BOTANY
Under Graduate SYLLABUS
FOR SEMESTER SYSTEM

DISTRIBUTION OF PAPERS OVER 6 SEMESTERS

SUBJECT	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV	SEMESTER V	SEMESTER VI	TOTAL MARKS
ELECTIVE I	100	100	100	100			**400**
ELECTIVE II	100	100	100	100			**400**
ELECTIVE HONS.	100	100	100	100	200	200	**800**
ENGLISH					100		**100**
ENVIRONMENTAL STUDIES						100	**100**
TOTAL MARKS	**300**	**300**	**300**	**300**	**300**	**300**	**1800**

UG BOTANY SYLLABUS
SEMESTER SYSTEM
North- Eastern Hill University, Shillong

		MARKS		
SEMESTER AND PAPER	**COURSE TITLE**	**Theory**	**Practical**	**Total**
SEMESTER – 1				
PAPER –1: THEORY	Algae, Bryophytes and Pteridophytes	75		
PAPER – 1: PRACTICAL	Algae, Bryophytes and Pteridophytes		25	
				100
SEMESTER – 2				
PAPER –2: THEORY	Gymnosperms, Paleobotany, Morphology and Anatomy	75		
PAPER – 2: PRACTICAL	Gymnosperms, Paleobotany, Morphology and Anatomy		25	
				100
SEMESTER – 3				
PAPER –3: THEORY	Angiosperm taxonomy, Economic Botany, Ethnobotany and Phytogeography	75		
PAPER – 3: PRACTICAL	Angiosperm taxonomy, Economic Botany, Ethnobotany and Phytogeography		25	
				100
SEMESTER – 4				
PAPER –4: THEORY	Microbiology, Mycology and Plant Pathology	75		
PAPER – 4: PRACTICAL	Microbiology, Mycology and Plant Pathology		25	
				100
SEMESTER – 5				
PAPER –5: THEORY	Plant Physiology and Biochemistry	75		
PAPER – 5: PRACTICAL	Plant Physiology and Biochemistry		25	
				100
PAPER –6: THEORY	Ecology and Conservation Biology	75		
PAPER – 6: PRACTICAL	Ecology and Conservation Biology		25	
				100
SEMESTER – 6				
PAPER –7: THEORY	Genetics, Plant Breeding and Molecular Biology	75		
PAPER – 7: PRACTICAL	Genetics, Plant Breeding and Molecular Biology		25	
				100
PAPER –8: THEORY	Plant Reproductive Biology and Plant Biotechnology	75		
PAPER – 8: PRACTICAL	Plant Reproductive Biology and Plant Biotechnology		25	
				100
	Grand Total			**800**

Duration of Examination: Theory Papers: 3 hours each; Practical Papers: 4 hours each

Semester 1

Paper 1: Theory

Algae, Bryophytes and Pteridophytes

Unit 1

1. Classification of algae according to Fritsch and Lee;
2. Range of vegetative and reproductive structures of Chlorophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae.
3. Life cycle types in green algae.

Unit 2

1. Life cycles of *Chara*,*Oedogonium, Ectocarpus, Polysiphonia*and Centric diatoms.
2. Origin and evolution of sex in algae.
3. Pigmentation in algae.
4. Economic importance of algae.

Unit 3

1. Classification of bryophytes according to Proskauer.
2. Origin and range of gametophyte structure in bryophytes.
3. Reproduction in bryophytes**.**
4. Evolution of sporophyte and gametophyte in bryophytes
5. Life cycles of *Anthoceros*, *Marchantia* and *Sphagnum.*

Unit 4

1. Classification of pteridophytes by Smith.
2. Evolution of stele in pteridophytes and telome concept.
3. Heterospory and seed habit.
4. Life cycles of *Lycopodium*and *Selaginella.*
5. Economic and ecological importance of pteridophytes.

Paper 1: Practical

Algae, Bryophytes and Pteridophytes

1. Study of vegetative and reproductive parts with the help of temporary preparations of all types of genera prescribed in Paper 1.
2. Dissection, sectioning, drawing, description and identification of the specimens covered in the preparations.

Recommended Readings

- Kumar H.D. and Singh, H.N. 1995. A Text Book of Algae, East West Press, New Delhi.
- Lee, R.E. 2008. Phycology. 4th Edition, Cambridge University Press India Pvt. Ltd. New Delhi.

- Parihar, N.S. 1986. Bryophyta. Central Book Depot, Allahabad.
- Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
- Sporne, K. R. 1991. Morphology of Pteridophytes. Central Book Depot. Allahabad

- Vashistha, B.R, Sinha, A.K. and Kumar, A. 2012. Botany for degree students: Bryophyta. S Chand & Co., New Delhi.
- Vashistha, B.R., Sinha, A. K. and Kumar, A. 2010. Botany for degree students: Pteridophyta. S Chand & Co., New Delhi.

Suggested Readings

- Bold, H.C. and Wynne, M.J. 1978. Introduction to Algae: Structure and reproduction. Publ. Prentice-Hall, New Delhi.
- Chapman, V.J. and Chapman, D.J. 1975. The Algae. 2nd edition, McMillan Publ. Inc. New York.
- Dodge, J.D. 1973. The Fine Structure of Algal Cells. Academic Press, New York.
- Gangulee, H.C., Das, H.C. and Dutta, T.C. 1986. College Botany. Vol I. New Central Book Agency, Kolkatta.
- Gilbert, M.S. 1985. Cryptogamic Botany, Vol I and Vol II. Tata McGraw Hill Publ. New Delhi.
- Hait, G., Bhattacharya, K. and Ghosh, A. 2013. A Text Book of Botany Volume 1. New Central Book Agency, Kolkata.
- Hoek, C.V., Mann, D.G., Jahns, H.M. 1995. Algae- An introduction to Phycology. Cambridge University Press, New Delhi.
- Kumar, S.S. 1995. Recent Studies on Indian Bryophytes. PublBishen Singh and Mahendra Pal Singh.
- Mitra, D., Guha, J. Chaudhury, S.K. 2000. Studies in Botany. Vol I and II. PublMoulik Library.
- Nath, V. and Asthana, A.K. 2001. Perspectives in Indian Bryology. Publ. Bishen Singh and Mahendra Pal Singh.
- Mukherjee, R.N. and Chakravarty, K. 1995. Introduction to Vascular Cryptogams (Pteridophyta). Publ. Kalyani Publishers.
- Pandey, B.P. 2000. College Botany (Vol. I) Algae, Fungi, Bryophyta. S. Chand & Co. New Delhi.
- Pandey, B.P. 2000. College Botany (Vol. II) Pteridophyta, Gymnosperm and Paleobotany. S. Chand & Co. New Delhi.
- Prasad B.N. and Singh Y. 1996. Algal Indicators of Water Pollution. Bishen Singh and Mahendra Pal Singh, Dehradun.
- Prescott, G.W. 1984. The Algae (A review). Publ. Bishen Singh and Mahendra Pal Singh, Dehradun.
- Puri, P. 1985. Bryophytes. Atmaram and Sons, Delhi.
- Rashid, A. 1998. An introduction to Bryophyta. Vikas Publishing House, New Delhi.
- Rashid, A.1999. An introduction to Pteridophyta .Vikas Publishing House, New Delhi.
- Sharma, O.P. 2007. A text book of Algae. Tata Mc Grow Hill, New Delhi.
- Singh A.P. and Nath, V. 2001. Hepaticaceae of Khasi and Jaintia Hills. Eastern Himalayas. Publ. Bishen Singh and Mahendra Pal Singh, Dehradun.
- Surange, K.R. 1966. Indian Fossil Pteridophytes. CSIR, New Delhi.
- Vashistha, B.R, Sinha, A.K. and Kumar, A. 2010. Botany for degree students: Algae. S Chand& Co., New Delhi.

SEMESTER 2

Paper 2: Theory
Gymnosperms, Paleobotany, Morphology and Anatomy

Unit 1

1. Classification of gymnosperms according to Coulter and Chamberlain.
2. Phylogenetic relationship and affinities of gymnosperms.
3. Morphology, reproduction and life cycles of *Cycas, Pinus* and *Gnetum.*
4. Economic importance of gymnosperms.

Unit 2

1. A general account of fossil gymnosperms Cycadofilicales
2. Geological time scale.
3. Fossil formation and plant fossil types.
4. General account of dominant Jurassic flora.

Unit 3

1. Types of bracts and inflorescence.
2. Floral morphology – Forms of calyx, corolla and aestivation; Types of stamens and carpels; ovule forms and placentation.
3. Leaf morphology – Phyllotaxy and venation, types of stipules.
4. Morphology and evolution of stamens and carpels.

Unit 4

1. Organization of apical meristem
2. Types of stomata in angiosperms
3. Components of xylem and phloem.
4. Secondary growth in stem.
5. Anomalous secondary growth in *Mirabilis, Bignonia* and *Dracaena.*

Paper 2: Practical
Gymnosperms, Paleobotany, Morphology and Anatomy

1. Study of vegetative and reproductive structures of all prescribed gymnosperms by preparing temporary stained slides (dissection, sectioning, drawing, description and identification upto genus).
2. Anatomical studies of anomalous secondary structures of *Mirabilis, Bignonia* and *Dracaena.*
3. Study of fossils through slides or specimens.
4. Spotting: Includes those groups and sections not covered in the preparations.
5. Study of double staining techniques **(**Safranin and Haematoxylin or Saffranin and fast green).
6. Sectioning and observation of placentation types,ovule structure and anther through temporary preparations.

Recommended Readings(Paper 2: Gymnosperms, Paleobotany, Morphology and Anatomy)

- Bhatnagar,S.P. and Moitra, A. 2005. Gymnosperms.New Age International Pvt. Ltd.
- Esau, K. 1985. Plant Anatomy, 2nd edition. Wiley eastern, New Delhi.
- Fahn, A. 1990, Plant Anatomy , Pergmon Press, Oxford, London.
- Sporne, K.R. 1991. The Morphology of Gymnosperms. B.I. Publications, Bombay.

Suggested Readings(Paper 2: Gymnosperms, Paleobotany, Morphology and Anatomy)

- Beek, B.C. 2002. Origin and Evolution of Gymnosperms
- Bhattacharya, K., Hait, G. and Ghosh, A. 2013. A Text Book of Botany Volume 2. New Central Book Agency, Kolkata.
- Clarke, D.L. 1976. Fossils, Paleobotany and Evolution. W.M.C. Brown Company, New York.
- Eames, A.J. 1981. Morphology of Angiosperms. McGraw Hill, New York.
- Fahn, A. 1997. Plant Anatomy. Publ. Aditya Books (P) Ltd. New Delhi.
- Foster, A.S. and Gifford, E.M. 1962. Comparative Morphology of Vascular Plants. Allied Pacific Pvt. Ltd. Bombay.
- Gangulee, H.C. and Kar, A.K. 1986. College Botany, Vol Ii. Central Book Depot, Calcutta.
- Gifford, E.M. and Foster, A.S. 1989. Morphology and Evolution of Vascular Plants (3rd edition). Publ. W.H. Freeman & Co. New York.
- Iqbal, M. 1994. Growth Patterns in Vascular Plants. Publ. Discorides Press, USA>
- Johanson, 1950. Plant Microtechnique. McGraw Hill Publ. London.
- Maheswari, J.K. 2001. Recent Researches in Plant Anatomy and Morphology. Publ. Science Publication, Jodhpur.
- Meyen, S.V. 1978. Fundamentals of Paleobotany. Chapman & Hall, London.
- Misra, S.P. &Shukla, A.C. 1982. Essentials of Paleoboany. Vikas Publishing House, New Delhi.
- Mitra, D., Guha, J. and Chaudhury, S.K. 2000. Studies in Botany, Vol I. Moulik Library, Kolkatta.
- Pandey, B.P. 2014. Plant Anatomy. S.Chand& Co. Ltd.
- Pandey, B.P. 2000. College Botany (Vol. II)Pteridophyta, Gymnosperm and Paleobotany. S. Chand & Co. New Delhi.
- Sporne, K.R. 1985. Morphology of Gymnosperms. Hutchinson University Library, London.
- Steward, W.N. and Rothwell, G.W. 1993. Paleobotany and The Evolution of Plants. Publ. Cambridge University Press, London.
- Thomas, B.A. and Spicer, R.A. 1986. The Evolution and Paleobotany of Land Plants. Publ. Crom Helm, London & Sydney.
- Trivedi, B.S. and Singh, D.K. 1965. Structure and reproduction of gymnosperms. ShashidharMalaviyaPrrakashan Publications.
- William C, Dickinson, 2000. Integrative Plant Anatomy. Publ. Academic Press.

Semester 3

Paper 3: Theory

Angiosperm taxonomy, Economic Botany, Ethnobotany and Phytogeography

Unit 1

1. Major systems of classification – artificial, natural and phylogenetic.
2. Bentham and Hooker's, and Hutchinson's system of classification.
3. I.C.N. – Principles of Botanical Nomenclature, Type method and typification, and Rules and limitations of Priority.

Unit 2

1. Distinguishing features and economic importance of the following dicotyledonous families: Ranunculaceae, Fabaceae, Asteraceae, Solanaceae, Verbenaceae and Lamiaceae.
2. Distinguishing features and economic importance of the following monocotyledonous families: Liliaceae, Zingiberaceae, Orchidaceae and Poaceae.

Unit 3

1. Ethnobotany and its significance; Study of some ethnobotanical plants of north- eastern India having medicinal and food values.
2. Study of economically important plants – cereals, pulses, oil yielding, spices, condiments, fibres, ornamentals and aromatic (scientific names, families, and parts used of at least three plants under each category).
3. Characteristics, cultivation and uses of aromatic and medicinal plants (*Citronella* and *Rauwolfia*).
4. Characteristics, cultivation and uses of timber yielding plants (Teak and Sal).
5. Cultivation and processing of tea and rubber.

Unit 4

1. Floristic regions of India.
2. Continuous and discontinuous plant distribution in India: Factors and theories.
3. Centre of origin of plants (Primary and Secondary centres).
4. Barriers to plant migration.

Paper 3: Practical

Angiosperm taxonomy, Economic Botany, Ethnobotany and Phytogeography

1. Taxonomic studies of angiosperm plants belonging to both dicot and monocot families mentioned in Paper 3. Flower dissection, drawing and description in technical language, and identification upto Genera.
2. Qualitative detection of starch, protein, fat and cellulose in plant materials by chemical tests.
3. Spotting: Economically important plants or plant products prescribed in Paper 3.
4. Techniques for preparation of herbarium sheets of flowering plants and submission of at least 5 herbarium sheets.
5. Study of 5 plants having ethnobotanical importance.
6. One local field trip of botanical relevance.

Recommended Readings

- Naik, V.N. 2014. Taxonomy of Angiosperms. Tata McGraw Hill Publ. New Delhi.
- Lawrence, G.H.M. 1951. Taxonomy of Vascular Plants. Macmillan Company, New York.
- Puri, G.S. 1990. Forest Ecology Volume 1. Oxford IBH, New Delhi.
- Jain, S.K. 1981. Glimpses of Indian Ethnobotany. Oxford IBH, New Delhi.

- Hill, A.F. 2003. Economic Botany: A Textbook of Useful Plants and Plant Products. Textbook Publishers

Suggested Readings

- Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Thomas Nelson, London.
- Davis, P.H. and Heywood, V.H. 1967. Principles of Angiosperm taxonomy. Oliver & Boyd, London.
- Gangulee, H.C., Das, K.S. and Dutta, T.C. 1986. College Botany Vol II. New Central Book Agency, Calcutta.
- Hutchinson, J. 1979. Evolution and Phylogeny of Flowering Plants. Publ. Acad. Press, London.
- Jain, S.K. 1987. A Manual of Ethnobotany, Scientific Publishers, Jodhpur.
- Jain, S.K. and Mundgal, V. 1999. Handbook of Ethnobotany, London.
- Mitra, D., Guha, A.C. and Chaudhury, S.K. 2000. Studies in Botany. Vol I and II Moulik Library, Calcutta.
- Misra, K.C. 1988. Manual of Plant Ecology 3rd edition. Oxford and IBH Publishing Co. New Delhi.
- Mondol, A.K. 2014. Advanced Plant Taxonomy. New Central Book agency, Kolkata.
- Pandey B.P. 2013. College Botany.Volume I, II and III. S.Chand& Company New Delhi.
- Saxena, N.B. and Saxena, S. 2008. Plant Taxonomy. PragatiPrakashan, Meerut.
- Koromondy, E.J. 1996. Concepts of Ecology. Prentice Hall, New Delhi
- Kumar, N.C. 1995. An Introduction to Taxonomy of Angiosperms. Himalaya Publishing House, Mumbai.
- Santra, S.C., Chatterjee, T.P. and Das, A.P. 2012. College Botany Practical Volume 2. New Central Book Agency.
- Sen, S. 2004. Economic Botany. New Central Book Agency.
- Shreemali, J.L. 1979. Economic Botany, KitabMahal, Allahabad.
- Singh, B.D. 1998. Plant Breeding. Kalyani Publishers.
- Vairavan, K. 2007. Biofuel Crops: Cultivation and Management (Jatropha, Sweet sorghum and Sugarbeet), Agrobios India Publications.

Semester 4

Paper 4: Theory

Microbiology, Mycology and Plant Pathology

Unit 1

1. Basic concept of Archaebacteria,Cyanobacteria, Actinomycytes and Mycoplasmas.
2. Ultra structure of bacterial cell; gram positive and gram negative cell wall.
3. Binary fission and endospore formation in bacteria.
4. Viruses: Classification, characters; Structure of TMV and Bacteriophage T4.
5. Lytic and Lysogenic cycles of viruses.

Unit 2

1. Growth and nutrition of microbes.
2. Different groups of micro-organisms in soil, their role in decomposition of organic matter and in Nitrogen fixation.
3. Sewage treatment.
4. Basic Concept of food spoilage and food poisoning. Microbes in milk and milk products.
5. Antibiotics: types of antibiotics, history and modes of action.

Unit 3

1. Classification of fungi according to Ainsworth.
2. Development of ascus and basidium
3. Range of vegetative structure and reproduction in fungi. Economic importance of fungi.
4. Life cycles of *Pythium, Erysiphe, Puccinia*and *Agaricus.*
5. Growth forms, structure and economic importance of lichens.

Unit 4

1. Classification of plant diseases; Koch's postulates.
2. Host parasite interaction and pathogenicity.
3. Histological and biochemical defense mechanism against infection.
4. Transmission and dissemination of diseases.
5. Disease symptoms, disease cycle and control measures of late and early blight of potato, white rust of crucifers and citrus canker.

Paper 4: Practical

Microbiology, Mycology and Plant Pathology

1. Calibration of microscope and measurement of microbial spores (fungal and bacterial).
2. Demonstration of fungal or bacterial population density (spores) using haemocytometer.
3. Study of gram positive and gram negative bacteria (leguminous root nodules and curd).
4. Study of the vegetative and reproductive parts of the specimens prescribed in Unit 3 of Paper 4 with the help of temporary preparations. Sectioning, drawing, description and identification and classification of the specimens.
5. Study of diseased specimens prescribed in Unit 4 of Paper 4 by temporary preparations and permanent slides.
6. Collection, identification and submission of at least 5 diseased plant specimens.

Recommended Readings

- Dubey, R.C. &Maheswari, D.K. 1999. A Text Book of Microbiology, S. Chand & Co. New Delhi.
- Mehrotra, R.S. 1995. Plant Pathology, 12th edition. Tata McGraw Hill Publishers Com. Pvt, Ltd.
- Mehrotra, R.S. and Aneja, K.R. 1990. An Introduction to Mycology. Published by New Agw International, New Delhi.
- Tórtora Gerard J., FunkeBerdell R., Case Christine L., 2007. Microbiology: An Introduction, Volume 1, 6th edition Publisher Pearson education
- Webster, J. and Weber, R. 2007 Introduction to Fungi. 3rd edition, Cambridge University Press,Cambridge.

Suggested Readings

- Agrios GN (2005) Plant Pathology, 5th Edition. Academic Press, U.K.
- Agrios, G.N. 2006. Plant Pathology, Indian reprint, Publ. Reed Elsevier India, New Delhi.
- Agrios, G.N. 2008. Microbiology and Plant Pathology, 5th edition. Publ. McMillan Publishing Co. N. York.
- Alexopoulos, C.J. and Mims, C.W. 1979. Introductory Mycology, 3rd edition, Wiley Eastern Limited, New Delhi.
- Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4th edition, John Wiley and Sons (Asia) Singapore.
- Banerjee, A.K. 2006. Fundamentals of Microbiology, 1st edition, New Central Book Agency, Kolkata.
- Bessey, E.A. 1979. Morphology and Taxonomy of Fungi. Vikas Publishing House, New Delhi.
- Bilgrami, K. and Vyas, K.N. 1980, 1981. Recent Advances in the Biology of Microorganisms Vol I &II.
- Bold, H.C., Alexopoulos, C.J. & Delevoryas, T. 1980. Morphology of Plants and Fungi. Harper and Foul, New York.
- Burnett, H.H. 1976. Fundamentals of Mycology. Edward Arnold, London.
- Dickson, J.G. 1956. Diseases of Field Crops, Tata McGraw Hill Publ. New Delhi.
- Dube, H.C. 1990. An Introduction to Fungi. Vikas Publishing House, New Delhi.
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- Kumar, H.D. and Rai, L.C. 1990. Microbes and Microbial Processes. Affiliated East Press, New Delhi.
- Misra, R.R. 1996. Soil Microbiology, CBS Publication.
- Mitra, D. Guha, J. and Chaudhury, S.K. 2000. Studies in Botany. Moulik Library, Calcutta.
- Mundkar, B.B. 1967. Fungi and Plant diseases. McMillan and Co. kolkata.
- Onions, A.H.S., Allsopp, D. and eggins, H.P.W. 1981. Introduction to Industrial Mycology, 7th edition. Edward Arnold, London.
- Pawar, C.B. 1987. General Microbiology, Vol I & II. Himalayan Publishing House, New Delhi.
- Pelczar, M.J. 2001. Microbiology, 5thedition, Tata McGraw Hill Co, New Delhi.
- Prescott L, Harley J, Klein D. 2005. Microbiology, 6th edition, McGraw-Hill Co., New Delhi.
- Singh V.P. and Stapleton R.D. (Eds.) 2002. Biotransformations: Bioremediation Technology for Health and Environmental Protection. “Progress in Industrial Microbiology Vol. 36”, Elsevier Science.
- Singh, R.P. 2004. Microbiology. Kalyani Publishers, New Delhi.
- Singh, R.S. 1998. Plant Diseases. 7th edition, Oxford & IBH, New Delhi.
- SubbaRao N.S. Advances in Agriculture Microbiology, Butterworth-Heinemann.
- Talaro Kathleen P. and Talaro Arthur, 2002. 4th edition Foundations in Microbiology: Basic Principles Publishers McGraw-Hill
- Vashistha, B.R. 1988. Fungi. S.Chand& Co., New Delhi.
- Webster, J. and Weber, R. 2007. Introduction to Fungi. 3rd edition, Cambridge University Press,Cambridge.

Semester 5

Paper 5: Theory

Plant Physiology and Biochemistry

Unit 1

1. Water potential and its significance
2. Translocation of minerals; active and passive transport
3. Mineral nutrition (micro and macro nutrients, criteria of essentiality - properties and deficiency symptoms)

Unit 2

1. Photosynthesis: Structure of chloroplast, photosynthetic pigments, PSI and PSII, mechanism of C_3, C_4 and CAM pathways, photosynthetic electron transport chain, and effect of environmental factors on photosynthesis.
2. Respiration: Glycolysis, Kreb's cycle, Electron transport chain.
3. Photorespiration.
4. Biological N_2 fixation, assimilation of ammonia.

Unit 3

1. Photoperiodism and Vernalization
2. Physiological effects of auxins, gibberellins, ABA and cytokinins.
3. Seed dormancy and its regulation.
4. Physiology of senescence

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Unit 4

1. Structure and classification of carbohydrates, amino acids and proteins. Levels of protein structure- primary, secondary and tertiary.
2. Enzymes – Classification, structure and mechanism of action (characteristics of enzyme active sites, kinetics of enzyme catalysis, Vitamins as co-enzymes).
3. Laws of Thermodynamics.

Paper 5: Practical

Plant Physiology and Biochemistry

1. Study of transpiration rate in dorsiventral leaves by Blackman's apparatus.
2. Determination of water potential by plasmolyticandgravimetric method.
3. Study of the effect of light on oxygen evolution during photosynthesis by Winkler's Method.
4. Preparation of standard curves for estimation of the following
   a) Starch by I_2KI method.
   b) Amino acid by Ninhydrin reagent.
6. Separation of amino acids by paper chromatography
7. Effect of substrate concentration on amylase activity.

Recommended Readings

- Hopkins, W.G. and Hunter, N.P. 2009. Introduction to Plant Physiology. John Wiley and Sons.
- Murray, R.K.,Rodwell, V. W., Bender, D., Botham, K.M. , Weil, P.A., Kennelly, P.J. 2009. Harper's illustrated Biochemistry, 28th Edition, MC Graw Hill.
- Nelson, D. L. and Cox, M. M. 2012. Lehninger Principles of Biochemistry, Sixth Edition. W.H. Freeman and Co. Publishers.
- Salisbury, F.B. and Ross, C.W. 2009. Plant Physiology, Publ. Wadsworth.

Suggested Readings

- Berg, J.M., Tymoczko, J.L. and Stryer, L. 2011. Biochemistry, 5th edition. W.H. Freeman & Co.
- Buchanan, B.B., Wilhelm, G. andRussel, J. 2003. Biochemistry and Molecular Biology of Plants. ASPB. US.
- Datta, S.C. 1989. Plant Physiology. Allahabad Central Book Depot, Allahabad.
- Devlin, R.M. 1969. Plant Physiology. Affiliated East West, New Delhi.
- Gangulee, H.C. &Kar, A.K. 1986. College Botany, Vol II. Central Book Depot, Calcutta.
- Lender, D.W. 2001. Photosynthesis. Mercer Deker.
- Mathews, C.K., Van Holde, K.E. & Ahern, K.G. 2000. Biochemistry. Macmillan Worth.
- Mitra, D., Guha, J. &Chaudhury, S.K. 2000 Studies in Botany Vol II. Moulik Library, Kolkata.
- Mukherjee, S., Ghosh, A.K. 2012. Plant Physiology. New Central Book Agency, Kolkata.
- Nelson, D.L. and Cox, M.M. 2000. Lehninger's Principles of Biochemistry. Macmillan Worth.
- Nelson, D.L. and Cox, M.M. 2005. Lehninger, Principles of Biochemistry, 4th edition, W.H. Freeman & Co.
- Noogle, G.R. and fritz, G.J. 1985. Introductory Plant Physiology. Prentice Hall of India, New Delhi.
- Pandey, S.N. and Sinha, B.K. 2014. Plant Physiology. Vikas Publishing House, New Delhi.
- Santra, S.C., Chatterjee, T.P. and Das, A.P. 2012. College Botany Practical Volume 1. New Central Book Agency.
- Sinha, R.K. 2007. Modern Plant Physiology 2nd edition. Publ. Narosha Publ. House.
- Taiz, L. and Zeiger, E. 2010. Plant Physiology, 5th edition. Panama Publishing Corp.
- Thomas, B. and Vince-Prue, D. 1997. Photoperiodism in Plants. Academic Press.
- Verma, S.K. 2013. Text book of Plant Physiology and Biochemistry. S. Chand & Company, New Delhi.
- Voet, D.J., Voet, J.G. & Pratt, C.W. 2008. Principles of Biochemistry. John Wiley Inc.
- Voet, D., Voet, J.G. & Pratt, C.W. 2006. Fundamentals of Biochemistry, 2nd edition. John Wiley and Sons Biochemistry (3rd edition) John Wiley & Sons.
- Wilkins, M.B. 1987. Advanced Plant Physiology. ELBS, Longman Group Ltd.

Semester 5

Paper 6: Theory

Ecology and Conservation Biology

Unit 1

1. Ecological Factors: Climatic (light, temperature, precipitation and fire), Edaphic (soil formation process, soil types, soil texture, soil profile, soil reaction and soil organic matter), Physiographic (slope and aspect of mountain) and Biotic (anthropogenic and non- anthropogenic) factors.
2. Ecological adaptations: hydrophytic, xerophytic, epiphytic and halophytic adaptations.
3. Ecological levels of organization: population, community, ecosystem, landscape, biome and biosphere.

Unit 2

1. Population ecology: Attributes of plant populations, mortality, natality, survivorship curves and population growth.
2. Population interactions: Types of interactions, symbiosis, parasitism, commensalism, proto-cooperation and competition.
3. Community ecology: Community structure – qualitative and quantitative attributes of community; Community dynamics – primary and secondary succession, stages of succession; hydrosere and xerosere.

Unit 3

1. Structural attributes of ecosystem: Abiotic components (Inorganic elements, organic compounds and climatic regimes) and Biotic components (producers, macroconsumers and microconsumers).
2. Functional attributes of ecosystem: Flow of energy: Energy flow model (Box and pipemodel), Ecological pyramids,Primary production (types and distribution),Food chain and food web.
3. Biogeochemical Cycles: Hydrological cycle, Gaseous cycle (carbon) and Sedimentary cycle (phosphorus).

Unit 4

1. Air, water and soil pollution: sources, effects and abatement.
2. Global environmental problems: Causes, consequences and remedial measures of ozone layer depletion, Climate change and global warming (greenhouse effect), Desertification.
3. Plant diversity and conservation: Magnitude of vascular plant diversity in India, Plant conservation measures – *in-situ* (Biosphere Reserve, National Park, Wildlife Sanctuary, World Heritage Site and Community Conserved Area) and *ex-situ* (Botanical Garden, Seed Bank, Gene Bank and Cryopreservation).

Paper 6: Practical

Ecology and Conservation Biology

1. Determination of pH of soil samples of various sites using pH meter.
2. Determination of moisture content of two different soil samples using gravimetric method.
3. Determination of soil organic matter content of different soil samples by Walkley and Black's rapid titration method.
4. Determination of requisite size and requisite number of quadrats for the study of a plant community.
5. Determination of frequency, density, abundance, and basal area by quadrat method and IVI.
6. Study of morphological and anatomical features of xerophytes, hydrophytes and epiphytes.
7. Study of spatial and temporal variations in climatic factors – light, temperature and relative humidity.

Recommended Readings

- Odum, E.P. 1983. Basic Ecology, 5th edition. Thomson Business InternationalWaldisPvt Ltd. Barichad.
- Townsend, C.R.,Begon, M. and Harper, J.L. 2006. Essentials of Ecology. 2ndedition. Blackwell Publishers.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand publishing, Delhi.

Suggested Readings

- Ambasht, R.S. and Ambasht, N.K. 2011. A Text Book of Plant Ecology, 15th edition. CBS Publishers and Distributors, New Delhi.
- Bell, P.R. and Woodcock, C.L.F. 1986. Diversity of Green Plants, 3rd edition, ELBS, Edward Arnold.
- Begon, M. Townsend, C.R. and Harper, J.L. 2006. Ecology from Individuals to ecosystem, 4th edition. Blackwell Publishers.
- Begon, M. and Harper, J.L. 2000. Essentials of Ecology. Blackwell Publishing.
- Crawley, M.J. 1997. Plant Ecology. Blackwell Science.
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- Hill, M.K. 1997. Understanding Environmental Pollution. CambridgeUniversity Press, Cambridge.
- Kandya, A.K. and Gupta, A. 2007. Advancing Frontiers of Ecological Researches in India.
- Koromondy, E.J. 1996. Concepts of Plant ecology, 4th edition, Publ. Prentice Hall of India, New Delhi
- Krebs, C. 2008. The Ecological World View. CSIRO publishing.
- Misra, K.C. 1988. Manual of Plant Ecology, 3rd edition. Oxford and IBH Publishing Co. New Delhi.
- Mitra, D., Guha, J. and Chaudhury, S.K. 2000. Studies of Botany, Vol II. Moulik Library, Kolkata.
- Mohapatra, A.C., Barik, S.K. and Rao, C.S. 2000. Man and Environment. Star Publ. House, Shillong.
- Molles, M.C. 2005. Ecology – Concepts and Applications. McGraw Hills.
- Odum, E.P. 1971. Fundamentals of Ecology, 3rd edition. W.B. Saunders Co. Philadelphia.
- Prasanthrajan, M. and Mahendran, P.P. 2008. A Text Book on Ecology and Environmental Sciences. Publ. Agrotech, Udaipur.
- Sharma, P.D. 2013. Ecology and Environment, Rastogi Publishers.
- Tiwari, S.C. 2005. Concepts of Modern Ecology.
- Weaver, J.E. and Clements, F.E. 1986. Plant Ecology, 2nd edition. Tata McGraw, New Delhi.

Semester 6

Paper 7: Theory

Genetics, Plant Breeding and Molecular Biology

Unit 1

1. Mitosis and Meiosis, and their significance.
2. General account of structure of chromosomes and their role in inheritance; Chromosomal theory of inheritance.
3. Mendel's laws of Inheritance, Alleles and multiple alleles.
4. Gene Interaction (epistasis, supplementary, complementary and duplicate genes).
5. Linkage and crossing over.

Unit 2

1. Extra-nuclear inheritance (cytoplasmic male sterility and variegated leaves in *Mirabilis*).
2. Sex chromosomes and mechanisms of sex determination.
3. Structural and numerical aberrations of chromosomes in plants.

Unit 3

1. Principles of crop improvement: domestication, introduction, hybridization, and artificial selection.
2. Methods of crop improvement: Pure line and mass selection with examples.
3. Heterosis and Inbreeding depression.
4. Gene mutation and its role in crop improvement and evolution.

Unit 4

1. Structure of B DNA and RNA; secondary folding of tRNA.
2. Mechanism of DNA replication: semi-conservative and semi discontinuous.
3. Mechanism of transcription; Operon concept: inducible and repressible operons.
4. Recombination in bacteria (conjugation, transformation and transduction).
5. Mechanism of protein synthesis in prokaryotes.

Paper 7: Practical

Genetics, Plant Breeding and Molecular Biology

1. Preparation of temporary slides of root tips, and study of mitosis.
2. Study of cell division in flower buds and identification of meiotic stages.
3. Study of Polytene chromosome through permanent slides.
4. Study of monohybrid and dihybrid ratios and their modifications by using Chi square test of significance.
5. Preparation of standard curve for estimation of:
   (a) DNA by diphenylamine method
   (b) RNA by orcinol method
6. Estimation of soluble proteins in plant materials by Bradford's method
7. Emasculation, bagging, tagging and pollination in self- pollinated plants.

Recommended Readings

- Gupta, P.K. 2014. Genetics. Rastogi Publications, Meerut.
- Misra, A.K. 2011. Fundamentals of Cell and Molecular Genetics. Panama Publ. House, New Delhi.
- Singh. B.D. 2013. Plant Breeding. Kalyani Publishers. New Delhi.
- Strickberger, M.W. 2008. Genetics. PHI Learning, Delhi.

Suggested Readings

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- Gardner, E.J., Simmons, M.J. and Snustad, D.P. 1991. Principles of genetics, 8th edition. John Wiley & Sons Inc.
- Gupta, P.K. 1999. A Text Book of Cell and Molecular Biology, Rastogi Publ. Meerut.
- Hartl,D.L. and Jones,E.W. 1998. Genetics: Principles and Analysis. Jones and Barlett, Massachusetts.
- Jain, H.K. 1999. Genetics. Oxford IBH
- Kar, D.K. and Haldar, S. 2013. Plant Breeding, Biometry, Biotechnology. New Central Book Agency, Kolkata.
- Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. 2010. Lewin's genes X. Jones and Barlett.
- Mitra, D., Guha, J. and Chaudhury, S.K. 2000. Studies in Botany Vol II. Moulik Library, Kolkata
- Razdan, M.K. 2002. Molecular Biology and Biotechnology, 4th edition. Publ. Panama Publ. House, New Delhi
- Roy, S.C. and DE, K.K. 2011. Cell Biology. New central Book Agency, Kolkata.
- Sharma, Archana. 1990. The Chromosomes, 3rd edition. Oxford & IBH, Delhi
- Sharma, A.K. and Sharma, A. 1980. Chromosome Techniques; Theory and Practice. Butterworths, London (Indian edition: Aditya Books, New Delhi).
- Sharma, J.R. 1994. Principles and Practice of Plant Breeding, Tata McGraw Hill.
- Singh. B.D. 2013. Genetics.KalyaniPublishers.NewDelhi.
- Simmons, M.J. and Snustad, D.P. 2010. Principles of Genetics, 5th edition. Publ. John Wiley.
- Sinha,U. and Sinha, U. 1976. Cytogenetics, Plant Breeding and Evolution. Vikas Publ. New Delhi.
- Tamarin, R.H. 2002. Principles of Genetics. Publ. Tata McGraw Hill.

Semester 6

Paper 8: Theory

Plant Reproductive Biology and Plant Biotechnology

Unit 1

1. Microsporogenesis and Microgametogenesis; Pollen production and dispersion in time and space
2. Pollination mechanisms; Pollen pistil interaction and self incompatibility
3. Pollen morphology and its role in taxonomy; Pollen allergy

Unit 2

1. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic)
2. Fertilization; Structure and function of synergids.
   Development, structure and function of endosperm and its haustoria;
3. Dicot embryogenyand suspensor; Polyembryony.

Unit 3

1. Cell and tissue culture techniques.
2. Cellular differentiation and totipotency; organogenesis and embryogenesis.
3. Protoplast isolation and culture; Somatic hybridization and clonal propagation of elite plants (Shoot tips, axillary buds and meristem culture)
4. Production of haploid plants from anther, pollen and ovule
5. Cryopreservation: Vitrification, artificial seeds

Unit 4

1. Concepts of genetic engineering and its applications.
2. Vectors for gene delivery (Ti Plasmid and Lambda phage)
3. Tools and techniques of Gene cloning.
4. Achievements in crop biotechnology (insect control and quality improvement) e,g Golden rice and BT cotton.
5. Introductory bio-informatics

Paper 8: Practical

Plant Reproductive Biology and Plant Biotechnology

1. Preparation of slides using acetolysis method and study of pollen morphology.
2. Excision of endosperm and embryo.
3. Estimation of germination percentage of pollen grains using Brewbaker and Kwack's medium.
4. Study of pollen development, microsporogenesis, megasporogenesis, fertilization, endosperm and embryo using permanent slides.
5. Pollen staining using acetocarmine.
6. Preparation of tissue culture medium and inoculation of explants.

Recommended Readings

- Bhojwani, S.S. and Bhatnagar, S.P. 2014. Embryology of Angiosperms, Vikas Publishing House, New Delhi
- Gupta, P.K. 2012. Biotechnology and Genomics. Rastogi Publications,Meeerut.
- Gupta, P.K. 2009. Elements of Biotechnology. Rastogi Publications,Meeerut.

- Maheswari, P. 1985. An Introduction to Embryology of Angiosperms. Tata McGraw Hill, New Delhi.

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- Bhattacharya, K., Majumdar, M.R. and Gupta Bhattacharya, S. 2006. A Text Book of Palynology, New Central Book Agency Pvt Ltd., Kolkata.
- Bhojwani, S.S. and Bhatnagar, S.P. 2000. Current Trends in Embryology of Angiosperms. Publ Blackwell Publishers.
- Chawla, H.S. 2002 Introduction to Plant Biotechnology. Published by Oxford and IBH Publ.
- Debta, A., Panda, D. and Debta, A. 2014. Language of Biotechnology. New Central Book Agency, Kolkata.
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- Pandey, A.K. 1997. Introduction to Embryology of Angiosperms. CBS Publishers and Distributors, New Delhi.
- Prakash, J. andJothi, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
- Pulliah, I. Laksminarayana, K. and Rao, H. 2008. Plant Reproduction, Publ Science, Jodhpur.
- Raghavan, V. 1999. Development Biology of Flowering Plants. Publ. Springer, Verlag, New Delhi.
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- Sharma, C.N. 1991. Palynology in Forestry and Tree Improvement.
- Shivanna, K.R., Rangaswami, N.S. 1993. Pollen Biology, A Laboratory Manual. Narosa Publishing House, New Delhi.
- Slater, A., Scott, N. W. and Fowler, M. R, 2008. Plant Biotechnology: The genetic manipulation of plants. Oxford University Press.
- Smith, J.E. 1988. Biotechnology 2nd edition. Edward Arnold, London.