of auxin and cytokinin. 2L
- Stress physiology: Definition, Types: biotic and abiotic stress, effect of stress on Plants and elaborate any one abiotic and biotic tolerance mechanism. 2L
- Schematic presentation of secondary metabolite synthesis pathways (home assignment), Classification, biosynthesis and significance of alkaloidsin plants. 2L

REFERENCES:

- Berg J.M., Tymoczko J.L., Stryrer L. (2002) Biochemistry. 5th Ed. Wlt. Freeman and Company, New York.
- Biology of Plants. American Society of Plant Physiologists Maryland, USA.
- Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologistsm Maryland, USA.
- Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
- Davis P. J. (Eds.)(2004) Plant Hormones.Kluwer Academic Publishers, Dordrecht, Netherlands.
- Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
- Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA.
- Goodwin T.W., Mercer E.I. (1998) Introduction to Biochemistry. CBS Publishers, New Delhi.
- Heldt H. W. (2004) Plant Biochemistry. Academic Press, California.
- Hopkins W. G. 1995. Introduction to Plant Physiology. John Wiley and Sons, Inc., New York, USA
- Lawlor D.W. (2001) Photosynthesis in C3 and C4 Pathway. 3rd Ed. Viva. New Delhi.

- Leninger A.C 1987. Principles of Biochmistry, CBS Publishers and Distributers (Indian Reprint)
- Lincolin Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
- Lodish H., Berk A., Zipursky S, L., Matsudaira P., Baltimore D and Darnell J. 2000. Molecular Cell Biology (Iv Edition) W. H. Freeman and Company, New York, USA.
- Metabolism (Second Edition) Longman, Essex, England.
- Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
- Nelson David and Cox Michael. (2007) Lehninger Principles of Biochemistry.W.H.Freeman and Company. New York.
- Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
- Salibury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.
- Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
- Lincolin Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
- Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
- Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.

Semester –III

M.Sc. Botany – II Botany Theory paper -4

BODT 234- a) Mycology (2 Cr- 30 Lectures)

Credit I – Fungi **(15L)**

1. Fungi – Affinities with plants, animals and their significance 2L

2. Outline classification of fungi upto order- 3L

E. A. Bessey System (1950)

Alexopoulos System (1962),

L. E. Hawkers System (1966),

Alexopoulos and Mims System (1979),

Webster and Weber System (2007)

3. General characters and structural variations in-

A) Myxomycota- Acrasiomycetes, Protosteliomycetes, Dictyosteliomycetes, Myxomycetes 4L

B) Straminipila- Plasmodiophoromycota, Hyphochytridiomycota, Labyrinthulomycotaand Oomycota 2L

C)Mastigomycota-Chytridiomycetes 1L

D)Zygomycota- Zygomycetes, and Trichomycetes 3L

Credit II –Higher Fungi – 15L

4.General characters, structural variations in-

A. Ascomycota- Archiascomycetes, Hemiascomycetes,Plectomycetes, Pyrenomycetes, Loculoascomycetes, Discomycetes 5L

B. Basidiomycota- Hymenomycetes- Agarics and Polypores, Homobasidiomycetes - Gasteromycetes,Heterobasidiomycetes- Auricularials Dacrymycetales, Tremellales Teliomycetes–Uredinales and Ustilaginales fungi 6L

C. Deuteromycota- Hyphomycetes- Moniliales, Mycelia Sterilia, Coelomycetes - Melanconiales, Sphaeropsidales 4L

Suggested Readings:

1. Ainsworth et al., 1973. The fungi VI –A, VI – B, Academic press.

2. John Webster and Weber, 2007. Introduction to Fungi, Cambridge.

3. Alexopolous C.J. Minms C.W. and Blackwell M., 1999. Introductory Mycology (4th Edition), Willey, New York.

4. Deacon J. W. Fungal Biology (4th Edition) , Blackwell Publishing, ISBN 1405130660

5. Kendrick B., 1994. The Fifth Kingdom, North America, New York Publisher.

6. Kirk et al., 2001. Dictionary of fungi, 9th edition, Wallingford.

7. Mehrotra R.S. and Aneja K.R., 1990. An introduction to mycology, New Age Publication.

8. Miguel U., Richard H., and Samuel A. 2000. Illustrated dictionary of mycology Elvira Aguirre Acosta Publisher.

9. WebsterJ., and Rpland W. 2007. Introduction to fungi (3rd Edition), Cambridge University Press.

10. Dube H.C. 2010.An Introduction to fungi, Vikas Publication.

11. Vashista B. R. and Sinha A.K. 2008. Botany for Degree students- Fungi, S. Chand's Publication.

Semester III

Botany Theory paper -4

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BODT 234 b) TAXONOMY OF ANGIOSPERMS (2 credits-30 Lectures)

Credit I: **15 Lectures**

- Introduction to Taxonomy , 4L

  Botanical Nomenclature: Brief history, Scientific names, ICN, Principles, typification, Principle of priority, effective and valid publication, rank of taxa
- Tools of taxonomy: Floras, monographs, revisions, websites. 4L

  Herbarium and botanical gardens, their role in teaching, research and conservation, important herbaria and botanic gardens of theWorld.

  Botanical Survey of India.
- Identification of Plants: Introduction, Morphological features used in identification.

  Keys: Types and Importance 4L
- Biodiversity, types, importance and methods of conservation 3L

  IUCN and its categories, Endemism, Hotspots

Credit II: **15 Lectures**

- Modern Trends in Angiosperm Taxonomy 4L

Embryology in relation to taxonomy: Embryological characters of taxonomic importance, Anatomy in relation to taxonomy: Anatomical characters of taxonomic importance, Palynotaxonomy: pollen characters of taxonomic importance.

- Chemotaxonomy 2L

  Classes of compounds and their biological significance, stages in chemotaxonomic investigations, Techniques-Criteria for use of chemical in plant taxonomy
- Serology and taxonomy 2L

  History, precipitation reaction, techniques, antigen, antisera antibody, application of serological data in systematic
- UltrastructuralSystematics: 3L

  SEM and TEM studies and plant systematics; SEM and plant surface structure, TEM and dilated cisterneae of endoplasmic reticulum and sieve element, plastids
- Molecular Systematics: 4L

  Molecular diagnostic tools, restriction fragment length polymorphism (RFLPs), Random Amplified Polymorphic DNA (RAPD), Polymerage Chain Reaction (PCR) analysis, specific applications of RAPD in molecular systematics. Molecular data and systematic position of Hydatellaceae.

Suggested Readings:

1. Balfour Austin (2016). Plant Taxonomy. Syrawood Publishing House
2. Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge, University Press.
3. Chopra G.L. (1984). Angiosperms: Systematics and Life-Cycle., Pradeep Publications
4. Cooke, Theodore (1903-8). The Flora of the Presidency of the Bombay Vol. I, II, III (Repr. ed), Botanical Survey of India.
5. Cronquist, A. (1968). The Evolution and Classification of Flowering Plants. Thomas Nel and Sons Ltd. London.
6. Datta S.C. (1988). Systematic Botany. New Age Publ.
7. Davis P.H and V.H Heywood (1963). Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
8. Heywood V.H. (1967). Plant Taxonomy, Hodder & Stoughton Educational, London.
9. Judd Walter S., Campbell, C. S., Kellogg, E. A., Stevens, P.F. and M. J. Donoghue. (2008). Plant Systematics- A Phylogenetic Approach. Sinauer Associates, INC, Publishers.Sunderland, Massachusetts, USA.
10. Kormondy Edward (1995). Concepts of Ecology, Pearson Publ.
11. Lawrence G.H.M. (1955). An Introduction to Plant Taxonomy. McMillan, New York.

12. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. McMillan, New York.
13. Michael P. (1984). Ecological Methods for field and Laboratory investigations TMH Co. ltd. Bombay.
14. Mondol A.K. (2016) Advanced Plant Taxonomy, New Central Book Agency (NCBA)
15. Naik V.N. (1988) Taxonomy of Angiosperms. Oxford and IBH
16. Odum E.P., (2004). Fundamentals of Ecology, Publ. Cengage Learning, Australia
17. Pande B.P. (1997). Taxonomy of Angiosperms. S. Chand.
18. Pande B.P. (2001) Taxonomy of Angiosperms. S. Chand.
19. Radford A.E. 1986. Fundamentals of Plant Systematics, Harper and Row N Y.
20. Santapau H. (1953). The Flora of Khandala on the Western Ghats of India. BSI
21. Sharma O.P. (2011), Plant Taxonomy, Tata Mc grow Hill
22. Shivrajan V.V. & N.K.P. Robson (1991). Introduction to Principles of Plant Taxonomy. Cambridge Univ. Press
23. Shukla Priti and Shital Mishra (1982). An introduction to Taxonomy of angiosperms. Vikas Publ.
24. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam.
25. Singh Gurucharan (2005). Systematics: Theory and Practice. Oxford IBH.
26. Singh J.S., S.P. Singh, and S.R. Gupta (2006). Ecology, Environment and Resource Conservation. Anamaya Publ. New Delhi.
27. Singh N.P. (2001) Flora of Maharashtra Volume-II BSI, Kolkatta
28. Singh N.P. (2003) Flora of Maharashtra Volume-III BSI, Kolkatta
29. Singh N.P., S. Karthikeyan (1996) Flora of Maharashtra Volume-I, BSI, Kolkatta
30. Singh V. and D.K. Jain, (1981). Taxonomy of Angiosperms. Rastogi Publication, Meerut.
31. Singh, Gurcharan. (2012). Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi.
32. Stuessy, Tod F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, second edition. Columbia University Press.
33. Swingle D.B. (1946). A Text book of Systematic Botany. McGraw Hill Book Co. New York.
34. Takhtajan A. (1969). Flowering Plants: Origin and Disposal.

IMPORTANT WEBSITES

THE FAMILIES OF FLOWERING PLANTS- L. Watson and M.J. Dallwitz
https://www.delta-intkey.com/angio/index.htm

ANGIOSPERM PHYLOGENY WEBSITE, version 14.
http://www.mobot.org/MOBOT/research/APweb/

THE PLANTS OF THE WORLD ONLINE PORTAL
http://www.plantsoftheworldonline.org/

INTERNATIONAL PLANT NAME INDEX (IPNI)
https://www.ipni.org/

TROPICOS
https://www.tropicos.org/home

BIODIVERSITY HERITAGE LIBRARY
https://www.biodiversitylibrary.org/

BOTANICUS DIGITAL LIBRARY
https://www.botanicus.org/
INTERNET ARCHIVE- DIGITAL LIBRARY
https://archive.org/
DATABASE OF PLANTS OF INDIAN SUBCONTINENT
https://sites.google.com/site/efloraofindia/
BOTANICAL SURVEY OF INDIA
https://bsi.gov.in/content/1416_1_FloraofIndia.aspx
FLOWERS OF INDIA
http://www.flowersofindia.net/
eFLORAS OF WORLD
http://www.efloras.org/

Botany Theory paper -4

M.Sc. Botany Semester-III

BOUT 234: c) Plant Ecology

(2 Credits) (30 Lectures)

Topic Details	Lectures
Credit-I	
Introduction to science of ecology, definition, concept, and scope, interdisciplinary science, autecology and synecology, branches of ecology	2
Environmental factors controlling plant distributions: geology, topography, elevation, soils, light, temperature, precipitation, water and humidity, fire	3
Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of meta-population – demes and dispersal, interdemic extinctions, age structured populations.	4
Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.	2
Community Ecology: definition, nature, composition and characteristics of community, structure/ stratification of community, levels of species diversity and its measurement; edges and ecotones, habitat, niche and guild	4
Credit-II	
Ecological succession: Types, mechanisms, changes involved in succession; concept of climax; relationship between ecosystem stability and diversity, ecological indicator plants	3

Ecosystems – concept, nature, structure and function; Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).	3
Energy flow in ecosystem, food chain, food web, biogeochemical cycles (C,N,P), primary production and decomposition; ecological pyramids, homeostasis, concept of limiting factors	3
Biogeography: Major terrestrial biomes; theory of island biogeography; floristic regions and vegetation zones of Maharashtra, India, and world and its characters, principals of classification, key species of each region.	3
Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.	3

Suggested Readings:

- Ambasht R.S. and N.K. Ambasht (2017). A Textbook of Plant Ecology (15/E). CBS Publishers & Distributors-New Delhi.
- Ambasht R.S., and N.K. Ambasht (2003). Modern Trends in Applied Terrestrial Ecology. Springer
- Avery Thomas E. and Burkhart Harold E. (2015). Forest Measurements. (5/E). McGraw-Hill.
- Barbier E.B., Burgess J.C. and Folke C. (1994). Paradise Lost? The Ecological Economics of Biodiversity; Earthscan, London
- Bhatnagar Aditya (2010). Ecology and Environment. Oxford Book Company
- Bowles M.L. and Whelan C.J (1996) edt. Restoration of Endangered Species Cambridge Univ. Press.
- Chapman, J.L. and Reiss, M.J. (1998). Ecology: Principles and applications. Cambridge University Press.
- Dash M.C. and S.P. Dash (2009). Fundamentals of Ecology (3/E). McGraw Hill Education (India) Private Limited
- Gadgil M. and Guha R (1992). This Fissured Land: An Ecological History of India. Oxford University Press, New Delhi
- Hajra P.K. and V. Mudgal (1997) Edt. Plant Diversity Hotspots in India - An Overview, BSI.
- Henderson Peter A., and T.R.E. Southwood (2016). Ecological Methods. (4/E). Wiley-Blackwell Publishers
- Heywood and Watson (1995), Edt. Global Biodiversity Assessment UNEP, Cambridge University Press.
- Hill David, Matthew Fasham, Graham Tucker, Michael Shewry and Philip Shaw (2004) Edt. Handbook of Biodiversity Methods – Survey, Evaluation and Monitoring; Cambridge

- Kent Martin (2011). Vegetation Description and Data Analysis: A Practical Approach (2E). Wiley-Blackwell.
- Kormondy Edward (1995). Concepts of Ecology. Pearson Publ.
- Krebs Charles J. (1999). Ecological Methodology (2/E). Pearson Education.
- Krishnamurthy K.V. (2003). An Advanced Textbook on Biodiversity-Principles and Practice, Oxford and IBH Publ. New Delhi
- Magurran Anne (1988). Ecological Diversity and Its Measurement Chapman and Hall India
- Mani, M.S. (1974). Biogeography of India, 1st Edn. Springer Publ.
- Michael J. Jeffries (2005). Biodiversity and Conservation, Routledge, London
- Michael P. (1984). Ecological Methods for field and Laboratory investigations Tata McGraw-Hill Co. Ltd.
- Misra R. (1968). Ecology Workbook. Oxford and IBH, New Delhi.
- Odum E.P and Gray Barrett (2004) Fundamentals of Ecology. Thomson Brooks
- Ramchandra T.V., R. Kiran, N. Ahalya (2002). Status, Conservation and Management of Wetlands. Allied Publ. New Delhi.
- Rana S.V.S. (2013). Essentials of Ecology & Environmental Science, (5/E). PHI Learning Press.
- Shailaja Ravindranath and Sudha Premnath (1997). Biomass Studies – Field Methods for Monitoring Biomass. Oxford and IBH, New Delhi.
- Sutherland William J. (2006). Ecological Census Techniques – A Handbook. Cambridge Univ. Press.
- Uma Shaanker, R. Ganeshiah, KN. and Bawa KS (2001). (Eds). Forest Genetic Resources: Status, Threats and Conservation Strategies. Oxford and IBH, New Delhi
- Wheater C Philip, James R. Bell, Penny A. Cook (2011). Practical Field Ecology: A Project Guide. John Wiley

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Botany Theory paper -4

M.Sc. Botany – II

Semester –III

BODT 234- d) Plant Biotechnology (2 Cr- 30 Lectures)

Credit –I **15 L**

Introduction to Biotechnology:

1. Definitions of Biotechnology, Multidisciplinary approach, scope and importance of Biotechnology wrt Plant genetic Engineering, Plant micropropagation, Plant mutation cloning, Plant cell technology and Environmental Biotechnology (02)
2. A. Plant Genetic Engineering: Gene constructs, A typical Plant gene, Promoters/ Enhancers, reporter genes

B. Vectors for production of Transgenic plants: Plasmid Vectors; Structure of Ti Plasmid, organization of T DNA, Vir region, transfer and integration of T DNA in host plant genome, Plant Virus vectors; Cauliflower Mosaic Virus (CaMV) , Gemini Viruses and Tobacco Mozaic Virus (TMV) (05)

3. Agrobacterium mediated gene transfer, integration of the transgenes, inheritance of transgenes, Analysis and confirmation of transgene integration (03)
4. Applications of transgenic Plants: Applications of Transgenic plants in Biotic and Abiotic Stress resistance, Quality modifications and Novel features such as modification of Endogenous genes, molecular farming, Plant derived vaccines (05)

Credit – II 15 L

5. **Plant tissue culture technology** (05)
   A. Introduction to plant tissue culture, Scope, Importance and types, Protoplast Culture and Somatic Hybridization: Isolation of protoplast, culture and regeneration of protoplasts, fusion of protoplasts, selection of hybrid cells. Identification of hybrid plants, Cybrids, Applications of somatic hybridization
   B. Somaclonal Variations: Introduction, Isolation of somaclonal variants, with and without *in-vitro* selection, factors affecting somaclonal variation, applications and limitations of somaclonal variation

6. **Environmental Biotechnology:** (05)
   Environmental Pollution: Sources and Nature, Measurement of Pollution: Biotechnological methods of Pollution management, air pollution ad its control, water pollution and sewage: Nature of water pollutants, organic and inorganic, microbiological and radioactive pollutants, Waste water and sewage: composition of sewage and its types, Sewage water treatment: Preliminary, Primary, Secondary or biological treatment processes, water recycling
7. **Biotechnology and Society**
   A. Biotechnology- Society, Risks, Ethics and Patenting (02)

ELSI of Biotechnology, Recombinant and Therapeutic products for human healthcare, Genetic modifications and food consumption, recombinant food and religious beliefs, Release of Trangenics

Patenting : What is a Patent, Intellectual property rights, the process of patenting, Plant Breeder's rights

B. Biosafety- (03)

Introduction, definitions, objectives and biosafety guidelines, Risk assessment during Laboratory research, planned introduction, for biotechnology products, Risk regulations, Physical and Biological contaminants, Biosafety guidelines in India

Suggested Readings:

1. U. Satyanarayan, Biotechnology Published by Books and Allied PVT. LTD.
2. B. D. Singh. Biotechnology : Expanding Horizons Kalyani Publishers
3. S. C. Dubey Biotechnology , Rastogi publication

Botany Theory paper 4

M.Sc. Botany – II
Semester –III
BODT 234 e) Genetics and plant breeding- (2 Credits – 30 lectures)

Credit - I **15 L**

1. **Karyotype analysis and application**: **7L**

Introduction and concept, Role of karyotype in evolution and plant species identification, Chromosome banding: i) Quinacrine dihydroculoride (Q) banding, ii) G-banding, iii) Giemsa C-banding, Modified C-banding, Combined C and N bonding for plants, B-Chromosome and accessory chromosomes, Applications of karyotyping analysis in taxonomy, Molecular analysis through in Situ hybridization of chromosomes: Types of hybridization, Nature of probes, P.C.R. and in situ hybridization, Prerequisites, steps and techniques of hybridization: Probe sequence, Metaphase chromosome, Labelling of probes, Hybridization and detection

2. **Transposable Elements:** **3L**

Genetic instability and the discovery of transposable elements. Transposable element in bacteria: IS elements and Tn3 Family, Transposable elements in Maize, The Genetics and evolutionary significance of transposable elements: Mutation and Chromosome Brekage, Use in genetic analysis and Evolutionary issues or significance

3. **Population and evolutionary genetics: 5L lectures**

Genetic variation, random mating and Hardy- Hardy-Weinberg Principle, Mating frequencies - Non-dominance - Codominance - Snyder's ratio, importance,and its effect over random mating in succeeding generations, Application of Hardy-Weinberg method in breeding, The inbreeding coefficient, Calculating F from pedigree, Genotype frequencies under inbreeding, Quantitative effects of inbreeding, Outbreeding and assortative mating, Evolutionary genetics: The synthetic theory of evolution, Evidence for adaptive evolution and Molecular evolution

Credit - II: 15 L

4. **Addition Molecular Markers in Plant breeding:** 4L

QTL mapping; Strategies for QTL mapping, desired populations for QTL mapping, Marker assisted selection (MAS),Classification of markers -Enzyme based markers, Hybridization based markers, DNA-sequence based markers, Approaches to apply MAS in plant breeding, Factors influencing MAS

5. **Breeding for resistance to Salinity:** 4L

Introduction, Effect of salinity stress: Salt toxicity, Salinity resistance : Resistance to salinity induced ion toxicity, Genetics of salinity resistance: Interspecific variation, Intraspecific variation, Gene action and heritability, Measurement of salinity resistance: Saline environment and Estimation of salinity resistance and selection criteria.

6. **Biometrical techniques in plant breeding: 4 L**

Introduction, Assessment of variability, Simple measures of variability.
Genetic Diversity: Introduction, D^2 statistics, Metroglyph Analysis, Correlation coefficient analysis (Aids to selection): Simple coefficient Analysis, Partial correlation, Choice of parents and Breeding procedures: Diallel cross analysis

7. **Intellectual Property Rights**: **3L**

Introduction, Intellectual property rights, Plant breeder's rights, A comparison among UPOV acts, PPVER Acts., Requirement for PBR and Farmers rights, The protection of plant varieties and farmers right act,2001, Geographical indications, Indian response to the IPR upheaval, The conditions for granting breeding rights (DUS) : Novelty , Distinctness, Uniformity and stability

Suggested Readings

Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.Darlington CD & La Cour LF. 1969.

The Handling of Chromosomes. Georger Allen & Unwin Ltd.

Arun Sharma and Archana Sharma, 1988. Chromosome Techniques: Theory and Practice. Butterworth.

Sumner AT. 1982. Chromosome Banding. Unwin Hyman Publ.

Elgin SCR. 1995. Chromatin Structure and Gene Expression. IRL Press.

Gupta PK & Tsuchiya T. 1991. Chromosome Engineering in Plants:

Genetics, Breeding and Evolution. Part A. Elsevier.

Gupta PK. 2000. Cytogenetics. Rastogi Publ.

Johannson DA. 1975. Plant Microtechnique. McGraw Hill.

Karp G. 1996. Cell and Molecular Biology: Concepts and Experiments.John Wiley & Sons.

Khush GS. 1973. Cytogenetics of Aneuploids. Academic Press.

E.J. Gardner Priciples of Genetics

Monroe Strikberger, (1995) Genetics Publisher: Prentice Hall India Learning Private Limited; 3

Hartl and Jones (1998) Genetics : Principal and Analysis. Sudbury, Mass. : Jones and Bartlett Publishers,

Peter J.Russel, Genetics (5^{th} edition),Pearson publication

Primrose, S.B.,and R.M. Twyman. Principles of gene manipulation and genomics , Blakwell Publication

Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.

Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.

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Gupta SK. 2005. Practical Plant Breeding. Agribios.

Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.

Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
Singh BD. 2006. Plant Breeding. Kalyani.
Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani.
Singh P. 2006. Essentials of Plant Breeding. Kalyani.
Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.Falconer DS & Mackay J. 1998. Introduction to Quantitative Genetics. Longman.
Mather K & Jinks JL. 1971. Biometrical Genetics. Chapman & Hall.
Mather K & Jinks JL. 1983. Introduction to Biometrical Genetics. Chapman & Hall.
Nadarajan N & Gunasekaran M. 2005. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani.
Naryanan SS & Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani.
Singh P & Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani.
Singh RK & Choudhary BD. 1987. Biometrical Methods in Quantitative Genetics. Kalyani.
Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.
Wricke G & Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.Chawla V & Yadava RK. 2006. Principles of Population Genetics – A Practical Manual. Dept. of Genetics, CCS HAU Hisar.
Falconer DS & Mackay J.1996. Introduction to Quantitative Genetics. Longman.
Jain JP, Jain J & Parbhakaran, VT. 1992. Genetics of Populations. South Asia Books. Li CC. 1955. Population Genetics. The Univ. of Chicago Press

Botany Theory paper -4

M.Sc. Botany – II
Semester –III
BODT- 234: f) SEED SCIENCE- 2 Credit (30 Lectures)

Credit -1 **15 L**

1. **Introduction:** **1 L**
   - Scope, Importance and Definition of Seed Technology
2. **Seed:** **4 L**
   - Definition
   - Difference between seed and grain
   - Orthodox and Recalcitrant seed
   - Classes of seed
   - Seed quality characteristics
3. **Seed Morphology:** **2 L**
   - Seed structure (embryo, endosperm and seed coat)
   - Chemical composition of seed (carbohydrates, proteins, oils, fats and other)
4. **Seed Dormancy and Seed Germination:** **6 L**
   - Definition of dormancy
   - Types of dormancy
   - Causes of seed dormancy
   - Methods of breaking dormancy
   - Definition of seed germination
   - Types of germination
   - Factors affecting seed germination
   - Seed vigour, Seed ageing and Seed viability,
5. **Genetic Purity** **2 L**
   - GOT (grow out test).
   - Germination testing, its methods (paper, sand and soil), evaluation and reporting of results

Credit 2 **15L**

1. **Quality testing** **3 L**
   - Moisture testing: Moisture Meter and Air oven method.
   - Physical purity analysis
   - Biochermical tests (Quick viability test (Tz), Peroxidase and Phenol colour test)
   - Aids for varietal identification: PCR, RAPD, RFLP, DNA finger printing, ELISA test.
2. **Seed Production:** **8 L**
   - General Principles of seed production
   - Artificial pollination (Hand pollination, Dusting and Honey bee)

- Seed production techniques in hybrids (use of Male Sterility, Self Incompatability and gametocides)
- Procedure of seed production in tomato, okra, soybean, cotton and maize (Land requirements, isolation requirements, brief cultural practices, plant protection-physical, chemical and biological, types of chemical pesticides-systemic and contact, roguing, harvesting and threshing)
- True potato seed (TPS), Artificial Seed Production

3. Seed Testing: 4 L

- Objectives and Definition
- ISTA, CSTL and SSTL
- Seed Sampling: Definition, Sampling, Dividing and Mixing equipments
- Procedure of sampling, (Kinds-Primary, composite, submitted and working)
- Types of seed samples (Service, official and certification sample)

Reference:

1. Ovcharov, K.E. 1977. Physiological Basis of Seed Germination. Amerind Publishing Co., New Delhi and New York.
2. Thompson, J.R. 1977. Advances in Research and Technology of Seeds. Part - 1, 3 & 4. Centre for Agrl. Publishing and Documentation, Washington.
3. Anonmyous. 1997. Seed Technology in Tropics. ISTA Zurich.
4. Sinclair, T.R. and F.P. Gardner. 1997. Principles of Ecology in Plant Production, CAB international, G.K.
5. Rai. M. and S. Mauria. 1995. Hybrid Research and Development. Indian Society of Seed Technology. IARI. New Delhi.
6. Agrawal, R.L. 1996. Seed Technology, IBH publishing Co., New Delhi.
7. Mayer, A.M. and A.P. Mayber. 1989. Germination of Seeds. Pergamon Press, Oxford.
8. Desai. B.B., P.M Kotecha and D.K. Salunkha. 1997. Seeds Hand Book - Biology Production, Processing and Storage. Marcel Dekker. New York.
9. Khairwal. P.S., C. Ram and A.K. Chabra. 1997. Pearl millet Seed Production and Technology. Manohar book service, New Delhi.
10. Jaima Kigel, J. and G. Galili. 1997. Seed Development and Germination. Marcel Dekker, New York.
11. Bewley, J.D. and M. Black. 1982. Physiology and Biochemistry of Seeds in relation to Germination, Vol. I & II. Springer Verlag, Berlin, Heidelberg, New York.
12. Justice, O.L. and L.N. Basu. 1978. Principles and Practices of Seed Storage. Castle House Publications Ltd, Great Britain.
13. Khan, A.A. 1977. The Physiology and Bio-chemistry of seed Dormancy and Germination. North Holland Publishing Co., Amsterdam, New York.
14. Kozlowski, T.T. 1972. Seed Biology, Vol. 1 Academic Press, London.
15. Purseglove, J.W. 1977. Tropical crops of Monocotyledons, Longmans, Green and Co., Ltd., London.

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 a) Mycology

Sr. No	Title of practical	No.
1	Preparation of culture medium for fungi-PDA medium, CDA medium, Sabourard's medium& preparation of fungal stain & mounting medium	1
2	Isolation of aquatic and soil fungi by baiting method	2
3	Isolation of fungi from rhizosphere and non-rhizosphere soil	2
4	Study of fungi from the following groups Myxomycetes- any four Chytridiomycetes- any two Oomycetes- any four Pyrenomycetes- any four Loculoascomycetes- any two Discomycetes- any four Teliomycetes – any eight Gasteromycetes- any four Hymenomycetes- any six Deuteromycetes- any six	10

Note: 1. Compulsory visit to Western Ghats for collection and observation of fungi (2-3 days).

2. Visit to any one Mycology Institute/ Laboratory.

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 b) Angiosperm Taxonomy

Sr. No	Title of practical	No.
1	Microtome technique for study of embryological characters	2
2	Study of wood character, vessels, storied and non storied wood	2
3	Pollen preparations by Acetolysis method (Semi-permanent) and study of different pollen morphotypes.	2
4	Study of chromosomes, chromosome banding and Karyotype analysis (Any two species)	2
5	Analyses and interpretation of data of any two species for taxonomic characterization (4P) (a) flavonoid data based on PC/TLC (b) Seed protein by SDS-PAGE and interpretation of protein profiles	3
6	Study of plant surface attributes with the help of SEM photographs and sieve tube plastid and dilated cisternae of endoplasmic reticulum with the help of TEM photographs	1
7	Identification of wild and cultivated plants represented in local flora.	1
8	Two local excursions to study vegetation, ecology and flowering pattern of the region.	2

Note:

Student should submit minimum 10 conventional herbarium specimens and 20 electronic herbarium specimens. Minimum 5 permanent slides of wood anatomy and 5 slides of floral anatomy (microtomy cut sections of flower specimens).

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 c) Plant Ecology

Sr. No	Title of practical	No.
1	Visit to any one plant diversity hotspots / National Parks/ Wildlife Sanctuary/ coastal area	2p
2	Find out the minimum area of quadrat by species-area curve method	1p
3	Find out the minimum number of quadrats required to study the herbaceous ecosystem	1p
4	Study of biotic structure by List Counts Quadrat method to find out frequency and relative frequency of different plant species and prepare their frequency class diagram; compare them with Raunkiaer's normal frequency diagram.	1p
5	Study of biotic components by List Counts Quadrat method to find out abundance, density and relative density.	1p
6	Study of ecological indicator plants (any five)	1p
7	Determination of water holding capacity, moisture content, color and pH of different soils	1p
8	To study the texture of the soil.	1p
9	Determination of the temperature, pH, dissolved oxygen, and turbidity of polluted and non-polluted water sample	1p
10	Study of wetland plants: submerged, emergent, free floating, marshy (two examples each)	1p
11	Study the map of Phytogeographical regions of India	1p
12	Study of aquatic productivity by light and dark bottle method	1p

Field trip to places for study of vegetation type (including any one plant diversity hotspot/national park/wild life sanctuary/Sacred groove) prescribed in the syllabus for 2 to 5 days under the guidance of teachers. Preparation and submission of field visit report.

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 d) Plant Biotechnology

Sr. No	Title of practical	No.
1	Isolation of Plant genomic DNA using suitable method	2
2	Separation of restriction fragments using Agarose gel Electrophoresis	2
3	Enzymatic isolation of protoplast using suitable plant material	2
4	Evaluation and viability counting of the protoplsts	2
5	Physicochemical Properties of waste water	1
6	Biological assessment of waste water	1
7	Demonstration of Transgenic Plants	1
8	Visit to a Research institute and write a report on Biosafety	1
9	Visit To Commercial Tissue culture Laboratory and write a report	1
10	Visit to Waste water treatment Plant and write a report	1
11	Prepare a case study report on Patenting of any one Biotechnology Product/invention	1

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 e) Genetics and Plant breeding

Sr. No	Title of practical	No.
1	Preparation of C- metaphase / G- banding in suitable material	2
2	Studies on the meiosis in cereals /millets / pulses	1
3	Karyotype studies of any 2 plants and preparation of ideogram	2
4	Detection of polymorphism from any DNA gel photograph or suitable material	1
5	Estimation of gene and gene frequencies	1
6	Preparation of dendrogram from given polymorphic data or by using similarities matrix and explanation and analysis of dendrogram (by suitable software)	1
7	Estimation of heritability and genetic advance (by suitable software)	1
8	Estimation of Correlation Coefficients(manual / by suitable software)	1
9	Problems on Diallel cross analysis	1
10	Effect of salinity on seed germination and morphological characteristics	1
11	Effect of salinity on content of proline and glycine betane	2
12	Study of transposable elements in suitable plant material	1

Compulsory Activities:

1. Preparation of various chemicals to be used for, fixation, dehydration, embedding, different chromosomal staining, cleaning etc. and understanding use of various types of microscopes.

2. Case studies of IPR and Visit to Plant breeding station and Genetic laboratory.

Note: Use suitable software for problem solving in Genetics and Plant breeding

M. Sc II Botany Practical Paper

BODP 234 Practical Paper based on BODT 234

BODP 234 based on BODT 234 f) Seed Science

Sr. No	Title of practical	No.
1	Study of chemical composition and seed structure	1
2	Study of methods of breaking seed dormancy	2
3	Study of Sampling, dividing and mixing equipments	1
4	Grow Out Test	1
5	Study of seed germination (epigeal, hypogeal and viviparous types).	2
6	Study of seed germination testing methods (Paper, soil and sand).	2
7	Study of physical purity test	1
8	Biochemical tests (Quick viability test (Tz), Peroxidase and Phenol colour test)	2
9	Moisture Testing by moisture meter and oven method	1
10	Visit to a seed industry and research institute/apiculture	2

M. Sc II Botany Practical Paper

BOUP 235 based on BOUT 231, BOUT 232, BOUT 233

Sr. No	Title of practical	No.
	BOUT 231 Computational Botany (Any 10 Practical)	
1	Measurement of central tendency (mean, mode and median), variance, standard deviation, coefficient of variance and standard error from the given grouped and ungrouped data.	1
2	Measures of skewness and measures of Kurtosis (grouped and ungrouped data).	1
3	Determination of regression lines and calculation of correlation coefficient – grouped and ungrouped data.	1
4	Examples based on t – test	1
5	Drawing a simple random sample with the help of table of random numbers	1
6	Chi-square test for goodness of fit and independent attributes.	1
7	Analysis of variance on the given data (ANOVA) using R/ SPPS/Excel	1
8	Tukey's test for pairwise comparison of treatments using R/ SPPS/Excel	1
9	Dunnet's test for comparison of treatment means with control using R/ S PPS/Excel	1
10	Duncan's multiple range test for comparing treatment means using R/ SPPS/Excel	1
11	Determination of Karl-Pearson's coefficient of correlation from the given grouped and ungrouped data.	1
12	Databases and database searching and DNA/protein sequence comparisons	1
13	Pair wise comparison of DNA and protein sequences using BLAST	1
	BOUT 232 Developmental Botany	
1	Histochemical analysis of secondary growth primary to secondary axis)	1
2	Histochemical comparison between vegetative And reproductive induced SA	1
3	In-Vitro Germination of Spore/Pollen	1
4	Dissection & Isolation of Developing Embryo	1
5	Dissection Isolation of Endosperm	1
6	Stomatal development and observations on Stomatal types	1
7	Study of Induced Leaf Senescence	2
8	Observations on Microsporogenesis and Development of Male Gametophyte	1
9	Observations on Megasporogenesis and Development of Female Gametophyte	1
	BOUT 233 Plant Physiology (Any 10 Practical)	
1	Preparation of standard solutions(%, ppm, molar, normal) of different concentrations, Preparation of buffers solutions, EC and pH measurements	1
2	Study of deficiency symptoms of essential elements on different crop plants.	1
3	Study of transpiration and stomatal physiology under abiotic stress	1
4	Detection of amino acids/sugars from the phloem sap using paper chromatography	1
5	To determine the chlorophyll a/chlorophyll b ratio in C3 and C4 plants.	1
6	Estimation of soluble proteins in germinating and non-germinating seed by Lowry / Bradford's method	1
7	Survey of C4 plants and CAM plants. Find out C4 pathways from the given plants	1

	by titration method(TAN)	
8	To determine the activity of enzyme amylase in germinating seeds and its induction by GA.1P	1
9	Determination of activity of nitrate reductase.	1
10	Effect of salt /Drought stress on accumulation of proline and its estimation.	1

SEMESTER IV

M.Sc. II Semester IV

BOUT 241 Botany Theory paper 1

BOUT 241: BOTANICAL TECHNIQUES

(4 CREDITS) (60 Lectures)

Credit 1 = (15 Lectures)

Microscopic Techniques

A. Image formation (properties of light), Lens- refraction, dispersion of light, objects, images, image quality, magnification concept, resolution **1L**

B. Optical microscopy- Light microscopy, Confocal microscopy, Phase Contrast microscopy, Fluorescence microscopy, Electron microscopy (SEM TEM and STEM), Flow cytometery and Atomic force microscopy **7L**

C. Dissection, maceration, squash, peeling and whole mount- pretreatment and procedures **1L**

D. Microtomy- serial sectioning, double or multiple staining, Lesser assisted Microtomy **2L**

E. Histochemical and cytochemical techniques- Localization of specific Compounds/ reactions/ activities in tissues and cells **3L**

F. Micrometry and camera lucida **1L**

Credit 2 = (15 Lectures)

A. Chromatography techniques:-

a) Introduction, Types, Peak Area, Solvent systems, immobilized and mobilized phase, retention time **2L**
b) Principle, method and applications of: Paper, TLC, Column Chromatography **2L**
c) Gel filtration, Affinity, Ion exchange **2L**
d) HPLC, Gas chromatography **2L**

B. Elctrophoretic techniques:-

a) History, Principles, Horizontal and Vertical Electrophoresis. **1L**
b) Agarose gel electrophoresis **1L**
c) Pulsed Field Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE/ Native), Sodium Dodecyl Sulphate polyacrylamide gel electrophoresis (SDS-PAGE/ Denaturing) **4L**
d) Isoelctric focusing, 2 Dimensional Gel Electrophoresis (2-D method) **1L**

Credit 3 = (15 Lectures)

A. Spectroscopic techniques:-

a) General principles, Beer and Lambert's Law, Molar extinction coefficient, Electromagnetic radiations (Dual nature), Wavelength, Frequency, Properties of Electromagnetic radiations, electromagnetic spectra, Light absorption and excitation of spectra **2L**
b) Spectrophotometer **1L**
c) Principle, working and applications of-UV-Visible spectroscopy **1L**
d) Nuclear Magnetic Resonance (NMR) spectroscopy, **2L**
e) X-ray crystallography, **1L**
f) Spectroflurometry, **1L**
g) AAS, MS, IR Spectroscopy **2L**

B. Radioactive techniques:-

a) Radioisotopes used in biology and their properties, Units of radioactivity. **1L**
b) Interaction of radioactivity with matter, **1L**
c) Detection and measurement of radioactivity, Scintillation counter **1L**
d) Autoradiography, Safe handling of radio isotopes, **1L**
e) Flurochromes, Green Fluorescent Proteins **1L**

Credit 4 = (15 Lectures)

A. Centrifugation techniques:-

a) Principles, Rotors, Speed and Unit, Factors affecting centrifugation, **1L**
b) Ultra-centrifugation, Density Gradient Centrifugation **1L**

B. Electrochemical techniques:-
Electrical conductivity, pH meter, Oxygen electrode **2L**

C. Immunological techniques:-
a) Introduction and Principles, **1L**
b) Antigen–antibody interaction, Immuno diffusion, **1L**
c) Immuno precipitation, **1L**
d) Radio-immuno assay, Rocket immumo-electrophoresis, ELISA **2L**

D. Bioinformatics-
a) Introduction to databases and retrieving information from databases: NCBI, EMBEL **2L**
b) Molecular tools in protein and nucleotide sequence analysis; origin of new genes and Proteins, gene duplication and divergence **3L**

E. Herbarium Techniques- Digital herbarium **2L**

REFERENCES:-

1. **SrivistavaM.L.** (2008). Bioanylatical Techniques. Narosa Publishing House (P) Ltd.
2. **Plummer David** (1987). An Introduction to Practical Biochemistry. 3rd Eds. Tata McGraw-Hill Publishing Company Ltd.
3. **Sadasivam S.,Manickam A.** (1996). Biochemical Methods. 2ndEdn. New Age International (P) Ltd.
4. **Khasim S.M.** (2002). Botanical Microtechniques: Principles and Practice. Capital Publishing Company.
5. **Harborne J.B.** (1998). Phytochemical Methods. Springer (I) Pvt. Ltd.
6. **Wilson K., Walker J.** (2005). Principles and Techniques in Biochemistry and Molecular Biology. Cambridge University Press.
7. **Wilson K., Walker J.** (2000). Practical Biochemistry Principles and Techniques. Cambridge University Press.
8. **Bisen P.S. Mathur S.** (2006). Life Science in Tools and Techniques. CBS Publishers, Delhi.
9. **Marimuthu R.** (2008). Microscopy and Microtechnique. MJP Publishers, Chennai.
10. **Sharma V.K.** (1991). Techniques in Microscopy and Cell Biology. Tata McGraw-Hill Publishing Company Ltd.
11. **Prasad and Prasad** (1984). Outline of Microtechnique. Emkay Publications, Delhi.

12. **Srivastava S. and Singhal V.** (1995). Laboratory Methods in Microbiology. Anmol Publication Pvt. Ltd. Delhi.

13. **Pal and Ghaskadabi** (2009). Fundamentals of Molecular Biology.Oxford Publishing Co.

M.Sc. II Botany Semester IV

BOUT 242: Theory Paper-2: Advanced Plant Ecology
Semester-IV (4 Credits- 60 Hrs)

Topic Details	Lectures
Credit-I	
Levels of species diversity and its measurement, indices of α-diversity, species rarefaction; β-diversity similarity & dissimilarity indices.	2
Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic.	2
Aquatic Ecology: Freshwater and marine, ecology of estuaries and intertidal zones, mangroves	2
Ecosystem Stability: Concept (resistance and resilience), ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems	2
Biomes: Concept, basis of classification; Holdrige life zone classification; Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Alpine Biome, Chapparal, Savanna, Tropical Rain forest; adaptations in plants in various biomes	3
Agro-ecological zones of India: basis of classification and characteristics	2
Forest types of India (Champion and Seth, 1968): basis of classification and characteristics	2
Credit-II	
Methods in field ecology: Methods of estimating population density of plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of habitat characterization: ground and remote sensing methods.	3
Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity; Principles of conservation, major approaches to management; methods of conservation with examples; Indian case studies on conservation and management strategy (Sanctuaries/Sacred groves/National Parks/Botanical Gardens). Concept and basis of identification of 'Hotspots'; hotspots in India.	5

Concepts of gene pool, bio-piracy and bio-prospecting; Concept of restoration ecology; Extinct, Rare, Endangered and Threatened flora of India.	2
Environmental Biotechnology: Phytoremediation – definition, types and role of plants for in-situ and ex-situ remediation; bio-indicators, bio-fertilizers, biofuels and biosensors.	2
Environmental issues: Local, regional and global; air, water, and soil pollution - kinds, sources, quality parameters; climate change and its relationship with plants; Use of plants in mitigation of pollution, effect on plants and ecosystems	3
Credit-III	
Plant relations (eco-physiology) with climatic factors such as water, precipitation, temperature, light and radiation. Plant relations with edaphic factors: types of soil, soil moisture and water holding capacity of the soil, soil nutrients, soil microbes	4
Plant-plant interaction, concept of allelopathy; Plant-animal interaction, herbivory, carnivorous plants; Plant- microbes interaction: Mutualism, parasitism	3
Ecological/Environmental Ethics: Definition, concept, nature and origin of environmental ethics, ecological consciousness, views of developed and developing countries, environment community and equity, integrating ethical values and knowledge, self centered development and environment	4
Restoration ecology, plants in conservation of soils, restoration of land and degraded water bodies	2
Overview of Environmental Laws in India: Wildlife Protection Act, 1972; Forest Conservation Act, 1982 (revised); Biological Diversity Act, 2002: National Forest Policy, 1988; National Environmental Policy, 2006	2
Credit-IV	
Environmental Impact Assessment: Aims and objectives of Environmental Impact Assessment; concept, scope, process and necessity; Environmental Impact Statement (EIS) and Environmental Management Plan (EMP).	4
EIA Guidelines; Impact Assessment Methodologies.	1
Procedure for reviewing EIA of developmental projects. Life-cycle analysis, cost-benefit analysis. Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit;	3
Human impact on ecosystem and its consequences- Agriculture societies, degradation of natural resources. Impact of fertilizers, pesticides, fungicides and weedicides on crops and plants	2
Bio-indicators of environmental degradation- Concept of Bio-indicators, bio indicators plants, role of bio-indicators in pollution control.	2

Concept of carrying capacity; ecological foot print; sustainability	1
Biomass carbon sequestration: above ground, belowground, deadwood, litter, soil organic carbon.	2

References:

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M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT 243 a) Applied Mycology (2 Cr- 30 Hrs)

Credit I: **15L**

1. Fungi- Colonization strategies in fungi and their ecological role. 3L
2. Agriculture and Forest Pathology:
    a) Fungi as plant pathogens (Mildews- Powdery and Downy, Wilts, Leafspots, Root rots, Smuts and Rusts). 6L
    b) Forest pathology and its significance 1L
    c) Fungi as biopesticides: mycofungicides, mycoweedicides, myconematicides and mycoinsecticides. 2L
    d) Seed and market pathology, its importance 2L
    e) Mycorrhiza types and significance as biofertilizers. 1L

Credit II: **15L**

3. Medical mycology- Superficial, Intermediate and Deep mycosis (Types, symptoms and clinical aspects). 3L
4. Industrial mycology- Medically important Fungal metabolites, production of alcohol, antibiotics, enzymes, organic acids (their production and importance). 4L
5. Fungi as food-
    A) Fermented foods- Mucoprotein, Bread, Cheese, Tempeh, Miso, Sauce. 2L
    B) Mushrooms- types, there food and medicinal value, methods of production of different mushrooms in brief. 3L
6. Fungal food spoilage, Biodeterioration of organic and inorganic materials by fungi with examples. 3L

SUGGESTED READINGS

1. Introduction to Fungi- John Webster and Roland W.S. Weber
2. Introductory Mycology -Alexopoulos C.J., C.W. Mims and M. Blackwell
3. The Mycota- Esser, K. and Bennet J. W. (Eds.)
4. An Introduction to Mycology - Mehrotra, R.S. and Aneja, K.R.

5. Fundamentals of Mycology -Burnett, J. H.

6. Chemical fungal taxonomy - Frisvad, J.C. Bridge, P.D. and Arora, D.K.

7. The Filamentous Fungi - Smith, J.E.

8. Fungal Nutrition and Physiology - Garraway, M. O. and Evans, R. C.

9. Mushroom Biology - Miles, P.G. and Chang, S.T.

10. MycorrhizaeVerma - A. and Hock, B.

11. Ectomycorrhizal Fungi - Cairney, J.W.G. and Chambers, S.M.

12. Industrial mycology - Berry, R.

13. Plant Pathology - Agrios, G.N.

14. Plant Pathology - Mehrotra, R.S.

15. Annual Review of Phytopathology - APS Press

16. Biotechnology in Plant Disease Control- Cheet,I.

17. Post infectional defense mechanisms - Mahadevan, A.

18. Pathogenesis and host specificity in plant diseases. Vol. III.-Rudra P. Singh, Uma S. Singh &KeiisukeKohmoto (eds.) 1995.

19. The nature of disease in plants - Scheffer, R.P.

20. Principles of Plant Pathology -Tarr, S.A.J .

21. Edible mushrooms and their cultivation Change. S.T. and P.G. Miles -

22. MycorrhizaeMosses, B.V.A. -

23. V.A. MycorhizaePowel, C and D. J. Bagyaraj -

24. Industrial mycology (Vol. I) Berry, R. -

25. Biotechnology.Dubey, S.C. -

26. Fungal biotechnology by smith

M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT 243 b) Advanced Medicinal Botany
(2 CREDITS) (30 Lectures)

Credit I- (15 L)

1. General Pharmacognosy

Definition and scope of Pharmacognosy **1L**
Classification of crude drugs **1L**
Processing of herbal drugs **1L**
Utilization of medicinal and aromatic plants in India **1L**
Indian trade in medicinal and aromatic plants **1L**
Case study of any two Ayurvedic drug industries from India **1L**

2. **Analytical Pharmacognosy**

Drug adulteration **1L**
Drug evaluation –Morphological, microscopical, chemical, physical and biological methods **5L**
Quality control of herbal drugs **1L**
Biosynthesis of glycosides and alkaloids **1L**
Biogenesis of phytopharmaceuticals **1L**

Credit II- (15 L)

3. Plant Drugs **7L**

Pharmacognostic study of the following drugs w.r.t. source, cultivation, collection,macroscopic characters, and application – Isabgol (*Plantago ovata*), Aloes (*Aloe vera)*, *Digitalis (Digitalis purpurea), Dioscorea (Dioscorea bulbifera*), SafedMusli (*Chlorophytum Borivilianum*), Shatavari (*Asparagus racemosus*), Brahmi (*Bacopa monnieri*), Arjuna (*Terminalia arjuna*), Ashwagandha (*Withania somnifera*), *Vinca(Catharanthus roseus)*, Vasaka (*Justicia adhatoda)*, and Turmeric (*Curcuma longa*)

4. Industrial Aspects **8L**

1. Phytopharmaceuticals prospects
2. Marine drugs
3. Nutraceuticals and cosmeceuticals
5. Natural pesticides- Pyrethrum, neem, Deris, tobacco
6. Immunomodulatory medicinal plants
7. Natural excipients

References:

1. Pharmacognosy. Tylor and Brady
2. Pharacognosy. Wallis
3. Pharmacognosy. Trees and Evans
4. Pharmacognosy. Kokate, Gokhale, and Purohit
5. Eonomic Botany. Hill
6. Econoic Botany. Panday
7. Economic Botany. V Verma

8. Medicinal Plants of India and Pakistan. Kirtikar and Basu
9. Medicinal Plants. S K Jain
10. Phytochemistry of Plants. McDaniels
11. Plant Physiology. Salisbury and Ross

M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT 243 c) Advanced Plant Physiology (2 Credits)

Credit-I: Photosynthesis and Respiration **15L**

1. Organization and functioning of Photosynthetic ETS in pro(bacteria and cyanobacteria) and eukaryotic organism **1L**
2. Determination of PSI and PSII efficiency using chlorophyll fluorescence kinetics and its significance **1L**
3. Influence of light and CO2 concentration on Photosynthesis(Light saturation curve, CO_2 response curve and CO_2 compensation point) **1L**
4. Photoprotection: role of enzymes, pigments and water-water cycle **2L**
5. Evolution of RUBISCO and PEP case **1L**
6. Schematic representation of fixation of atmospheric CO_2in C3,C4, C4- subgroups and CAM pathway(Home assignment), comparative account of C3,C4 and CAM pathway, C3-C4 intermediate pathway, CO_2 assimilation in Diatoms. CAM idling and cycling in desert and aquatic plants. **3L**
7. Partitioning of photosynthetic assimilate during vegetative and reproductive phase. **1L**
8. Regulation of photosynthesis in C3 and C4. **1L**
9. Comparative account of aerobic, anaerobic and cyanide resistant respiration and their significance. **1L**
10. Role of respiration in plant carbon balance **1L**
11. Modern concept of electron transport and ATP synthesis and inhibitors of respiration. **1L**

Credit-II: Post Harvest and Stress physiology **15L**

1. Post harvest physiology-ripening of fruits, storage of vegetables and flowers. **2L**
2. Stress Physiology: **8L**
   a) Biotic and abiotic stress: water, salt, temperature, biotic agents
   b) Responses and tolerance mechanisms
   c) Developmental and physiological mechanisms that protects plants in drought, flooding, salt, light and temperature stress(cold and high temperature) and stress from pathogenic microorganisms, insects and other organisms.

3. Case studies for improvement of stress tolerance by conventional and recombinant DNA technology. **3L**

4. Mechanism of action of herbicides, fungicides and bactericides. **2L**

REFERENCES:

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- Goodwin T.W., Mercer E.I. (1998) Introduction to Biochemistry. CBS Publishers, New Delhi.
- Heldt H. W. (2004) Plant Biochemistry. Academic Press, California.
- Hopkins W. G. 1995. Introduction to Plant Physiology. John Wiley and Sons, Inc., New York, USA
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- Lodish H., Berk A., Zipursky S, L., Matsudaira P., Baltimore D and Darnell J. 2000. Molecular Cell Biology (Iv Edition) W. H. Freeman and Company, New York, USA.
- Metabolism (Second Edition) Longman, Essex, England.
- Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
- Nelson David and Cox Michael. (2007) Lehninger Principles of Biochemistry.W.H.Freeman and Company. New York.
- Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
- Salibury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.

- Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
- Lincolin Taiz and Eduardo Zeiger (2010) Plant Physiology, Fifth edition. Sinauer Associates, Inc. Publishers. Sunder land, USA.
- Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
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M.Sc. II Botany Semester IV

BODT 243-Botany Paper 3

BODT-243 d) INDUSTRIAL BIOTECHNOLOGY

Credits: 02 (30 Lectures)

Credit I: Microbial Biotechnology: **(15L)**

1. **Biotechnology**: Scope and importance, Commercial potential of Biotechnology in India. Role of Biotechnology in Fermentation technology, Enzymes and Food supplements **2L**
2. **Microbial Biotechnology**:
   A. **Fermentation Technology**: A brief outline of processes for the production of some commercially important organic acids (Citric acid); amino acids (glutamic acid & tryptophan) and alcohols (ethanol & butanol), Primary metabolites & secondary metabolites: Vitamin production, B12, Riboflavin and β-carotene: occurrence, economic significance, biosynthesis, production process. toxins, antibiotics, Microbial Food : Fermentation processes in dairy and other food products: toffu, kaffir, cheese, buttermilk, yogurt, sour cream etc, Feed production, SCP, fats, amino acid, food additives **7L**

B. **Enzyme technology:** Microbes involved in enzyme production, Immobilization of enzymes, applications of enzymes: Therapeutic, analytical, Manipulative and Industrial. Biosensors and its types, Biochips: Principles and applications. **6L**

Credit II: Environmental Biotechnology: **(15L)**

3. Introduction, Scope and importance, Application of EB in Bioremediation, Biodegradation of Xenobiotics, bioaugmenatation, Bioleaching, Biofuels, Bioplastics, Biocatalysts and Bionanotechnology **2L**
4. **Bioremediation**: Introduction, types: *Insitu* Bioremediation: Intrinsic and Engineered, *Exsitu* Bioremediation: Solid phase treatment, Composting, Composting process, Slurry phase treatment, Aerated lagoons, LSARs. **2L**
5. **Bioremediation of industrial wastes**: types of wastes , role of microorganisms, Bioremediation of heavy metals : Adsorption, Complexation, precipitation, Volatilization, biosorption, role of Am fungi in bioremediataion. **3L**
6. **Bioremediation of other wastes**: Introduction, objectives and pathways of degradation of Xenobiotics, Hydrocarbons, Bioaugmentation, Bioleaching and Biofilteration. **3L**
7. **Nano-Bioremediation**: Applications of Nanomaterials as an effective sorbents, Nanofilteration, Nanocatalysis, use of magnetic nanoparticles in bioremediation. **3L**
8. **Bioplastic in Environment protection**: Definition, sources and types and uses. **2L**

Suggested readings:

1. R. C Dubey. A Textbook of Biotechnology. S. Chand Publications.
2. B.D. Singh. Fundamentals of Biotechnology. Kalyani Publications
3. Peter F. Stanbury, Allen Whitaker, Stephen J. Hall. Principles of Fermentation Technology Second Edition Elsevier Science Ltd

4. Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton. Industrial Microbiology: An Introduction. Blackwell Science Ltd
5. M Nduka Okafor odern Industrial Biotechnology & Microbiology., SCIENCE PUBLISHERS, Edenbridge Ltd.,
6. H.J. Peppler and D. Perlman. Microbial Technology .Vol 1&2 . Academic Press.
7. L E Casida Jr. Industrial Microbiology. John Wiley and Sons Inc.
8. Wulf Cruger and Anneliese Cruger, "A Textbook of Industrial Microbiology",Panima Publishing Corporation
9. Michael J. Waites, Neil L.Morgan, John.S. Rockey and Grey Higton, "Industrial Microbiology": An Introduction, Blackwell science publishing house.
10. Presscott. Dunn, "Industrial Microbiology", Agrobios (India).Trevor Palmer "Enzymes", Affiliated East West Press Pvt Ltd, New Delhi,2004
11. Harvey W. Blanch, Douglas S. Clark, "Biochemical Engineering", Marcel Dekker Inc, 1996
12. James M. Lee, "Biochemical Engineering", PHI, USA, 1992
13. James. E. Bailey & David F. Ollis, "Biochemical Engineering Fundamentals", McGraw Hill, 1986
14. Christ of M.Niemeyer,Chad A.Mirkin, "Nanobiotechnology: Concepts", Applications and Perspectives, (eds.), Wiley-VCH, Weinheim, (2004)
15. Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, "Nanotechnology: basic science and emerging technologies" , Overseas Press (2005)
16. B. Roszek,, W.H. de Jong, and R.E. Geertsma: "Nanotechnology in medical applications": state-of-the-art in materials and devices (2005)
17. Tuan Vo-Dinh, "Nanotechnology in Biology and Medicine": Methods, devices and applications, ISBN no. 1249329494
18. Mark Ratner and Daniel Ratner, "Nanotechnology - A Gentle Introduction to the Next Big idea", Pearson Education, Inc.2005
19. Handbook of "Nanostructured Biomaterials and Their Applications in Nanobiotechnology" - Hari Singh Nalwa

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M.Sc. II Botany Semester IV

BODT- 243: BOTANY THEORY PAPER 3 (2 Credit)

BODT- 243: e) SEED TECHNOLOGY

(30 Lectures)

Credit 1= **15 lectures**

1. **Field Inspection:** 2 **L**
   - Seed inspector, powers and duties
   - Number of inspection with reference to stage of crop
   - Procedure and observations during field inspection
2. **Seed Pathology:** **4 L**

- Definition
- Mechanism of seed transmission and entry point of seed infection (soil, air, insect and nematodes)
- Quarantine for seed
- Integrated management of seed borne diseases
- Seed health testing methods

3. Seed entomology: 3 L

- Relation of insects and plants
- Pest of fibre crop, pulses, vegetable and storage grain pest (Any one example from each) with respect to their life cycle, way of infestation and control measures (Physical, Chemical and Biological)

1. **Seed Processing: 6 L**
    1. Objectives of seed processing
    2. General layout of seed processing unit
    3. Steps in Seed Processing (Receiving, Drying, Pre-cleaning, Grading, Treatment, weighing, Packing and Storage)
    4. Study of Seed processing machineries and its working:
        1. Pre-cleaners
        2. Scalper, Debearder and Huller
        3. Seed dryers
        4. Air screen cleaner
        5. Specific gravity separator
        6. Magnetic separator
        7. Colour separator

Credit 2= 15 lectures

1. Seed treatment: 2 L

- Importance
- Seed treating equipment- slurry, mist-o-matic and drum mixer.
- Chemicals used and precautions in seed treatment.

2. Packaging and handling of seeds 4 L

- Bagger weighed machine
- Automatic packing machine
- Material used for packing
- Handling of seeds: Conveyor and Elevators
- Precautions during packaging

3. Seed Deterioration and Seed Storage: 4 L

- Definition, manifestation and causes of seed deterioration.
- Prevention measures of seed deterioration.
- Definition of seed storage
- Factors affecting seed storage
- Ideal ware house for seed storage, sanitation, fumigation and dehumidification
- Cold storage

4. Seed legislation: 2 L

- Seed legislation in India

- Types of seed legislation.

5. Seed Certification and Quality Control: 3 L

- General procedure for seed certification
- Seed certification Board, Central Seed committee and their functions.
- Minimum seed certification Standards (Field and Seed)

Suggested Readings:

1. Ovcharov, K.E. 1977. Physiological Basis of Seed Germination. Amerind Publishing Co., New Delhi and New York.
2. Thompson, J.R. 1977. Advances in Research and Technology of Seeds. Part - 1, 3 & 4. Centre for Agrl. Publishing and Documentation, Washington.
3. Anonmyous. 1997. Seed Technology in Tropics. ISTA Zurich.
4. Sinclair, T.R. and F.P. Gardner. 1997. Principles of Ecology in Plant Production, CAB international, G.K.
5. Rai. M. and S. Mauria. 1995. Hybrid Research and Development. Indian Society of Seed Technology. IARI. New Delhi.
6. Agrawal, R.L. 1996. Seed Technology, IBH publishing Co., New Delhi.
7. Mayer, A.M. and A.P. Mayber. 1989. Germination of Seeds. Pergamon Press, Oxford.
8. Desai. B.B., P.M Kotecha and D.K. Salunkha. 1997. Seeds Hand Book - Biology Production, Processing and Storage. Marcel Dekker. New York.
9. Khairwal. P.S., C. Ram and A.K. Chabra. 1997. Pearl millet Seed Production and Technology. Manohar book service, New Delhi.
10. Jaima Kigel, J. and G. Galili. 1997. Seed Development and Germination. Marcel Dekker, New York.
11. Bewley, J.D. and M. Black. 1982. Physiology and Biochemistry of Seeds in relation to Germination, Vol. I & II. Springer Verlag, Berlin, Heidelberg, New York.
12. Justice, O.L. and L.N. Basu. 1978. Principles and Practices of Seed Storage. Castle House Publications Ltd, Great Britain.
13. Khan, A.A. 1977. The Physiology and Bio-chemistry of seed Dormancy and Germination. North Holland Publishing Co., Amsterdam, New York.
14. Kozlowski, T.T. 1972. Seed Biology, Vol. 1 Academic Press, London.
15. Purseglove, J.W. 1977. Tropical crops of Monocotyledons, Longmans, Green and Co., Ltd., London.

M.Sc. II Semester IV

BODT 244 Botany Theory paper 4

BODT 244 a) Plant Tissue Culture Technology

(2 CREDITS) (30 Lectures)

Credit I: In vitro culture **15 L**

- Totipotency of plant cells, de- and re-differentiation, Organogenesis and somatic embryogenesis, *In vitro* responses of plant cells, tissue and organs- effect of source of explants, nutrient medium constituents, growth regulators and environmental factors. **4L**

- Protoplast culture, somatic hybridization and cybridization, applications. **3L**
- In vitro production of haploids and their applications **2L**
- Physiological and genetic basis of somaclonal variation and their applications **2L**
- Case studies– Banana and Sugarcane: Stages of micro propagation, Factors affecting micro-propagation, Merits and demerits of in vitro propagation, **3L**
- Ex-situ conservation of germplasm **1L**

Credit II: In vitro production of secondary metabolites and genetic transformation **15L**

- Screening and selection of high secondary metabolite producing cell lines. **1L**
- Standardization of Culture media, immobilization of cells, elicitation using biotic and abiotic elicitors, Biotransformation **3L**
- Case studies for production of secondary metabolite: Scaling up and use of Bioreactor **2L**
- Genetic transformation of plants - transfer of foreign DNA into host plant tissues using *Agrobacterium* based vectors, *m*echanism of integration of DNA into plant genomes. **3L**

- Factors affecting transformation, Screening and analysis of transformants.

3L

- Direct DNA transfer to plants – Electroporation, biolistic transfer **2L**
- Modifications of plant secondary metabolism by genetic engineering: case studies

1L

M.Sc. II Semester IV

BODT 244 Botany Theory paper 4

BODT 244 b) Herbal Technology

(2 CREDITS) (30 Lectures)

Credit I: **15L**

a) Herbal Technology: Definition, concept and prospects. 1L

b) Herbal medicines: history and scope, role of medicinal plants in Ayurveda, Siddha, Unani and Homeopathy, Medicinal plant as source of alkaloids, flavonoids, glycosides, tannins, phenolics, 4L

c) Selection, identification and authentication of herbal materials for medicine. 1L

d) Processing of herbal raw material 1L

e) Preparation and standardization of Ayurvedic formulations viz Aristas, Asawas, Ghutika,Churna and Bhasma. 3L

f) Herbal cosmetics: Study and description of herbal plants used in products such as skin care, hair care, dyes,aromatic oil and oral hygiene products via fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants. 5L

Credit II **15L**

a) Herbal Nutraceuticals: Medicinal mushrooms for human health, Phytochemicals as nutraceuticals, herbs as a source of dietaryfibre, Probiotics, Prebiotics, polyunsaturated fatty acids, antioxidant, vitamins, polyphenols, proteins, amino acids, carotenoids. 5L

b) Evaluation of Drugs: WHO and International Council of Harmonization (ICH) guidelines for the assessment of herbal products, Guidelines of Materia Medica and Charak Samhita. Stability testing of herbal drugs. 3L

c) **Herbal drugs industry**: Present scope and future prospects. A brief account of plant based industries and institutions involved in work on medicinal and aromatic plants in India. 2L

d) **Packaging of Herbal Products:**Introduction of concept and need of packaging, Classification of Herbal Products: Classification based on product texture- dry, liquid, emulsion, aromatic oils, Classification based on product usage- cosmetic, edible, nutraceutical, pharmaceutical 3L

e) **Patenting and Regulatory requirements of natural products:** Definition of the terms: Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy. Patenting aspects of Traditional Knowledge and Natural Products. Case study of Curcuma & Neem. 2L

Suggested readings:

Agarwal, S.S. and Paridhavi, M., Herbal Drug Technology Universities Press, Pvt Limited, 2007.

Ambasta SP (1986) Useful Plants of India. CSIR, Delhi.

Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.

Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.

Bogers RJ, Craker LE, Lange D (2006) Medicinal and Aromatic Plants: Agricultural, Commercial, Ecological, Legal, Pharmacological and social aspects. Springer

Chowdhary V (2014) Fundamentals of food processing, packaging, labeling and marketing. Anmol Publications, Pune

Daniel, M., Herbal Technology: Concepts and Advances Satish Serial PublishingHouse, 2008.

Deshmukh LP (2013) Medicinal Plants of India. Oxford Book Co., New Delhi

Drury CH (2006) Ayurvedic Useful Plants in India. Asiatic Publishing House, New Delhi.

Evans, W.C., Trease and Evans Pharmacognosy 15th Edition, Elsevier HealthSciences, 2001.

Glossary of Indian medicinal plants, R.N. Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.

Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.

Hoffmann F, Manning M (2009) Herbal Medicine and Botanical Medical Aids. Viva Books. New Delhi.

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Maheshwari JK, Kunkel G, Bhandari MM, Duke J (1993) Ethnobotany in India. Scientific Publishers. Jodhpur, Rajashtan.

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Pal DC, Jain SK (1998) Tribal medicine. Naya Prakash Publication, New Delhi

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Roseline A (2011) Pharmacognosy. MJP Publishers, New Delhi.

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Wallis, T.E., Textbook of Pharmacognosy 5th Edition, CBS Publishers and Distributors, 2005.

Yoga- The Science of Holistic Living by V.K.Yoga, VKY Prakashna Publishing, Bangalore, 2005.

M.Sc. II Semester IV

BODT 244 Botany Theory paper 4

BODT 244 c) Research Methodology (2 CREDITS) (30 Lectures)

Credit I **15L**

Unit I: Basic Concepts of Research ` **8 L**

Research definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit II: Data Collection and Documentation of Observations **7 L**

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue, specimens and application of scale bars. The art of field photography.

Credit II:

Unit III: Overview of Biological Problems **8 L**

History; Key biology research areas, Model organisms in biology (A brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit IV: Ethics and Good Practical's and Art of Scientific Writing **7 L**

Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

M. Sc II Botany

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 a) Applied Mycology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Study of plant diseases with reference to histopathology of symptoms, causal organisms of – Any four downy & powdery mildews of crops of local importance, any 3 leaf spot diseases & any 4 rusts & Smuts of local significance.	5
2	Study of any 3 diseases of forest plants for eg. Powdery mildews, rots, spots etc.	1
3	Study of any 6 post harvest diseases or market pathogens of local market.	1
4	Isolation of any 6 seed borne fungi from cereals, pulses, & oil seed crops.	2
5	Cultivation of wheat straw mushroom Pleurotus	2
6	Isolation any one mycorrhizal fungi &trichoderma as biofertilizer.	1
7	Biodeterioration of any 3 inorganic materials & any 4 foods spoilage fungi.	1
8	Isolation of any 1 plant pathogen to study Koch's postulates.	1
9	Study of any 4 fungal industrial metabolites/ antibiotics with their importance.	1

Note: 1. Compulsory visit to mushroom industry &biofertilizer production unit& submission of report.

M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 b) Advanced Medicinal Botany (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Identification of with the help of organoleptic and microscopic evaluation techniques	2
2	Percentage extractives and fluorescence analysis of drugs	1
3	Determination of ash values of drugs	1
4	Histochemical studies of drugs	1
5	Biological activity of any two drugs	2
6	Estimation of alkaloids from suitable medicinal plants	1
7	Estimation of glycosides from suitable medicinal plants	1
8	Extraction of essential oils from suitable medicinal plants	1
9	Estimation of oleoresin from suitable medicinal plants	1
10	Preparation of herbal cosmetics and foods	2
11	Visit to any two pharmaceutical industries and submission of report	1
12	Field visit to study ethnobotany and preparation of report	1

Note:
1. At least one short and one long study tour be arranged for studying medicinal plants and to explore ethnobotanical data. Students must submit the tour report and ethnobotanical data during practical examination.
2. Student must carry out detailed pharmacognostic investigation of at least one drug and should submit a report at the time of practical examination as a project.

M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 c) Plant Physiology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Estimation of chlorophylls and carotenoids.	1
2	Study of effect of abiotic factors on activity of RuBisco/PEPcase enzyme.	1
3	Separation of pigment using column Chromatography. Determination of absorption spectra of each pigment.	2
4	Demonstration of Hill Reaction.	1
5	Effects of auxins and cytokinin's or gibberellins on growth	1
6	Measurement of CO_2 uptake using IRGA (Demonstration).	1
7	Screening of cultivars for biotic and abiotic stress tolerance using in vitro technique.	1
8	Determination of secondary metabolite.	1
9	Estimation of ascorbic acid in ripe and unripe fruits.	1
10	Measurement of respiration using oxygen electrode (demonstration).	1
11	Enzyme assays – extraction and estimation of enzyme activity- Catalase/acid phosphatase/ amylase/lipase/peroxidase (Any one).	1
12	Estimation of total amino acid in germinating and non germinating seed.	1
13	Separation of flavonoids using chromatography.	1
14	Estimation of MDA content.	1

M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 d) Industrial Biotechnology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Isolation of *Aspergillus niger* from a suitable medium and its maintenance in pure culture.	2
2	Inoculation of Spore suspension of *Aspergillus niger* on a fermentation medium to prepare citric acid broth	1
3	Estimation of citric acid by Spectrophotometric and titration method	1
4	Recovery of citric acid from fermentated broth.	1
5	Fermentative production of Ethanol	2
6	Demonstration practical on microbial food.	1
7	Study of Biosorption using suitable sample	1
8	Demonstration practical on Biosensors and Biochip	1
9	Study of preparation of Biolastic using suitable material	1
10	Demonstration of various nano materials used in bioremediation	1

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.M. Sc II Botany Semester IV

BODP 243 Botany Practical paper

BODP 243 based on BODT 243 e) Seed Technology (2Cr)

Sr. No	Title of practical (Any 12 practical)	No.
1	Detection and identification of important seed borne fungi by various detection methods- washing, agar and blotter method	2
2	Detection and identification of seed borne bacteria	2
3	Study of important Pest of fibre crop, pulses, vegetable and storage grain (Any two example from each), with reference to their life cycle, damage and control measures	2
4	Demonstration of seed processing and treating equipments	2
5	Demonstration: Aids for varietal identification and Preparation of artificial seed	2
6	Collection, submission of crops and storage pests, different seed varieties of any three-crop plants	2
7	Visit to any two Seed industries and submission of report	2

M. Sc II Botany Semester IV

BOUP 244 Botany Practical paper / PG Dissertation based on BOUP 244

BOUP 244 based on BODT 244 a) Plant Tissue Technology (2Cr)

Sr. No	Title of practical (Any 12 Practical)	No.
1	Study of different Laboratory instruments used in Plant Tissue culture Laboratory	1
2	Study of different sterilization techniques used in Plant tissue culture	1
3	Preparation and sterilization of MS- medium	1
4	Study of different growth regulators and their role in PTC	1
5	Study of dedifferentiation of a suitable plant tissue to induce callus	2
6	Study of *invitro* production of haploid using suitable plant material	2
7	Study of the method of isolation of protoplast from suitable plant material for somatic hybridization	1
8	Study of production of secondary metabolites from suitable plant material using callus culture and qualitative estimation of the secondary metabolites	2
9	Studies on use of any one Biotic/Abiotic elicitor for enhancement of secondary metabolite production through Callus culture	1
10	Visit to any Commercial tissue culture laboratory and write a case study report.	1
11	Visit to *Ex situ Germplasm Bank* and write a visit report.	1
12	Studies on methods of DNA transfer in plant cell (Demonstration)	1

M. Sc II Botany Semester IV

BOUP 244 Botany Practical paper / PG Dissertation based on BOUP 244

BOUP 244 based on BODT 244 b) Herbal Technology (2Cr)

Sr. No	Title of practical	No.
1	To perform preliminary phytochemical screening of crude drugs.	2
2	Determination of Ash value and moisture content of crude drugs	1
3	Determination of the alcohol content of Asava and Arista.	2
4	Preparation of any one herbal cosmetics.	2
5	Preparation and standardization of any oneherbal formulation.	2
6	Monograph analysis of herbal drugs from recent Pharmacopoeias	1
7	Analysis of fixed oils.	1

8	Study of different processes of packaging of dry,liquid and aromatic herbal products.	1
9	Market study of herbal products- cosmetics, medicines, nutraceuticals.	1
10	Visits to industry related to herbal products and quality testing centres related to herbal products.	2

M. Sc II Botany Semester IV

BOUP 244 Botany Practical paper (2Cr)

OR PG Dissertation (2Cr)

BOUP 244 based on BODT 244 c) Research Methodology (2Cr)

Sr. No	**Title of practical (Any 12 Practical)**	**No.**
1	Experiments based on chemical calculations.	1
2	Plant microtechnique experiments.	1
3	The art of imaging of samples through microphotography and field photography.	1
4	Poster presentation on defined topics.	1
5	Technical writing on topics assigned.	1
6	Identification of different type of research in day by day life	1
7	Testing of a formulated hypothesis with type I and type II errors	1
8	Curation of relevant scientific literature from Google Scholar, NCBI PubMed etc	1
9	Poster presentation on defined topics	1
10	Demonstration for checking of plagiarism using recommended software	1
11	Technical writing on topics assigned.	1
12	More Practical may be added depending on the local habitats and available facilities	1

M. Sc II Botany Practical Paper (4 CR)

BOUP 245 based on BOUT 241 and BOUT 242

Sr. No	Title of practical	No.
	BOUT 241 Botanical Techniques (Any 12 Practical)	
1	Use of flurochromes to visualize specific cell components	1
2	Micrometry	2
3	Maceration technique	1
4	Electrical conductivity and pH measurements	1
5	Absorption spectra of BSA/DNA and determination of absorption maxima	1
6	Rocket immune electrophoresis	1
7	Separation of leaf pigments by paper chromatography and TLC	1
8	Separation of isozymes by native polyacrylamide gel electrophoresis	2
9	Microtomy- Processing, double staining, sectioning	2
10	Cytochemical analysis- Nucleus, Golgi bodies, Mitochondria	2
11	Databases and database searching and DNA and protein sequence comparison	1
	BOUT 242 Plant Ecology Ecology (Any 12 Practical, 15th is compulsory)	
1	Study of phytoplanktons and macrophytes from clean and polluted water bodies	1
2	Estimation of chlorides and alkalinity of the water sample	1
3	Prepare shoot/canopy profile of tree stand along the line transect.	1
4	Remote sensing techniques for vegetation/ plant diversity assessment using satellite imagery and aerial photographs	2
5	Methods for estimating above-ground biomass for carbon pool assessment	1
6	Find out various diversity indices with the help of computer software.	1
7	Find out the Simpson's Index of Dominance.	1
8	Find out the β-diversity, similarity and dissimilarity indices.	1
9	Comparison of stomatal index and pollen fertility of any two plants from polluted and non-polluted areas	1
10	Compare protected and unprotected herbaceous stand using community coefficients (similarity indices).	1
11	To find out relationship between two ecological variables using correlation and regression analysis.	1
12	To estimate dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Winkler's method.	1
13	To determine percent soil organic carbon and organic matter in soils of cropland, grassland and forest.	1
14	To find out association between important herbaceous species using Chi-square test.	1
15	Visit to different types of ecosystems to understand the species composition and diversity (plateaus/grasslands/forests/wetlands/deserts/mangroves)	1

Note: A survey of a part of the town or city should be carried out by the entire class in batches. Individual student will select one avenue/road and locate the trees planted on the graph paper. They will identify the trees, mention their size, canopy shape, flowering and fruiting period and their status (healthy, diseased, infested, misused or dying) and report the situation of plants. (The purpose of this exercise is to make the students aware of the kinds of trees and value in urban ecosystem and ecological services.) Submission of report on this survey will be assessed and marks out of 15 will be added as internal marks.