

**COURSE CURRICULUM AND
SCHEME OF EXAMINATION**

**Under
Choice Based Credit System**

For

M. Sc. (Botany)

(Effective from the Academic Session 2017 – 2018)

Chaudhary Devi Lal University, Sirsa – 125 055

M.Sc. Botany (1 st 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)

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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)

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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 A	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BOT-307 B	Lab – VI Pertaining to Theory Papers BOT-303, 305 B		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

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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)

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M. Sc. (Botany) – 1st Semester
BOT – 101 – Biology and Diversity of Virus, Bacteria and Fungi (Core Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **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

Archaeobacteria 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. Alexopoulos, C.J. et al. 1996. Introductory Mycology. John Wiley & Sons, Inc.
8. Mehrotra, R.S. and Aneja, R.S. 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



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M. Sc. (Botany) – 1st Semester
BOT – 102 – Biology and Diversity of Algae and Bryophytes (Core Course)

Credits: 4
Time: 3 Hrs.

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 features 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, CA. 720 pp. 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. 368 pp. 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. Bryophyta, 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 & Company Pvt. Ltd., New Delhi.



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

Credits: 4
Time: 3 Hrs.

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 (C₂, C₃ and C₄ 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, Sphingolipids, 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 Hrs.

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 Hrs.

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, Rauwolfia, 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 C., 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. Cobby, 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



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

Marks: 100

Credits: 4

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*, *Prochloron* 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 Phanerogamium 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), bioluminescent 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*, *Microsporium*, *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.

***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. Kluwer 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)

Marks: 100

Credits: 4

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 ferricyanide 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 C₃ and C₄ 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. Principles of Biochemistry by Lehninger. CBS Publishers & Distributors, Delhi.
2. Harper's Biochemistry by RK Murray, DK Granner, PA Mayes and VW Rodwell. 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)-Narosha 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, Book Company, U.K.
 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)

Marks: 100

Credits: 4

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.

M. Sc. (Botany) – 2nd Semester

BOT – 201 – Biology and Diversity of Pteridophytes and Gymnosperms (Core Course)
Credits: 4
Time: 3 Hrs.

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, Salviniaceae.

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.

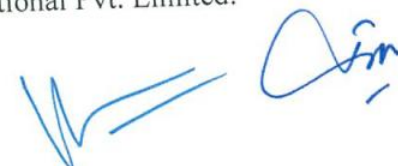
UNIT-IV

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 Hrs.

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 cytometry. 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.


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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.
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
Time: 3 Hrs.

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

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. T_m 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, 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. Sinaur 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 Hrs.

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 Powdery 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 Academic 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. Dagainawala. General Microbiology, Vols. I & II. 2nd Ed. Himalaya Publishing House, New Delhi. 1995.
9. Schlegel, H.S. General Microbiology. 7th Ed. Cambridge University Press, Cambridge. pp. 676, 1993.
10. Sharma, P.D. Plant Pathology. Rastogi Publications, Meerut. 1998.
11. Sharma, P.D. The Fungi and allied organisms. 1st Ed. Alpha Science International Ltd. pp. 300, 2005.
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 Publishing 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. pp. 424, 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 Hrs.

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. Poehlman 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. Poehlman, 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 Excercises in Cytology, Genetics, Plant Breeding and Biostatistics (1st Edition). CBS Publishers and Distributors, 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 Publsiher, New Delhi.
18. Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

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

Credits: 4
Time: 3 Hrs.

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- Sarpagandha, 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 adulterants.

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. Cogley, 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., New York.
11. Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford IBH Pub. Co., New Delhi.
12. Hancock. J. F. 2004. Plant evolution and the origin of crop species. 2nd edition. CABI Publishing, Cambridge, MA USA.
13. Radford, A.E., W.C. Dickison, J.R. Massey, C.R. Bell. 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)

Marks: 100

Credits: 4

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.

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 Anthocerotata 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.

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

Marks: 100

Credits: 4

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 Academic Press, San Diego. 922 pp. 2005.
2. Alexopoulos, 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. 292 pp. 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. 300 pp. 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. 424 pp. 1980.
16. Stewens, N.E. The Fungi which Cause Plant Disease, Int. Books & Periodicals, New Delhi, 1984. pp. 754.
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)

Marks: 100

Credits: 4

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.
 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, NY.
 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.
- Biotechnology: Prospects and Applications, Salar et al. 2013 ISBN 978-81-322-1683-4, Springer

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