1st to 4th Sem.

COURSE CURRICULUM AND SCHEME OF EXAMINATION

Under
Choice Based Credit System

For

M. Sc. (Botany)

(Effective from the Academic Session 2018 – 2019)

Chaudhary Devi Lal University, Sirsa – 125 055

M.Sc. Botany (1st Semester)

Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	BOT-101	Biology and Diversity of Viruses, Bacteria and Fungi	CC	4	4	30	70	100	3
2	BOT-102	Biology and Diversity of Algae & Bryophytes	CC	4	4	30	70	100	3
3	BOT-103	Biochemistry	CC	4	4	30	70	100	3
4	BOT-104	Cell Biology	CC	4	4	30	70	100	3
5	BOT-105	Plant Resources & Utilization –I	OEC	4	4	30	70	100	3
6	BOT-106	Lab – I Pertaining to Theory Papers BOT-101.102	CC	4	8	--	100	100	6 Two sessions of 3 Hrs. each
7	BOT-107A	Lab – II Pertaining to Theory Paper BOT-103	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs each
	BOT-107B	Lab – II Pertaining to Theory Paper BOT-104		4	8	--	100	100	6 Two sessions of 3 Hrs each
Total				28	44	120	480	600	

*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

M.Sc. Botany (2nd Semester)

Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	BOT-201	Biology and Diversity of Pteridophytes & Gymnosperms	CC	4	4	30	70	100	3
2	BOT-202	Cytogenetics	CC	4	4	30	70	100	3
3	BOT-203	Molecular Biology	CC	4	4	30	70	100	3
4	BOT-204A	Principles of Plant Pathology	CEC (Any One)	4	4	30	70	100	3
	BOT-204B	Principles of Plant Breeding		4	4	30	70	100	3
5	BOT-205	Plant Resources & Utilization – II	OEC	4	4	30	70	100	3
6	BOT-206	Lab – III Pertaining to Theory Papers BOT-201,202	CC	4	8	--	100	100	6 Two sessions of 3 Hrs each
7	BOT-207 A	Lab – IV Pertaining to Theory Papers BOT-203, 204 A	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BOT-207 B	Lab – IV Pertaining to Theory Papers BOT-203, 204 B		4	8	--	100	100	6 Two sessions of 3 Hrs. each
Total				28	48	120	480	600	

*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

M.Sc. Botany (3rd Semester)									
Sr. No.	**Course ID**	**Subject**	**Type**	**Credit**	**Contact Hours per week**	**Internal Assessment (IA)***	**External Exam**	**Maximum marks**	**Duration of Exam (Hours)**
1	BOT-301	Taxonomy of Angiosperms	CC	4	4	30	70	100	3
2	BOT-302	Biology of Reproduction & Anatomy	CC	4	4	30	70	100	3
3	BOT-303	Plant Biotechnology & IPR	CC	4	4	30	70	100	3
4	BOT-304	Plant Physiology	CC	4	4	30	70	100	3
5	BOT-305 A	Biophysical & Biochemical Techniques	CEC (Any One)	4	4	30	70	100	3
	BOT-305 B	Plant Tissue Culture		4	4	30	70	100	3
6	BOT-306	Lab – V Pertaining to Theory Papers BOT-301, 302	CC	4	8	--	100	100	6 Two sessions of 3 Hrs. each
7	BOT-307 A	Lab – VI Pertaining to Theory Papers BOT-303, 305 B	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BOT-307 B	Lab – VI Pertaining to Theory Papers BOT-304, 305 A		4	8	--	100	100	6 Two sessions of 3 Hrs. each
Total				26	46	140	510	650	

*IA – 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance

M.Sc. Botany (4th Semester)

Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	BOT-401	Plant Ecology: Principles and Concepts	CC	4	4	30	70	100	3
2	BOT-402A	Plant Growth & Development	CEC (Any One)	4	4	30	70	100	3
	BOT-402B	Applied Botany		4	4	30	70	100	3
3	BT-403 A	Plant Diversity and Conservation	CEC (Any One)	4	4	30	70	100	3
	BOT-403 B	Phytogeography and Applied Ecology		4	4	30	70	100	3
4	BOT-404	Lab – VII Pertaining to Theory Papers BOT-401, 402 A & 402 B	CC	4	8	--	100	100	6 Two sessions of 3 Hrs. each
5	BOT-405 A	Lab – VIII Pertaining to Theory Paper 403A	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BOT-405 B	Lab – VIII Pertaining to Theory Paper 403B		4	8	--	100	100	6 Two sessions of 3 Hrs. each
6	BOT-406	Credit Seminar	CC	2	2	50	--	50	To be evaluated by a committee of two members
Total				22	46	140	410	550	

*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

M. Sc. (Botany) – 1st Semester

BOT – 101 – Biology and Diversity of Virus, Bacteria and Fungi (Core Course)

Credits: 4 **Marks: 100**
Time: 3 h **Theory: 70**
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit–I

Viruses: Characteristics and ultrastructure of virions; isolation and purification, chemical nature, replication, transmission and economic importance of viruses.
Phytoplasma: General characteristics and role in causing plant diseases.

UNIT–II

Archaebacteria and eubacteria: General account; ultrastructure, nutrition and reproduction; economic importance.
Cyanobacteria: Salient features and biological importance.

UNIT–III

Mycology: General characters of fungi, their significance to human, Organization of thallus, cell wall composition, nutrition (saprobic, biotrophic, symbiotic), reproduction, kinds of spores.
Fungal classification, general account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

UNIT–IV

Heterokaryosis, heterothallism, parasexuality, sex hormones, mycorrhizae and predaceous fungi. Lichens: structure, reproduction and economic importance.
Importance of fungi in different microbiological and Biotechnological processes; role of fungi in industry (Alcohol), medicine (Antibiotics and steroids) and food (edible mushrooms).

Suggested Readings:

1. Tortora et al. 2001. Microbiology: An Introduction. Addison Wesley Longman, New York.
2. Brock Biology of Microorganisms: by Madigan, Mortinko and Parker (2000). Prentice Hall.
3. Microbiology: by Prescott, L.M., Harley, J.P. and Klein, D.A. (1992). WCB Publishers.
4. Introductory Mycology: by Alexopoulos, C.J. et al. (1996). John Wiley & Sons.
5. An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press.
6. Introduction to Plant Viruses: by Mandahav, C.L. (1978). Chand & Co., New Delhi. Agrios, G.N. 1997. Plant Pathology. Academic Press, London.
7. Alexopoulus, C.J. et al. 1996. Introductory Mycology. John Wiley & Sons, Inc.
8. Mehrotra, R.S. and Aneja, K.R. 1998. An introduction to Mycology. New Age Intermediate.
9. Webster, J. 1985. Introduction to Fungi. Cambridge University Press.
10. Microbiology 9th Revised Edition. Prescott L.M.; Harley J.P. (2013) Tata McGraw Hill, USA.
11. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. (2010) Tata McGraw Hill, New Delhi.
12. Brock Biology of Microorganisms 14th Edition. Madigan, M.T.; Martinko, J. M. and Parker, J. (2015), Prentice Hall, New Jersey.
13. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

M. Sc. (Botany) – 1st Semester

BOT – 102 – Biology and Diversity of Algae and Bryophytes (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Criteria for algal classification (pigments, reserve food, flagella, chloroplasts, pyrenoids, eye spots, endoplasmic reticular membrane etc.); Comparative account of important systems of classification (Fritsch, Round, Chapman and Lee).

Salient features: Cell structure, thallus organization, reproduction and broad classification of i) Chlorophyta ii) Phaeophyta iii) Cryptophyta and iv) Rhodophyta .

UNIT–II

Reproduction (vegetative, asexual and sexual), origin and evolution of sex, life cycles.

Current concepts and relationships of protochlorophycean algae.

Rhythms and bioluminescence in dinoflagellates.

Economic importance of algae (algal biofertilizers, algal blooms, algae as food and feed, uses in industries etc.). Algae in Biotechnology.

UNIT–III

General characteristics feature of bryophytes and Classification up to order level.

General account of structure and development of gametophyte and sporophyte of following orders: Sphagnales, Andreaeales, Takakiales, Funariales (Funaria, Physcomitrium) and Polytrichales (Polytrichum).

Origin and Evolution of sporophyte in bryophytes. Cytology of bryophytes: chromosome number, sex chromosome, m chromosomes, accessory chromosomes.

UNIT–IV

Biology of reproduction - *in vitro* regulation of gametangia formation: effect of physical and chemical factors. Morphogenetic studies on spore germination, protonemal differentiation and bud initiation. Economic importance of bryophytes, Medicinal uses of bryophytes especially as a source of biologically active compounds, Ecological importance of bryophytes: bryophytes as indicators of pollution and minerals; role of bryophytes in succession.

Suggested Readings:

1. Ahluwalia, A.S. (Ed.). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. 2003.
2. Bold, H.C. and M. J. Wynne. Introduction to the Algae: Structure and Reproduction. Prentice Hall, Englewood Cliffs, New Jersey. / PHI, New Delhi. 706 pp. 1978.
3. Carr, N.G. and B.A. Whitton (Eds.). The Biology of Cyanobacteria. Blackwell Scientific Publications, Oxford. 1982.
4. Chapman, V.J. and D.J. Chapman. The Algae. ELBS and Macmillan, NY. 1977.
5. Fritsch, F.E. The Structure and Reproduction of Algae (Vol. I and II). Vikas Publishing House Pvt. Ltd., New Delhi. 1979.
6. Grahm, L.E. and L.W. Wilcox. Algae. Prentice Hall, U.S.A. 2000.
7. Grahm, L.J. and L.Wilcox. Algae. 2nd Ed. Benjamin Cummings (Pearson), San Francisco, 2009.
8. Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New Delhi. pp.651
9. Lee, R.E. Phycology. 4th Ed. Cambridge University Press, London. 2008.
10. Round, F.E. The Biology of Algae.2nd Ed. Edward Arnold Ltd., London. 278 pp. 1973.
11. South, G.R. and A. Whittick. Introduction to Phycology. Blackwell Scientific Pub, Oxford. 1987.

12. Smith, J.E. Biotechnology. 2nd Edition. Edward Arnold, London. 1988.
13. Trainer, F.R. Introductory Phycology. John Wiley and Sons, New York. 1978.
14. Van Den Hock, C., D.G. Mann and H.M. Jahns. Algae: An Introduction to Phycology. Cambridge University Press, Cambridge. 1995.
15. Parihar, N.S. 1965. An Introduction to Embryophyta Vol. I. Bryohpyta, Central Book Depot. Allahabad, India.
16. Schofield, W.B. 1985. Introduction to Bryology. Macmillan, New York.
17. Chopra, R.N. and Kumra, P.K. 1988. Biology of Bryophytes. Wiley Eastern Ltd., New Delhi.
18. Chopra, R.N. & Bhatla, S.C. 1990. Bryophyte Development: Physiology and Biochemistry. CRC Press, Boca Raton, USA.
19. Rashid, A. 1998. An Introduction to Bryophyta. Vikas Publ. House Pvt. Ltd. New Delhi.
20. Watson, E.V. 1967. The Structure and Life of Bryophytes. B.I. Publications, New Delhi.
21. Glime, J.M and Saxena D. 1991. Uses of Bryophytes. Today and tomorrow's Printers and Publishers, New Delhi.
22. Richardson, D.H.S. 1981. The Biology of Mosses. Blackwell Scientific Publications, London
23. Anderson RA (2005) Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.
24. Mycotechnology: Present status and future prospects. Edited by Mahendra Rai. I.K., International Publishing House Pvt. Ltd.; 2007.
25. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.
26. Algae & Bryophytes Annie Ragland, 2014 ISBN 9789382459903
27. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.

M. Sc. (Botany) – 1st Semester
BOT – 103 –Biochemistry (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Photosynthesis: Photo-oxidation of water, cyclic and non-cyclic photophosphorylation, photorespiration and its significance. The sequence of reactions in photosynthesis, the path of carbon assimilation (C_2, C_3 and C_4 cycles, CAM pathway).

UNIT–II

Respiration: Glycolysis, Krebs cycle, electron transport chain and ATP synthesis, pentose phosphate pathway, glyoxylate cycle.

Nitrogen Metabolism: Biochemistry of nitrogen fixation, nitrogenase, nitrogen fixation in legumes, nitrate assimilation, ammonium assimilation, biosynthesis of amino acids.

UNIT–III

Lipid Metabolism: Structure of fatty acids, Classification of lipids, Structure and functions of major lipid subclasses- Acylglycerols, Phospholipids, Glycolipids, Sphingholipids, Waxes, Terpenes and Sterols. Fatty acids biosynthesis, degradation and their regulations, Ketone bodies synthesis. Biosynthesis of TAG, Cholesterol, Phospholipids and Glycolipids.

Enzymes: Structure, properties and functions of enzymes, factors affecting rates of enzymatic reactions, isozymes, allosteric enzymes, Enzyme kinetics and Enzyme inhibitions.

UNIT–IV

Nucleic Acids: Structure and properties of nucleic acid bases, nucleosides and nucleotides.

Biosynthesis and degradation of purines and pyrimidines, Salvage pathway.

Vitamins: Structure and biochemical roles of fat and water-soluble vitamins and their co-enzymes.

Suggested Readings:

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
2. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
3. Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.
4. Dey, P.M. and Harborne, J.B. (1997). First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.
5. Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.
6. Hopkins, W.G. (1995) Introduction to Plant Physiology, John Wiley and Sons.
7. Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
8. Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition. Affiliated East-West Press Pvt Ltd. New Delhi.
9. Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana, India (Indian edition).
10. Lehninger, A.L., Nelson, D.L. and Co MM 1993 Principles of Biochemistry Second edition, CBS Publishers.

11. Moore, Thomas. C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi.
12. Noggle, G.R. and Fritz, G.J. (1983). Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd., New Delhi, Second edition Seventh reprint, 1993.
13. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition. Wadsworth Publishing Co. Belmont, California, USA.
14. Singhal, G.S. Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (editors) (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
15. Srivastava, L.M. (2006). Plant Growth and Development: Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
16. Taiz, L and Zeiger, E. (1998). Plant Physiology. Second edition. Sinauer Associates, Inc., Publishers, Massachusetts, USA
17. Lehninger; Principle of Biochemistry, 6th Edition by David L. Nelson and M.M Cox [2013] Free and company. New York.
18. Fundamental of Biochemistry. D. Voet and J. G. Voet [2013] John Wiley and Sons New York.
19. Biochemistry 8th Edition by L. Stryer [2015], W.H Freeman and New York
20. Biochemistry 6th Edition by R.H Garrett and C.M. Grisham [2017] Saunders college Publishing. New York

M. Sc. (Botany) – 1st Semester
BOT – 104 – Cell Biology (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit–I

Cell and Cell wall: Ultrastructure of prokaryotic & eukaryotic cells. Structural organization and function of plant cell wall.

Membrane structure and function -Structure of model membrane, lipid bilayer and membrane proteins diffusion, osmosis, ion channels, active transport, pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Unit–II

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Organization of genes and chromosomes: Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.

Unit–III

Cellular energy transactions: role of mitochondria and chloroplast

Cellular response to environmental signals in plants – mechanisms of signal transductions. Intracellular protein localization and transport.

Unit–IV

Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Text/Reference Books:

1. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
2. Molecular biology of cell 6th Edition Alberts, Bruce; Watson, JD (2015) Garland Science Publishing, New York.
3. Molecular cell biology 8th Edition, Lodish, H.; Berk, A.; Matsudaira, P.; Kaiser, C.A.; Krieger, M. et al. (2016) W.H. Freeman and Co., New York.
4. Cell and Molecular Biology 8th Edition, Robertis, EDP De & Robertis, EMF De (2002) lippincott Williams & Wilkins international student edition, Philadelphia.
5. Cell and Molecular Biology: concepts and experiments. Karp, Gerald (2012) John Wiley and sons, New York.
6. The Cell: A molecular approach, 3rd ed Cooper et al. (2004) ASM Press, Washington DC.

M. Sc. (Botany) – 1st Semester
BOT – 105 – Plant Resources & Utilization – I (Open Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Plants and Civilization: Origin of agriculture, World centers of primary diversity of domesticated plants. Secondary centers of origin. origin and evolution of economically important plants.
Plant as a source of renewable energy: Innovations for meeting world food demands.
Green Revolution: Benefits and adverse consequences.

UNIT–II

Botany, origin, uses of important fibres (Cotton, Jute).
Cultivation and uses of cereals (wheat, rice), Sugarcane, Potato, Oil yielding plants (groundnut, mustard, sunflower).

UNIT–III

General account of important medicinal plants (Aconite, Cinchona, Belladonna, Digitalis, Glycyrrhiza, Rauvolfia, Papaver, Vasaka, Aloe and Ginseng).
A brief account of major Indian Medicinal plants (Amla, Neem, Arjun, Harad, Bahera, Isabgol, Ashwagandha, Bhringraj and Senna).

UNIT–IV

Beverage Plants: Source and general account of Tea and Coffee.
Gums: Important commercial gums and their uses.
General account of important timber, dye, gums and tannin yielding plants

Suggested Readings:

1. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row Publishers Inc.
2. Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan Co., New York.
3. Davis, P.H. and Heywood, V.H. 1965. Principles of Angiosperm Taxonomy. D Van Nostrand Co., New York.
4. Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford IBH Pub. Co., New Delhi.
5. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
6. Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
7. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
8. Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
9. SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd., Delhi
10. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
11. Judd, W.S.; Campbell, C.S. et al. 1999. Plant Systematics A Phylogenetic Approach. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, U.S.A.
12. Schery, R.W. 1972. Plants for Man. Prentice Hall, Englewood Cliffs, N.J. USA
13. Simpson B.B. and M.C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.

14. Hancock. J.F. 2004. Plant evolution and the origin of crop species. 2nd edition. CABI Publishing. Cambridge, MA USA.
15. Radford, A.E., W.C. Dickison et al. 1976. Vascular Plant Systematics Harper and Row, New York.
16. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

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M. Sc. (Botany) – 1st Semester
Laboratory – I
BOT – 106 – Pertaining to Theory Papers BOT-101,102 (Core Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Study of the vegetative and reproductive structures in *Nostoc*, *Chlamydomonas*, *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*, *Vaucheria*, Bacillariophyta, *Ectocarpus*, *Fucus*, *Polysiphonia*, *Procholoron* through, Microscope, temporary preparations and permanent slides.
2. EMs/models of viruses and virus infected plants.
3. Types of bacteria from temporary/permanent slides. Study of bacterial infected plants and Root nodules. Gram staining.
4. Study of Phaneroplasmodium from actual specimens and/or photograph. Study of *Physarum* sporangia.
5. Study of symptoms of plants infected with *Albugo*; asexual and sexual structures of through sections/tease mounts and permanent slides.
6. *Rhizopus:* Students to culture Black bread mould in the laboratory to study asexual stage from temporary mounts. Sexual stages of mould to be studied from permanent slides.
7. *Aspergillus* and *Penicillium*: asexual stages from tease mounts.
8. *Neurospora*: Asexual and sexual stage from culture/permanent slides/ photographs.
9. *Peziza*: Habit; sectioning through ascocarp, and permanent slides.
10. *Puccinia*: Herbarium specimens of Wheat Rusts- (Black, Brown and Yellow) and infected barberry leaves; section/tease mounts of spores on wheat, and permanent slides of both the hosts.
11. Mushrooms: Specimens of button stage and full-grown mushroom; sectioning of gills of *Agaricus*, study of basidiocarp from permanent slides; Photograph of fairy ring, edible and poisonous fungi (two each), bioluminesecent mushroom to be shown.
12. Specimens/photographs and tease mounts of *Alternaria,* and *Colletotrichum.*
13. Applied mycology: Photographs of Mycorrhizae, fungi used in medicine (*Cylindriocarpon, Tolyposporium, Ganoderma, Cephalosporium* – **any one**), fungi used as biological control agents (fungi used in control of seedling, soil borne, post-harvest diseases and in control of nematodes, insects & weeds – **any one**), photographs / mounts of spores of fungi causing human infections along with pictures of patients suffering from such infections (*Aspergillus, Candida, Cryptococcus, Histoplasma, Microsporum,Trichophyton* – **any one**).
14. Study of growth forms of lichens (crustose, foliose, fruticose) on different substrata.
15. Study of thallus and reproductive structures (soredia, apothecium) through permanent slides
16. White rust of Crucifers, Early & Late blight of potato, Herbarium/museum specimens of the diseased plants.
17. Preparation of media to isolate bacteria, fungi and other microbes.
18. Isolation of *Rhizobium* from legume root nodules.
19. Sensitivity tests of bacteria using different antibiotics.
20. Structural details of *Marchantia, Asterella, Plagiochasma, Targionia, Pellia, Frullania, Porella, Notothylas, Anthoceros, Sphagnum Pogonatum, Barbula, Bryum and Entodon* and *Thuidium.*
21. Morphology and Internal Organization of the following: Representatives of Polytrichales: *Polytrichum, Atrichum;* Sphagnales: *Sphagnum;* Fissidentales: *Fissidens*; Pottiales: *Barbula*, Eubryales: *Mnium*; Entodontales: *Entodon*; Thuidiales: *Thuidium*; Jungermanniales: *Porella, Frullania;* Metzgeriales: *Pellia*; Marchantiales: *Targionia, Plagiochasma, Athalamia, Conocephalum, Reboulia Wiesnerella, Dumortiera;* Anthocerotales: *Anthoceros, Phaeoceros, Notothylas.*
22. To compare the structure and behaviour of endohydric and ectohydric mosses.
23. To study regeneration potential of dried moss leaves and stem fragments.

Students should submit six specimens of algae, fungi, Bryophytes and other microbes at the time of examination.

-15- -14-

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Agrios, G.N. (1997) Plant Pathology, 4th Edition, Academic Press, U.K.
2. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments. Springer Nature, Germany.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996) Introductory Mycology, 4th Edition. John Wiley and Sons (Asia) Singapore.
4. Singh, R.S. (1998) Plant Diseases. 7th Edition, Oxford & IBH, New Delhi.
5. Webster, J. and Weber, R. (2007) Introduction to Fungi. 3rd Edition, Cambridge University Press, Cambridge.
6. Wickens, G.E. (2004) Economic Botany: Principles and Practices. Springer. Klwer Publishers, Dordrecht, The Netherlands.
7. Bilgrami,K.S. and R.N.Verma. Physiology of Fungi. 2nd Ed. Vikas Publi House, New Delhi.
8. Bos, L.. Introduction to Plant Virology. Longman, New York. 160 pp. 1992.
9. Burnett, J.H. Fundamentals of Mycology. Edward Arnold, London. 673 pp.1976.
10. Mathews, R.E.F. Plant Virology. 2nd Ed., Academic Press, London. 897 pp. 1981.
11. Pelczar M.J. Jr., E.C.S. Chan and N.R. Krieg. Microbiology. 5th Ed. Tata McGraw Hill, New Delhi. 2007.
12. Sinha, U. and S. Srivastava. An Introduction to Bacteria. Vikas Publi House, New Delhi. 1983.
13. Kumar, S.S. An Approach towards Phylogenetic Classification of Mosses, Jour. Hattori Bot. Lab. Nichinan, Japan, 1984.
14. Richardson, D. H. S. Biology of Mosses, Blackwell Scientific Publications, Oxford. pp. 220
15. Schofield, W.B., Introduction to Bryology, Macmillan Publishing Company, NY, pp. 431
16. Schuster, R.M. New Manual of Bryology, (Vols. I & II), Jour. Hattori. Bot. Lab., Nichinan, Japan. pp. 1295
17. Dyer, A.F. The Experimental Biology of Ferns, Academic Press, London, 1979.

M. Sc. (Botany) – 1st Semester
Laboratory – II
BOT – 107 A – Pertaining to Theory Paper BOT-103 (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in biochemistry laboratory.
2. Preparation of buffers.
3. To prepare the standard curve of protein, carbohydrates and amino acids.
4. Qualitative estimation of amino acid and protein
5. Qualitative estimation of lipids.
6. Qualitative estimation of carbohydrates.
7. Quantitative estimation of protein by Lowry's method.
8. Detection of reducing, non-reducing and total sugars.
9. Quantitative estimation of total carbohydrates by anthrone reagent.
10. Quantitative estimation of amino acid and phenols by using Spectrophotometer.
11. Determination of total soluble sugars by ferricynide method. (Volumetric procedure)
12. Separation of various components in the different lipid fraction by thin layer chromatography.
13. To measure the activity of enzyme: alpha amylase/ catalase / peroxidase and any other.
14. To study the effect of temperature on enzyme activity.
15. To study the effect of substrate conc. on enzyme activity.
16. Determination of water potential by various methods.
17. Isolation and quantification of plant lipids.
18. Extraction and estimation of total phenols.
19. Determination of antioxidants in plant tissues – ascorbic acid, tocopherol, β – carotene.
20. Spectroscopic determination of chlorophyll a, chlorophyll b, and total chlorophyll, carotenoids and anthocyanins under varied environmental conditions.
21. Determination of chlorophyll a and chlorophyll b ratio in C_3 and C_4 plants.
22. Seed germination as affected by environmental factors.
23. Bioassays of Hormones.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Principals of Biochemistry by Lehninger. CBS Publishers & Distributors, Delhi.
2. Harper's Biochemistry by RK Murray et al. Prentice-Hall International Inc.
3. Introduction to Plant Biochemistry by TW Goodwin and EI Mercer. Pergamon Press, Oxford
4. Experiments in Microbiology, Plant Pathology and Biotechnology 4th Edition. Aneja, K.R. (2010) New Age International Publishers, New Delhi.
5. Introductory practical biochemistry by S.K. Sawhney and Randhir Singh (2000)-Narosa Publishing House, New Delhi.
6. Principles and techniques of practical biochemistry by K. Wilson and Wolker (1994) Cambridge University Press, Cambridge.
7. An introduction to practical biochemistry by David T. Plummer (1988) Tata McGraw Hill
8. Prince, N.C and Stevens, L., Fundamentals of Enzymology. Oxford University Press, Oxford. 1984.
9. Dey, P.M. and Harborne, J.B., Plant Biochemistry. Academic Press, London. 1997.

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M. Sc. (Botany) – 1st Semester
Laboratory – II
BOT – 107 B – Pertaining to Theory Paper BOT-104 (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in Cell Biology laboratory.
2. Preparation of normal and molar solutions, buffers, pH setting etc.
3. Preparation and study of prefixatives, fixatives and stains.
4. To study various parts of microscope and demonstration of microscopic techniques.
5. Study of the structure of cell organelles through photomicrographs.
6. Demonstration of Brownian movement.
7. Demonstration of tyndall effect.
8. Demonstration of plasmolysis and deplasmolysis in plant cell.
9. Demonstration of exosmosis and endosmosis in grapes and resins.
10. Study of structure of plant cell through temporary mounts.
11. To discriminate between viable and non-viable cells using staining techniques.
12. Effect of solution concentration on plant cells.
13. To study the structural diversity of fungi, algae and plant cells.
14. Cell Division: Mitosis and meiosis in higher plants.
15. Study of various stages of mitosis using cytological preparation of Onion root tips.
16. Microtomy
17. Histochemical techniques
18. Cell counting using haemocytometer.
19. Cell disruption using Sonicator
20. Organelle isolation, mitochondrion and chloroplast.
21. Fixation and maceration techniques, staining techniques of plant tissues.
22. Study of effect of temperature & organic solvent on permeability of cell membrane.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Smith and Wood. Cell Biology. Chapman and Halls 1996
2. Molecular biology of cell 6th Edition Alberts, Bruce; Watson, JD (2015) Garland Science Publishing, New York.
3. Molecular cell biology 8th Edition, Lodish, H.; Berk, A.; Matsudaira, P.; Kaiser, C.A.; Krieger, M. et al. (2016) W.H. Freeman and Co., New York.
4. Cell and Molecular Biology 8th Edition, Robertis, EDP De & Robertis, EMF De (2002) lippincott Williams & Wilkins international student edition, Philadelphia.
5. Cell and Molecular Biology: concepts and experiments. Karp, Gerald (2012) John Wiley and sons, New York.
6. The Cell-a molecular approach, 3rd ed Cooper, GM and Hausman, RE (2004) ASM Press, Washington DC.

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M. Sc. (Botany) – 2nd Semester

BOT – 201 – Biology and Diversity of Pteridophytes and Gymnosperms (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

General characteristics of pteridophytes and classification
Comparative morphology and reproduction of the following: Psilophytales (Rhynia, Zosterophyllum), Psilotales (Psilotum), Lycopodiales (Lycopodium, Selaginella), Lepidodendrales (Lepidodendron), Sphenophyllales (Equisetum).

UNIT–II

Comparative morphology and reproduction of the following:
Ophioglossales (Ophioglossum, Botrychium), Marattiales (Marattia, Angiopteris), Osmundales, Filicales (Pteris, Dryopteris), Marsileales, Salviniales.

UNIT–III

Classification of gymnosperms and their distribution in India.
Brief account of the following families: Lyginopteridaceae, Medullosaceae, Glossopteridaceae, Caytoniaceae.
General account of the following orders: Cycadeoidales (Cycadeoidea), Pentoxylales, Cordiatales.
Comparative account of Structure and reproduction in the following orders: Cycadales (Cycas), Ginkgoales (Ginkgo), Coniferales (Pinus, Cedrus), Ephedrales (Ephedra), Welwitschiales, Gnetales.

UNIT–IV

Teleome Theory, Evolution of stellar system, Apogamy, apospory, significance and experimental induction, Heterospory and origin of seed habit in Pteridophytes.
Modern methods of propagation of gymnosperms: somatic embryogenesis, haploids and protoplast culture, Economic importance of gymnosperms.

Suggested Readings:

1. Parihar, N.S. 1977. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
2. Rashid, A. 1976. An Introduction to Pteridophyta (Diversity and Differentiation). Vikas Publishing House Pvt. Ltd., New Delhi.
3. Sporne, K.R. 1985. The Morphology of Pteridophytes. B.I. Publications Pvt. Ltd., Delhi.
4. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New Delhi.
5. Sporne, K.R. 1965. The Morphology of Gymnosperms. B.I. Publ. Pvt. Ltd., New Delhi.
6. Bierhorst, D. W. 1971. Morphology of Vascular Plants. Macmillan. New York.
7. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. A. V. S. S. Sambamurty. 2006. I.K. International Pvt. Limited.

M. Sc. (Botany) – 2nd Semester
BOT – 202 – Cytogenetics (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Principles of heredity and variation: Mendel's law and his experiments, penetrance and expressivity, phenocopy.

Fine Structure of Gene: Classical versus molecular concept of the gene, the cis-trans complementation for functional allelism, limitation of cis-trans test, fine structure of phage T4 II Locus; fine structures of gene and "Complex loci" in eukaryotes, genes within genes in phage $\phi \times 124$, pseudogenes, overlapping genes, repeated genes, gene amplification.

Chromatin structure and organization: Chromosome structure and DNA packaging; euchromatin and heterochromatin. Organization of plastid and mitochondrial genomes.

UNIT–II

Special Chromosomes: Structure, occurrence and behaviour of polytene, lampbrush, B and sex chromosomes.

Karyotype: Karyotype analysis and its evolution; FISH, CGH and flow cytometery. Chromosome banding techniques: Q-banding; G-banding; R-banding and their uses.

Genes and chromosomes: General features of chromosomes, chromosomal theory of inheritance, sex determination. Sex-linked, sex-limited and sex-influenced inheritance.

Extra-chromosomal inheritance, sex chromosomal abnormalities-syndrome and autosomal abnormalities.

UNIT–III

Mutation: Types of mutation and molecular mechanism, nonsense, missense and frame shift mutations. Ames test for mutagenesis; Mutagenesis by nitrous acid, hydroxylamine, alkylating agents, intercalators and UV. DNA repair mechanisms - excision, mismatch, SOS, photo-reactivation, recombination repair. Variation in chromosome number: Haploids, aneuploids and euploids- origin, production, effects and uses; polyploidy and crop improvement.

UNIT–IV

Gene Linkage and chromosome Mapping: Complete and incomplete linkage, recombination of genes in a chromosome, crossing over, gene mapping by 2-point and 3-point test crosses, somatic cell hybridization.

Population Genetics and Evolution: Allele frequencies and genotype frequencies, random mating and Hardy- Weinberg principle, inbreeding, mutation, migration, natural selection, random genetic drift, quantitative inheritance.

Suggested Readings:

1. Principles of Genetics, 8th ed., Gardener et al. (2001), John Weley, New York.
2. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
3. Genetics, 6th ed., Snustad P.D. and Simmons M.J. (2012), John Weley, New York.
4. Concept of Genetics, 10th ed., Klug and Cummings (2012), Pearson Education, Singapore.
5. Genetics: Analysis and Principles (2016), Brooker, RJ, McGraw Hill, New York.
6. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5th Ed.). Garland Publishing Inc., New York.
7. Gustafson JP (2002) Genomes, Kluwer Academic Plenum Publishers, New York, USA.
8. Karp G (1999) Cell and Molecular Biology, John Wiley and Sons, USA.

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9. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
10. Lewin B (2010) Gene X, Jones and Barlett Publishers.
11. Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008) Molecular Cell Biology (6th Ed), W.H. Freeman and Company, New York, USA.
12. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
13. Poehlman JM and Sleper DA (1995) Breeding Field Crops, AVI. Publ., U.S.A.
14. Russell PJ (2006) Genetics (5th Ed.), Addison Wesley Longman, California, USA.
15. Genetics, 6th ed., Snustad P.D. and Simmons M.J. (2012), John Weley, New York.
16. Concept of Genetics, 10th ed., Klug and Cummings (2012), Pearson Education, Singapore.
17. Genetics: Analysis and Principles (2016), Brooker, RJ, McGraw Hill, New York.
18. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

M. Sc. (Botany) – 2nd Semester
BOT – 203 – Molecular Biology (Core Course)

Credits: 4 **Marks: 100**
Time: 3 h **Theory: 70**
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit–I

Nucleic acid – structure: DNA and RNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Supercoiled DNA, Forces stabilizing nucleic acid structure, properties of DNA, Renaturation and denaturation of DNA. Tm and Cot curves. Structure of RNA.
DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication, of replication, Prokaryotic and eukaryotic replication mechanism. Replication in phages, Replication in retroviruses.

Unit–II

Transcription: Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases and promoters, Post-transcriptional processing of tRNA, rRNA and mRNA (5′ capping, 3' polyadenylation and splicing).
Antisense and ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, biochemistry of ribozyme, hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications for antisense and ribozyme.

Unit–III

Translation: Genetic code, General features, Deciphering of genetic code, Code in mitochondria. Translational mechanism in prokaryotes and eukaryotes. Post translational modification and transport. Protein targeting (in brief), Non ribosomal polypeptide synthesis, Antibiotic inhibitors and translation.

Unit–IV

Regulation of Gene Expression in Prokaryotes and Eukaryotes: Operon concept, Positive and negative control, lac, trp and arb operon. Catabolite repression, attenuation, regulation of gene expression in eukaryotes (a brief account).
Homologous recombination: Holiday junction, Site specific recombination: FLP/FRT and Cre Lox combination, RecA and other recombinases.

Suggested Readings:

1. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments. Springer Nature, Germany.
2. Lewin B. (2010) Gene X, Pearson Prentice and Hall, New Delhi.
3. Karp G. (2010) Cell and Molecular Biology - Concept and Experiments, 5th Edition.
4. Lodish et al. (2013) Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher.
5. Klug and Cummings (2012) Concept of Genetics, 10th ed., Pearson Education, Singapore.
6. Cooper G.M. et al (2013) The Cell: A molecular approach. Sinnaur Associates Inc.
7. Alberts B. and Johnson A (2016). Molecular Biology of Cell. Garland Science publisher.

M. Sc. (Botany) – 2nd Semester
BOT – 204A – Principles of Plant Pathology (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Symptomatology in Fungal infections of plants. Fundamentals of plant pathology: History of plant pathology; various levels of parasitism; Classification of plant diseases.
Pathogenesis: Penetration and entry of plant pathogens; development inside host tissue.
Host-parasite interactions: Alteration in plant physiological functions.

UNIT–II

Agents of plant diseases: General characteristics and symptoms caused by- agents of infectious diseases (fungi, bacteria, mycoplasma, virus, MLOs, Spiroplasma, Viroids, Mycoviruses and nematodes) and Agents of non-infectious diseases (air pollution, chemicals, minerals excesses, temperature). Enzymes and toxins in plant diseases. Disease forecasting and assessment. Nutrition in Fungi.

UNIT–III

Etiology, epidemiology and control of following diseases:

a) Paddy: Paddy Blast, Brown Leaf Spot, Bacterial Blight
b) Wheat: Rusts, Bunt and Smuts, Tundu Disease
c) Sugarcane: Red Rot, Smut
d) Grapes: Downy and Powdry Mildews
e) Peach: Leaf Curl
f) Groundnut: Tikka disease
g) Apple; Apple Scab
h) Mustard: White Rust, Downy Mildew
i) Potato: Early and Late Blight, Wart Disease
j) Linseed: Rust
k) Damping off of the seedlings
l) Ergot of Rye

UNIT–IV

General symptoms and Principles of Control, Defense Mechanism in plants: Structural, Induced and Biochemical defense mechanisms; Hypersensitivity reaction.
Detoxification of pathogen toxin; Application of molecular biology in diseases control strategies. Plant quarantine.

Suggested Readings:

1. Agrios, G.N. Plant Pathology. 5th Ed. Elsevier Acadmic Press, San Diego. 922 pp. 2005.
2. Alexopolous, C.J., C.W. Mims and M. Blackwell. Introductory Mycology. 4th Ed. John Wiley & Sons, New York. 880 pp. 2007.
3. Bilgrami, K.S. and H.C. Dube. A Textbook of Modern Plant Pathology. Vikas Publishing House, New Delhi. 1990.
4. Bilgrami, K.S. and R.N. Verma. Physiology of Fungi. 2nd Ed. Vikas Publ House, New Delhi.1994.
5. Bos, L. Introduction to Plant Virology. Longman, New York. pp. 160 1978.
6. Burnett, J.H. Fundamentals of Mycology. 2nd Ed. Edward Arnold, London. pp.673 1976.
7. Mathews, R.E.F. Plant Virology. 2nd Ed., Academic Press, London. pp. 897 1981.
8. Powar, C.B. and H.F. Daginawala. General Microbiology, Vols. I & II. 2nd Ed. Himalaya Publishing House, New Delhi. 1995.

9. Schlegel, H.S. (1993) General Microbiology. 7th Ed. Cambridge University Press, Cambridge.
10. Sharma, P.D. Plant Pathology. Rastogi Publications, Meerut. 1998.
11. Sharma, P.D. (2005) The Fungi and allied organisms. 1st Ed. Alpha Science International Ltd.
12. Singh, R.S. Plant Diseases. 8th Ed. Oxford & IBH, New Delhi. pp. 721, 2008.
13. Sinha, U. and S. Srivastava. An Introduction to Bacteria. Vikas Publ. House, New Delhi. 1983.
14. Smith, K.M. Plant Viruses. 6th Ed. Chapman Hall, London. pp. 251, 1977.
15. Stanier, R.Y. General Microbiology. 5th Ed. Macmillan Co., London. pp. 704, 2008.
16. Webster, C.J. Introduction to Fungi. 2nd Ed., Cambridge University Press, Cambridge. 1980.
17. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

M. Sc. (Botany) – 2nd Semester
BOT – 204B – Principles of Plant Breeding (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants- Centres of Origin-biodiversity and its significance.

Primary and secondary centres of diversity, utilization of wild plants in crop improvement, introduction and domestication as methods of plant breeding.

UNIT–II

Principles of plant breeding: Principles and objectives; methods of breeding self and cross pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding.

UNIT–III

Asexual breeding systems: Methods of breeding of vegetatively propagated crops; Non- conventional methods; gene variability.

Male sterility: Concept; classification; genetic control; inheritance pattern and breeding utility.

UNIT–IV

Plant genetic resources: Importance of plant genetic resources and diversity in plant breeding, collection, evaluation and conservation of germplasm. Breeding for disease resistance, classification of resistance, responses of the host to pathogens, variability systems of pathogenic fungi, breeding disease resistant varieties; multiline varieties.

Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Suggested Readings:

1. Pochlman JM and Sleper DA (1995) Breeding Field Crops, AVI. Publ., U.S.A.
2. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
3. Allard, R. W. (1960). Principles of Plant Breeding. John Wiley & Sons, N. York.
4. Anonymous (1997). National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
5. Singh, B.D. (2005), Plant Breeding - Principles and Methods, Kalyani Publishers, Ludhiana.
6. Bhandari, M.M. (1974). Practicals in Plant Breeding. A Manual cum practical record. Oxford and IBH Publ. Co. New Delhi.
7. Chopra, F.L. (Ed.) (1989). Plant Breeding: Theory and Practice. (Reprint 1994). Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
8. Choudhari, H.K. (1980). Elementary Principles of Plant Breeding (2nd Edition). Oxford and IBH Publishing Co., New Delhi.
9. Choudhari, R.C. (1982). Introduction to Plant Breeding. Oxford and IBH Publishing Co., New Delhi.
10. Pochlman, J.M. and Sleper, D.A. (1995). Breeding Field Crops (4th Edition) Panima Publishing Corporation, New Delhi.
11. Raghuvanshi, R.K., Chauhan, A.K.S and Sidhigui, B.A. (1995). Practical Exercises in Cytology, Genetics, Plant Breeding and Biostatistics (1st Edition). CBS Publishers, New Delhi.

12. Sharma, J.R. (1994). Principles and Practice of Plant Breeding, Tata McGraw Hill Publ. Comp. Ltd., New Delhi.
13. Allard, R.W. 1960. Principles of Plant Breeding. John Wiley & Sons, New York.
14. Hays, H.K., Immer, F.R. and Smith, D.C. 1955. Methods of Plant Breeding. McGraw Hill Book Company, Inc., New York.
15. Fehr, W.R. 1987. Principles of Cultivar Development (2 Volumes). Mac Millan Publishing Co., New York.
16. Poehlman, J.M. 1986, Breeding Field Crops. AVI Publishing Company, Connecticut.
17. Singh, B.D. 2000. Plant Breeding-Principles and Methods. Kalyani Publsihers, New Delhi.
18. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

M. Sc. (Botany) – 2nd Semester
BOT – 205 – Plant Resources & Utilization – II (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Plants used as avenue trees for shade, pollution control and aesthetics.
Origin crop plants: Idea about centre of origin of common crop plants
Spices and condiments (Saffron, Clove, Cardamom, Ginger, Turmeric, Cinnamon, Capsicums, Asafetida, Coriander, Fennel, Fenugreek).

UNIT–II

Medicinal plants: Importance of medicinal plants – role in human health care
Traditional knowledge and utility of some common medicinal plants- Sarpgandha, Isabgol,Vasaka, Neem, Bhiringraj, Amla, Harrad, Bahera, Arjun ,Punarnava , Brahmi, Kasondi, Ghritkumari, Quinine and Eucalyptus. Insecticides from plants (Pyrethrum). Hallucinogenic plants – general account

UNIT–III

Cultivation and uses of Fruits and vegetables, Nutritive and medicinal value of some fruits and vegetables (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate, Moringa, Cabbage).
Common ornamental plants. Common food adultrants.

UNIT–IV

Wood and its Uses: Soft woods and hard woods, wood as fuel, construction material (Pilings, Veneers, Plywood), wood containers (cooperage), chemically derived products and wood distillation.
Common timber yielding plants and minor forest products.
Unexploited plants of potential economic value: plants as a source of renewable energy. Genetic Resources and their conservation.

Suggested Readings:

1. Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
2. Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
3. Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
4. Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
5. SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany, Wiley Eastern Ltd., Delhi
6. Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA
7. Simpson B. B. and M.C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, USA.
8. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row Publishers Inc.
9. Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan C., New York.
10. Davis, P.H. and Heywood, V.H. 1965. Principles of Angiosperm Taxonomy. D Van Nostrand Co., USA
11. Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford IBH Pub. Co., India
12. Hancock, J.F. 2004. Plant evolution and the origin of crop species. 2nd edition. CABI Publishing, Cambridge, MA USA.
13. Radford et al. 1976. Vascular Plant Systematics Harper and Row, New York.
14. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

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M. Sc. (Botany) – 1st Semester
Laboratory – III
BOT – 206 – Pertaining to Theory Papers BOT-201, 202 (Core Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Study of problems on Mendelian Genetics, Gene interactions, Multiple allele and multiple gene inheritance.
2. To test the genetics Hypothesis by Chi-square Test and study goodness of fit.
3. Preparation of Linkage Maps in Diploids using three points test cross method.
4. Tetrad analysis and Centromere mapping in ordered and unordered tetrads.
5. Pedigree analysis.
6. Problem relating to population genetics.
7. Study of B chromosome in Maize/ Drimia.
8. Induction of polyploidy using Colchicine.
9. Study different stages of mitosis in root tips of Allium species.
10. Study meiotic behaviour of chromosomes in Anthers of Allium sp. or Rhoeo
11. Separation of membrane and demonstration of permeability.
12. Isolation and demonstration of mitochondria activity.
13. Isolation of chloroplast and demonstration of chloroplast activity.
14. Histochemical localization of nucleus and nucleolus.
15. Study of the morphology, anatomy and reproductive structures of the representatives of the fern families mentioned in the theory part.
16. Study of morphology and anatomy of vegetative and reproductive organs using cleared whole mounts, sections, macerations and permanent preparations of following living genera: *Psilotum, Lycopodium, Isoetes, Selaginella, Equisetum, Angiopteris, Ophioglossum, Botrychium, Osmunda, Marsilea, Salvinia, Azolla, Lygodium, Hymenophyllum, Cyathea, Pteris, Asplenium, Dryopteris, Polystichum, Adiantum, Polypodium,* and *Lepisorus.*
17. Study of some fossil pteridophytes through specimens and permanent slides.
18. Preparation of permanent slides / charts.
19. Taxonomical characters of ferns for generic identification and characterization of families.
20. Studies on the fern spores and their morphology.
21. Wood Anatomy in *Cedrus, Ginkgo, Ephedra* and Gnetum.
22. Leaf Anatomy in *Cedrus, Abies, Picea, Podocarpus Cryptomeria, Cephalotaxus.*
23. Male cones (external morphology) & microsporophylls in *Cedrus, Abies, Cephalotaxus, Podocarpus, Cryptomeria, Cupressus, Thuja* and *Juniperus.*
24. Female cones in *Cedrus, Abies, Picea, Taxodium, Araucaria, Cunninghamia.* Seed scale complex in *Cryptomeria, Cupressus,* and *Thuja.*
25. Field trips to familiarize with natural habitats, growth forms and diversity of Bryophytes, Pteridophytes and Gymnosperm.

Students should submit six specimens of Pteridophytes and Gymnosperms at the time of examination.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

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Suggested Readings:

1. Brooker, R.J. 2014. Genetics. Mc Graw –Hill education.
2. Brown, T.A.2011. Genetics: A Molecular Approach. 4th Ed. Taylor & Francis.
3. Gupta, P.K.2014. Genetics. 4th Edition, Rastogi Publication, Meerut.
4. Russell, P.J. Genetics. 1998. 5th Ed. Addison Wesley Longman, California, U.S.A.
5. Snustad, D.P. & M.J. Simmons.2015. Principles of Genetics.7th ed. John Wiley & Sons Inc.
6. Stickberger, M.W. 2008. Genetics, 3rd Ed., MacMillan, New York.
7. Chopra, R. S. Taxonomy of Indian Mosses, CSIR, New Delhi, 1975.
8. Dyer, A. F. and Duckett, J.G. The Experimental Biology of Bryophytes, Academic Press.
9. Richardson, D. H. S. Biology of Mosses, Blackwell Scientific Publications, Oxford, pp. 220
10. Schofield, W.B., Introduction to Bryology, Macmillan Publishing Company, NY, pp. 431
11. Schuster, R.M. The Hepatical and Anthocerota of North America. Vol. I-IV. Columbia University Press, New York
12. Dyer, A.F. The Experimental Biology of Ferns, Academic Press, London, 1979.
13. Kubitzki, K. The Families and Genera of Vascular Plants, Kramer, K.U. and Green, P.S. (eds.) Narosa Publishing House, New Delhi, 1991.
14. Rashid, A. An Introduction to Pteridophyta, Vikas Publishers, New Delhi, 1999.
15. Sporne, K.R. The morphology of Pteridophytes, B.I., Publications, Bombay, Delhi, Madras
16. Beck, C. E. Gymnosperm Phylogeny, Bot. Rev., 51: 176-294, 1985.
17. Bhatnagar, S.P. and Moitra, A. Gymnosperms. New Age International Limited, New Delhi
18. Bierhorst, D.W. Morphology of Vascular Plants, The Macmillan and Co., New York, 1971
19. Dalimore, W., Jackson, A.B. and Morrison, S.L. A Handbook of Coniferae including Ginkgoaceae, Edward Arnold and Co., London, 1966
20. Sporne, K.R. The Morphology of Gymnosperms, B. I. Publications, Delhi, 1974.
21. Sharma, O.P. and Dixit, S. Gymnosperms. Pragati Prakashan, Meerut, 2001.

M. Sc. (Botany) – 1st Semester
Laboratory – IV
BOT – 207A – Pertaining to Theory Papers BOT- 203, 204A (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Study of plant diseases mentioned in Theory syllabus.
2. Isolation, purification and single spore culture of pathogens.
3. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method.
4. To study the symptoms and diagnostic features of causal organisms of the following plant diseases:
   a) V. S. of White Rust of Crucifer.
   b) T. S. of Linseed Rust.
   c) Rust on Wheat and Berbery.
   d) Smut diseases: Wheat, Rice, Sorghum, Sugarcane and Grass.
   e) Downy mildew of Grapes.
   f) Powdery mildew of Grapes.
   g) Red rot of Sugarcane.
   h) Tikka disease of Groundnut.
   i) Late blight of Potato.
   j) Early blight of Potato.
   k) Diseases caused by fungi imperfecti.
   l) Study of Viral diseases.
   m) Study of Nematode diseases.
   n) Bunt diseases of Wheat and Rice.
   o) Wart disease of Potato.
   p) Apple scab.
   q) Citrus canker.
   r) Tundu disease of Wheat
5. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/ live specimens along with a report.
6. Isolation of Nucleic acid
7. Gel electrophoretic separation of nucleic acid.
8. Molecular size determination of DNA samples by Agarose gel electrophoresis.
9. Isolation of proteins.
10. PAGE
11. Quantitative analysis of DNA.
12. Restriction digestion of DNA and ligation of DNA fragments.
13. Isolation of plasmid DNA.
14. Southern blotting.
15. Western blotting

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Agrios, G.N. Plant Pathology. 5th Ed. Elsevier Acadmic Press, San Diego. 922 pp. 2005.
2. Alexopolous, C.J., C.W. Mims and M. Blackwell. Introductory Mycology. 4th Ed. John Wiley & Sons, New York. 880 pp. 2007.

3. Bilgrami, K.S. and H.C. Dube. A Textbook of Modern Plant Pathology. Vikas Publishing House. New Delhi. 1990.
4. Bilgrami, K.S. and R.N.Verma. Physiology of Fungi. 2nd Ed. Vikas Publ House, New Delhi.1994.
5. Bos, L. Introduction to Plant Virology. Longman, New York. 160 pp. 1978.
6. Burnett, J.H. Fundamentals of Mycology. 2nd Ed. Edward Arnold, London. 673 pp.1976.
7. Gibbs, A.J. and B.D. Harrison. Plant Virology: The Principles. John Wiley and Sons, NY. 1979.
8. Pelczar M.J. Jr., E.C.S.Chan and N.R.Krieg. 2007. Microbiology. 5th Ed. Tata McGraw Hill Co., New Delhi.
9. Sharma, P.D. Plant Pathology. Rastogi Publications, Meerut. 1998.
10. Sharma, P.D. The Fungi and allied organisms. 1st Ed. Alpha Science International Ltd. 2005.
11. Singh, R.S. Plant Diseases. 8th Ed. Oxford & IBH, New Delhi. 721 pp. 2008.
12. Sinha, U. and S. Srivastava. An Introduction to Bacteria. Vikas Publishing House. New Delhi. 1983.
13. Smith, K.M. Plant Viruses. 6th Ed. Chapman Hall, London. 251 pp. 1977.
14. Stanier, R.Y. General Microbiology. 5th Ed. Macmillan Co., London. 704 pp. 2008.
15. Webster, C.J. Introduction to Fungi. 2nd Ed., Cambridge University Press, Cambridge. 1980.
16. Stewens, N.E. The Fungi which Cause Plant Disease, Int. Books & Periodicals. New Delhi, 1984.
17. Mukerji, K.G. Biotechnological Approaches in Biocontrol of Plant Pathogens. Int. Books and Periodicals, Delhi, 1999.
18. Mundkur, B. B. Fungi and Plant Disease, MacMillan & Co. Ltd., New York, 1959, pp. 246.
19. Adams et al. (1992) Biochemistry of Nucleic Acids, 11th ed., Chapman and Hall, New York.
20. Lewin B. (2010) Gene X, Pearson Prentice and Hall, New Delhi.
21. Karp G. (2010) Cell and Molecular Biology - Concept and Experiments, 5th Edition, John Wiley, NY.
22. Lodish et al. (2013) Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher.
23. Gardener et al. (2001) Principles of Genetics, 8th ed., John Weley, New York.
24. Klug and Cummings (2012) Concept of Genetics, 10th ed., Pearson Education, Singapore.

M. Sc. (Botany) – 1st Semester
Laboratory – IV
BOT – 207B – Pertaining to Theory Papers BOT- 203, 204B (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Preparation and study of karyotype.
2. Mitosis and meiosis in higher plants.
3. Study of aberrant meiosis in *Rhoeo*, *Tradescantia* and *Chrysanthemum*.
4. Calculation of mitotic index and chiasma frequency.
5. Floral biology in self and cross pollinated species, selfing and crossing techniques.
6. Selection methods in segregating populations and evaluation of breeding material.
7. Estimation of heritability and genetic advance.
8. Determination of extent of outcrossing
9. Learning techniques in hybrid seed production using male-sterility in field crops.
10. Self-incompatibility and techniques of maintenance and overcoming sporophytic and gametophytic incompatibility
11. Selection methods in segregating populations selection differential and intensity - demonstration of their relationship and effect on genetic gain.
12. Screening for quality traits, resistance/tolerance to biotic & abiotic stresses.
13. Demonstration of quality seed production through nucleus and breeders seed production techniques.
14. Isolation of Nucleic acid
15. Gel electrophoretic separation of nucleic acid.
16. Molecular size determination of DNA samples by Agarose gel electrophoresis.
17. Isolation of proteins.
18. PAGE
19. Quantitative analysis of DNA.
20. Restriction digestion of DNA and ligation of DNA fragments.
21. Isolation of plasmid DNA.
22. Southern blotting.
23. Western blotting
24. Maintenance of experimental records.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
2. Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.
3. Chopra VL. 2004. Plant Breeding. Oxford & IBH.
4. Gupta SK. 2005. Practical Plant Breeding. Agribios.
5. Pohlman JM & Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.
6. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
7. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
8. Simmonds NW. 1990. Principles of Crop Improvement. English Language Book Society.
9. Singh BD. 2006. Plant Breeding. Kalyani.
10. Singh P. 2002. Objective Genetics and Plant Breeding. Kalyani.
11. Singh P. 2006. Essentials of Plant Breeding. Kalyani.

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12. Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.
13. Adams et al. (1992) Biochemistry of Nucleic Acids, 11th ed., Chapman and Hall, New York.
14. Lewin B. (2010) Gene X, Pearson Prentice and Hall, New Delhi.
15. Karp G. (2010) Cell and Molecular Biology - Concept and Experiments, 5th Edition, John Wiley
16. Lodish et al. (2013) Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher.
17. Gardener et al. (2001) Principles of Genetics, 8th ed., John Weley, New York.
18. Klug and Cummings (2012) Concept of Genetics, 10th ed., Pearson Education, Singapore.
19. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

M. Sc. (Botany) – 3rd Semester

BOT – 301 – Taxonomy of Angiosperms (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Origin and evolution of angiosperms; general principles of angiosperm phylogeny, evolutionary trends in angiosperms, ecads and ecotypes; speciation; various species concepts, adaptive radiation, adaptive modifications; concept of taxonomic characters; character weighting; taxonomic hierarchy and different taxonomic categories.

UNIT–II

Principles of taxonomy, characters considered before plant identification; identification keys, computer aided identification, floral formula and floral diagram. Salient features of the International Code of Botanical Nomenclature (ICBN); (Principles, Ranks of taxa, typification, Principle of priority and citation of authors' names).some important rules of nomenclature; brief idea about phylocode as a new system of nomenclature.

UNIT–III

Systems of angiosperm classification: Phenetic *versus* phylogenetic systems; cladistics in taxonomy; Relative merits and demerits of major systems of classification. Salient features of various systems of classification (Bentham & Hooker, Engler and Prantl, Coronquist, Takhtajan, Hutchinson).

Taxonomic evidence: Morphology, anatomy, palynology, embryology, cytology. Modern trends in plant taxonomy: Numerical taxonomy, Chemotaxonomy, molecular taxonomy.

UNIT–IV

Herbarium and botanical garden: purpose of modern herbarium, techniques of herbarium preparation, description of flowering plants in different types of herbaria, major Indian herbaria and botanical gardens, importance of herbarium and botanical gardens in botanical research; Relevance of taxonomy to conservation, sustainable utilization of bio- resources and ecosystem research.

Suggested Readings:

1. Verma, B.K. 2011. Introduction to Taxonomy of Angiosperms. PHI Learning Pvt. Ltd. New Delhi.
2. Sharma, O.P. 2009. Plant Taxonomy. Tata McGraw Hill Education Pvt. Ltd. New Delhi.
3. Naik, V.N. 2006. Taxonomy of Angiosperms. Tata McGraw Hill Education Pvt. Ltd. New Delhi.
4. Sambamurty, A.V.S.S. 2005. Taxonomy of Angiosperms. I.K. International Pvt. Ltd., New Delhi.
5. Singh, G. 2005. Plant Systematics: Theory and Practices (2nd Ed.) Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
6. Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. Plant Systematics for 21st Century. Portland Press Ltd. London.
7. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.
8. Radford, A.E. 1986. Fundamentals of Plant Systematics, Harper & Row Publ. USA.
9. Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd ed.) Edward Arnold Ltd. London.
10. Grant, W.F. 1984. Plant Biosystematics. Academic Press, London.
11. Davis, P.H. and Heywood, V.M. 1973. Principles of Angiosperm Taxonomy. Kereiger Publ. USA
12. Davis, P. H. and Heywood, V. H. 1973. Principles of Angiosperm Taxonomy, Robert E. Kreiger Pub. Co., New York.
13. Recent reviews in scientific journals.

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M. Sc. (Botany) – 3rd Semester

BOT – 302 – Biology of Reproduction and Anatomy (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit–I

History of plant embryology; Male gametophyte: structure of anther, microsporogenesis, role of tapetum, Pollen development, male sterility; Pollen germination, pollen tube growth and guidance; pollen allergy

Unit–II

Female gametophyte; ovule development, megasporogenesis; organization of the embryosac, structure of the embryo sac cells. Pollination mechanisms and vectors.

Unit–III

Pollen pistil interaction and fertilization; structure of pistils; pollen-stigma interaction sporophytic and gametophytic incompatibility, double fertilization; endosperm development, polyembryony; apomixis Experimental Embryology: *in vitro* fertilization Anther, Pollen and embryo culture.

Unit–IV

Anatomy in relation to taxonomy: Anomalous secondary Structure, anomalous secondary growth, anomalous position of cambium, abnormal behaviour of normal cambium, accessory cambium formation and its activity, extra stelar cambium, interxylary and intraxylary phloem, presence of medullary bundles, cortical bundles, presence of exclusive phloem and xylem bundles, secondary growth in monocots.

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.
2. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge Univ. Press, USA
3. Shivanna, K.R. and Johri, B.M. 1985. The Angiopsrem Pollen: Structure and Function. Wiley Eastern Ltd., New Delhi.
4. Fahn, A. 1967.Plant Anatomy. Pergamon Press, London, New York.
5. Esau, K. 1965. Plant Anatomy. John Wiley & Sons New York.
6. Eames, A. J. 1961. Morphology of Angiosperms. McGraw Hill Book Company, New York.
7. Eames, A.J. and MacDaniels, L.H. 1947. An Introduction to the Plant Anatomy (2nd Ed.). McGraw Book Comp., New York.
8. Johri, B.M. (ed.) Embryology of Angiosperms. Springer-Verlag, Heidelberg, Berlin.
9. Recent reviews in scientific journals.

M. Sc. (Botany) – 3rd Semester
BOT – 303 – Plant Biotechnology & IPR (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit–I

Genetic engineering: Principles, methods and applications in Agriculture. Methods for genetic transformation and transgenic plants production through *Agrobacterium tumefaciens* and *A. rhizogenes*; Gene transfer methods in plants; viral vectors and their applications, Bt cotton and Golden rice (A brief introduction). Chloroplast transformation its success with tobacco and potato.

Unit–II

Molecular Mapping: Molecular markers and their importance; construction of genetic and physical map; gene mapping and cloning; map based cloning; QTL mapping and cloning; marker assisted selection (MAS) for genes of agronomic importance, e.g. insect resistance, grain quality and yield.

Unit–III

Plant Secondary Metabolites: Sources and production of secondary metabolites; criteria for cell selection, factors affecting the culture of cells; different bioreactors and their use in secondary metabolite production; biochemical pathways for the production of different secondary metabolites; biotransformation.

Unit–IV

Intellectual Property Rights: Patents, trade secrets, copyright, trademarks; Geographical Indicators (GI); Registration, subject matter and ownership of IPRs.

Plant genetic resources; GATT & TRIPPS; Patenting of biological material; Plant breeder's rights (PBRs) and farmer's rights. Infringement, passing off action and remedies available to IPR holder. Some legal cases related to trademarks, copyrights and patents.

Suggested Readings:

1. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
2. Molecular cell biology 8th Edition, Lodish *et al.* (2016) W.H. Freeman and Co., New York.
3. Molecular biology of cell 6th Edition Alberts, Bruce; Watson, JD (2015) Garland Science Publishing, New York
4. Salar et al. (2013) Biotechnology: Prospects and Applications. Springer, Germany
5. Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani.
6. Bhojwani S.S. and Rajdan MK (2004) Plant Tissue Culture: Theory and Practice –A revised edition, Reed Elsevier, India, New Delhi.
7. Rajdan MK (2003), Plant Tissue Culture (2nd ed.) IBH Publishing House, New Delhi.
8. Chawla H.S. Introduction to Plant Biotechnology (2nd edition), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Glick BR and Pasternak J.J. (1998) Molecular Biotechnology: Principles and Applications, ASM Press, Washington DC.
10. Rup Lal and Sukanya Lal (2000), Crop improvement utilizing Biotechnology, CRC Press, Florida.
11. http://patentoffice.nic.in
12. www.wipo.org
13. Recent reviews in scientific journals.

M. Sc. (Botany) – 3rd Semester
BOT – 304 –Plant Physiology (Core Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Plant Water Relations: Water potential and its significance in soil-plant atmosphere continuum.
Water stress: Drought definition and quantification, water deficit and plant growth, Salt stress mechanism; stress constraints & stressors; physiological and biochemical functions, adaptive strategies, temperature stress, heat shock proteins, chilling and frost injury and mechanism of tolerance; oxidative stress, biotic and abiotic stress tolerance; stress induced gene expression; stress detection. Osmoprotectants; water logging/ oxygen deficiency and its effects on plant growth.

UNIT–II

Photosynthesis: The four major complexes of thylakoids; Path of carbon in photosynthesis (C_2, C_3, C_4 and CAM plants). Rubisco, structure and its association with the mechanism of carboxylation and oxygenation of RUBP. Effect of environmental factors on photosynthetic rates. Translocation of photosynthates and its importance in sink growth.

UNIT–III

Respiration: Glycolysis, TCA cycle, electron transport chain and ATP synthesis, pentose phosphate pathway, glycolate cycle, alternative oxidase systems, gluconeogenesis, interconversion of hexoses and pentoses. Glycolic acid metabolism & photorespiration; glyoxylate cycle. Cyanide insensitive respiration its mechanism and significance.

UNIT–IV

Nitrogen Metabolism: Biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation; nitrogen transformation during plant development.
Sulphur Metabolism: Sulphate uptake, transport and assimilation.

Suggested Readings:

1. R.H Garrett and C.M Grisham [2017] Biochemistry 6th Edition. Saunders college Publishing, New York.
2. L. Stryer et al [2015] Biochemistry 8th Edition. W.H Freeman and New York.
3. D. Voet and J. G. Voet [2013] Fundamental of Biochemistry. John Wiley and Sons New York.
4. Principle of Biochemistry, 6th Edition by David L. Nelson and M.M Cox [2013] Free and company, New York.
5. Noggle, G.R. and Fritz, G.J. (1983) Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition (Seventh reprint, 1992).
6. Salisbury, F.B. and Ross, G.W. (1992) Plant Physiology. Fourth Edition, Wadsworth Publishing Co. Belmont, California, USA.
7. Dey, P.M. and Harborne, J.B. (1997) Plant Biochemistry. Academic Press, Asia Pvt. Ltd.
8. Buchanan, B.B., Gruissem, w. and Jones, R.L. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
9. Sawhney, S.K. and Singh, Randhir (2000) Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
10. Recent reviews in scientific journals.

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M. Sc. (Botany) – 3rd Semester

BOT – 305A – Biophysical and Biochemical Techniques (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Microscopic techniques: Introduction; Simple and Compound microscope; Phase contrast microscope; Fluorescent microscope; Electron microscope - SEM, TEM and STEHM; scanning probe microscopes- scanning tunneling microscope and atomic force microscope; Different fixation and staining techniques.

Centrifugation: Principles of sedimentation; types, care and safety aspects of centrifuges; differential centrifugation; density gradient centrifugation and their applications; ultracentrifugation (velocity and buoyant density).

UNIT–II

Chromatographic techniques: Theory of chromatography; Types of chromatography- Paper chromatography, Thin layer chromatography, Adsorption chromatography, Partition chromatography, Affinity chromatography, Ion exchange chromatography, HPLC, GC and Size-exclusion chromatography.

UNIT–III

Electrophoresis: Principle; Agarose gel electrophoresis; Polyacrylamide gel electrophoresis; 2-Dimensional gel electrophoresis; Capillary electrophoresis; Microchip electrophoresis and isoelectric focusing.

Spectrophotometry: Colorimetry; UV and Visible spectrophotometry; NMR and ESR spectroscopy; X-ray diffraction.

UNIT–IV

Immunotechniques: Detection of molecules using ELISA, RIA, Immunoprecipitation and Immunofluorescence microscopy; Detection of molecules in living cells, ImmunoPCR.

Radioisotope techniques: Radioactive isotopes; Nature of radioactivity; Detection and measurement of different types of radioisotopes normally used in biology; Incorporation of radioisotopes in biological tissues and cells; Molecular imaging of radioactive material; Disposable of radioactive wastes and safety guidelines.

Suggested Readings:

1. Hegyi G, Kardos J, Kovacs M, Csizmadia AM, Nyitray L et al (2013) Introduction to Practical Biochemistry. Eotvos Lorand University, Hungary.
2. Ranade R and Deshmukh S (2013) Handbook of Techniques in Biotechnology. Stadium Press (India) Pvt. Ltd. New Delhi.
3. Wilson K and Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th Ed.), Cambridge University Press, New Delhi.
4. Prescott L and Harley J Klein D (2005) Microbiology (6th Ed) Mc Graw-Hill.
5. Sawhney SK and Singh R (2000) Introductory Practical Biochemistry (Ed.), Narosa Publishing House Pvt. Ltd., New Delhi.
6. Plummer DT (1990) An Introduction to Practical Biochemistry. Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.
7. Recent reviews in scientific journals.

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M. Sc. (Botany) – 3rd Semester

BOT – 305B – Plant Tissue Culture (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit–I

Plant Tissue Culture: History, basic concept, principles and scope of plant cell and tissue culture. concepts of cellular differentiation; totipotency; basic techniques of plant tissue culture: callus formation, organogenesis and embryogenesis; status of tissue and cell culture technology in India.

UNIT–II

Micropropagation: meristem culture and virus-free plants; factors affecting morphogenesis and proliferation rate, technical problem in micropropagation, applications of micropropagation.
In vitro haploid production and its significance, anther/pollen culture and ovary culture; embryo and ovule culture for wide hybridization. Genetic stability in haploid cell culture.

UNIT–III

Somatic hybridization: Protoplast isolation and fusion, hybrid selection and regeneration. Asymmetric and symmetric hybrids, cybrids and their application. Somaclonal variations in plant cell cultures: mechanisms and applications in genotype improvement. Plant breeding and secondary metabolite production.

UNIT–IV

Somatic embryogenesis: Production of synthetic seeds, importance, limitation and their utilization. Cryopreservation and germplasm conservation, cryobiology of plant cell cultures and establishment of seed banks, factors affecting revival of frozen cells. Application of tissue culture in forestry and agriculture.

Suggested Readings:

1. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
2. Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani Publisher, Meerut, India.
3. Bhojwani S.S. and Rajdan MK (2004) Plant Tissue Culture: Theory and Practice - A revised edition, Reed Elsevier, India, New Delhi.
4. Rajdan MK (2003), Plant Tissue Culture (2nd Ed.) IBH Publishing House, New Delhi.
5. Rup Lal and Sukanya Lal (2000) Crop improvement utilizing Biotechnology, CRC Press, Inc. Bra Raton, Florida.
6. Collins, H.A. and Edwards, S. 1998, Plant Cell Culture, Bios Scientific Pub., Oxford, U.K.
7. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs, CRC Press, Boca Raton, U.S.A.
8. Chawla H.S. Introduction to Plant Biotechnology (2nd edition). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Yeoman, M.N. (1987) Plant Cell Culture Technology, Narosa Publ., New Delhi, India.
10. Razadan, M.K. (1993) An introduction to Plant Culture, Oxford & IBH Pub. Co., New Delhi.
11. Glick BR and Pasternak J.J. (1998) Molecular Biotechnology: Principles and Applications, ASM Press, Washington DC.
12. Recent reviews in scientific journals.

M. Sc. (Botany) – 3rd Semester
Laboratory – V
BOT – 306 – Pertaining to Theory Papers BOT-301, 302 (Core Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Description of a specimen from representative, locally available families such as Apiaceae, Asclepiadaceae, Asteraceae, Apocynaceae, Brassicaceae, Chenopodiaceae, Convolvulaceae, Cryophyllaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Liliaceae, Malvaceae, Myrtaceae, Poaceae, Ranunculaceae, Rosaceae, Rubiaceae, Solanaceae, Verbenaceae etc.
2. Location of key characters and use of keys at family level.
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.
4. Preparation of herbarium of locally available wild plants.
5. Training in using floras and herbarium for identification of specimens described in fields or class.
6. Field trips / excursion, compilation of field notes and preparation of herbarium specimens of wild plants.
7. Field study of angiosperm in different types of habitats and preparation of plant herbarium.
8. Study of morphology, primitive and advanced characters of cultivated and wild representatives of various families. Study of basic structure of flower, variations, floral parts in details, floral symmetry, insertion of floral parts etc.
9. Study of microsporogenesis and gametogenesis in sections of anthers.
10. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Tradescantia, Crotolaria, Brassica, Petunia, Solanum melongena*, etc.).
11. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface cultures.
12. Estimating percentage and average pollen tube length *in vitro*.
13. Role of transcription and translation inhibitors on pollen germination and pollen tube growth.
14. Pollen storage, pollen –pistil interaction, self-incompatibility, *in vitro* pollination.
15. Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic type of embryo sac development through examination of permanent, stained serial sections.
16. Field study of several types of flowers with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
17. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self-compatible and obligate out crossing systems.
18. Study of cleistogamous flowers and their adaptations.
19. Study of nuclear and cellular endosperm through permanent slides.
20. Isolation of zygotic globular, heart shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun, etc. by dissections.
21. Study of seed dormancy and methods to break dormancy.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Pandey, S.N. and S.P. Misra. 2008. Taxonomy of Angiosperms. Ane Books, India.
2. Subramaniam, N.S. 2007. Modern Plant Taxonomy. Vikas Publishing House Pvt. Ltd., Delhi.
3. Sharma, O.P. 2002. Plant Taxonomy. Tata McGraw Hill Publishing Co. Pvt. Ltd., New Delhi.
4. Bhojwani, S.S. and Bhatnagar, S.P. 2000The embryology of Angiosperms. (4th revised and enlarged edition), Vikas publishing house, New Delhi.
5. Bhojwani, S.S. and Bhatnagar, S.P. 1999. The Embryology of Angiosperms. Vikas Publishing House, New Delhi.
6. Raghwan,V. 1997. Developmental biology of flowering plants. Springer verlag, New York.

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7. Shivanna, K.R. and Sawhney,V.K. 1997. Pollen biotechnology for crop production and improvement. Cambridge University press, Cambridge.
8. Sporne, K.R. 1986. The Morphology of Angiosperms. B.I. Publication, Bombay, Calcutta, Delhi.
9. Shivana, K.R. and B.M. Johri. 1985. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd. New Delhi.
10. Stace, C.A. 1984. Plant Taxonomy and Biosystematics. Contemporary Biology Series. Edward Arnold, London.
11. Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, Columbia.
12. Gupta, R.K. 1981. Systematic Botany. Atma Ram and Sons, New Delhi.
13. Sneath, P.H.A and R.R. Sokal. 1973. Numerical Taxonomy. W.H. Freeman, San Francisco.
14. Collet, H. 1971.Flora Simalensis. Thacker and Spink, Calcutta and Simla.
15. Takhtajan, A.E. 1969. Flowering plants: Origin and dispersal. Oliver and Boyd Ltd., Edinburg.
16. Eames, A.J. 1961.Morphology of Angiosperms. McGraw – Hill Inc., New York.
17. Benson, L.D.1962. Plant Taxonomy: Methods and Principles. Ronald Press, New York
18. Shivanna, K.R. and Johri, B.M. The Angiosperm Pollen: structure and Function, Wiley Eastern Ltd., Publications, 1989.
19. Recent reviews in scientific journals.

M. Sc. (Botany) – 3rd Semester
Laboratory – VI
BOT – 307A – Pertaining to Theory Papers BOT-303, 305 B (Core Elective Course)

Credits: 4 Marks: 100

Duration of exam: (3+3 hour)

1. To draw the basic requirements and design for setting up for a tissue culture laboratory Preparation of solutions of various concentrations of a few selected solutes.
2. Study of Agrobacterium mediated transformation.
3. To prepare the stock solutions of various growth regulators as well as of Murashige and Skoog's medium.
4. Composition and preparation of various culture media: Knop medium and MS media.
5. Visit of various laboratories in the university, preparation and submission of report.
6. Culture of explants on MS medium
7. To study the various sterilization techniques adopted while carrying out the various tissue culture experiments.
8. To carry out in-vitro germination of seeds of sunflower/carrot.
9. Induction of callus from highly differentiated tissue (*e.g.* cambial part of carrot tap-root) and to record the growth rate of callus tissue by forming growth curves.
10. To induce somatic embryogenesis/organogenesis in callus cultures of carrot obtained in previous expt. and to record the effect of different growth hormones in this process.
11. To carry out anther culture of Datura and to examine the effect of activated charcoal on anther culture.
12. To perform the embryo culture of any available plant (*e.g.* wheat, rice, sweet corn, barley *etc.*) and to record the effect of ABA on embryo development *in vitro*.
13. Preparation and maintenance of cell suspension cultures of any available plant (*e.g. Nicotiana tabacum*, carrot etc.) and form the growth curves.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Experiments in Microbiology, Plant Pathology and Biotechnology 4th Edition. Aneja, K.R. (2010) New Age International Publishers, New Delhi.
2. Singh, B.D. Biotechnology: Expanding Horizon. Kalyani Publishers, New Delhi.860 pp. 2007.
3. Bhojwani, S.S. & M.K. Razdan. Plant Tissue Culture – Theory and Practices. 5th Ed. Elsevier Science Pub. Co. Inc., New York.776pp. 2005.
4. Gupta, P.K. Biotechnology and Genomics. Rastogi Publication Meerut.796 pp. 2004
5. Razdan, M.K. An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.397 pp. 2001.
6. Smith, R.H. Plant Tissue Culture, Technique and Experiments. (2nd Ed.), Academic Press, New York.231pp. 2000.
7. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.
8. Scott, R.P.W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., New York.
9. Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition. Cambridge University Press, Cambridge, UK.
10. Dryer, R.L. and Lata, G.F. 1989. Experimental Biochemistry. Oxford University Press, USA.
11. Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
12. Kumar, H.D. A Text of Biotechnology. E.W.P., New Delhi.639 pp. 1998.
13. Butcher, D.N. & D.S. Ingram. Plant Tissue Culture, Edward Arnold Ltd., U.K. 1976.
14. Ignacimuthu, S.J. Basic Biotechnology. Tata McGraw Hill Pub. Co. Ltd., New Delhi.284 pp. 1995.
15. Reinert, J. and M.M Yeoman. Plant Cell and Tissue Culture-A Laboratory Manual, Springer Verlag, Berlin. 83pp. 1982.
16. Recent reviews in scientific journals.

M. Sc. (Botany) – 3rd Semester
Laboratory – VI
BOT – 307B – Pertaining to Theory Papers BOT-304, 305 A (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Preparation of solutions of various concentrations of a few selected solutes.
2. Introduction to Plant Physiology Laboratory; A review of plant structure
3. Mineral nutrition and nutrition deficiency symptoms
4. Seed viability test
5. Plant movements: gravitropism and phototropism
6. Light and hormone on seed germination and seedling growth
7. To demonstrate the process of imbibition by using raisins
8. Demonstration of working of different types of microscopes
9. To demonstrate osmosis in living plant cells by potato osmoscope
10. Demonstration of plasmolysis and deplasmolysis in plant cell
11. Demonstration of exosmosis and endosmosis in grapes and resins
12. To demonstrate the process of osmosis with varying solution concentration
13. To demonstrate the process of plasmolysis in onion cells
14. To demonstrate unequal transpiration from the two surfaces of a leaf
15. To demonstrate the presence of starch histochemically
16. Effect of temperature on cell membrane permeability
17. Effects of Environmental factors on Photosynthesis
18. Demonstration of working of weighing balances, autoclaves, incubators, laminar flow, water bath.
19. Principle and demonstration of various analytical techniques:
    a. Chromatography (HPLC, TLC, Paper Chromatography, Column chromatography, Ion exchange Chromatography)
    b. Centrifugation
    c. UV-visible spectrophotometer
    d. Nanodrop
    e. ELISA reader
    f. Sonicator
    g. Microtome
    h. PCR / Real Time PCR
    i. Electrophoresis (AGE and PAGE)

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Noggle, G.R. and Fritz, G.J. (1983) Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition (Seventh reprint, 1992).
2. Salisbury, F.B. and Ross, C.W. (1992) Plant Physiology. Fourth Edition, Wadsworth Publishing Co. Belmont, California, USA.
3. Dey, P.M. and Harborne, J.B. (1997) Plant Biochemistry. Academic Press, Asia Pvt. Ltd.
4. Buchanan, B.B., Gruissem, w. and Jones, R.L. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
5. Sawhney, S.K. and Singh, Randhir (2000) Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
6. Principles and techniques of Practical Biochemistry; K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
7. Bophysical Chemistry: Principle and Techniques, (2nd ed.) by A. Upadhyay, K. Upadhyay and N. Nath. (1998). Himalya Publication House, Delhi
8. Recent reviews in scientific journals.

M. Sc. (Botany) – 4th Semester

BOT – 401 – Plant Ecology: Principles and Concepts (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Concept and structure of ecosystem: Cybernetic nature and stability (resistance and resilience) of ecosystems; structure and function of some Indian ecosystems: forest, grassland, fresh water, marine and eustarine. Brief idea of microcosms, spacecraft and city as ecosystems.

Concept of Habitat and ecological niche; fundamental and realized niche; resource partitioning; ecological equivalents, natural selection, allopatric and sympatric speciation. Artificial section and domestication.

UNIT–II

Concept of community: intra-community classification, analysis of communities (analytic and synthetic characters), species diversity, ecotones and edge effect.

Concept related to energy: primary productivity and its measurements, global pattern and controlling factors; food chain, food web, trophic levels, energy flow pathways, ecological energetics, energy budgets, ecological efficiencies.

UNIT–III

Concept of limiting factors; Liebig's law of the minimum, Shelford's law of tolerance, factor compensation and ecotypes, ecads, ecological indicators.

Pattern and basic types of biogeochemical cycles (C, N, P and S), sedimentary cycle, cycling of non-essential elements and organic nutrients; nutrient cycling in the tropics, recycle index.

UNIT–IV

Population group properties, life history strategies (r and k selection), carrying capacity, population regulation, types of interactions, concept of metapopulation- demes and dispersal, interdemic extinctions.

Ecological succession and its types, relay floristics and initial floristics composition, bioenergetics, models (facilitation, tolerance and inhibition), causes, changes in ecosystem properties during succession, concept of climax; its unit's theories and forms.

Suggested Readings:

1. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Thomson Books/Cole, USA.
2. P.S. Verma & V.K. Agarwal (2004) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd., New Delhi.
3. Stiling, P. 1999. Ecology Theories and Applications, Prentice Hall Inc., London.
4. Kormondy, E.J. 1996. Concepts of Ecology, Prentice-Hall of Indian Ltd., New Delhi.
5. Smith R.L. 1996. Ecology and Field Biology, Harper Colins, New York.
6. Tiwari, S.C. 1993. Concept of Modern Ecology, Bishan Singh Mahendra Pal Singh, Dehra Dun.
7. Sharma, P.D. 1992. Ecology and Environment, Rastogi Publ. Meerut.
8. Chapman, J.L. and Reiss, M.J. 1988. Ecology Principles and Applications. Cambridgde University Press, U.K.
9. Odum, E.P. 1983. Basic Ecology, Saunders College Publ. co., Philadelphia.
10. Recent reviews in scientific journals.

M. Sc. (Botany) – 4th Semester
BOT – 402A – Plant Growth & Development (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Plant Growth: Concepts, growth curves and growth analysis.
Germination and Dormancy of seeds; factors affecting dormancy and its regulation by plant growth regulators and environmental factors.
Stress Physiology: Response of plants to abiotic stresses: abiotic stress affecting plant productivity. Basic principles of crop improvement programme under stress.

UNIT–II

Plant Growth Regulators: Discovery, biosynthetic pathways, transport, influence on plant growth: mechanism of action of: auxins, gibberellins, cytokines, ethylene and abscisic acid.

UNIT–III

Senescence and abscission: Physiological and biochemical changes associated with senescence and abscission. Tropism: Phototropism, nature of receptors, role of hormones, geotropism and nastism.

UNIT–IV

Sensory Photobiology: Mechanism of phytochrome action, photomorphogenesis and cryptochromes. Flowering process; nature & events during flowering, florigen concept, and chemical control of flowering. Photoperiodism and its significance, importance of light & dark periods, role of vernalization.

Suggested Readings:

1. Srivastava, L.M. (2006) Plant Growth and Development: Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
2. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000) Biochemstry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
3. Singhal, G.S. Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (editors) (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
4. Davies, Peter J. (1995) Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.
5. Krishnamoorthy, H.N. (1993) Physiology of Plant Growth and Development. AR and Sons, Delhi.
6. Salisbury, F.B. and Ross, C.W. (1992) Plant Physiology. 4th editon, Wadsworth Publishing Co. Belmont, California, USA.
7. Kumar, H.D. and Singh, H.N. (1993) Plant Metabolism. 2nd edition. Affiliated East- West Press.
8. Zubay, Geoffrey (1989) Biochemistry. McMillan Publishing Co. New York.
9. Wilkins, M.B. (1987) Advanced Plant Physiology. ELBS, Longman, England.
10. Recent reviews in scientific journals.

M. Sc. (Botany) – 4th Semester

BOT – 402B – Applied Botany (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Food Plants: History and nature of food plants, major and minor cereals, legumes and pulses, vegetables, fruits and nuts, vegetable oils and fats. Flow diagram of the process with a critical study of the steps involved, problems faced by the sugar industry in India. Bye-products of sugar industry, distillation of alcohol and other products. Food adjuncts: Spices condiments and other flavoring agents, beverages, fumitory and masticatory materials.

UNIT–II

Forest trees: Physical characteristics of Indian woods, methods of seasoning and chemical treatment of specialized use, fire proofing of the wood. Industrial manufacturing of packing material and plywood and the classifications of plywoods according to their use.

Some important commercial woods: *Dalbergia* spp., *Shorea robusta*, *Tectona grandis*, *Cedrus deodara*, Bamboo-the 'greengold' of India.

UNIT–III

Industrial Plant products: Fiber yielding plants, essential oils, fatty oil and waxes, tanning and dyeing materials, rubber and other latex yielding products, gums and resins, sugars, starches and other cellulose products. Manufacturing of paper and board from raw plant material. Manufacturing of crude and high quality paper, recycled paper.

UNIT–IV

Fibres: Classification of fibres, physical and chemical processes involved in the manufacturing of fibres from different types of fiber yielding plants. Sources of gums and resins and their classifications according to their chemical nature.

Sources of natural dyes in India and their extraction methods, merits and limitations of plant based dyes.

Suggested Readings:

1. Shankar Gopal Joshi (2000). Medicinal Plants. Oxford & IBH Publishing Co. New Delhi.
2. Pandey B.P. (1984). Economic Botany (3rd Ed.). S. Chand & Company Ltd., New Delhi.
3. Ambasta S.P. (1994). The Useful Plants of India. (3rd Ed.). Publications & Information Directorate, New Delhi.
4. Kochhar S.L. (1998). Economic Botany in the Tropics. MacMillan India Limited, Delhi.
5. Brown H.P. (1989). An Elementary Manual on Indian Wood Technology (Reprinted). International Book Distributors, Dehradun, India.
6. Trotter H. (1982). The Common Commercial Timbers of India and Their Uses. The Controller of Publications, Delhi.
7. Recent reviews in scientific journals.

M. Sc. (Botany) – 4th Semester

BOT – 403A – Plant Diversity and Conservation (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Biodiversity: concept; Types of biodiversity, national & global status; endemism, speciation and extinction; levels of biodiversity, hotspots and hottest hotspots; major plant diversity regions of India with special reference to Himalaya, Western Ghats, Central India and Indo-Gangatic Plains. Significance of biodiversity and its socio-economic importance, causes of biodiversity depletion, rarity of species, threat value, blue/red data categories. ICUN categories of threat; Red Data Books. Importance of Ethnobotany in Indian context.

UNIT–II

Principles of conservation a holistic approach, objectives, implications, major approaches to management, action plans and conservation status in India. Strategies for conservation: *In-situ* conservation: International efforts and Indian initiatives; potential areas in India – sanctuaries, national park, biosphere reserves, wetlands and Ramsar convention, mangroves and coral reefs for conservation of wild biodiversity. *Ex-situ* conservation: Principles and practices; botanical gardens.

UNIT–III

Plant explorations; invasions and introductions; Role of National Bureau of Plant Genetic Resources (NBPGR), IARI, IUCN, UNEP, WRI, WWF, Convention of Biological Diversity (CBD), Indian initiatives in biodiversity conservation, National Biodiversity Authority (NBA), State Biodiversity Boards (SBSs) and National Biodiversity Fund (NBF) in managing biodiversity.

UNIT–IV

Phytogeography and forest types of India - Ecological and economic importance of forests, afforestation, deforestation and social forestry; endangered plants, endemism, invasive species; desertification and wasteland reclamation, effects of global warming, climatic change and stratospheric ozone depletion on plant diversity. Indian Biodiversity Act, Environmental Protection Act and Forest Conservation Act.

Suggested Readings:

1. Stiling, P. 2009. Ecology: Theory and Applications (4th Ed.). PHI Learning Pvt. Ltd. New Delhi.
2. Kormondy, E.J. 2008. Concepts of Ecology. Prentice Hall of India., New Delhi.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
4. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology (5th Ed.) Brooks/Cengage Learning India Pvt. Ltd., New Delhi.
5. Kumar, U. & Asija, M.J. 2000. Biodiversity Principles and Conservation, Agrobios (India)
6. Aggarwal, K.C. 1999. Biodiversity, Agro Botanica, Bikaner.
7. Dhar, U. 1993. Himalayan Biodiversity. Conservation, Strategies, G.B. Pant Institute of Himalayan Environment and Development, Kosi, Almorha (Himvikas Publication No. 3).
8. Negi, S.S. 1993. Biodiversity and its conservation in India. Indus Publishing, Co., New Delhi.
9. Rao, R.R. 1994. Biodiversity in India (Floristic Aspects), Bishen Singh & Mohindra Pal Singh, Dehradun.
10. Jeffries, M.J. 1997. Biodiversity and Conservation, Routlege, London & New York.
11. Recent reviews in scientific journals.

M. Sc. (Botany) – 4th Semester

BOT – 403B – Phytogeography and Applied Ecology (Core Elective Course)

Credits: 4
Time: 3 h

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

UNIT–I

Phytogeographical regions of World, age and area hypothesis, endemism, theories of discontinuous distribution. Impact of Ice Ages and continental drift on plant distribution. Biogeography of major biomes, theory of island biogeography. Basic idea of remote sensing; photogrammetry and photointerpretation, remote sensing platforms. Application of remote sensing in ecology and forestry.

UNIT–II

Environmental global Issues: Ozone depletion and global warming; greenhouse gasses, strategies and measures to combat ozone depletion and global warming; acid rain; eutrophication.

Ecology of plant invasions, environmental impact assessment. Ecosystem restoration. solid waste management, reclamation of wasteland, waste water treatment.

UNIT–III

Pollution and environmental health: Monitoring of pollution, Bioindicators. Environmental monitoring and Environmental impact assessment. Environmental laws: All (Prevention & Control of Pollution) Act 1981; Water (Prevention & Control of Pollution) Act 1974.

Radiation ecology: Radiation effects at ecosystem level, fate of radio nuclides in environment, radioactive fallout, waste disposal.

UNIT–IV

Basic Statistical Methods: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Errors; Level of significance; Regression and correlation; analysis of variance; t-test and chi-square Test.

Suggested Readings:

1. Rastogi, V.B. 2007. Fundamentals of Biostatics. Ane Books India, New Delhi, India.
2. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Thomson Brooks/Cole, USA
3. Stiling, P. 1999. Theories and Applications. Prentice-Hall Inc., London.
4. Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press, Cambridge
5. NNRMS Reading Material 1997. Photogrammetry and Remote, Sesning – Special Course on Remote Sensing applications for University Teachers, Indian Institute of Remote Sensing, Dehra Dun.
6. Newman, E.I. (2000) Applied Ecology Blackwell Scientific Publisher, UK. pp. 328
7. Sharma, P.D. (2000) Ecology & Environment. Rastogi Publications, Meerut, India. 653pp.
8. Chapman, J.L. & M.J. Reiss (1992) Ecology (Principles & Applications) Cambridge University Press
9. Verma, P.S. & Agarwal, V.K. (1999) Concept of Ecology (Enviromental Biology) S. Chand & Co., New Delhi-264pp.
10. Good, R. (1997) The Geography of flowering Plants (2nd Ed.), New Delhi-495pp.,
11. Biostatistics by P.N. Arora and P.K. Malhan, Himalaya Publishing House.
12. Paul, Brown 1996. Global Warming – Can Civilization Survive? University Press (India)
13. Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment, Cambridge University
14. Harrison, R.M. 1992. Understanding Environmental Pollution. Cambridge University Press
15. Recent reviews in scientific journals.

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M. Sc. (Botany) – 4th Semester
Laboratory – VII
BOT – 404 – Pertaining to Theory Papers BOT-401, 402A, 402B (Core Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. To study the physical characteristics (temperature, colour and texture) of soil.
2. To determine water holding capacity of soils collected from different locations.
3. To determine pH and conductivity of soils and water collected from different locations.
4. To determine percentage organic carbon and organic matter in the soils of crop land, grassland and forest.
5. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples.
6. To record the abiotic components i.e. pH, temperature, turbidity and light intensity of water in a pond ecosystem.
7. To determine the minimum size of the quadrat by species- area curve.
8. To study the community by quadrat method by determining frequency, density and abundance of different species present in the community.
9. Determination of species diversity index and importance value index of local vegetation.
10. To compare protected and unprotected grasslands using community coefficients (similarity index).
11. To study the species composition of an area for analyzing biological spectrum and comparison with Raunkiaer's normal biological spectrum.
12. To survey and study the ecological adaptations of locally available hydrophytes and xerophytes.
13. Field visit of any protected area and to discuss causes and impacts of biodiversity loss.
14. Study of Cytohistological zonation in the shoot apical meristem in sectioned permanent slides.
15. Examination of L.S. of root apical meristem from a permanent slide preparation.
16. Study of phyllotaxy in different plants.
17. Study of V.S. & T.S. of leaves of dicots and monocots plants.
18. Study of epidermal peels of leaves of dicots & monocots to study the development and final structure of stomata and prepare stomatal index.
19. Study of T.S. of stem of various plants having primary and secondary anomalous structure.
20. Effect of gravity, unilateral light and plant growth regulators on the growth of young seedlings.
21. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
22. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
23. Study of alternate and distichous; alternate and superposed; opposite and superposed; opposite and decussate leaf arrangement. Examination of rosette plants (Launaea, *Mullugo*, *Raphanus*, *Hyoscyamus*, etc.) and induction of bolting under natural conditions as well as by GA treatement.
24. Microscopic examination of vertical sections of leaves such as *Cannnabis*, *Nicotiana*, *Nerium*, *Zea mays* and *Triticum* to understand the internal structure of leaf tissues and trichomes, glands, etc. Also study the C_3 and C_4 leaf anatomy of plants.
25. Study of epidermal peels of leaves such as *Coccinia*, *Gaillardia*, *Tradescantia*, *Notonea*, etc.
26. To study the development and final structure of stomata and prepare stomatal index.
27. Demonstration of the effect of ABA on stomatal closure.
28. Study of whole roots in monocots and dicots. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives (use maize, aerial roots of banyan, *Pistia*, *Jussieua*, etc.). Origin of lateral roots. Study of leguminous roots with different types of nodules.
29. Study of permanent tissues.
30. **Food Crops:** Wheat, Rice, Maize, Potato, Chickpea (Bengal gram), Sugarcane. Morphology, anatomy, microchemical tests for stored food materials.

Fodder Crops: Sorghum, Bajra, Berseem, Guar, Oat.
Plant Fibres: Cotton, Jute, Sun hemp, Coir.
Medicinal and Aromatic Plants: Study of live or herbarium specimens or other visual materials to become familiar with following plants: *Papaver somniferum, Atropa belladona, Catharanthus roseus, Adhatoda zeylanica, Allium sativum, Rauwolfia serpentine, Withania somnifera, Phyllanthus niruri, Andrographis paniculata, Aloe barbadensis, Mentha arvensis, Ricinus communis, Abutilon indicum, Datura* sp., *Artemisia* sp., *Pedalium murex, Ocimum sanctum, Vetiveria zizanoides, Cymbopogon maritini.*
Gums, Resins, Tannins, Dyes: *Acacia, Terminalia, Tea, Turmaric, Bixa orellana, Indigo, Butea monosperma, Lawsonia inermis.*

31. **Field Survey:** Prepare a list of important sources of firewood and timber in your locality. Give their local names, scientific names and families to which they belong.
32. **Scientific visits:** Students should be taken to any protected area, a recognized botanical garden or museum (such as FRI, BSI, NBRI), to a CSIR laboratory doing research on plants and their utilization and an ICAR research institute or a field station dealing with crops.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested readings:

1. Taiz et al., 2015. Plant Physiology and Development, 5th edition.
2. Dekker. M. 2013. Plant Roots: the Hidden Half (4th edition), CRC press, New York.
3. Peter B. Kaufman et al., 1999. Natural Products from Plants.
4. Howell, S.H. 1998. Plant Growth and Development. A Molecular approach. Academic Press, San Diego.
5. Kocchar, S.L. 1998. Economic Botany of Tropics.
6. Waisel, Y., Eshel, A. and Kafkaki, V. (eds) 1996. Plant Development (2nd edition). Cambridge University Press, Cambridge.
7. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment.
8. Richard B. Primack. 1993. Essentials of Conservation Biology.
9. Negi, S.S. 1993. Biodiversity and its Conservation in India.
10. Lyndon, R.F. 1990. Plant Development. The Cellular Basis. Unnin Hyman, London.
11. Mauseth, J.D. 1988. Plant Anatomy. Benjamin Cummings. California.
12. Kothari, 1987. Understanding biodiversity, life sustainability and equity. Orient Longman. Sharma, O.P. 1996. Hills Economic Botany.
13. CSIR 1986. The Useful Plants in India.
14. Swaminathan, M.N. & Jain, R.S. Biodiversity: Implications for global security, Macmillan,1982.
15. Recent reviews in scientific journals.

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M. Sc. (Botany) – 4th Semester
Laboratory – VIII
BOT – 405A – Pertaining to Theory Papers BOT-403A (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Study of climate / topography/flora-fauna in the perspective of biodiversity conservation.
2. Understanding the concept of sampling: Random sampling, sample size, quadrat, transect and point method for the study of community structure.
3. Study the community structure using quadrate method by establishing minimum size and minimum number of quadrates.
4. Study of community structure and assessing frequency of the species as assessed by Raunkiaer (1934). Prepare a frequency diagram and divide the species into classes based on percentage frequency (Raunkiaer, 1934).
5. Study of community structure and assess the density and abundance of the species.
6. Study of community structure and assessment of cover and basal area of species present and determine the IVI (Importance Value Index) of the species.
7. Understand the concept of community coefficient by comparing the frequency of two communities.
8. Assessment of β diversity to measure the degree of turnover in species composition along a gradient or transect.
9. Estimating β diversity by employing similarity measures like Jaccard measure and Sorenson measure and species diversity by Simpsons Index.
10. Study the dispersion of the species by calculating mean and variance of species 10. Assess the soil texture by mechanical method and pH and conductivity of soil using pH meter and conductivity meter
11. **Scientific visits:** Students should be taken to any protected area, a recognized botanical garden or museum (such as FRI, BSI, NBRI), to a CSIR laboratory doing research on plants and their utilization and an ICAR research institute or a field station dealing with crops.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested readings:

1. Rana, S.V.S. 2009. Essentials of Ecology and Environmental Sciences (4th Ed.) PHI Learning Pvt. Ltd. New Delhi.
2. Sahasranaman, P.B. 2009. Handbook of Environmental Law. Oxford University Press, New Delhi, India.
3. Stiling, P. 2009. Ecology: Theory and Applications (4th Ed.). PHI Learning Pvt. Ltd. New Delhi.
4. Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
5. A. Rosencranz and S. Divan. 2004, Environmental Law and Policy in India: Cases, Materials and Statutes. Oxford University Press, New Delhi.
6. P. Leelakrishnan. 2004. Environmental Law Case Studies. Lexisnexis Butterworths, Nagpur, India.
7. Upadhyay, C.B. 2001. Forest Laws: Central and States. Hind Publishing House, Allahabad, India.
8. Singh, Chhatrapati. 2000. India's Forest Policy and Forest Laws. Natraj Publishers, Dehradun, India.
9. Biswas, S.K. 1988. Forest Administration in India. Cough Publications, Allahabad, India.
10. Dogra, B. 1983. Forests and People: A Report on the Himalayas. Bharat Dogra, New Delhi.
11. Recent reviews in scientific journals.

M. Sc. (Botany) – 4th Semester
Laboratory – VIII
BOT – 405B – Pertaining to Theory Papers BOT-403B (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Study of following microclimatic variables in different habitats: soil and air temperature, wind velocity, relative humidity, rainfall and light intensity.
2. Permeability (percolation; total capacity as well as rate of movement) of different soil samples.
3. Saturation capacity and field capacity of different soil samples and rapid test for texture of soils.
4. Soil organic matter in different soil samples by titration method.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. Study of morphological and anatomical features of hydrophytes and xerophytes.
7. Study of morphological features of epiphytes, parasites and halophytes.
8. Study of vegetation by the quadrat line transects, estimation of frequency, density & Dominance cover.
9. Determination of soil & water pH. Analysis of soil water to detect the presence of dissolved salts.
10. The light and dark bottle experiment for primary productivity study in the aquatic ecosystem.
11. Retentivity, absorption and capillarity of soil.
12. Descriptive statistics: Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion, measures of skewness (using calculators).
13. Correlations (product- moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting).
14. To develop null and alternate hypothesis.
15. Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages).
16. Statistical distributions: fitting discrete uniform, binomial, Poisson and normal probability distributions to given data.
17. Testing of hypotheses: Tests of significance (mean, standard deviation, and correlation coefficient), chi-squared test for goodness of fit, test for independence of attributes, non-parametric tests (run test), design of experiments, ANOVA.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

Suggested Readings:

1. Newman, E.I. (2000) Applied Ecology Blackwell Scientific Publisher, U.K-328pp.
2. Chapman, J.L. & M.J. Reiss (1992) Ecology (Principles & Applications) Cambridge University Press
3. Verma, P.S. & Agarwal, V.K. (1999) Concept of Ecology (Environmental Biology) S. Chand & Co.
4. Sharma, P.D. (2000) Ecology & Envoronment Rastogi Publications, Meerut, India. 653pp.
5. Cain, S.A. (1944) Foudations of Plant Geography Harper & Brothers
6. N.Y. Mani, M.S (1974) Ecology & Biogeography of India Dr. W. Junk Publishers, The Haque.
7. Good, R. (1997): The Geography of flowering Plants (2nd Edn.,) Longmans, Green & Co., Inc., London & Allied Science Publishers, New Delhi-495pp.,
8. Biostatistics by P.N. Arora and P.K. Malhan, Himalaya Publishing House.
9. Intuitive Biostatistics by Harvey Motulsky, Publisher: Oxford University Press.
10. Introduction to Biostatistics by Robert R. Sakal and F. James Rohlf: Dover Publications, Inc. Mineola, New York.
11. Recent reviews in scientific journals.