

SHOOLINI UNIVERSITY

of

Biotechnology and Management Sciences

SOLAN, HIMACHAL PRADESH



School of Botany

FACULTY OF SCIENCE,

SOCIAL SCIENCE AND LANGUAGES

SYLLABI

FOR

M.Sc. (TWO YEAR COURSE)

BOTANY

(I-IV) SEMESTER

EXAMINATIONS 2011 – 2012

**OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M.Sc.
BOTANY (TWO-YEAR COURSE) SEMESTER SYSTEM EXAMINATIONS OF
2011–2012**

FIRST SEMESTER:

PAPER	SUBJECT	THEORY Max. Marks
Bot. 501	Biology and Diversity of Algae and Fungi	50
Bot. 502	Biology and Diversity of Microbes and Plant Pathology	50
Bot. 503	Biology and Diversity of Bryophytes and Pteridophytes	50
Bot. 504	Plant Resource Utilization and Plant Breeding	50

Practical, Seminar, Attendance, Assignment, Sessional- 50 Marks per course

Total Marks 200+200
GRAND TOTAL OF MARKS=400

SECOND SEMESTER:

PAPER	SUBJECT	THEORY Max. Marks
Bot. 505	Spermatophytes	50
Bot. 506	Cell and Plant Molecular Biology	50
Bot. 507	Biotechnology	50
Bot. 508	Ecology and Biophysical Environment	50
Bot. 509	Computer Applications and Biostatistics	50

Practical, Seminar, Attendance, Assignment, Sessional- 50 Marks per course

Total Marks 250+250
GRAND TOTAL OF MARKS=500

THIRD SEMESTER:

PAPER	SUBJECT	THEORY Max. Marks
Bot. 510	Reproductive Biology	50
Bot. 511	Plant Physiology and Biochemistry	50
Bot. 512	Cytogenetics and Evolutionary Biology	50
Bot. 525-30	Elective Course (Any one)	50

Practical, Seminar, Attendance, Assignment, Sessional- 50 Marks per course

Total Marks 200+200
GRAND TOTAL OF MARKS=400

FOURTH SEMESTER:

PAPER	SUBJECT	THEORY Max. Marks
Bot. 513	Plant Morphogenesis and Anatomy	50
Bot. 514	Metabolism of Biomolecules and Immunology	50
Bot. 515	Instrumentation Methods and Analysis	50
Bot. 531-36	Elective Course (Any one)	50

Practical, Seminar, Attendance, Assignment, Sessional- 50 Marks per course

Total Marks 200+200
GRAND TOTAL OF MARKS=400

MASTER OF SCIENCE IN BOTANY (SEMESTER SYSTEM)
SCHOOL OF BOTANY

SCHEME OF COURSES:

IST SEMESTER:

Sr.No.	Course No.	C/E*	Course Title	Credits	Total Credits
Core Courses					
1.	Bot. 501	C	Biology and Diversity of Algae and Fungi	3+1	4
2.	Bot. 502	C	Biology and Diversity of Microbes and Plant Pathology	3+1	4
3.	Bot. 503	C	Biology and Diversity of Bryophytes and Pteridophytes	3+1	4
4.	Bot. 504	C	Plant Resources Utilization and Plant Breeding	3+1	4
Total Credits				12+4	16

*C- Core Course

E- Elective Course

IIND SEMESTER:

Sr.No.	Course No.	C/E*	Course Title	Credits	Total Credits
Core Courses					
5.	Bot. 505	C	Spermatophytes	3+1	4
6.	Bot. 506	C	Cell and Plant Molecular Biology	3+1	4
7.	Bot. 507	C	Biotechnology	3+1	4
8.	Bot. 508	C	Ecology and Biophysical Environment	3+1	4
9.	Bot. 509	C	Computer Applications and Biostatistics	2+1	3
Total Credits				14+5	19

*C- Core Course

E- Elective Course

IIIRD SEMESTER:

Sr.No.	Course No.	C/E*	Course Title	Credits	Total Credits
Core Courses					
10.	Bot. 510	C	Reproductive Biology	3+1	4
11.	Bot. 511	C	Plant Physiology and Biochemistry	3+1	4
12.	Bot. 512	C	Cytogenetics and Evolutionary Biology	3+1	4
Elective Course					
		E	Elective Course	2+1	3
Total Credits				11+4	15

*C- Core Course

E- Elective Course

IVTH SEMESTER:

Sr.No.	Course No.	C/E*	Course Title	Credits	Total Credits
Core Courses					
13	Bot. 513	C	Plant Morphogenesis and Anatomy	3+1	4
14.	Bot. 514	C	Metabolism of Biomolecules and Immunology	3+1	4
15.	Bot. 515	C	Instrumentation Methods and Analysis	2+1	3
Elective Course					
		E	Elective Course	2+1	3
Total Credits				10+4	14

*C- Core Course

E- Elective Course

LIST OF ELECTIVE COURSES

Sr.No.	Course No.	C/E*	Course Title	Credits	Total Credits
ELECTIVE COURSES FOR THIRD SEMESTER					
16.	Bot. 525	E ₁	Restoration Ecology	2+1	3
17.	Bot. 526	E ₂	Applied Mycology	2+1	3
18.	Bot. 527	E ₃	Ethnobotany and Sustainable Utilization of Plant Resources	2+1	3
19.	Bot. 528	E ₄	Advanced Plant Physiology	2+1	3
20.	Bot. 529	E ₅	Agroforestry System	2+1	3
21.	Bot. 530	E ₆	Ecological Modelling	2+1	3
ELECTIVE COURSES FOR FOURTH SEMESTER					
22.	Bot. 531	E ₁	Conservation Biology	2+1	3
23.	Bot. 532	E ₂	Principles of Plant Pathology	2+1	3
24.	Bot. 533	E ₃	Wood Science and Forest biodiversity	2+1	3
25.	Bot. 534	E ₄	Plant Growth and Development	2+1	3
26.	Bot. 535	E ₅	Forest as a Land Use System	2+1	3
27.	Bot. 536	E ₆	Environmental Management	2+1	3
Note: The order/sequence of preference for elective course will remain same in the fourth semester as in third semester.					

*C- Core Course

E- Elective Course

Course- Bot. 501

Credits: 3+1

BIOLOGY AND DIVERSITY OF ALGAE AND FUNGI

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

ALGAE:

Algae in diversified habitats (terrestrial, fresh water, marine).

Thallus organization in algae.

Cell ultrastructure.

Reproduction (vegetative, asexual, sexual) and patterns of life cycle

Criteria for classification of algae (pigments, reserve food, flagella)

UNIT-II

Fine structure of algal plastids.

Algal blooms.

Algal biofertilizers.

Economic importance of algae.

General account of lichens and their economic importance.

UNIT-III

FUNGI:

Introduction to Mycology: General characteristics of fungi, their significance to human, organization of fungal cell and thallus, reproduction (vegetative, asexual, sexual), recent trends in classification.

Comparative study of habit, habitat, somatic organization, anamorphs, teleomorphs and evolutionary tendencies in any of these phases in the life cycle of the members of Dictyosteliomycota and Myxomycota (*Dictyostelium*, *Physarum*), Chytridiomycota and oomycota (*Olpidium*, *Synchytrium*, *Allomyces*, *Plasmodiophora*, *Saprolegnia*, *Pythium*, *Phytophthora* and downy mildews), Zygomycota (within members of zygomycetes), Ascomycota (ascocarp) development, ascocarp types, centrum types and their bearing on

classification with emphasis on *Protomyces*, *Taphrina*, *Yeast*, *Penicillium*, *Aspergillus*, *Chaetomium*, *Neurospora*, *Claviceps* and *Venturia*; general account of powdery mildews and dictyomycetes, Basidiomycota (basidiocarp types, development, general account of Hymenomycetes, Ustilagomycetes and Urediomycetes); Deuteriomycetes (sporulating structure predaceous fungi, dermatophytes, *Alternaria*, *Helminthosporium*, *Cercospora*, *Colletotrichum*, *Pyricularia*, *Fusarium*).

UNIT-IV

Sex hormones in fungi, heterothallism and parasexual cycle in fungi, nutrition in fungi (saprophytes, parasites, predators, symbionts).

Importance of fungi in different microbiological and biotechnological process: fungi in food and food industry, as agents of biodeterioration and biodegradation in agriculture, in medical biotechnology and as agents of biotransformation, biosorption and biomining.

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, 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, 2009.
8. Kumar, H.D. *Introductory Phycology*. 2nd Ed. Affiliated East-West Press, New Delhi, 1999.
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, 1973.
11. South, G.R. and A. Whittick. *Introduction to Phycology*. Blackwell Scientific Pub, Oxford, 1987.
12. Ainsworth, G.C. Sparrow, F.K., and A.S. Sussman. *The Fungi- An Advanced Treatise. Vols. IV A*. Academic Press, London, 1973.
13. Alexopoulos, C.J., Mims, C.W. and M. Blackwell. *Introductory Mycology*, John Wiley and sons, INC, New York, 1996.
14. Hawksworth, D.L., Kirk, P.M., Sulton, B.C. and D.N. Pegelr. *Ainsworth and Bisby's Dictionary of Fungi*, International Mycological Institute. CAB International, 1995.
15. Mehrotra, R.S. and K.R. Aneja. *An Introduction to Mycology*. New Age International Publishers, New Delhi, 1995.

16. Webster, J. *Introduction to Fungi*, Cambridge University Press, Cambridge, London, 1980.
17. Vasishta, B.R. and A.K. Sinha, *Botany for Degree Students-Fungi*. S. Chand and Company Ltd, New Delhi, 2008.
18. Bilgrami, K.S. and R.N. Verma. *Physiology of Fungi*, 2nd Ed. Vikas Publi. House, New Delhi.
19. Burnett, J.H. *Fundamentals of Mycology*. Edward Arnold, London, 1976.
20. Sharma, P.D. *The Fungi*, 2nd Ed. Rastogi Publications, Meerut, 2004.

Course- Bot. 502

Credits: 3+1

BIOLOGY AND DIVERSITY OF MICROBES AND PLANT PATHOGENS

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

History of plant pathogens, concept, diagnosis, classification, importance and identification of unknown diseases; symptomology and disease development.

Host-pathogen-interaction at plant and cellular level: Mechanism of pathogen attack and defense; Physical, Physiological, Biochemical and molecular aspects.

Host-pathogen-interaction at population level: Transmission and spread of plant pathogens, disease epidemics, modeling and disease forecasting to control crop losses.

Management of plant diseases: Chemical, Biological, IPM system, development of transgenics, biopesticides, plant diseases clinics, quarantine.

Genetics of plant disease: Gene for virulence and avirulence, their application in resistance and susceptibility, induced resistance (immunization).

UNIT-II

Specific plant diseases caused by diverse pathogens: Black wart disease of potato, club root of crucifers, damping of seedlings, late blight of potato, downy mildew of grapes and bajra, stem gall of coriander, peach leaf curl, powdery mildew of wheat and apple, apple scab, general account of rusts, smuts, bunts, fusarial wilt of tomato, rhizome rot of ginger, tikka disease of groundnut, red rot of sugarcane, brown leaf spot and blast of rice, bacterial blight of bean, common scab of potato, fire blight of apple, citrus canker, potato leaf roll, potato spindle tuber, tobacco mosaic virus.

UNIT-III

History and scope of microbiology, landmarks in microbiology, major groups of microorganisms, characterization, identification and classification of microorganisms.

Structure of Bacteria: Structure and fine structure of cell wall and of internal and external structures to cell wall, spores and cysts. Nutrition of bacteria: modes of nutrition and nutritional types, growth characteristics. Reproduction and genetic recombination: binary fission, resting structure, conjugation, transformation and transduction; mechanism of antibacterial action.

General account of Rickettsia, Chlamydeae, Mollicutes and disease caused by them.

UNIT-IV

Viruses: History, structure and classification, plant and animal viruses, nature and transmission, genome organization (TMV, CMV, CAMV and Gemini viruses), isolation and purification, detection, identification and economics importance; Bacteriophages, virioids and prions- nature and importance.

Viruses in cancer; Principles of immunology: general account of immunity, allergy, antigen-antibody, serology and types of vaccines.

Applications of microbes in agriculture (Biofertilizers, biopesticides), industry (alcoholic beverages, citric acid, penicillin production), environment (pollution indicator and control), and genetic engineering.

SUGGESTED READINGS:

1. Agrios, G.N. *Plant Pathology*. 5th Ed. Elsevier Academic Press, San Diego, 2005.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. *Introductory Mycology*. 4th Ed. John Wiley & Sons, New York, 2007.
3. Bilgrami, K.S. and H.C. Dube. *A Textbook of Modern Plant Pathology*. Vikas Publishing House, New Delhi, 1990.
4. Bos, L. *Introduction to Plant Virology*. Longman, New York, 1992.
5. Clifton, A. *Introduction to the Bacteria*, Mc Graw Hill Books Co., New York, 1958.
6. Gibbs, A.J. and B.D. Harrison. *Plant Virology: The Principles*. John Wiley and Sons, NY, 1979.
7. Mandahar, C.L. *Introduction to Plant Viruses*, 2nd Ed. S. Chand & Co. Ltd., New Delhi, 1987.
8. Mathews, R.E.F. *Plant Virology*. 2nd Ed., Academic Press, London, 1981.
9. Mehrotra, R.S. and K.R. Aneja, *An Introduction to Mycology*, New Age International Press, Delhi, 1990.
10. Mehrotra, R.S. and A. Aggarwal. *Plant Pathology*. 2nd Ed. Tata McGraw Hill Co. Ltd., New Delhi, 2003.
11. Pelczar M.J. Jr., E.C.S. Chan and N.R. Krieg. *Microbiology*, 5th Ed. Tata McGraw Hill, New Delhi, 2007.
12. Powar, C.B. and H.F. Dagainawala. *General Microbiology*, Vols. I & II. 2nd Ed. Himalaya Publishing House, New Delhi, 1995.
13. Ronald, M. Atlas. *Principles of Microbiology*, Mosby-Year Book, Inc. St. Louis, Missouri, USA, 1995.
14. Schlegel, H.S. *General Microbiology*, 7th Ed. Cambridge University Press, Cambridge, 1993.
15. Sharma, P.D. *Plant Pathology*. Rastogi Publications, Meerut, 1998.
16. Singh, R.S. *Plant Diseases*. 8th Ed. Oxford & IBH, New Delhi, 2008.
17. Sinha, U. and S. Srivastava. *An Introduction to Bacteria*. Vikas Publishing House, New Delhi, 1983.

18. Smith, K.M. *Plant Viruses*. 6th Ed. Chapman Hall, London, 1977.
19. Stanier, R.Y. *General Microbiology*. 5th Ed. Macmillan Press Ltd., 2008.
20. Sumbali, G. *The Fungi*, Narosa Publishing House, New Delhi, 2010.
21. Webster, C.J. *Introduction to Fungi*, 2nd Ed., Cambridge University Press, Cambridge, 1980.

Course- Bot. 503

Credits: 3+1

BIOLOGY AND DIVERSITY OF BRYOPHYTES AND PTERIDOPHYTES

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

General introduction and salient features of Bryophytes, comparison among cryptogamous plants.

Classification of Bryophytes into liverworts, hornworts and mosses.

A general account of MARCHANTIALES, JUNGERMANNIALES, ANTHOCEROTALES, SPHAGNALES, FUNARIALES AND POLYTRICHALES.

A general account of peristome in mosses

Origin of land plants including fossil evidence.

UNIT-II

Primitive versus advanced/derived features and evolutionary lines within Bryophytes.

Alternation of generation in Bryophytes.

Morphogenesis in Bryophytes.

Distribution and ecology of Bryophytes in India with particular reference to Himachal Pradesh.

Ecological importance of Bryophytes.

Economical importance of Bryophytes.

UNIT-III

General introduction and salient features of Pteridophytes, comparison among ARCHEGONIATAE.

Classification of Pteridophytes.

Introduction to Palaeobotany, some basic principles and techniques

A general account of the following fossil Pteridophytes: RHYNIA, HORNEOPHYTON, TRIMEROPHYTON, PSILOPHYTON, ZOSTEROPHYLLUM, ASTEROXYLON,

LEPIDODENDRON, SIGILLARIA, PLEUROMEIA, NATHORSTIANA, SPHENOPHYLLUM, SPHENOPHYLLOSTACHYS, CALAMITES, CLADOXYLON, ETAPTERIS, ANKYROPTERIS and OSMUNDITES.

Salient features of PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA and PTEROPSIDA

UNIT-IV

Structure and Evolution of STELAR SYSTEM in Pteridophytes.

Structure and Evolution of SPORE PRODUCING ORGAN in Pteridophytes.

TELOME THEORY or evolution of Sporophytes in Pteridophytes.

Alternation of generation in Pteridophytes.

Natural and Induced implications of APOGAMY in Pteridophytes.

Natural and Induced implications of APOSPORY in Pteridophytes.

Heterospory and Seed Habit in Pteridophytes.

Distribution and ecology of FERNS of the Himalayas with particular reference to Himachal Pradesh.

Cytological Evolution in Pteridophytes.

Economic importance of Pteridophytes.

SUGGESTED READINGS:

1. Chopra, R.N. and P. K. Kumra. *Biology of Bryophytes*. Wiley Eastern Ltd., New Delhi, 1988.
2. Chopra, R.S. *Taxonomy of Indian mosses*. CSIR, New Delhi, 1975.
3. Chopra, R.S. and S.S. Kumar. *Mosses of Western Himalayas and Adjacent Plains*. Chronica Botanica, New Delhi, 1981.
4. Dyer, A. F. and J. G. Duckett.(Eds.). *The Experimental Biology of Bryophytes*. Academic press, London, 1984.
5. Goffinet, B. and A.J. Shaw. *Bryophyte Biology*. 2nd Ed. Cambridge Univ. Press, Cambridge, 2009.
6. Kashyap, S.R. *Liverworts of Western Himalayas and the Punjab Plains. Vols I II*. Researchco Publications, New Delhi, 1932
7. Kumar, S.S. *An Approach towards Phylogenetic Classification of Mosses*. Jour. Hattori Bot. Lab. Nichinan, Japan, 1984.
8. Rashid, A. *An Introduction to Bryophyta*. Ist Ed. Vikas Publishing House Pvt. Ltd., New Delhi, 1998.
9. Richardson, D.H.S. *Biology of Mosses*. Blackwell Scientific Publications, Oxford, 1981.

10. Schofield, W.B. *Introduction to Bryology*. Macmillan Publishing Co., New York., 1983.
11. Schuster, R.M. (Ed.). *New Manual of Bryology. Vols. I & II*. Jour. Hattori Bot. Lab., Nichinan, Japan, 1983-84.
12. Vashishta, B.R., A.K. Sinha and A. Kumar. *Bryophyta*. S. Chand & Co. Ltd., New Delhi, 2003.
13. Watson, E.V. *The Structure and Life of Bryophytes*. Hutchinson University Library, London, 1964.
14. Bierhorst, D.W. *Morphology of Vascular Plants*. The MacMillan, New York, 1971.
15. Bold, H.C., C.J. Alexopolous and T. Delevoryas. *Morphology of Plants and Fungi*. 4th Ed. Harper and Row Publishers, Inc., New York, 1980.
16. Chandra, S. and M. Srivastava (Eds.). *Pteridology in the New Millenium*. Kluwer Acad. Publishers, Dordrecht / Boston / London, 2003.
17. Dyer, A.F. *The Experimental Biology of Ferns*. Academic Press, London, 1979.
18. Foster, A.S. and E.M. Gifford. *Comparative Morphology of Vascular Plants*. 2nd Ed. W.H. Freeman and Co., San Francisco, 1974.
19. Gifford, E.M. and A.S. Foster. *Morphology and Evolution of Vascular Plants*. 3rd Ed. W.H. Freeman & Co., New York, 1989.
20. Khullar, S.P. *An Illustrated fern Flora of West Himalayas . Vols. I & II*. International Book Distributors, Dehradun, 2000.
21. Kubitzki, K. *The Families and Genera of Vascular Plants, Vol. I. Pteridophytes and Gymnosperms*. Kramer, K.U. and P.S. Green (Ed.) Narosa Publishing House, New Delhi, 1991.
22. Mehra, P.N. and A. Gupta. *Gametophytes of Himalayan Ferns*. Publisher: Mehra, P.N., Botany Department, P.U., Chandigarh, 1986.
23. Parihar, N.S. *An Introduction to Embryophyta Vol. II, Pteridophytes*. Central Book Depot, Allahabad, 1965.
24. Raghavan, V. *Developmental Biology of Fern Gametophytes (Developmental and Cell Biology Series)*. Cambridge Univ. Press, Cambridge, 1989.
25. Ranker, T. and C.H. Haufler (Eds.) *The Biology and Evolution of Ferns and Lycophytes*. Cambridge Univ. Press, Cambridge, New York, 2008.
26. Rashid, A. *An Introduction to Pteridophyta*. Vikas Publishing House Pvt. Ltd., New Delhi, 1999.
27. Sporne, K.R. *The Morphology of Pteridophytes*. Hutchinson University Library, London./ B.I. Publications, Bombay / Delhi / Madras, 1982.

Course- Bot. 504

Credits: 3+1

PLANT RESOURCE UTILIZATION AND PLANT BREEDING

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Forest Products-Wood and Timber-General introduction, formation and composition of wood: differences between softwood and hardwood, sapwood and heartwood, storied and non-storied woods and between ring –porous wood and diffuse- porous woods; definition of different types of annual rings; properties and seasoning of woods; uses of woods; structure and identification of important timber plants namely *PINUS*, *CEDRUS*, *TECTONA* and *POPULUS*.

UNIT-II

Non-Wood Forest Products I- BAMBOO, THE GREEN GOLD OF INDIA- Its Structure, properties and uses.

Non Wood Forest Products II – CORK- Its structure, properties and uses.

Non Wood Forest Products III- TANNINS AND DYES- A general account.

Non Wood Forest Products IV- GUMS AND RESINS- A general account.

UNIT-III

Plant Resources I- AROMATIC PLANTS- A general account, essential oils and perfumery.

Plant Resources II- PSYCHOACTIVE DRUGS AND POISONS FROM PLANTS- A general account.

Plant Resources III- FRUITS AND NUTS- A list of important fruits and nuts with particular reference to HIMACHAL PRADESH (details are not required).

Plant Resources IV- UNDEREXPLOITED/ UNDERUTILIZED PLANTS- Winged or Goa Bean (*Psophocarpus tetragonolobus*); Jojoba or Hohoba (*Simmondisa chinensis*), Guayule or wuyule (*Parthenium argenatum*), Leucaena or Subabul (*Leucaena leucocephala*) and Triticale (*Triticosecale*). A general account of edible wild plants.

Plant Resources V- ORNAMENTAL PLANTS- A list of important ornamental plants of Himachal Pradesh. Economic importance of flowers.

Plant Resources VI- BIOENERGY (BIOFUELS) OF PLANTS ORIGIN- A general account of fuel wood, energy plantations and organic waste materials for energy, petroleum plants, alcohol fuel and biogas.

UNIT-IV

A general account of the origin of Cultivated Plants with special reference to Vavilov's centre of origin.

A general account of plant introduction and acclimatization.

Methods and modes of reproduction in relation to breeding self pollinated, cross pollinated, vegetatively propagated and apomictic plants.

A general account of inbreeding depression and heterosis; Exploitation of hybrid vigour; Production of hybrids, composites and synthetics.

SUGGESTED READINGS:

1. Sharma, O.P. *Hills Economic Botany*, Tata Mc Graw Hill, New Delhi, 1996.
2. Anonymous, *Underexploited Tropical Plant With Promising Value*, National Academy of Sciences, Washington, D.C. 1975.
3. Bole, P.V. and Y. Vaghani. *Field Guide to Common Indian Trees*. Oxford University Press, Mumbai, 1991.
4. Cobley, L.S. and W.M. Steels. *An Introduction to the Botany of Tropical Crop Plants*. 3rd Ed. The English Language Book Society and Longman, London, 1979.
5. Chandel, K.P.S., G. Shukla and N. Sharma. *Biodiversity in Medicinal and Aromatic Plants in India: Conservation and Utilization*. National Bureau of Plant Genetic Resources, New Delhi, 1996,
6. Chauhan, N.S. *Medicinal and Aromatic Plants of Himachal Pradesh*, Indus Publi. House, Delhi, 2006.
7. Conway, G. and V.W. Rattan. *The Doubly Green Revolution. Food for all in the 21st Century*. Cornell Univ. Press, 1999.
8. Council for Scientific & Industrial Research. *The Useful Plants of India*. Publications and Information Directorate, CSIR, New Delhi, 1986.
9. Dastur, J.F. *Medicinal Plants of India and Pakistan*. 3rd Ed. Meyerbooks, 1985.
10. Frankel, O.H., Brown, A.H.D. and J.J. Burdon. *The Conservation of Plant Diversity*. Cambridge University Press, Cambridge, U.K. 1995.
11. Hill, A.F. *Economic Botany*. McGraw Hill Book Co. Inc., New York, 1986.
12. Kirtikar, K.R. and D.D. Basu. *Indian Medicinal Plants. Vols. I & II*. 2nd Ed. Lalit Mohan Basu, Allahabad, 1953.
13. Kochhar, S.L. *Economic Botany of the Tropics*. 2nd Ed. MacMillan India Ltd., Delhi, 1998.
14. Leonard, W.H. and J.H. Martin. *Cereal Crops*. MacMillan Co., New York, USA, 1963.

15. Parry, J.W. *Spices, Morphology, History and Chemistry. Vol. I.* 2nd Ed. Chemical Publishing Co. Inc., New York. London, Food Trade Press, 1969.
16. Parry, J.W. *Spices: Morphology, History and Chemistry. Vol. II.* 2nd Ed. Chemical Publishing Co. Inc., New York. London, Food Trade Press, 1969.
17. Sambhamurthy, A.V.S.S. and Subramanyam, N.S. *A text book of Economic Botany*, Wiley Eastern Ltd. New Delhi, 1989.
18. Simpson, B.B. and M. Conner- Ogorzaly. *Economic Botany- Plants in our World*. Mc Graw Hill, New York, 1986.
19. Simmonds, N.W. *Principles of Crop Improvement*. Longman, London, 1979.
20. Singh B.D. *Plant Breeding- Principles and Methods*, Kalyani Publishers, Ludhiana, 2005.
21. Conway, G. and E. Barbier. *After the Green Revolution*. Earthscan Press, London, 1990.
22. Cristi, B.R. (Ed.) *Handbook of Plant Sciences and Agriculture. Vol. I. In-situ Conservation*. CRC Press, Boca Raton, Florida, 1999.
23. Haye, H.K., Immer, F.R., and D.C. Smith. *Methods of Plant Breeding*. McGraw Hill Book Co., New York, 1955.

SPERMATOPHYTES

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

General introduction and salient features of Gymnosperms. Classification of gymnosperm and their distribution in India. Origin and evolution of gymnosperms, tendencies in organographic and organ evolution: male and female sporophylls, cones, ovules, seeds and archegonia, pollination mechanism, chromosome number.

Palaeobotany: Introduction, methods and techniques.

UNIT-II

A general account of structure, reproduction and evolutionary relationships of Progymnosperms, Cycadofilicales, Cycadeoidales, Glossopteridales, Pentoxylales, Cycadales, Cordaitales, Coniferales, Ginkgoales, Taxales, Ephedrales, Welwitschiales, Gnetales.

Economic Importance of Gymnosperms.

UNIT-III

Principles and methods of taxonomy: Taxonomy as a synthetic discipline, numerical taxonomy, chemotaxonomy, biosystematics. Taxonomic evidences: morphology, anatomy, palynology, embryology, cytology. Taxonomic tools: herbarium, floras, computers, electrophoresis, role of GIS. Important Botanical gardens and herbaria.

Species concept: Taxonomic hierarchies, species, genus, family and other categories. Botanical survey of India- its organization and role.

UNIT-IV

Salient features of International Code of Botanical Nomenclature.

Systems of Angiosperm classification: Benthom and Hooker, Engler and Prantl, Bessey, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne. Relative merits and demerits of these systems.

Phylogeny of Angiosperms: Origin, evolution and inter-relationship of dicots and monocots.

SUGGESTED READINGS:

Gymnosperms:

1. Andrews, H.N.Jr. *Studies in Paleobotany*. John Wiley and Sons, New York, 1961.
2. Arnold, C.A. *An Introduction to Paleobotany*. McGraw Hill, New York, 1947.
3. Bhatnagar, D.W. *Morphology of Vascular Plants*. The Macmillan and Co., New York, 1971.
4. Bhatnagar, S.P. and A. Moitra. *Gymnosperms*. New Age International Ltd., New Delhi, 2000.
5. Bierhorst, D.W. *Morphology of Vascular Plants*. The Macmillan and Co., New York, 1971.
6. Chamberlain, C.J. *Gymnosperms: Structure and Evolution*. University of Chicago Press, Chicago, 1935.
7. Coulter, J.M. and C.J. Chamberlain. *Morphology of Gymnosperms*. Univ. of Chicago Press, Chicago, 1917.
8. Dallimore, W. and A.B. Jackson. *A Handbook of Coniferae and Ginkgoaceae*. 4th Ed. Edward Arnold and Co., London, 1966.
9. Delevoryas, T. *Morphology and Evolution of Fossil Plants*. Holt, Rinehart and Winston, New York, 1962.
10. Foster, A.S. and E.M. Gifford. *Comparative Morphology of Vascular Plants*. 2nd Ed. W.H. Freeman and Co., San Francisco, 1974.
11. Sharma, O.P. and S. Dixit. *Gymnosperms*. Pragati Prakashan, Meerut, 2002.
12. Sporne, K.R. *The Morphology of Gymnosperms*. Hutchinson Univ. Library, London, 1974.

Angiosperms:

13. Benson, L.D. *Plant Taxonomy: Methods and Principles*. Ronald Press, New York, 1962.
14. Collet, H. *Flora Simalensis*. Thacker and Spink, Calcutta and Simla (reprinted 1971), 1902.
15. Cronquist, A. *The Evolution and Classification of Flowering Plants*. Houghton Mifflin, Boston, 1968.
16. Cronquist, A. *An Integrated System of Classification of Flowering Plants*. Columbia University Press, Columbia, 1981.
17. Davis, P.H. and V.H. Heywood. *Principles of Angiosperm Taxonomy*. Van Nostrand Reinhold, New York, 1973.
18. Eames, A.J. *Morphology of Angiosperms*. McGraw–Hill Inc., New York, 1961.
19. Gupta, R.K. *Systematic Botany*. Atma Ram and Sons, New Delhi, 1981.
20. Hutchinson, J. *The Families of Flowering Plants. Vol. I, II*. Clarendon Press, Oxford. 1959.
21. Lawrence, H.M. *Taxonomy of Vascular plants*. MacMillan, New York, 1951.
22. Naik, V.N. *Taxonomy of Angiosperms*. Tata McGraw Hill, New Delhi, 1984.
23. Pandey, S.N. and S.P. Misra. *Taxonomy of Angiosperms*. Ane Books, India, 2008.
24. Shivana, K.R. and N.S. Rangaswamy. *Pollen Biology: A Laboratory Manual*. Springer-Verlag, Berlin, 1992.

25. Shivana, K.R. and B.M. Johri. *The Angiosperm Pollen: Structure and Function*. Wiley Eastern Ltd. New Delhi, 1985.
26. Singh, G. *Plant Systematics: Theory and Practice*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1999.
27. Sharma, O.P. *Plant Taxonomy*. Tata McGraw Hill Publishing Co. Pvt. Ltd., New Delhi, 2002.
28. Sneath, P.H.A. and R.R. Sokal. *Numerical Taxonomy*. W.H. Freeman, San Francisco, 1973.
29. Solbrig, O.T. *Principles and Methods of Plant Biosystematics*. The MacMillan Co., New York, 1970.
30. Sporne, K.R. *The Morphology of Angiosperms*. B.I. Publication, Bombay, Calcutta, Delhi, 1986.
31. Stace, C.A. *Plant Taxonomy and Biosystematics*. Contemporary Biology Series, Edward Arnold, London, 1984.
32. Subramaniam, N.S. *Modern Plant Taxonomy*. Vikas Publishing House Pvt. Ltd., Delhi, 2007.
33. Takhtajan, A.E. *Flowering plants: Origin and Dispersal*. Oliver and Boyd Ltd. Edinburg, 1969.

Course- Bot. 506

Credits: 3+1

CELL AND PLANT MOLECULAR BIOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

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

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

UNIT-II

Cell signalling: Signalling molecules and their receptors, functions of cell surface receptors, signal transduction pathways, second messengers, regulation of signalling pathways, regulation of programmed cell death.

Cell division and cell cycle: Mitosis and meiosis; Eukaryotic cell cycle, steps in cell cycle and control of cell cycle.

Microbial physiology: Growth, yield and characteristics, strategies of cell division, stress response.

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

UNIT-III

Nucleic acids: DNA and RNA- Structure and classes, repeated DNA, unique sequences and hybridization kinetics, split genes, transposable elements.

DNA replication, repair and recombination: Units of replication, enzymes involved, replication fork, fidelity of replication, origins and initiation of replication, replication at the ends of chromosomes, DNA damage and repair mechanism.

RNA synthesis and processing: Transcription mechanism, initiation, elongation and termination. RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

UNIT-IV

Protein synthesis, processing and regulation: Translation mechanism, initiation, elongation and termination, genetic code. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase. Translational proof-reading, translational inhibitors, post-translational modification of proteins.

Control of gene expression: Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

SUGGESTED READINGS:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and J.D. Watson. *Molecular Biology of the Cell*. Garland Publishing Inc. New York, 1999.
2. Brown, T.A. *Genomes*. Jones Wiley & Sons (Asia) Pvt. Ltd. Singapore, 1999.
3. Buchanan, B.B., Gruissem, W. and R.L. Jones. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Rockville, Maryland, 2000.
4. Clark, D. *Molecular Biology: Understanding the Genetic Revolution*. Elsevier Inc. C. California, 2005.
5. Grierson, D. and S.N. Covey. *Plant Molecular Biology*. 2nd Ed. Blackie Academic and Professionals, London, 1988.
6. Gupta, P.K. *Cell and Molecular Biology*. Rastogi Publication, Meerut, 2004
7. Karp, G. *Cell and Molecular Biology*. John Wiley & Sons, U.S.A. 1999.
8. Kindt, T.A., R.A. Goldsby and B.A. Osborne. *Immunology*. W.H. Freeman and Co., NY, 2007.
9. Lea, P. and C.R.C. Leegood (Ed.) *Plant Biochemistry and Molecular Biology*. 2nd Ed. John Wiley & Sons, New York. 1999.
10. Lehninger, A. *Principles of Biochemistry*. Worth Publishers, New York, 1993.
11. Lewin, B. *Gene VIII*. Pearson Education International, Philadelphia. 2004.
12. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and J. Darnell. *Molecular Cell Biology*. 4th Ed. W.H. Freeman & Co., U.S.A. 2000.
13. Nelson, D.L. and M.M. Cox. *Principles of Biochemistry*. 5th Ed. W.H. Freeman Publishers, 2008.
14. Robert, D.D. *Cell Biology – A Molecular Approach*. Allyn and Bacon, Inc., 1978.
15. Robertis de, C.D.P. and E.M.S. de Robertis. *Cell and Molecular Biology*. Lea and Febiger, Philadelphia, 1998.
16. Russell, P.J. *Genetics* 5th Ed. The Benjamin/ Cummings Publishing Comp. Inc., 1998.
17. Snustad, P. and M.J. Simmons. *Principles of Genetics* 2nd Ed., John Wiley, New York, 2003.
18. Voet, D. and J.G. Voet. *Biochemistry*. 2nd Ed. John Wiley & Sons Inc., 2006.

19. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and R. Losick. *Molecular Biology of the Gene*, Pearson Education Pvt. Ltd., Delhi, 2004.
20. Wilson, K. and J. Walker. *Practical Biochemistry: Principles and Techniques*. Cambridge University Press, Cambridge, 2000.

BIOTECHNOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Concept and Scope of Biotechnology

Recombinant DNA-technology: Enzymes and vectors (plasmids, bacteriophages, viruses, cosmids, BAC and YAC) in gene cloning, gel electrophoresis, labelling of nucleic acids, cloning in bacterial construction, screening of genomic and c-DNA libraries. DNA sequencing.

Molecular techniques/ Markers in plant identification and plant improvement: RFLP, SSR, AFLP, RAPD, ribosomal gene analysis, finger printing, southern/ northern/ western blotting.

Polymerase chain reaction and its applications, genomics and proteomics.

UNIT-II

Agrobacterium-mediated gene transfer: Ti and Ri plasmids, marker genes. Direct gene transfer: particle bombardment, electroporation, microinjection, chemical gene transfer, gene silencing.

Nitrogen fixing genes: Nitrogenase hybridization, alternative nitrogenase transfer potential of nif genes to other organisms.

Methods and significance of enzyme engineering and immobilization.

Transgenics: Methods of production and applications.

UNIT-III

Plant cell and tissue culture: Introduction, history, scope, concept of cellular differentiation, totipotency, organogenesis and adventitious embryogenesis. Fundamental aspects of morphogenesis, somatic embryogenesis and androgenesis- mechanism, techniques and utility.

Application of plant tissue culture: Artificial seed, production of hybrids and somaclones, production of secondary metabolites, cryopreservation and germplasm storage.

Protoplast culture and somatic hybridization : Isolation of protoplasts, culture and fusion methods, selection of fusion products, production of hybrids and cybrids.

UNIT-IV

Fermentation technology: Batch and continuous system, media for industrial fermentation, production of wine, beer, antibiotics and amino acids.

Intellectual property rights: Concept and administration, national and international laws, conventions related to IPR (GATT, TRIPS, CITES). Patenting of biological material, plant breeders rights, biosafety and product labelling considerations.

Biosensors : Principles of detection and Applications.

Phytoremediation of organic and heavy metal pollutants, xenobiotics, biofiltration and bioleaching.

SUGGESTED READINGS:

1. Bajaj, Y.P.S. *Biotechnology in Agriculture and Forestry Plant Protoplasts and Genetic Engineering I*, Springer Verlag, Berlin, 1989.
2. Balasubramaniam, D., Dharmalingam, K., Bryce, C.F.A., Green, J. and K. Kunthala. *Concepts in Biotechnology*. University Press Ltd., Hyderabad, India, 1996.
3. Bhojwani, S.S. and M.K. Razdan. *Plant Tissue Culture – Theory and Practices*. 5th Ed. Elsevier Science Pub. Co. Inc., New York, 2005.
4. Brown, T.A. *Genomes*. John Wiley & Sons (Asia) Pvt. Ltd. Singapore, 1999.
5. Bull, A.T., Holt, G. and M.D. Lilly. *Biotechnology (International Trends and Perspectives)*. Oxford & IBH Publishing Co. Pvt. Ltd. 1982.
6. Butcher, D.N. and D.S. Ingram. *Plant Tissue Culture*, Edward Arnold Ltd., U.K. 1976.
7. Dubey, R.C. *Introduction to Biotechnology*. Delhi Book Trust, New Delhi, 2006.
8. Evans, D.A., Sharp, W.R., Ammirato, P.V. and Y. Yamada (Ed.). *Handbook of Plant Cell Culture- Vol. I*, Coolier MacMillan Publishing Co. USA, 1983.
9. Glazer, H.A. and S. Edwards. *Plant Cell Culture*. Bios Scientific Publishers, Oxford, UK. 1998.
10. Gupta, P.K. *Biotechnology and Genomics*. Rastogi Publication Meerut, 2004
11. Henry, R.J. *Practical Applications of Plant Molecular Biology*. Chapman & Hall, London, 1997.
12. Ignacimuthu, S.J. *Basic Biotechnology*. Tata McGraw Hill Pub. Co. Ltd., New Delhi, 1995.
13. Kumar, H.D. *A Text of Biotechnology*. E.W.P., New Delhi, 1998.
14. Murary, David R. (Ed.). *Advanced Methods in Plant Breeding and Biotechnology*. Redwood Press Ltd., Melksham, 1991.
15. Ratledge, C. and B. Kristiansen. *Basic Biotechnology*. Cambridge University Press, Cambridge, 2001.
16. Razdan, M.K. *An Introduction to Plant Tissue Culture*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2001.
17. Reinert, J. and M.M. Yeoman. *Plant Cell and Tissue Culture-A Laboratory Manual*, Springer Verlag, Berlin, 1982.

18. Singh, B.D. *Biotechnology: Expanding Horizon*. Kalyani Publishers, New Delhi, 2007.
19. Smith, R.H. *Plant Tissue Culture, Technique and Experiments*. 2nd Ed. Academic Press, New York, 2000.
20. Trihan, K. *Biotechnology*, Wiley Eastern, New Delhi, 1990.

ECOLOGY AND BIOPHYSICAL ENVIRONMENT

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Importance and scope of ecology, levels of organization, spatial and temporal scales, sustainable development and ecological sustainability, environmental issues in India.

Population ecology: characteristics of a population, population growth curve and regulation, life history strategies (*r* and *K* selection), concept of meta population- demes and dispersal, interdemec extinctions, age structured populations.

Species interactions: mutualism, competition, allelopathy, predation, parasitism.

UNIT-II

Community ecology: Nature of communities, community structure and attributes, concept of habitat and niche, levels of species diversity and its measurement, keystone species, edges and ecotones. Ecological Succession: Types, mechanism, changes involved in succession, concept of climax.

Ecosystem: Structure and function, energy flow and mineral cycling (CNP), primary production and decomposition, structure and function of some Indian ecosystem: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine), ecosystem stability (resistance and resilience).

UNIT-III

The environment: Solar radiation and temperature, hydrological cycle, plant water relation, soil development and formation, floristic realms and biogeographical regions, speciation and extinction.

Biogeography: Major terrestrial biomes, theory of island biogeography, biogeographical zones of India

Applied ecology: environmental pollution: types, sources, effects on plant and animal ecosystem. Global environmental change: greenhouse gases, ozone depletion, consequences of climate change.

UNIT-IV

Biodiversity: status, monitoring and documentation, significance in terms of economic, spiritual, scientific, educational, ecological and genetical values, major drivers of biodiversity change, biodiversity management approaches.

Invasion of alien plants: Concept, ecological impact and management

Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation, management strategies (Project Tiger, Biosphere reserves).

Natural history of Indian subcontinent: Major habitat types of subcontinent, geographic origins and migrations of species; seasonality and phenology of the subcontinent.

SUGGESTED READINGS:

1. Altieri, M.A. and M. Liebman. *Weed Management in Agro-Ecosystems- Ecological Approaches*. CRC Press, Florida, U.S.A. 1988.
2. Begon, M., John, H. and C.R. Townsend. *Ecology: Individuals, Populations and Communities*. 2nd Ed. Blackwell Science, USA. 1995.
3. Botkin, D.B. and E.A. Keller. *Environmental Science: Earth as a Living Planet*, John Wiley, New York, USA, 2004.
4. Chapman, J.L. and M.J. Reiss. *Ecology Principles and Applications*. Cambridge Univ.Press, 1995.
5. Dash, M.C. *Fundamentals of Ecology*. Tata McGraw Hill, New Delhi, 1994.
6. Engler, E.D. and B.F. Smith. *Environmental Science*. WCB Publishers, Iowa, U.S.A. 1992.
7. Frankel, O.H., Brown, A.H.D. and J.J. Burdon. *The Conservation of Plant Biodiversity*. Cambridge Univ. Press, Cambridge, U.K. 1995.
8. Karmondy, E.J. *Concepts of Ecology*. 4th Ed. Prentice-Hall of India Pvt. Ltd., New Delhi. 2007.
9. Kohli, R.K., N. Jerath and Dazy Rani (Eds.). *Some Facets of Biodiversity*. SES Pub. & PSCST Publication, Chandigarh, India, 1996.
10. Kohli, R.K, H.P. Singh and D.R. Batish. *Allelopathy in Agroecosystem*. Haworth Press, NY. 2001.
11. Kohli, R.K., Jose, S., Singh, H.P. and D.R. Batish. *Invasive Plants & Forest Ecosystems*. CRC Press NY. 2009.
12. Kumar, H.D. *Modern Concepts of Ecology*. Vikas Publ. House, New Delhi, 1996.
13. Miller, (Jr.) and G. Tyler, *Living in the environment*, Wadsworth Publishing Company, Belmont, California, 1994.
14. Newman, E.I. *Applied Ecology*. Blackwell, U.K. 1994.
15. Odum, E.P., *Basic Ecology*, Sanders, Philadelphia, 1983.
16. Odum, E.P. and W.G. Barret. *Fundamentals of Ecology*. Thomson Books / Cole, U.S.A. 2007.
17. Pandey, B.N. and G.K. Kulkarni. *Biodiversity and Environment*. APH Publishing Corporation, New Delhi, 2006.

18. Ramakrishanan, P.S. *Ecology and sustainable development*, National Book Trust, India, 2000.
19. Rana, S.V.S. *Essentials of Ecology and Environmental Sciences*. Prentice Hall of India Pvt. Ltd., New Delhi, 2007.
20. Rice, E.L. *Allelopathy*. Academic Press Inc., U.S.A. 1987.
21. Smith, R.L. *Ecology and Field Biology*. Harper Collins, New York, 1996.
22. Sharma, P.D. *Ecology and Environment*. Rastogi Publications, Shivaji Road, Meerut, 1996.
23. Stiling, P. *Ecology: Theories and Applications*. Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
24. Treshow, M. *Air Pollution and Plant Life*. John Wiley, New York, U.S.A. 1984.
25. Townsend, C.R., Begon, M. and J.L. Harper, *Essentials of Ecology*. Second Edition, Blackwell Publishing, Oxford, 2003.

Course- Bot. 509

Credits: 2+1

COMPUTER APPLICATIONS AND BIOSTATISTICS

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Number systems: Binary, octal, hexadecimal and decimal numbers, conversion from one system to another, binary addition and subtraction.

Computer organization: Component of digital computers, hardware and software, compiler and interpreters.

Programming languages: Introduction to programming in Q Basic and C/C⁺⁺.

UNIT-II

Flow chart and programming technique

Application software: Introduction to MS Office software covering word processing, spreadsheets and presentation software.

Data and database: Introduction to data structure and database concept

UNIT-III

Overview of Bioinformatics: Introduction, bioinformatics and Internet, useful bioinformatics sites on WWW; Applications of Bioinformatics.

Internet: Introduction to internet and its applications

Computer- oriented statistical techniques: Frequency table of single discrete variable, bubble sort, computation of mean, variance and standard deviation, correlation coefficient

UNIT-IV

Biostatistics: Brief description and tabulation of data and its graphical representation

Statistical methods: Measures of central tendency and dispersion: Mean, median, mode, range, levels of significance, test of significance (F & t test), Chi- Square test; probability distribution (Binomial, Poisson and Normal); sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; basic introduction to Multivariate statistics.

Correlation and regression analysis: Simple correlation, scatter diagrams, linear and non-linear regression

One way ANOVA, Two ways ANOVA, Multiple range test.

SUGGESTED READINGS:

1. Daniel, W.W. *Biostatistics: A Foundation for analysis in the Health Sciences*. 7th Ed. John Wiley and Sons, New York. 2006.
2. Dunn, O.J. and V.A. Clark. *Basic Statistics: A Primer for Biomedical Science*. John Wiley and Sons, New York, 2009.
3. Goon, A.M., Gupta, M.K. and B. Dasgupta. *Fundamentals of Statistics*. Vol. I. World Press, Kolkotta, 1983.
4. Hunt, R. and J. Shelly. *Computer and Common Sense*. 4th Ed. Prentice Hall, India, 2002.
5. Kanetker, Y. *Let us 'C'*. 8th Ed. B.P.B. Publication, 2006.
6. Rajaraman, V. and T. Radhakrishanan. *An Introduction to Digital Computers*. 5th Ed. Prentice Hall, India, 2004.
7. Sinha, P.K. *Computer Fundamentals*. 4th Ed. B.P.B. Publication, 2003.

REPRODUCTIVE BIOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Historical perspectives of plant embryology

Male gametophyte: Structure of anther, microsporogenesis, role of tapetum, pollen development, pollen tube growth and guidance, pollen viability and germination, pollen storage, male sterility, sperm dimorphism

UNIT-II

Female gametophyte: Ovule development, megasporogenesis.

Embryosac types: Ultrastructure of components, synergid and antipodal haustoria, nutrition of embryosac.

Pollination: Ultrastructural and histochemical details of style and stigma, self and interspecific incompatibility, significance of pollen-pistil interaction, role of pollen- pistil interaction, role of pollen wall proteins and stigma surface proteins, barriers to fertilization, methods of over coming incompatibilities.

UNIT-III

Fertilization: Heterospermy, differential behaviour of male gametes, discharge and movement of sperms, syngamy and triple fusion, post fertilization, metabolic and structural changes in embryo sac.

Endosperm: Ultrastructure, types and development.

Embryo: Development of embryo in monocots and dicots.

UNIT-IV

Polyembryony: Types, somatic and genetic, pollen embryos.

Apomixis: Types and evolutionary significance.

Seed: Structure and development, seed testing, seed storage, seed dormancy.

Experimental embryology: *in vitro* fertilization. Anther, pollen and embryo culture.

SUGGESTED READINGS:

1. Bhojwani, S.S. and S.P. Bhatnagar. *The Embryology of Angiosperms*. Vikas Publishing House Pvt. Ltd., Delhi, 2003.
2. Maheshwari, P. *An Introduction to the Embryology of Angiosperms*. Tata McGraw Hill Publishing Company Ltd., Bombay – New Delhi, 1980.
3. Eames, A.J. *Morphology of the Angiosperms*. Tata McGraw Hill Publishing Co. Ltd. Bombay, 1961.
4. Johri. B.M. *The Embryology of Angiosperms*. McGraw Hill Publishing Co. Ltd. Bombay, 1980.
5. Raghvan, V. *Molecular Embryology of flowering plants*. Cambridge Univ. Press, Cambridge, 1998.
6. Raghvan, V. *Developmental Biology of Flowering plants*. Springer- Verlag, New York, 1999.
7. Raven, P.H., Evert, R.F. and S.E. Eichhorn. *Biology of plants*. 7th Ed. W. H. Freeman & Co., New York, 2004.
8. Sedgely, M. and A.R. Griffin. *Sexual Reproduction of Tree crops*. AP, London, 1989.
9. Shivana, K.R. and B.M. Johri. *The Angiosperm Pollen: Structure and Function*. Wiley Eastern Ltd. New Delhi, 1985.
10. Shivana, K.R. and N.S. Rangaswamy. *Pollen Biology: A Laboratory Manual*. SV Berlin, 1992.
11. Swamy, B.G.L. and K.Y. Krishnamurthy. *From flower to fruit: Embryology of Flowering plants*. Tata McGraw-Hill, New Delhi, 1980.

PLANT PHYSIOLOGY AND BIOCHEMISTRY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Water: Structure, physio-chemical properties, importance of water, passive and active absorption of water, dissociation of water and pH

Solute transport and photoassimilate translocation: Uptake, transport and translocation of water, ion, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanism of loading and unloading of photoassimilates.

Stomatal physiology: Chemiosmotic mechanism of stomatal movements, hormonal regulation and significance.

UNIT-II

Stress Physiology: Response of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

Plant pigments: Chlorophyll and pigments of Cyanobacteria and Bacteria: their role in photosynthesis; Carotenoids and other accessory pigments.

Photosynthesis: General concept, evolution of photosynthetic apparatus, light harvesting complex, photo-oxidation of water, water oxidizing clock, cyclic and non-cyclic photophosphorylation, pathway of CO₂ fixation, differences between C₃ and C₄ photosynthesis, different kinds of C₄ pathways, CAM pathway – occurrence, biochemical events, and adaptive advantage

UNIT-III

Respiration: Overview of plant respiration, significance, mechanism. Fermentation, glycolysis, kreb's cycle, electron transport chain and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternate oxidase system, general account of photorespiration.

Nitrogen metabolism: Biochemistry of nitrogen fixation, nitrogen fixation of free living and symbiotic organisms, nitrate and ammonium assimilation, amino acid biosynthesis.

Enzymology: Chemical nature and properties, classification and nomenclature (IUB system) of enzymes.

Lipid metabolism: Fat synthesis, alpha and beta oxidation and conversion into carbohydrates

UNIT-IV

Plant hormones: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; photoperiodism and biological clocks.

Secondary metabolites: Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

Plant senescence and programmed cell death: Basic concepts, difference with ageing, metabolic changes associated with leaf senescence and its regulation by plant growth regulators and environmental factors.

SUGGESTED READINGS:

1. Bidwell, R.G.S. *Plant physiology*- 2nd Ed. MacMillan Publishing Co. Inc., New York, 1979.
2. Buchanan, B.B., Gruissem, W. and R.L. Jones. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Maryland, USA. 2000.
3. Conn, E.E., Stumpf, P.K., Bruening, G. and R.H. Doi. *Outlines of Biochemistry*. 5th Ed. Wiley, India, 2006.
4. Devlin, R.M., and F.H. Witham. *Plant Physiology*. C.B.S. Publishers, New Delhi, 1986.
5. Deb, A.C. *Fundamental of Biochemistry*. 9th Ed. New Central Book Agency Pvt. Ltd., Kolkatta, 2008.
6. Dey, P.M. and J.B. Harborne. *Plant Biochemistry*. Academic Press, London, 1997.
7. Hames, D. and N. Cooper. *Biochemistry*. Garland Science Publishers, U.S.A. 2008.
8. Jain, J.L., N. Jain and S. Jain. *Fundamentals of Biochemistry*. S. Chand & Co. Ltd., New Delhi, 2007.
9. Hopkins, W.G. (Ed.) *Introduction to Plant Physiology*. C.B.S. John Wiley & Sons Inc. USA. 2003.
10. Kramer, P.J. *Plant and Soil Water Relations*. T.M.H. Publishers, 1980.
11. Lehninger, A. *Principles of Biochemistry*. Worth Publishers, 1982.
12. Malik, C.P. and M.B. Singh. *Plant Enzymology and Histoenzymology*. Kalyani Publishers, 1980.
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15. Levitt, J. *Responses of Plants to Environmental Stresses (Physiological Ecology): Chilling, Freezing and High Temperature Stress*- 2nd Ed. Acad. Press, London, 1980.
16. Malik, C.P. *Plant Physiology*- 3rd Ed. Kalyani Publishers India, 2002.

17. Moore, T.S. *Biochemistry and Physiology of Plant Hormones*. Narosa/Springer,Verlag, 1989.
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19. Nobel, P.S. *Physiochemical and Environmental Plant Physiology*. 4th Ed. Academic Press, San Diego, USA. 2009.
20. Noggle, G.R. and G.J. Fritz. *Introductory Plant Physiology*. 2nd Ed. Prentice Hall of India Pvt. Ltd., New Delhi, 1991.
21. Palmer, T. *Enzymes Biochemistry, Biotechnology, Clinical Chemistry*. Affiliated East – West Press Pvt. Ltd. 2004.
22. Plummer, D.T. *An Introduction to Practical Biochemistry*. 2nd Ed. T.M.H. Publishing Co., New Delhi, 1979.
23. Prince, N.C and L. Stevens. *Fundamentals of Enzymology*. Oxford University Press, Oxford, 1984.
24. Salisbury, F.B. and C. Ross. *Plant Physiology*. 4th Ed. CBS Publisher and Distributors, 1992.
25. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee. *Concepts in Photobiology: Photosynthesis and Photomorphogenesis*. Narosa Publishing House, New Delhi, 1999.
26. Stumpf, P.K. and E.E. Conn. *The Biochemistry of Plants – A Comprehensive Treatise*. Academic Press, London, 1981.
27. Taiz, L. and E. Zeiger. *Plant Physiology*. 4thed. Sinauer Associates Inc. Publishers, Massachusetts, USA. 2006.
28. Voet, D. and J.G. Voet. *Biochemistry*. 3rd Ed. John Wiley & Sons_Inc. 2008.

CYTOGENETICS AND EVOLUTIONARY BIOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Organization of genes and chromosomes: Operon, interrupted genes, gene families; Chromosome structure and packaging of DNA; Molecular organization of centromere and telomere; nucleolus and ribosomal RNA genes; Unique and repetitive DNA ; Euchromatin and heterochromatin.

Karyotype : Karyotype analysis ; Karyotype evolution; Various banding techniques and their uses.

Linkage and crossing over: Cytological basis of crossing over, molecular mechanism of crossing over and role of different enzymes.

Sex determination and sex linkage: Mechanisms of sex determination, environmental factors and sex-determination, sex-influenced dominance, sex-limited gene expression, sex-linked inheritance, Morgan's discovery of sex-linkage in *Drosophila*.

UNIT-II

Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Microbial, human and quantitative genetics: Methods of genetic transfers- transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes; Pedigree analysis, lod score for linkage testing, genetic disorders; Polygenic inheritance, heritability and its measurements, QTL mapping.

Mutation: Types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

Recombination: Homologous and non- homologous recombination, including transposition, site- specific recombination.

UNIT-III

Growth of science from Mendel to genetic engineering.

Extensions of Mendelian principle: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy.

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Emergence of evolutionary thoughts: Lamarck; Darwin- concept of variation, adaptation, struggle, fitness and natural selection; Mendelism; spontaneity of mutation; evolutionary synthesis.

Origin of cell and unicellular evolution: Concept of Oparin and Haldane, experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes.

UNIT-IV

Paleontology and evolutionary history: The evolutionary time scale; eras; periods and epoch; origin of unicellular and multicellular organisms; major groups of plants and animals; stages of primate evolution including Homo.

Molecular evolution: Concept of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; origin of new genes and proteins

The mechanisms: Population genetics- populations, gene pool, gene frequency; Hardy-Weinberg law; migration and random genetic drift; speciation- allopatricity and sympatricity; convergent evolution; sexual selection; co- evolution.

Brain, behaviour and evolution: Approaches and methods in studying behaviour; proximate and ultimate causation; altruism and evolution; neural basis of learning, memory, cognition, sleep and arousal; biological clock; development of behaviour; human selection and optimality in foraging; migration, orientation and navigation; domestication and behavioural changes.

SUGGESTED READINGS:

1. Minkoff, J.C. *Evolutionary Biology*. Addison Wesley Publishing Company, 1983.
2. Ayala, F.J. and J.W. Valentine. *Evolving the theory of organic evolution*. The Benjamin cumming Publishing Company, Melno Park, California, 1979.
3. Lull, R.S. *Organic Evolution*. Light and Life Publishers, New Delhi, 1976.
4. Smith, J.M. *Evolutionary Genetics*. Oxford University Press, 1998..
5. Alberts, B., Lewis, D., Raff, M., Roberts, K. and J.D. Watson. *Molecular Biology of the Cell*. 5th Ed. Garland Publishing Inc., New York, 2007.
6. Brown, T.A. *Genomes*. 3rd Ed. John Wiley & Sons, U.S.A. 2006.

7. Dobzhansky, T. *Evolutionary Biology*. Appleton – Century – Crofts, Educational Division/ Meredith Corporation, New York, 1972.
8. Griffiths, A.J.F., Gelbart, W.M. and J.H. Lewontin. *Modern Genetic Analysis*. 2nd Ed. W.H. Freeman & Company, U.S.A. 2002.
9. Graur Dan and Li Wen-Hsiung. *Fundamentals of Molecular Evolution*. 2nd Ed. Sinauer Publications.
10. Gupta, P.K. *Genetics*. Rastogi Publication, Meerut, 1995.
11. Gupta, P.K. *Cytogenetics*. Rastogi Publication, Meerut, 2004.
12. Hayward, M.D., Basemark, M.O. and I. Romagosa. *Plant Breeding: Principles and Prospects*. Chapman and Hall, U.K. 1993.
13. Khush, G.S. *Cytogenetics of Aneuploids*. Academic press, New York, 1974.
14. Lewin, B. *Genes VIII*. Pearson Prentice Hall, U.S.A. 2004.
15. Poehlman, J.M. and D.A. Sleper. *Breeding field crops*. Iowa State Press, USA. 1995.
16. Primrose, S.B., Twyman, R.M. and R.W. Old. *Principles of Gene Manipulation*. 6th Ed. Wiley-Blackwell Publ., U.K. 2002.
17. Snustad, D.P. and M.J. Simmons. *Principles of Genetics*. 5th Ed. John Wiley & Sons Inc., U.S.A. 2008.
18. Swanson, C.P., Young, W.J. and T. Merz. *Cytogenetic: The Chromosomes in Division, Inheritance and Evolution*. Prentice Hall, Englewood Cliffs, New Jersey, 1981.
19. Schulz-Schaeffer, J. *Cytogenetics*. 2nd Ed. Springer-Verlag, Berlin, 1980.

Course- Bot. 513

Credits: 3+1

PLANT MORPHOGENESIS AND ANATOMY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

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

Correlation: Physiological and genetic correlations.

Polarity: Polarity as expressed in external and internal structures, polarity in isolated cells, polarity in plasmodia and coenocytes, physiological manifestations of polarity, developmental patterns.

Symmetry: Inorganic and organic symmetries, radial symmetry bilateral symmetry, dorsiventral symmetry, development of symmetry.

UNIT-II

Differentiation: Growth and differentiation, differentiation as expressed in structure, external and internal differentiation, differentiation during ontogeny, differentiation in relation to environment, physiological differentiation, differentiation without growth.

Regeneration: Regeneration in lower plants, regeneration in higher plants, reconstitution, restoration, reproductive regeneration.

Tissue mixtures: Stock – scion interrelations, chimeras, somatic mutations.

Abnormal growth: Abnormal development of organs, production of new types of organized structures, amorphous structures.

Morphogenetic factors: Introduction to factors, light, water, temperature, physical factors like tension, compression, balancing and swaying, ultrasonics, gravity, bioelectrical effects, genetic factors, chemical factors in general.

UNIT-III

Levels of structural organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.

The shoot and root system: Primary structure and basic vasculature, the root-stem transition, secondary growth in stems and roots, the origin of cambium and its activity, anomalous secondary growth, polycyclic vasculature, secondary meristems, origin and function, the role of pericycle, phellogen, phellem, phelloderm, distribution of sclerenchyma in leaves, stem and roots.

Nodal anatomy: Types of nodes in dicots and monocots, the node-internode transition, formation of leaf and branch traces, leaf development and phyllotaxy.

UNIT-IV

Floral anatomy: The anatomy of floral axis and the whorls, the leaf origin of carpel, evidences from anatomy of essential and accessory whorls, floral development in *Arabidopsis* and *Antirrhinum*.

Fruit and seed anatomy: Gross and ultrastructural surface features of the fruits and seeds, role in taxonomy, internal anatomy of dicot and monocot seeds, organ and cellular anatomy of typical monocot and dicot seeds.

Laticifers and lenticels: Types and distribution, anatomy in relation to physiological roles

Functional anatomy: Anatomy of leaf in relation to photosynthesis and transpiration, modification of the root, stem and leaf anatomy in relation to habit and habitat with special reference to aquatics, nitrogen fixers, xerophytes parasites and mycorrhizae.

SUGGESTED READINGS:

1. Bhojwani, S.S. and S.P. Bhatnagar. *The Embryology of Angiosperms*. Vikas Publishing House, Delhi, 1975.
2. Brown, H.P. *An Elementary Manual on Indian Wood Technology*. R.P.S Publishers, 1989.
3. Cutter, E.G. *Part- I Cells and Tissues*, Edward Arnold, London, 1969.
4. Cutter, E.G., *Plant anatomy: Experiment and Interpretation, Part-II, Organs* Edward Arnold, London, 1971.
5. Eames, A.J. *Morphology of the Angiosperms*. Tata McGraw Hill Publishing Co., Bombay, 1961.
6. Esdu, K. *Anatomy of Seed Plants*, 3rd Ed. John Wiley and Sons, New York, 1977.
7. Hartman, H.T. and D.E. Kestler. *Propagation: Principles and Practices*, 3rd Ed. Prentice Hall of India Pvt.Ltd., New Delhi, 1976.
8. Mauseth, J.D. *Plant Anatomy*. The Benjamin Cumming publishing company Inc. Menlo Park, California, USA. 1998.
9. Maheshwari, P. *An Introduction to the Embryology of Angiosperms*. Tata McGraw Hill, Publishing Co. Bombay – New Delhi, 1950.
10. Sinnet, E.W. *Plant Morphogenesis*, McGraw Hill Book Company, New York, 1960.

Course- Bot. 514

Credits: 3+1

METABOLISM OF BIOMOLECULES AND IMMUNOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Structure of atoms, molecules and chemical bonds.

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc.).

Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.

UNIT-II

Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.

Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds).

Conformation of nucleic acids (A-, B-, Z-DNA), t-RNA, micro-RNA).

Stability of protein and nucleic acid structures.

Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.

UNIT-III

An overview of the immune system : Historical perspective, an introduction to the immune system – innate and adaptive immunity. Immunodeficiencies: congenital and acquired immunodeficiency, vaccines

Antigens and antigen recognition: Antigens: prerequisites for immunogenicity, relative immunogenicity of different types of molecules, molecules that enhance immunogenicity.

Activators of lymphocytes: antigens, superantigens, mitogens. Antigen recognition by cells of innate immunity and adaptive immunity.

UNIT-IV

Antibodies: Gamma globulins; Structure, bifunctional property of antibodies, determining bifunctionality, cross reactivity, Antigen antibody interactions: primary interactions, secondary interactions. Classification of antibodies: Isotypes, Allotypes, properties & biological functions of antibody isotypes, IgG, IgE, IgM, IgD, IgA, Monoclonal antibodies.

Cells and tissues of immunity: Lymphoid tissues: primary & secondary lymphoid tissues, cells of innate immunity : phagocytes, antigen presenting cells, natural killer cells, Eosinophils, mast cells and basophils, B and T epitopes, activation and differentiation of B and T cells, B and T cell receptors. The major histocompatibility complex, antigen process and antigen presentation, complement system, primary and secondary immune modulation.

Humoral and cell mediated immune response, immune response during bacterial (tuberculosis), parasitic (malarial) and viral (HIV) infections.

SUGGESTED READINGS:

1. Buchanan, B.B., Gruissem, W. and R.L. Jones. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Maryland, 2000.
2. Benjamin, E., Coico, R. and G. Sunshine. *Immunology; A short course* 4th Ed. Wiley-Liss, Inc. New York, 2000.
3. Dennis, D.T., Turpin, D.H., Lefebvre, D.D., and D.B. Layzell. *Plant Metabolism*. Longman, Essex, 1997.
4. Galston, A.W. *Life Processes in Plants*. Scientific American Library, Springer-Verlag, New York, 1989.
5. Goldsby, R.A. Kindt, T.J., Osborne B.A. and J. Kuby. *Immunology*. W.H. Freeman & Company, New York, 2003.
6. Hooykaas, P.J.J., Hall, M.A., and K.R. Libbenga. (Eds.) *Biochemistry and Molecular Biology of Plant Hormones*. Elsevier, Amsterdam, 1999.
7. Hopkins, W.G. *Introduction to Plant Physiology*. John Wiley & Sons, Inc., New York. 1995.
8. Lodish, H., Berk, A., Zipursky, S.I., Matsudaira, P., Baltimore, D. and J. Darnell. *Molecular Cell Biology*. W.H. Freeman and Company, New York, 2000.
9. Moore, T.C. *Biochemistry and Physiology of Plant Hormones*. Springer-Verlag, New York, 1989.
10. Nobel, P.S. *Physiochemical and Environmental Plant Physiology*. Academic Press, San Diego, 1999.
11. Paul, W.E. *Fundamentals of Immunology* 6th Ed. Lippincott Williams and Wilkins, 2008.
12. Salisbury, F.B. and C.W. Ross. *Plant Physiology*, Wadsworth Publishing Co., California, 1992.

13. Stanley, J. *Essentials of Immunology and Serology*. Delmar Thomson Learning, USA, 2002.
14. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.-D. and Govindjee. *Concepts in Photobiology: Photosynthesis and Photomorphogenesis*. Narosa Publishing House, New Delhi, 1999.
15. Taiz, L., and E. Zeiger. *Plant Physiology*. Sinauer Associates, Inc., Publishers, Massachusetts, 1998.
16. Thomas, B. and D. Vince-Prue. *Photoperiodism in Plants*. Academic Press, San Diego, 1997.
17. Westhoff, P. *Molecular Plant Development: From Gene to Plant*. Oxford University Press, Oxford, 1998.

INSTRUMENTATION METHODS AND ANALYSIS

NOTE: Nine questions will be set in all. Question No. 9 will be of very short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Principles of analytical methods: Titrimetry, gravimetry, colorimetry, spectrophotometry, atomic absorption spectrophotometry and flame photometry

Molecular biology methods: Isolation and purification of RNA, DNA and proteins, different separation methods, analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; molecular cloning of DNA and RNA fragments in bacterial and eukaryotic systems, expression of recombinant proteins using bacterial, animal and plant vectors; *in vitro* mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; methods of analysis of gene expression at RNA and protein level; isolation, separation and analysis of carbohydrates and lipid molecules.

UNIT-II

Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

Biophysical methods: Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; Analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

UNIT-III

Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

Radiolabeling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

UNIT-IV

Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

Methods in field biology: Methods of estimating population density of plants, ranging patterns through direct, indirect and remote observations, habitat characterization- ground and remote sensing methods.

Computational methods: Nucleic acid and protein sequence databases; Data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation.

SUGGESTED READINGS:

1. Wilson K. and J. Walker. *Practical Biochemistry: Principles and Technique* Cambridge University Press, U.K. 1995
2. Riley, T. and C. Tomilson. *Principles of Electroanalytical Methods*. John Wiley and Sons Ltd. Chichester, England, 1987.
3. Sheehan, D. *Physical Biochemistry: Principles and Applications*, John Wiley and Sons Ltd. Chichester, England, 2000.
4. Pungor, E. *A Practical Guide to Instrumental Analysis*. CRC press LCC, U.S. 1995.

RESTORATION ECOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Natural and anthropogenic disturbances: Characteristics and sources, effects on structural and functioning of terrestrial and aquatic ecosystems.

Restoration- Terms and definitions, importance of ecological restoration, strategies of restoration- natural recovery, active restoration, rehabilitation, restoration plan and rehabilitation measures.

Physical, chemical and biological tools of restoration.

UNIT-II

Microbial diversity and ecological restoration

Restoration of soil fertility of degraded lands: No-tillage, role of mycorrhizae, forestry plantations, biofertilizers

Sustainable forestry management and agroforestry

Biotechnological tools of restoration

UNIT-III

Prevention and mitigation of invasive species, habitat fragmentation

Global change and human impact on ecological systems

Climate change mitigation and biological carbon sequestration

Environmental impact and risk assessment

Ecosystem stability: structural and functional stability

UNIT-IV

Degradation and restoration of forest and grassland ecosystems

Degradation and restoration of aquatic resources: River corridors, wetlands and lakes. Adaptive restoration of wetlands; Waste water recycling and waste management

Reclamation of mining sites, bioremediation and phytoremediation

SUGGESTED READINGS:

1. Botkin, D.B. and E.A. Killer. *Environment Science: Earth as a Living Planet*, John Wiley and Sons Inc., New York, 2004.
2. Carson, Rachel. *Silent Spring*, Boston, Houghton Mifflin, 1962.
3. Morgan, R.K. *Environmental Impact Assessment: A methodological Perspective*. Kluwer Academic Publishers, London.
4. Singh, J.S., Singh, S.P. and S.R. Gupta. *Ecology, Environment and Resource Conservation*, Anamaya Publishers, New Delhi, 2006.
5. Bradshaw, A.D. and M.J. Chadwick. *The restoration of Land Ecology and Reclamation of Derelict and Degraded Land*. Blackwell Scientific Publication, Oxford, England, 1980
6. Packard, S. and C.F. Mutel (Eds.) *The Tall Grass Restoration Handbook*, Island Press, Washington, D.C. 1997.
7. Urbanska, K.M., Webb, N.R. and P.J. Edwards. *Restoration Ecology and Sustainable Development*, Cambridge University Press, Cambridge, 1998.

APPLIED MYCOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Primary metabolites production by fungi: industrial alcohol, organic-acid, beer

Secondary metabolites production by fungi: Antibiotics, steroid transformation, enzymes, amino-acids, growth regulators and vitamins

UNIT-II

Fungi as biofertilizers: Endomycorrhizae and ectomycorrhizae

Fungi as biocontrol of plant pathogens and weeds

Biodeterioration of materials: Paper, painted surface and wood

Fungi in bioremediation

UNIT-III

Food processing by fungi: Bread, cheese and baker's yeast

Fungal sources of health food: Single cell protein and edible mushroom

Cultivation of Mushroom

Spoilage of food and fungal toxicity

UNIT-IV

Culturing and preservation of fungi: isolation of fungi, culturing of fungi, establishment a pure culture, aseptic technique, maintenance of culture collection, selection of method of preservation and identification centres.

Common culture media and sterilization techniques

Conservation of fungal diversity

SUGGESTED READINGS:

1. Alexopolous, C.J., C.W. Mims and M. Blackwell. *Introductory Mycology*. 4th Ed. John Wiley & Sons, New York, 2007.

2. Ainsworth, G.C. Sparrow, F.K., and A.S. Sussman. *The Fungi- An Advanced Treatise. Vols. IV A*. Academic Press, London, 1973.
3. Bilgrami, K.S. and R.N. Verma. *Physiology of Fungi*. 2nd Ed. Vikas Publ. House, New Delhi, 1981
4. Burnett, J.H. *Fundamentals of Mycology*. Edward Arnold, London, 1976.
5. Dubey, R.C. *A Text Book of Biotechnology*, S. Chand & Co. Ltd. New Delhi, 2005.
6. Gupta, R. and K.G. Mukejii, *Microbial Technology*, APH Publ. Co. New Delhi, 2001.
7. Mehrotra, R.S. and K.R. Aneja. *An Introduction to Mycology*. New Age International Publishers, New Delhi, 1990.
8. Mundukur, B.B. *Fungi & Plant Diseases*, Pochillion Co. Ltd. USA, 1967.
9. Sharma, P.D. *The Fungi*. 2nd Ed. Rastogi Publications, Meerut, 2004.
10. Sumbali, G. *The Fungi*, Narosa Publishing House, New Delhi, 2010.
11. Vashista, B.R. and A.K. Sinha, *Botany for Degree Students-Fungi*. S. Chand and Company Ltd, New Delhi, 2008.
12. Webster, C.J. *Introduction to Fungi*. 2nd Ed., Cambridge University Press, Cambridge, 1980.

Course- Bot. 527

Credits: 2+1

ETHNOBOTANY AND SUSTAINABLE UTILIZATION OF PLANT RESOURCES

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Medicinal Plants: Introduction, history and classification of drugs, antibiotics, plants as sources of drugs, parts used, composition and uses.

Global importance of medicinal plant

Economic aspect of Exploitation of medicinal plants

UNIT-II

Himalayan plant resources

Sources of information on plant resources of India

Traditional botanical knowledge

Methods of research in ethnobotany

UNIT-III

Sustainable development: Concept and growth of the idea, indicators of sustainability, sustainable exploitation and development, mechanism of sustainable utilization of biological resources

Ecological and practical uses of biodiversity; distribution and conservation status of plants with particular reference to economically important species, red data book categories, strategies and practices for *in situ* and *ex situ* conservation of biodiversity

UNIT-IV

Wasteland management in Himalayan region

Remote sensing and bioresources

Bio-indicators

Importance of genetic resources and conservation of plant genetic resources

SUGGESTED READINGS:

1. Anonymous. *National Gene Bank: Indian Heritage on Plant Genetic resources* (Booklet). National Bureau of Plant Genetic Resource, New Delhi, 1997.
2. Cotton, C.M. *Ethnobotany- Principles and Application*, John Heywood, 1996.
3. Cobley, L.S. and W.M. Steels. *An Introduction to the Botany of Tropical Crop Plants. 3rd Ed.* The English Language Book Society and Longman, London, 1979.
4. Council for Scientific & Industrial Research. *The Useful Plants of India*. Publications and Information Directorate, CSIR, New Delhi, 1986.
5. Chandel, K.P.S., G. Shukla and N. Sharma. *Biodiversity in Medicinal and Aromatic Plants in India: Conservation and Utilization*. National Bureau of Plant Genetic Resources, New Delhi, 1996.
6. Dastur, J.F. *Medicinal Plants of India and Pakistan*. 3rd Ed. Meyerbooks. 1985.
7. Frankel, O.H., A.H.D. Brown and J.J. Burdon. *The Conservation of Plant Diversity*. Cambridge University Press, Cambridge, U.K. 1995.
8. Gupta, N.L. and K.K. Gurjar. *Sustainable Development (Vol. I & II)*. Rawat Publications, New Delhi.
9. Jain, S.K. *Methods and Approaches in Ethnobotany*, Surya Publishers, Dehradun, 1989.
10. Kirtikar, K.R. and D.D. Basu. *Indian Medicinal Plants. Vols. I & II*. 2nd Ed. Lalit Mohan Basu, Allahabad, 1953.
11. Kochhar, S.L. *Economic Botany of the Tropics*. 2nd Ed. MacMillan India Ltd., Delhi, 1998.
12. Ramakrishanan, P.S. *Ecology and sustainable development*, National Book Trust, India, 2000.
13. Wiley, V. *Global Biodiversity Assessment*, Cambridge University Press, Cambridge, 1995.

ADVANCED PLANT PHYSIOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I**Keto acid metabolism:**

- a) Importance of keto acids
- b) Methodology for qualitative and quantitative estimations
- c) Metabolic studies in relation to seedling growth, flower development and fruit setting and C₄- pathway
- d) Amido acids: Protein and free amino acids- extraction, separation and significance

UNIT-II**Photosynthesis:**

- a) The four major complexes of thylakoids
- b) The path of carbon in photosynthesis (C₃, C₄ and CAM plants)
- c) Rubisco: structure and its association with the mechanism of carboxylation and oxygenation of RUBP
- d) C₄ dicarboxylic acid cycle; NADP-ME, PCK and NAD-D-ME type of CO₂- fixation. Tco-2

UNIT-III**Respiration:**

- a) Cyanide insensitive respiration: (i) Historical account and discovery (ii) Mechanism and significance
- b) Comparison between normal electron transport chain and alternate oxidase pathway of respiration
- c) Glycolic acid metabolism and photorespiration
- d) Glyoxylate cycle

UNIT-IV

Nitrogen and sulphur metabolism : Introduction, overview of nitrogen in the biosphere and in plants, overview of nitrogen fixation, enzymology of nitrogen fixation, symbiotic nitrogen fixation, ammonia uptake and transport, overview of nitrate uptake and reduction, nitrate reduction, nitrate reduction, interaction between nitrate assimilation and carbon metabolism,

overview of sulfate assimilation, sulfur chemistry and function, sulfur uptake and transport, the reductive sulfate assimilation pathway, synthesis and function of glutathione and its derivatives.

SUGGESTED READINGS:

1. Bonner, J. And J.E. Varner. *Plant Biochemistry*, 3rd Ed. Academic Press, New York and London, 1976.
2. Buchanan, B.B., W. Gruissem and R.L. Jones. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Maryland, USA. 2000.
3. Cooper, T.G. *Electrophoresis. In: The Tools of Biochemistry*. John Wiley and Sons, New York, 1977.
4. Devlin, R.M., and F.H. Witham. *Plant Physiology*. C.B.S. Publishers, New Delhi, 1986.
5. Dey, P.M. and J.B. Harborne. *Plant Biochemistry*. Academic Press, London, 1997.
6. Hopkins, W.G. (Ed) *Introduction to Plant Physiology*. C.B.S. John Wiley & Sons Inc. USA. 2003.
7. Noggle, G.R. and G.J. Fritz. *Introductory Plant Physiology*. 2nd Ed. Prentice Hall of India Pvt. Ltd., New Delhi, 1991.
8. Plummer, D.T. *An Introduction to Practical Biochemistry*. 2nd Ed. T.M.H. Publishing Co., New Delhi, 1979.
9. Salisbury, F.B. and C. Ross. *Plant Physiology*. 4th Ed. CBS Publisher and Distributors, 1992.
10. Sawhney, S.K. and R. Singh. *Introductory Practical Biochemistry*, Narosa Publishing House, New Delhi, 2000.
11. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee. *Concepts in Photobiology: Photosynthesis and Photomorphogenesis*. Narosa Publishing House, New Delhi, 1999.
12. Solmos, T. *Cyanide Resistance Respiration in Higher Plants*. In: Ann. Rev. Pl. Physiol. 28: 279-297, 1977.
13. Taiz, L. and E. Zeiger. *Plant Physiology*. 4th Ed. Sinauer Associates Inc. Publishers, Massachusetts, USA. 2006.

AGROFORESTRY SYSTEM

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Introduction: The history of agroforestry, definition and concepts of agroforestry, community forestry, farm forestry and social forestry.

Classification of agroforestry systems: Structural classification of systems, classification based on function of systems, ecological classification, classification based on socioeconomic criteria, a framework for classification. Agroforestry systems and practices.

Distribution of agroforestry systems in the tropics: The tropical environment, distribution of tropical agroforestry systems, agroecological spread of tropical agroforestry systems.

Shifting cultivation and improved fallows: System overview, soil management and shifting cultivation, the evolution of planted fallows, improved tree fallows.

UNIT-II

Plantation crop combinations: Integrated land-use systems with plantation crops, small holder systems with coconuts: a notable example of integrated land-use, crop combinations with other plantation crops, multistory tree gardens.

Alley cropping: Nutrient yield, effect on soil properties and soil conservation, effect on crop yields, future directions.

Other agroforestry systems and practices: Tree fodder and silvopastoral systems, agroforestry for firewood production, intercropping under scattered or regularly planted trees, agroforestry for reclamation of problem soils, underexploited trees in indigenous agroforestry systems, buffer-zone agroforestry.

UNIT-III

Agroforestry species: Multipurpose trees (MPTs), herbaceous species.

Component interactions: Positive (production-enhancing) interactions, negative (production decreasing) interactions, component management.

Effects of trees on soils: Beneficial effects, adverse effects.

Field experiments in agroforestry : Agroforestry research, different perspectives, principles of field experimentation, special considerations in agroforestry experiments, the current state of agroforestry field experimentation, prognosis of the directions in agroforestry research.

UNIT-IV

Sociocultural considerations: Agroforestry as a social science, important sociocultural factors in agroforestry, farmer's perception of tree planting, government policies and agroforestry implementation, social acceptability of agroforestry.

Evaluation of agroforestry systems: Productivity evaluation, sustainability evaluation, adoptability evaluation, towards development of a methodology for evaluating agroforestry systems.

SUGGESTED READINGS:

1. Nair, P.K.R. *An introduction to Agroforestry*. Kluwer Academic Publishers, London, 1993.
2. Indian Council of Agricultural Research. Proceedings of National Seminar on Agroforestry, May, 1979, ICAR, New Delhi India. 1979.
3. Evans, J. *Plantation Forestry in the Tropics*, 2nd Ed. Clarendon Press, Oxford, U.K. 1992.
4. MacDicken, K.G and N.T. Vergara, (Eds.) *Agroforestry: Classification and Management*. JohnWiley, New York, USA, 1990.
5. Nair, P.K.R. (Eds.) *Agroforestry Systems in the Tropics*, Kluwer, Dordrecht, The Netherlands, 1989.
6. Grigg, D.B. *The Agricultural Systems of the World*. Cambridge University Press, London, U.K. 1974.

ECOLOGICAL MODELLING

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Exponential population growth: Differential and difference equations, finite rate of increase, population doubling time, life tables, life expectancy, net reproduction rate, generation time, intrinsic rate of natural increase, stable age distribution.

Matrix model for population growth: Matrix operations, addition, subtraction, multiplication, inversion, latent roots of a matrix, Leslie's matrix model for population growth in unlimited environment, finite rate of increase with stable age distribution.

Logistic population growth: Differential, difference and matrix models for population growth in limited environment.

UNIT-II

Dispersal: Empirical models, random walk model.

Dispersion: Poisson and negative binomial distribution, random, regular and aggregate patterns, Morisita's index of aggregation.

Interaction between two species: Competition – Differential and difference equations, Leslie- Gower Model, Lotka-Volterra model for predator – prey interaction, Leslie model, deterministic models for simple and general epidemics.

UNIT-III

Association analysis and community classification: Chi-square, Cole's measures and point correlation coefficient for association, information analysis, ordination, continuum concept.

Species diversity: Species area relationships, species abundance relationships – Logarithmic series, broken stick model, niche pre-emption model, log normal distribution, information measures of diversity. Brillouin's measure, Shannon-Wiener measure, Simpson's measure. Extinction and formation of single populations, McArthur – Wilson theory of biogeography.

UNIT-IV

Production and energy flow: Production in animal populations, efficiency, measurement of ingestion. Bertalanffy's growth equation, measurement of production in plants, litter

decomposition – differential and difference equations, Gompertz curve – differential and difference equations, theoretical analysis of energy flow and nutrient cycling.

SUGGESTED READINGS:

1. Barbour, M.G., Burk, J.H. and W.D. Pitts. *Terrestrial Plant Ecology*. Benjamin/Cummings Publication Company, California, 1987.
2. Batschelet, E. *Introduction to Mathematics for Life Scientists*. Springer-Verlag, Berlin, 1971.
3. Begon, M., Harper, J.L. and C.R. Townsend. *Ecology*, Blackwell Science, Cambridge, 1996.
4. Chapman, J.L. and M.J. Reiss. *Ecology: Principles and Applications*. Cambridge University Press, Cambridge, 1988.
5. Curran, P.J. *Principles of Remote Sensing*. E.L.B.S., Longman Scientific and Technical, Harlow, 1988.
6. Heywood, V.H. and R.T. Watson. *Global Biodiversity Assessment*. Cambridge University Press, Cambridge, 1995.
7. Kormondy, E.J. *Concepts of Ecology*. Prentice-Hall of India Pvt. Ltd., New Delhi, 1996.
8. Krebs, C.J. *Ecological Methodology*. Harper and Row, New York, USA, 1989.
9. Ludwig, J. and J.F. Reynolds. *Statistical Ecology*. John Wiley & Sons, New York, 1988.
10. Magurran, A.E. *Ecological Diversity and its Measurement*. Chapman & Hall, London, 1988.
11. Moldan, B. and S. Billharz. *Sustainability Indicators*. John Wiley & Sons, New York, 1997.
12. Moore, P. W and S.B. Chapman. *Methods in Plant Ecology*. Blackwell Scientific Publications, Cambridge, 1986.
13. Muller-Dombois, D. and H. Ellenberq. *Aims and Methods of Vegetation Ecology*, Wiley, New York, 1976.
14. Odum, E.P., *Basic Ecology*. Saunders, Philadelphia, 1983.
15. Pielou, E.C. *The Interpretation of Ecological Data*. Wiley, New York, 1984.
16. Poole, R.W. *An Introduction to Quantitative Ecology*. McGraw Hill Book Co., New York, 1974.
17. Sabbins Jr, F.F. *Remote Sensing: Principles and Intrepretation*. WH Freeman & Co., New York, 1986.
18. Smith, R.L. *Ecology and Field Biology*. Harper Collins, New York, 1996.
19. Sokal, R.R. and Rohlf, F.J. *Biometry*. W.H. Freeman & Co. San Francisco, 1995.

CONSERVATION BIOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Principle and importance of conservation biology; genetic variations, natural selection, genetic drift and gene flow, minimum viable population, genetic swamping.

Biodiversity: Magnitude, global accumulation; Levels biodiversity- species, genetic and ecosystem diversity; species diversity indices, rank abundance patterns.

UNIT-II

Global biodiversity: Spatial patterns and processes, factors affecting biodiversity patterns. Terrestrial and marine hotspots of biodiversity

Biodiversity of wetlands, mangroves and coral reefs- A general account

Biodiversity and ecosystem services.

UNIT-III

Ecological and practical uses of biodiversity; Distribution and conservation status of plants with particular reference to economically important species, red data book categories, strategies and practices for *in situ* and *ex situ* conservation of biodiversity, role of botanical gardens.

Biodiversity assessment and inventory

UNIT-IV

Importance of genetic resources and conservation of crop genetic resources

Recent concerns for biodiversity beginning with Rio summit, national and international conventions and regulations on biodiversity with detailed study of CBD, major agencies involved and their activity profiles.

Role of remote sensing and GIS in biodiversity conservation

SUGGESTED READINGS:

1. Singh, J.S., Singh, S.P. and S.R. Gupta. *Ecology, Environment and Resource Conservation*, Anamaya Publishers, New Delhi, 2006.

2. McNaughton, S.J. and L.L. Wolf. *General Ecology* 1st Ed. Holt, Rinehart & Winston Inc. New York. 1973.
3. Benton, A.H. and W.E. Werner (Jr.). *Field Biology and Ecology* 3rd Ed. MacGraw Hill-Book Company, New York, 1974
4. Frankel, O.H., A.H.D. Brown and J.J. Burdon. *The Conservation of Plant Biodiversity*. Cambridge Univ. Press, Cambridge, U.K. 1995.
5. Ramakrishanan, P.S. *Ecology and Sustainable Development*, National Book Trust, India, 2000.
6. Pandey, B.N. and G.K. Kulkarni. *Biodiversity and Environment*. APH Publishing Corporation, New Delhi, 2006.

PRINCIPLES OF PLANT PATHOLOGY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Nature and concept of plant diseases, history of plant pathogens, various levels of parasitism, effect of plant pathogens on human affairs, classification of plant diseases

Pathogenesis: Penetration and entry of plant pathogens, development inside host tissue

How pathogen attack plants: Chemical weapons of pathogen (enzymes and toxins)

UNIT-II

Defence mechanism of plants against pathogens: Structural defence and biochemical defence

Genetics of plant pathogen interaction.

Plant diseases epidemiology and plant diseases forecasting: Importance of disease forecasting services, methods used in plant diseases forecasting

UNIT-III

Management of plant pathogens: Cultural, chemical and biological methods

Dispersal of plant pathogens: Direct and indirect transmission

Effect of environmental factors and nutrition on disease development

Mycotoxin producing fungi during storage and major mycotoxins produced by them

UNIT-IV

Application of biotechnology in plant pathology: The use of tissue culture techniques (callus culture, apical meristem culture and protoplast fusion), Recombinant DNA technology, use of monoclonal antibodies in plant pathology

Phytopathological techniques in plant pathology: Isolation of fungi, requirement for isolation of fungi, plant disease assessment methods

SUGGESTED READINGS:

1. Agrios, G.N. *Plant Pathology*. 5th Ed. Elsevier Academic Press, San Diego, 2005.

2. Alexopolous, C.J., C.W. Mims and M. Blackwell. *Introductory Mycology*. 4th Ed. John Wiley & Sons, New York, 2007.
3. Bilgrami, K.S. and H.C. Dube. *A Textbook of Modern Plant Pathology*. Vikas Publishing House, New Delhi, 1990.
4. Clifton, A. *Introduction to the Bacteria*, Mc Graw Hill Books Co., New York, 1958.
5. Mehrotra, R.S. and K.R. Aneja. *An Introduction to Mycology*, New Age International Press, Delhi, 1990.
6. Mehrotra, R.S. and A. Aggarwal. *Plant Pathology*. 2nd Ed. Tata McGraw Hill Co. Ltd., New Delhi, 2003.
7. Ronald, M. Atlas. *Principles of Microbiology*. Mosby-Year Book, Inc. St. Louis, Missouri, USA, 1995.
8. Sharma, P.D. *Plant Pathology*. Rastogi Publications, Meerut, 1998.
9. Singh, R.S. *Plant Diseases*. 8th Ed. Oxford & IBH, New Delhi, 2008.
10. Sumbali, G. *The Fungi*, Narosa Publishing House, New Delhi, 2010.
11. Webster, C.J. *Introduction to Fungi*. 2nd Ed., Cambridge University Press, Cambridge, 1980.

WOOD SCIENCE AND FOREST BIODIVERSITY

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Historical background of forestry and forest product research. Status of wood utilization research and broadening horizons of research at various ICFRE, CSIR and other institutes.

Status of Indian forestry, forest types, changing trends in social agro and plantation forestry, National Forest Policy and its salient changing features.

UNIT-II

Biochemical constituents of wood and bark.

Cellulose, hemi-cellulose and lignin: structure, chemical properties, effect of acids and bases.

Variation of major constituents in different morphological regions of wood.

Resins, oleo resins, gum oleo resins in some characteristic woods.

Gums in some prominent timber species with special references to larch arabinogalactan, Gum Arabic, Gum Karaya, Gum Ghatti, Gum Tragacanth etc.

UNIT-III

Structure, identification and evolution of coniferous woods with special reference to Chir Pine, Blue Pine, Deodar, Cypress and Yew.

Structure, identification and evolution of dicot woods with particular reference to Sal, Teak, Sshisham, Walnut, Indian Oak, Toon and Himalayan Poplar.

A general account of texture, figure, spiral grain and knots in woods.

UNIT-IV

Supply and demand status of wood, export and import of timber, its products and channels.

Growth of wood based industry in India, effect of globalization. Role of skilled manpower in this sector.

Brief status of solid wood, reconstituted and handicraft industry; such as wood carving, basketry, furniture, cabinets, sport goods, saw mills, wood flooring and paneling, plywood, flush doors, match wood, wooden houses/ bamboo huts and log cabins.

SUGGESTED READINGS:

1. Agrawal, H.O. and M.K. Seth. *Sericulture in India Vol. I-IV*, Bishen Singh Mahendra Pal Singh, Dehradun, 2000.
2. Bawa, R. and P.K. Khosla, *Biodiversity of Forest Species (A Community Forestry Approach)*, Bishen Singh Mahendra Pal Singh, Dehradun, 1998.
3. Carlquist, S. *Comparative Wood Anatomy- Systematic, Ecological and Evolutionary Aspects of Dicotyledonous Woods*, Springer Verlag, Berlin, 1988.
4. Dhar, U. *Himalayan Biodiversity*, Him Vikas Publication No. 3, Gyanodya Prakashan, Nainital, 1993.
5. Jane, F.W. *The Structure of Wood*, Adam and Charles Blanck, London, 1970.
6. Nair, M.N.B. *Wood Anatomy and Major Uses of Woods*, Faculty of Forestry, Universiti Putra, Malaysia, 1998.
7. Panshin, A.J. and C. De Zeeuw, *Textbook of Wood Technology Vol. I*, Mc Graw Hill Book Co., New York.
8. Timell, T.E. *Compression Wood in Gymnosperms Vol. I-III*, Springe Verlag, Berlin, 1986.

PLANT GROWTH AND DEVELOPMENT

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Plant growth: Growth concepts and parameters for its measurement; Growth curves and compound interest law of growth

Common plant growth regulators: History of discovery, structure, metabolism, transport, significance and mechanism of action of Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic Acid.

UNIT-II

Hormonal receptors and signal transduction

General account of phenolics and flavonoids

Polyamines, growth retardants and morphactins

UNIT-III

Plant Development: Germination and dormancy of seeds and buds: factors affect dormancy and its regulation by plant growth regulators and environmental factors.

Senescence and abscission: Process of induction, metabolic changes and role of plant growth regulators

UNIT-IV

Flowering Process: Nature and events during flowering, florigen concept, Gibberellin-Anthesin hypothesis, chemical control of flowering, role of vernalization.

Fruit Physiology: Climacteric and non- climacteric fruits, fruit ripening; Post harvest storage of fruits- quality maintenance, physiological and biochemical studies under different kinds of storage conditions.

SUGGESTED READINGS:

1. Audus, L.J. *Plant Growth Substances Vol. I*, Chemistry and Physiology, Leonard Hill, London, 1972.

2. Bonner, J. And J.E. Varner. *Plant Biochemistry*, 3rd Ed., Academic Press, New York and London, 1976.
3. Buchanan, B.B., Gruissem, W. and R.L. Jones. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Maryland, USA. 2000.
4. Davies, Peter, J. *Plant Hormones: Physiology, Biochemistry and Molecular Biology* 2nd Ed., Kluwer Academic Publishers, The Netherlands, 1995.
5. Dey, P.M. and J.B. Harborne. *Plant Biochemistry*. Academic Press, London. 1997.
6. Hopkins, W.G. (Ed) *Introduction to Plant Physiology*. C.B.S. John Wiley & Sons Inc. USA, 2003.
7. Lehninger, A.L., Nelson, D.L. and M.M. Co. *Principles of Biochemistry*, 2nd Ed., CBS Publihers, 1993.
8. Khan, A.A. *The Physiology and Biochemistry of Seed Dormancy and Germination*. North- Holland Publishing Co., Amsterdam, New Oxford, 1977.
9. Krishnamoorthy, H.N. *Physiology of Plant Growth and Development*. Atma Ram and Sons, Delhi, 1993.
10. Moore, T.C. *Biochemistry and Physiology of Plant Hormones*, 2nd Ed. Reprint 1994, Narosa Publishing House, New Delhi, 1989.
11. Noggle, G.R. and G.J. Fritz. *Introductory Plant Physiology*. 2nd Ed. Prentice Hall of India Pvt. Ltd., New Delhi, 1991.
12. Salisbury, F.B. and C. Ross. *Plant Physiology*. 4th Ed. CBS Publisher and Distributors. 1992.
13. Saymour, G.B., Taylor, J.E. and G.A. Tucker. *Biochemistry of Fruit Ripening*, Chapman and Hall, London, 1993.
14. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee. *Concepts in Photobiology: Photosynthesis and Photomorphogenesis*. Narosa Publishing House, New Delhi, 1999.
15. Srivastava, L.M. *Plant Growth and Development: Hormones and Environment*, Academic Press, Published by Elsevier India Pvt. Ltd., New Delhi, 2006.
16. Trivedi, P.C. *Applied Botany*, Aavishkar Publishers, Distributors, Jaipur, 2005.
17. Taiz, L. and E. Zeiger. *Plant Physiology*. 4th Ed. Sinauer Associates Inc. Publishers, Massachusetts, USA. 2006.
18. Wilkins, M.B. *Advanced Plant Physiology*, ELBS- Longman, England, 1987.

FOREST AS LAND USE SYSTEM

NOTE: Nine questions will be set in all. Question No. 9 will be of short answer type covering entire syllabus and will be compulsory. Remaining eight questions will be set section-wise with two questions from each unit. As far as possible, each question will be subdivided into parts and will not be essay type. The candidates will be required to attempt Question No. 9 and four more questions selecting one from each unit. All questions may carry equal marks, unless specified.

UNIT-I

Interrelationship of biological science with forestry subjects; Biological spectrum; Forest Biodiversity and its services; Major classification of forest plant

Extent of forest in India in relation to other countries. Forest types, principal forest types of India and their distribution. Susceptibility of forest to damages, destructive agencies. Importance of forest.

UNIT-II

Definition of land use systems related to agro forestry

Sustainability of land use systems- soil conservation and sustainability

Agroforestry for soil conservation, soil restoration-need and reclamation of degraded soils, flood prone areas; Agroforestry for maintenance of soil fertility, ecological balance and conservation of biodiversity, management innovation in agroforestry systems of the tropics.

UNIT-III

Review of regional nursery practices. Nursery site selection, type, design and layout.

Seed source, collection, processing, storage, testing and pre-sowing treatments. Seed bed preparation and sowing

Media and mixtures, macro and micro-propagation.

Propagation structures: Shade house, poly house, mist chambers and growth chambers.

Nursery soil fertility management

UNIT-IV

Forest Management; sustained yield; production period or rotation; normal forest; growing stock and its increment; yield and its regulation; forest valuation- valuation principles, interest and investment, valuation of forest land and timber stand, non-wood forest outputs, valuation of financial alternatives.

Smallholder livelihood and the role of agroforestry-food and nutritional security, fulfilment of food, fodder, firewood and shelter based needs, income generation and subsistence production.

SUGGESTED READINGS:

1. Paul L. *Tropical forestry Hand Book*, 2nd Ed. Springer Verlag publications, New York, 1993.
2. Chadurvedi, A.A. *Technology of Forest Nurseries*, Khanna Bandhn, 1994.
3. Evan, J.W. *In: Seed Test and Their Control*, Samir Book Center, Delhi, 1989.
4. Kumar. V. *Nursey and Plantation Practices in Forestry*, Scientific Pub. 1999.
5. Luna, R.K. *Plantation Forestry in India*, International Book Distributors. 1989
6. Evans, J. *Plantation Forestry in the Tropics*, Clarendan Press, Oxford, 1982.
7. Dwivedi, A.P. *Forestry in India*. Surya Publ. 1993.
8. Luna, R.K. *Plantation Forestry in India*, Internationl Book Distributors, Dehra Dun, 1989.
9. Kumar, V. *Nursery and Plantation Practices in Forestry*, Scientific Publishers, 1999.
10. Ram Prakash, Chaudhari, D.C. and S.S. Negi. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors, Dehra Dun, 1998.

Course- Bot. 536

Credits: 2+1

ENVIRONMENTAL MANAGEMENT

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UNIT-I

Environmental management: Concept and scope, Systems and approaches, Standards-international and national; Ecomark; Environmental accounts and auditing, Green funding and taxes, Trade and environmental management

Ecosystem management: Ecosystem analysis, modeling, monitoring and planning; Ecotourism and heritage management; Eco-restoration Environmental management of water, forest and biological resource

UNIT-II

Environmental management of industrial pollution: Management of pollution due to chemical, mining and manufacturing industries (petroleum, coal, cement, paper, fertilizer).

Management of solid wastes: Different types of solid wastes, Methods of disposal and management of Municipal solid wastes, Bio-medical wastes and Hazardous wastes; Recycling of wastes and waste minimization techniques.

UNIT-III

International environmental laws: International Environmental laws with reference to Stockholm Conference, Nairobi Declaration, Rio Conference, Rio+5 and the Rio+10, etc. Role of UN authorities in protection of Global Environment

Environmental laws in India: Legal, administrative and constitutional provisions for environmental protection in India; Statutory protection of the Human Environment– Factories Act, Motor Vehicle Act, Hazardous Waste legislation for pollution abatement; Anti Pollution Acts - The water Act. 1974. The Air Act 1981. The Environment Protection Act, 1986

UNIT-IV

Sustainable development: Concept and growth of the idea, indicators of sustainability, models of sustainable development. Sustainable development scenario– global, national.

Major environmental movements in India: Chipko Movement, Narmada Dam, Tehri Dam, Almetti Dam, Reclamation of alkaline and saline soil

SUGGESTED READINGS:

1. Gupta, N.L. and K. K. Gurjar (Ed.), *Sustainable Development Vol. I & II*, Rawat Publications, 1993.
2. Pandey, G.N. *Environmental Management*, Vikash Publishing House, New Delhi, 1997.
3. Saxena, H.M. *Environmental Management*, New Delhi, 2000.
4. Divan, S. And A. Rosencranz. *Environmental Law and Policy in India*, Oxford University Press, 2001
5. Rai, Mohapatra and Goel (Ed); *Environmental Management – Physio-ecological facets Vol. I & II*, Rawat Publications, New Delhi, 1996.
6. Sapru, R.K. *Environmental Management in India Vol. I & II*, Ashish Publishing House, New Delhi, India, 1987.