

INSTRUCTION FOR THE PAPER- SETTER

The question paper will consist of four units I, II, III and IV. Units I, II, III and IV will have two questions from respective units of the syllabus and carry 10 mark each. There shall be 9 questions and question No. 1 will be compulsory which will cover the entire syllabus uniformly and will carry 10 marks in all.

INSTRUCTION FOR THE CANDIDATES

Candidates are required to attempt FIVE questions and ONE question each from units I, II, III and IV of the question paper together with question No. 1.

SEMESTER -I

PAPER-I: Phycology and Bryology

Unit I

Introduction to phycology, Principles and systems of classification of algae, Comparative account of algal pigments, food reserves, cell wall, flagellation, chloroplasts and eye-spots, their phylogenetic and taxonomic importance. Cell structure and thallus organization, heterocyst and akinete development and their role; chromatic adaptations and reproduction in Cyanophyta, distribution and ecology of cyanobacteria.

Unit II

Range of thalli and methods of reproduction in Chlorophyta, evolutionary tendencies in Chlorophyta. A brief account of Bacillariophyta, Pyrrophyta, Haplophyta, Crysophyta, Xanthophyta, Euglenophyta and Prochlorophyta, and other related and recent new groups. Thallus organization and reproduction in Phaeophyta and Rhodophyta.

Unit III

General introduction including broad outline of classification and evolutionary trends. Distribution of the group in India, general features and adaptation to land habit .Origin and evolution of gametophyte and sporophyte generation. Endemism and endemic liverwort genera of India. Bryophyte ecology, Moss protonema, protonemal differentiation and bud induction. Regeneration in bryophytes. Economic uses, chemistry of bryophytes, fossil history.

Hepaticopsida/ Marchantiophyta: distribution: Global and Indian. General characteristics, morphology, anatomy and life history of Marchantiales – *Plagiochasma*, *Asterella*, *Cryptomitrium*, *Targionia*, *Cyathodium*; Monocleales- *Monoclea*; Sphaerocarpaceae- *Sphaerocarpus*, *Riella*; Calobryales – *Calobryum*, *Haplomitrium*; Metzgeriales – *Riccardia*, *Metzgeria*, *Pallavicinia*; Jungermanniales – *Radula*, *Herberta*, *Porella*, *Frullania*, etc.; Treubiaceae – *Apotreubia*

Unit IV

Anthocerotophyta: distribution – Global and Indian, general features, Morphology, anatomy and life history of Anthocerotales- *Anthoceros*, *Notothylas* etc. Bryopsida / Musci: distribution: Global and Indian, general features, morphology and anatomy, life history of Sphagnales – *Sphagnum*, Andreaeales – *Andreaea*, Andreaebryales – *Takakia*, Polytrichales- *Polytrichum*,

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Pogonatum; Tetrarchidales – *Tetrarchis / Georgia*, Buxbaumiales – *Buxbaumia*, Bryales – *Bryum*, *Rhodobryum*, *Funaria*, etc.

Suggested readings:

1. Lee, Robert Edward, 2008, Phycology, Fourth edition, Cambridge University Press
2. Graham Robin South and Alan Whittick, 1998, Introduction to Phycology, Blackwell Scientific Publication
3. Bold, H.C. and Wynne, M.J., 1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.
4. Dixon, R. , Biology of Rhodophyta, Koelt Science Publisher, West Germany
5. Fritsch, F.E., Structure and Reproduction of Algae, Vol. I & II, Cambridge University Press, Cambridge
6. Gangulee, H.C. and Kar, A.K., 2011, College Botany Vol. II (Algae+Fungi+Brophyta+Pteridophyta) , New Central Book Agency, Kolkata
7. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae+Fungi+Brophyta+Pteridophyta) , Pub. Rastogi Publication, Meerut
8. Parihar N. S. 1965, An Introduction to Embyophyta- Bryophyta. Central Book Depot. Allahabad.
9. Kashyap S. R. 1972, Liverworts of the Western Himalayas & the Punjab Plains. Part 1 & 2.
10. . Richardson D. H. S, The Biology of Mosses.
11. Janice. M. Glime, 2006, Bryophyte Ecology.
12. Goffinet B. & Shaw. A. J. 2008, Bryophyte Biology.

PAPER-II : Mycology and Lichenology

Unit I

Introduction to fungi and their significance to humans, general characteristics of fungi, Fungal Cell, fungal cell walls and fungal organelles, systematics, molecular methods of fungal taxonomy, reproduction and spores in fungi, heterothallism, parasexual cycle and sex hormones in fungi, Biology, general characteristics, importance and life cycles of Plasmodiophora, dictyosteliomycota, acrasiomycota and myxomycota. Biology, general characteristics, classification and brief introduction of **Mastigomycotina**-Chytridiomycetes, Hypochytridiomycetes and Oomycetes **Zygomycotina**- Mucorales, Endogonales, Glomales, Entomophthorales and Zoopagales with special reference to evolutionary tendencies in thallus, asexual and sexual reproduction.

Unit II

Ascomycotina- Taphrinales, Schizosaccharomycetales, Saccharomycetales, Eurotiales, Hypocerales, Melanosporales, Phyllachorales, Ophiostomatales, Dioporthales, Xylariales, Sordariales, Meliolales, Rhytismales, Helotiales, Pezizales, Dothidiales, Pleosporales and Erysiphales.

Unit III

Basidiomycotina- Agaricales, Lycoperdales, Sclerodermatales, Phallales, Nidulariales, Aphylophorales, Uredinales, Ustilaginales, Auriculariales and Tremellales, **Deuteromycotina**-Hyphomycetes, Coelomycetes.

Unit IV

Introduction to lichens, the symbiotic relationship and classification of lichens, methodology for lichens taxonomy, morphology and anatomy of thallus, reproduction, physiology, ecological aspects and chemistry, conservation, culture, bioprospection and economic importance of lichens.

Suggested readings:

1. Webster, John, 1980, Introduction to Fungi, Cambridge University Press
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996, Introductory Mycology, Wiley
3. Carlile, M.J., Watkinson S.C. and Booday, G.W., 2001, The Fungi, Academic Press
4. Maheshwari, R., 2012, Fungi: Experimental Methods in Biology, CRC Press, Boca Raton, Florida
5. Deacon, J.W., Blackwell, M, 1997, Introduction to Modern Mycology, Oxford
6. Webster, John and Roland, W.S., 2007, Introduction to Fungi, Cambridge University Press.
7. Hale, M.E. (1983), The biology of lichens (3rd ed.). Edward Arnold.
8. Hawksworth, DL & Hill, DJ 1984: The Lichen-Forming Fungi. - Blackie, Glasgow and London. 158 pp
9. Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume I. - CRC Press, Inc., Boca Raton.
10. Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume II. - CRC Press Inc., Boca Raton.
11. Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume III. - CRC Press, Inc., Boca Raton
12. Awasthi, D.D. 2000. A hand book of Lichens : Bishen Singh Mahendra Pal Singh., Dehradun
13. Awasthi, D.D. 2000. Lichenology in Indian subcontinent: Bishen Singh Mahendra Pal Singh., Dehradun
14. Culberson, C.F. 1979. Chemical and Botanical Guide to Lichen Products, Otto Koeltz Sci Publishers, Germany
15. Singh G. P. and Singh K.P., 2005, Macrolichens of Sikkim, Botanical survey of India, ministry of environment & forests.
16. Brown D. H., Hawksworth D. L. & Bailey R. H. 1976, Lichenology: Progress & problems, Academic Press. London.
17. Smith A. L. (1921) Lichens, Cambridge university Press
18. Orange A, James PW and White FJ (2001) Microchemical methods for identification of lichens. British Lichen Society.
19. Thomas H. N. (2001) Lichen Biology, Cambridge University Press.
20. Clair L and Seaward M. R. D. (2004) Biodeterioration of stone surfaces: Lichen and Biofilms as weathering agents of rock and cultural heritage, Kluwer academic publishers.
21. Kershaw K. A. (1985) Physiological Ecology of Lichens, Cambridge University Press
22. Longton R. E. (1988) Biology of polar bryophytes and lichens, the press syndicate of the university of Cambridge.
23. Casselman D. K. (2001) Lichens dyea: the new source book, Studio vista publication.
24. Nimis P.L. and Wolseley P.A. (2002), Monitoring with Lichen, Kluwer academic publishers

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25. Karner I., Beckett R. and Varma A.(2002), Protocol in Lichenology, Springer-Verlag Berlin Heidelberg New York.
26. Baron G. (1999) Understanding Lichens, Richmond Publishing co.
27. Ahmadjian, V. 1993. The Lichens symbiosis. Jhon Wiley & Sons.
28. Nayaka, S and Upreti, DK. 2013. The Lichens of Uttar Pradesh. UP State Biodiversity Board.

PAPER-III: Pteridology and Gymnosperms

Unit I

General Introduction of pteridophytes, their peculiar features and similarities and dissimilarities with bryophytes and gymnosperms.

Classifications based on molecular data by Smith et al. 2006.

Origin and Evolution of Pteridophytes, Gametophytes of pteridophytes, ecology of pteridophytes. Stomatal structures in pteridophytes, Spores of pteridophytes. Apogamy, Apospory and parthenogenesis. Sex organs and embryogeny in pteridophytes .

World distribution of pteridophytes with special reference to India, their conservation strategies, economic importance of the pteridophytes.

Unit II

Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: Early land plant and their evolution, Psilopsida, Lycopsida, Sphenopsida, Filicopsida. Coenopteridales, Ophioglossales, Manatales, Osmundales and filicales; Economic importance of pteridophytes, ecology of pteridophytes; Monographic study of *Psilotum*, *Lycopodium*, *Isoetes*, *Ophioglossum*, *Osmunda*, *Lygodium*, *Cyathea*, *Gleichenia*, *Adiantum*, *Pteris*, *Christella* and aquatic ferns.

Unit III

General introduction of gymnosperms with special reference to its salient features, similarities and dissimilarities with other groups like pteridophytes and angiosperms.

Classifications of gymnosperms. Origin and Evolution of gymnosperms with special reference to Progymnosperms and origin of seeds. Global distribution of gymnosperms with special reference to Indian plants. Endangered gymnosperms, their conservation and present status.

Unit IV

Comparative morphology, anatomy, reproductive biology and phylogenetic studies of the following groups: Pteridospermopsida, Cycadopsida, Pentoxyllopsida, Coniferopsida; Economic importance of gymnosperms

Suggested readings:

1. Rashid, A, 2011, An Introduction to Pteridopyta, 2nd edition, (Reprint), Pub. Vikas Publishing House Pvt. Ltd., Noida.
2. Gifford, Ernest, M., Foster, Adriance.S., 1989, Morphology and Evolution of vascular plant. W. H. Freeman; Third Edition.

3. Ogura, Yuzuru., 1972, Comparative Anatomy of Vegetative Organs of The Pteridophytes. Gebr. Borntraeger; 2nd edition.
4. Rashid, A.1999, An Introduction to Pteridophyta: Diversity,Development,Differentiation. Vikas Publishing House Pvt Ltd.
5. Parihar, Narayan Singh., 1977, The Biology and Morphology of The Pteridophyte. Central Book Depot.
6. Eames, A.J. (1936) Morphology of Vascular plant-lower group. Tata Mc Graw Hill, New Delhi.
7. Chamberlain, Charles Joseph,b.1863, Gymnosperm S;Structure and Evolution. Chicago,III.,The University of Chicago Press
8. Chhaya Biswas and B.M.Johri. The Gymnosperm. Springer; 1997 edition (16 April 2014)
9. Bhatnagar, S.P. Moitra, Alok. 1996. Gymnosperms. New Age International.
- 10, Pant DD. 2002, An Introduction to Gymnosperms, Cycas, and Cycadales, Birbal Sahni Institute of Palaeobotany.

Paper:IV: Taxonomy of Angiosperm

Unit I

Latin diagnosis, definition and use of taxonomic terms, history of plant taxonomy in India, history of plant classification, needs and aim of classification, units of classification, delimitation of taxa and their practical consideration, artificial, natural and phylogenetic system of classification, A critical study of Takhtajan's, modern system of classification, an introduction of angiosperm phylogeny group (APG), characteristics and phylogeny of orders

Unit II

Taxonomic features , systemetic phylogeny and economic importance of families; Magnoliaceae ,Capparadiaceae, Combretaceae, Rosaceae, Asteraceae, Apocynaceae, Asclepidaceae, Convolvulaceae ,Scrophulariaceae , Acanthaceae , Bignoniaceae, Lamiaceae ,Verbenaceae ,Polygonaceae , Euphorbiaceae , Zingiberaceae , Araceae , Cyperceae and Poaceae

Unit III

Needs and aim of nomenclatures, International Rules of Botanical Nomenclature, Concept of species genus, family with special reference to the type concept. Interrelationship of plant taxonomy with morphology, anatomy, embryology, palynology, cytology, genetics, phytogeography and Chemistry, A general survey of recent advances in taxonomy: Biosystematics, biochemical and molecular systematic and numerical taxonomy

Unit IV

Indigenous flora of the country with special reference to local flora (Uttar Pradesh), A general knowledge of Herbarium and Botanical garden of the world and India, organization of Botanical Survey of India and its role.

Suggested readings:

1. Sumbhamurti A. V. S. S., Taxonomy of Angiosperm, I. K. international Pvt Ltd.

2. APG III 2009. An update of the Angiosperm Phylogeny Group Classification for the Order and Families of Flowering Plants: APG III. *Bot. J. Linn. Soc.* 161: 105-121.
3. Bhattacharyya, B. and B. M. Johri. 1998. *Flowering Plants-Taxonomy and Phylogeny*. Narosa Publishing House, New Delhi.
4. Crawford, DJ. 1990. Plant molecular systematics. Macromolecular approaches. John Wiley & Sons, Inc. USA.
5. Davis, PH and Heywood VH. 1991. Principles of Angiosperm Taxonomy. Krieger Publishing Company.
6. Forey, PL. 1993. Cladistics: A Practical course in Systematics. Clarendon Press.
7. Harborne, JB and Turner, BL. 1984. Plant Chemosystematics. Academic Press.
8. Heywood, V. H. and Moore, D. M. 1984. *Current Concepts in Plant Taxonomy*. Oxford University Press.
9. Duthie J. S.: Flora of upper Gangetic plains, Calcutta superintendent, government printing India.
10. Jain, S.K. and Rao, R.R. 1977. *A Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers and Publishers, New Delhi.
11. Jones, SB. 1986. Plant Systematics. McGraw Hill.
12. Judd, W.S., Christopher, S., Campbell, K., Kellogg, A.E., Stevens, P.F. 1999. Plant Systematics: A Phylogenetic Approach. Sinauer Associates Inc. Publishers.
13. Leadley E. and Jury S., Taxonomy and plant conservation, The cornerstone of the Conservation and the Sustainable use of Plants, Cambridge university press 2006.
14. McNeill, J, Barrie, FR, Buck, WR, Demoulin, V, Greuter, W, Hawksworth, DL, Herendeen, PS, Knapp, S, Marhold, K, Prado, J, Prudhomme van Reine, WF, Smith, GF, Wiersema, JH and Turland, N. (eds. & comps.) 2012. International Code of Nomenclature for algae, fungi and plants (Melbourne Code), adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011. Koeltz Scientific Books, Königstein.
15. N. S. Subramaniam, Taxonomy of Angiosperm, Vikas publishing house Pvt Ltd.
16. Pandey, A. K., J.V.V. Dogra & Wen, J. 2006. *Plant Taxonomy: Advances and Relevance*. CBS Pvt. Ltd.
17. Pullaiah, T. 2007. Taxonomy of Angiosperms. Regency Publications, New Delhi.
18. Rao, R. R. 1994. *Biodiversity in India (Plant Aspects)*, Bishan Singh Mahandrapal Singh, Dehradun.
19. S. N. Pandey and S. P. Mishra, Taxonomy of Angiosperm. Awe Books Pvt Ltd.
20. Sharma, O. P. 1993. *Plant Taxonomy*. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
21. Simpson M. G., 2006, Plant Systematics. Elsevier Academic Press.
22. Singh, G. 2004. Plant Systematics: An integrated approach. Science Publishers, INC.
23. Singh, Gurucharan, Plant Systematics- Theory and Practices, Oxford and I.B.H. Publishing Co. New Delhi
24. Singh, MP, Singh, BS and Dey S. 2002. Plant Biodiversity & Taxonomy. Daya Publishing House, New Delhi.
25. Singh, V. and Jain, D.K., Taxonomy of Angiosperms. Rastogi Publication, Meerut

26. Sivarajan, VV. 1991. Introduction to principles of plant Taxonomy, edited by NKB Robson. Press Syndicate of University of Cambridge.
27. Sokal, RR and Sneath PHA. 1963. Principles of Numerical Taxonomy. W.H. Freeman.
28. Soltis PE, Soltis DE and Doyle JJ. 1992. Molecular Systematics of Plants. Chapman & Hall, New York.
29. Soltis PE, Soltis DE and Doyle JJ. 1998. Molecular Systematics of Plant II DNA Sequencing. Kulwer Academic Publishers.
30. Stace , CA. 1989. Plant Taxonomy and Biosystematics. Press Syndicate of University of Cambridge.
31. Stuessy, TF, Crawford, DJ, Soltis, DE and Soltis PS. 2014. Plant Systematics: The origin, interpretation, and ordering of plant biodiversity. Koeltz Scientific Books, Königstein.
32. Subramanyam, NS. 1996. Laboratory Manual of Plant Taxonomy. Vikas Publishing House Pvt Ltd.
33. Takhtajan A. 2009. *Flowering plants*, 2nd edn. St. Petersburg Russia: Springer
34. Verma, B. K. 2010. *An introduction to Taxonomy of Angiosperms*. PHI Learning Pvt. Ltd. New Delhi.
35. Wheeler, WC. 2012. Systematics: a course of lectures. Wiley –Blackwell.

PRACTICAL-I: Lab Work based on Paper I and II

PRACTICAL-II: Lab Work based on Paper III and IV

SEMESTER -II

PAPER-I: Plant Morphology , Anatomy and Embryology

Unit I

Introduction of morphology and anatomy including brief historical account. External and internal organization of higher plants; Cell and its inclusions, cellular organization microscopic and sub-microscopic structure and organization of cell wall; Meristems: Organization of root apical meristem (RAM) and shoot apical meristem (SAM) differentiation; Xylem and phloem: Ontogeny and structure of components and phylogeny, transfer cells.

Unit II

Secretory and excretory structures; Primary and secondary structure of root and stem. Origin of lateral roots, root-stem transition, nodal anatomy and its evolutionary significance; Leaf – structure and function with apical reference to epidermis. Systematic significance of trichomes and stomata; Vascular cambium and its derivatives periderm, anomalous secondary growth; Floral morphology and anatomy, fruits and seeds; Morphology phenomenon: Symmetry polarity, totipotency and differentiation.

Unit III

Introduction to life history of angiosperms, brief history of plant embryology; Anther: Structure and development wall layers and their role; Microsporogenesis: Cytoplasmic reorganization during microsporogenesis, Pollen wall morphogenesis and anther dehiscence; Development of male gametophyte, ultrastructure, abnormal male gametophyte, pollen germination; Ovule:

Ontogeny, structure, integuments and nucellus specialized structures, megasporogenesis; Development of embryo sac.

Unit-IV

Pollen-pistil interaction: Role of pollen wall proteins and stigma surface proteins, pollen tube growth in pistil, fertilization and apomixis; Endosperm: Major types, ultrastructure and histochemistry; Embryo: Polarity in embryo differentiation, major types, polyembryony; Experimental embryology, anther, ovary and endosperm culture.

Suggested readings:

1. Katherine Esau (1965), Plant Anatomy, published by John Wiley and Sons. Inc, New York.
2. Arthur J.Eames; Laurence H.Mac Daniels (1951), An Introduction To Plant Anatomy, published by London; New York: Mc Graw Hill.
3. Carquist,S.(1961),Comparative Plant Anatomy Holt, Rinehart and Winston, published by New York Press.
4. A.Fahn (1982), Plant Anatomy Vol I and Vol II, published by Pergamon Press. Oxford New York
5. Pandey, B.P., Angiosperms-Taxonomy, Emrbyology and Anatomy, S. Chand and Co., New Delhi
6. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi

PAPER-II: Plant resource Utilization

Unit-I

Food Plants: Cereal crops, sugar yielding plant, legume or pulses,vegetables, fruit, oil and fats, spices, condiments etc.

Unit-II

Medicinal and Aromatic Plants: Medicinal plant, aromatic plants, insecticide, herbicide and sacred plants.

Unit-III

Beverages and Mastication: Tobacco, areca, cannabis, coca, tea, coffee

UNIT-IV

Timber, Furniture's, fibre and petro crops: Timber, tannins and dye stuffs, rubber, gums and resin and bio-fuels.

Suggested reading:

1. S. L. Kocchar, Economic Botany in the Tropics. Macmillan Publisher,
2. Albert F. Hill, Economic Botany: A Textbook of Useful Plants and Plant Products. McGraw-Hill publications, New York
3. A. V. S. S. Sammbamurthy, A Textbook of Modern Economic Botany, CBS Publications

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PAPER-III: Ecology and Phytogeography

Unit I

Introduction to ecology, and environmental terminology, population dynamics, vegetation organization and development: population characteristics, population growth forms, density dependent and density independent controls, population structure (distribution, aggregation, isolation territoriality) energy partitioning, r - and k-selection, concept of carrying capacity. Wild life sanctuaries, botanical gardens.

Unit II

Concepts of community and continuum, analysis of communities (analytical and synthetic characters), community coefficients, competition, ecological niche, succession, mechanism of ecological succession (relay floristic and initial floristic composition facilitation, tolerance and inhibition models), concept of climax.

Unit III

Ecosystem organization, structure and function: primary production (methods of measurement), energy dynamics (tropic organization, energy flow pathway, energy quality, ecological efficiencies), biogeochemical cycles.

Unit IV

Pollution and climate change: kinds, sources and effects of pollution, heavy metals (Pb, Cd, Hg), green house gases (CO₂, CH₄, N₂O, CFCs), green house effect and global warming, ozone layer depletion and ozone hole, acid rain. Environmental impact assessment, threatened and endangered plant species, role of diversity in ecosystem stability, general account of remote sensing and its application, sustainable development. Major terrestrial biomes, biogeographical area of India, major vegetations.

Suggested reading:

1. Odum, E. P. and Barret G.W. 2005. Fundamentals of Ecology. Cengage publication
2. Odum, E.P., 1983. Basic Ecology., Saunders College Publishing
3. Singh, J.S., Singh S.P. and Gupta S.R. 2006. Ecology Environment and Resource Conservation. Anamaya Publishers

PAPER-IV: Microbiology and Plant Pathology

Unit I

History and Developmental Microbiology, History of Plant Pathology, General techniques used in microbiology and plant pathology, Microbial evolution, Systematics and taxonomy of microorganisms. The microbial cell: general organization of cell and cell wall of prokaryotes, eukaryotes and Archaea, Viruses –structure, chemical composition, replication and classification of viruses. General account of Mycoplasma.

Unit II

Growth- growth kinetics and regulation, effect of environmental factors on growth, batch and continuous cultures, nutritional classification of microorganisms, Microbes in extreme environment: The basis of extremophiles and their applications, thermophile and halophiles. Quorum sensing in Bacteria: gram negative bacteria: LUXI LUXR-Type: gram positive bacteria: peptide mediated quorum sensing.

Unit III

Application of microbiology in industrial, agriculture and waste water management: symbiotic nitrogen fixation, *Rhizobium*, *Azotobacter* *Cyanobacteria* (*Anabaena*, *Azolla* etc.), Mycorrhizal symbiosis. Major industrial products from microbes viz., beverages, antibiotics, secondary metabolites, recombinant products. Biodegradation by microbes, sewage pollution control, control of oil spills, super bugs.

Unit IV

Classification of Plant Diseases, Kinds and amount of losses, Parasitism and disease development, symptoms, Epidemiology, Control of plant diseases, quarantines and inspection, physical, chemical, cultural and biological methods of disease control, Genetic Engineering and Plant Pathology.

Some important diseases caused by fungi, bacteria, viruses and mycoplasma/phytoplasma.

Fungal diseases: White rust of crucifers, Late blight of potato, Powdery mildew of pea, Black rust of wheat, Early blight of potato, and Red rot of sugarcane.

Bacterial disease: Citrus Canker, Viral diseases: Mosaic disease and Yellow vein mosaic of lady finger; Mycoplasmal Disease: Little leaf of brinjal.

Suggested Readings:

1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganisms. 13th edition, Pearson Education Inc.
2. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan.
3. Dubey, RC and Maheshwari. DK. 1999. A Textbook of Microbiology. S. Chand & Company Ltd.
4. Atlas, RM. 1995. Principles of Microbiology. Moby.
5. Lim, DV. 2003. Microbiology. Kendall/Hunt.
6. Boundless.2013. Microbiology. Boundless Learning, Incorporated.
7. Cornelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology. Lippincott Williams & Wilkins.
8. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition. McGraw-Hill.
9. Tortora, G.J., Funke, B.R., Case, C.L. 2003, Microbiology: An Introduction. Benjamin Cummins
10. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.
11. Agrios, G. N., 1988. Plant Pathology, Academic Press.

12. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
13. Dickinson, C. M., 2003. Molecular Plant Pathology, Bios Scientific Publisher
14. Robert, N., Trigiano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.
15. Bridge, P.D and Clarkson, J.M., 1998. Molecular Variability of Fungal Pathogens, CAB, International
16. Singh, R. S., 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd
17. Singh, R. S., 2008. Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt Ltd.
18. Dhingra, O.D. and James, B. Sinclair, 1995. Basic Plant Pathology Methods, CRC Press
19. Pelczar, JM, Chan, ECS and Krieg, MR. 1993. Microbiology. Tata McGraw Hill.
20. Bishen, PS. 2014. Microbes in Practice. I.K. International Publishing House Pvt. Ltd.
21. Aneja, KR, Jain, P and Aneja, KR. 2008. A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi

SEMESTER-III

PAPER-I : History of Botany and Microtechnique

UNIT-I

A brief introduction of major discoveries in Botany and contribution of renowned Indian scientists: Prof. Birbal Sahni, Prof. Panchanan Maheshwari, Prof. Shiv Ram Kashyap, Prof. M.O.P. Iyengar, Prof. P.N. Mehra, Prof. Divya Darshan Pant, Prof. K.C. Mehta, Prof. R.N. Singh, T.V. Desikachary, Prof. Ramdeo Mishra, P.Maheshwari and K.S. Bhargava

UNIT-II

A brief introduction of major discoveries in Botany and contribution of renowned scientists: Pier Antonio Micheli, Melvin Kelvin, Sir Hans A. Krebs, Erick Acharius, Kary Banks Mullis, Edwin Southern, E.J. Butler, Prof. F.E. Fritsch, Prof. T.H. Morgan, Toppur Seethapathy Sadasivan,

Lynn Margulis, Sir Charles Darwin, Sir George Bentham , Sir Joseph Dalton Hooker, Carolus Linnaeus.

UNIT-III

Microscopy: Optical, Electron, Scanning probe, Ultraviolet, Infrared, Fluorescence. Staining techniques: Gram staining and Acid Fast staining. Reagents used for the microscopic examinations e.g. Methylene blue, Fast Green, Phloroglucin/HCl, Safranin, Hematoxylin, Lugols's solution, Rutenium red, Cotton Blue and eosin.

UNIT-IV

Chromatography: Basic concept, GC, LC viz TLC, HPLC, HPTLC, Size Exclusion Filtration, Affinity chromatography, Ion Exchange, Hydrophobic interaction chromatography. Radio and

Fluorescent Labelling. Spectroscopy: Basic concept, MALDI-TOF, Mass spectroscopy, X-Ray diffraction, FTIR, ESR and NMR Spectroscopy. Gel Electrophoresis: AGE, PAGE, Native PAGE, SDS PAGE, 2D Electrophoresis, IEF.

Suggested Reading :

1. Wilson, K. and Walker, J., 2000, Practical Biochemistry: principles & techniques (5th Edition), Cambridge University Press. ISBN 0521799651..

PAPER-II : Plant Physiology

Unit I

Transport and translocation of water and solutes: Plant water relations, mechanism of water transport through Xylem, mineral nutrition, nutrient uptake, solute transport, comparison of xylem and phloem translocation, phloem loading and unloading,

Unit II

Nitrogen metabolism, respiration and lipid metabolism : Biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation, foliar nitrogen nutrition. Interaction of nitrogen assimilation with carbon metabolism. Glycolysis, TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, Cyanide resistant respiration, Lipid metabolism.

UNIT-III

Photochemistry and photosynthesis: History of photosynthesis, photosynthetic apparatus, photoreceptor, light reaction of photosynthesis, photo oxidation of water mechanism photophosphorylation, Structure and function of Rubisco and PEP Carboxylase, carbon assimilation, Calvin cycle, photorespiration and its significance, C₄ cycle, CAM pathway

Unit IV

Plant growth substances and signal molecules: Chemical structure, physiological effects and mechanism of action of auxin, gibberellins, cytokinins, ethylene abscisic acid. Growth regulator nature of Polyamines, Jasmonic acid Salicylic acid and Brassinosteroids, systemin, secondary metabolite and plant defense Growth and Development Aspects: Metabolic changes during seed germination, factors affecting seed germination and dormancy, breaking of dormancy, biochemistry of flowering: initiation and development of flower, induction of flowering-vernalization, physiology and biochemistry of leaf abscission and senescence. Sensory photobiology: Phytochromes and cryptochromes and their photochemical and biochemical properties, photo physiology of light-induced responses, cellular localization, molecular mechanism of action of photomorphogenic receptors, signaling and gene expression

Suggested readings:

1. Taiz and Zeiger, 2010, Plant Physiology, 5th Edition , Sinauer Associates
2. Hopkins, W.G. and Huner N.P.A., 2009, Introduction to Plant Physiology, 4th Edition Wiley International Edition, John Wiley & Sons, USA

3. Jones, Russell L. Buchanan, Bob B. Guissem, Wilhelm., 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.
4. Peter Scott, Physiology and Behaviour of Plants. Wiley-Blackwell.
5. Frank Boyer Salisbury and Cleon Ross, 1991, Plant Physiology, CA

PAPER-III: Cytogenetics , Plant Breeding and Biostatistics

Unit I

Basic concept and organization: Chromosome structure, nucleosome, solenoid nucleolus, euchromatin and heterochromatin, special type of chromosomes- Polytene chromosomes, lampbrush chromosomes, B chromosomes. Gene concept; allele concept, multiple alleles, isoalleles, Pseudoalleles, Cell division.

Unit II

Inheritance Genetics: Principles of Mendelian Inheritance and interaction of genes, Cytoplasmic inheritance involving chloroplast and mitochondria, mitochondrial and chloroplast genomes, interaction between nuclear and cytoplasmic genes, Sex determination in plants.

Unit III

Cytogenetics and Induced Variations: Linkage and recombination: Concept of Linkage, evolution of linkage concept, cis and trans arrangement of linked gene, kinds of linkage, germinal and somatic crossing over, detection of crossing over, kinds of crossing over.

Mutation: Spontaneous and induced mutations, point mutation, transitions, transversions, physical and chemical mutagens, molecular basis of mutations.

Numerical alterations in chromosomes: Euploidy, polyploidy and its significance, aneuploidy. autopolyploidy, allopolyploidy, Induction of trisomics and monosomics

Structural changes in chromosomes: Deficiency, duplication, inversion, translocation heterozygotes.

Unit IV

Plant Breeding: Breeding systems, methods, selection in self and cross pollinated crops, male sterility, self-incompatibility, heterosis and hybrid vigour,

Importance and scope of Biostatistics. Sample and sampling, Collection and representation of data-tabulation, graphical, diagrammatic Measures of Central tendency Measures of dispersion: range, mean deviation, Standard deviation, Variance, Deviation Tests of significance: Significance and difference in means, Standard error of mean, Standard error of SD, Students 't' test Chi-square test. Analysis of variance (ANOVA). Correlation and regression - Meaning,

kinds of correlation, coefficient of correlation, methods of studying correlation. Aims of regression analysis. Kinds of regression analysis.

Suggested reading:

1. Clark, M.S. and Wall, W.J. 1996, Chromosomes : The Complex Code. Chapman & Hall, London.
2. Stebbins, G.L. 1950, Variation and Evolution in Plants. Columbia Univ. Press, New York.
3. Swanson, C. P., Mertz, T.F. and Young, W.J. Cytogenetics : The Chromosomes in Division, Inheritance and Evolution (2nd Edn). Englewood Cliff, Prentice-Hall, New Jersey.
4. Sharma, A.K. and Sharma, Archana. 1985. Advances in Chromosome and Cell Genetics. Oxford & IBH Publishing Co., Calcutta.
5. Schnedl, W.. Banding patterns in chromosomes. In: International Review of Cytology (Suppl. 4).
6. Lewine, Benjamin, Jones and Bartlet, Genes X, Sudbury, Masschusetts
7. Gupta, P.K., Cytogenetics, Rastogi Publication, Meerut
8. Peter, D, Snustand and Simmons, M.J., John Wiley and Sons Inc.

PAPER-IV: Molecular Biology and Molecular Techniques

Unit -I

Structure of nucleotides and DNA: A,B and Z form of DNA and properties , coding and noncoding sequences , satellite DNA , DNA damage and repair , replication and transcription of DNA , structure of mRNA , rRNA and tRNA ,replication of RNA ,Splicing , transport of RNAs , RNA editing

Unit II

Protein synthesis: Mechanism of translation-Initiation, elongation and termination, post translational modification , protein targeting to organelles , regulation of protein synthesis at transcription and translation level in prokaryotes and eukaryotes.

Unit III

Molecular Techniques: Isolation and purification- genomics and plasmid DNA , RNA , Proteins , Blotting principles , types of blotting , immunoblotting-Southern , Northern , Western and dot blots , ELISA ,RIA, DNA amplification and genome mapping: PCR , RT -PCR , RFLPs , RAPD , FISH , gene silencing.

Unit IV

DNA Sequencing: Various Methods of DNA Sequencing- Sanger's Dideoxy Method, Maxam & Gilbert Method, Shotgun, Pyrosequencing, DNA-Protein Interaction Analysis Methods: Foot Printing, ,CHIP Assay, EMSA; Protein-Protein Interaction analysis methods: Co-IP, Far-Western, Yeast Two Hybrid Assay,

Genome Expression Analysis: SAGE, EST, Microarray, Quantitative Real Time PCR; RNA Interference (RNAi), Genome Editing- CRISPR

Suggested readings:

1. Green, M. R. and Sambrook, J. 2000, Molecular Cloning: a laboratory manual (4th Edition) Cold Spring Harbor Laboratory Press.
2. Wilson, K. and Walker, J., 2000, Practical Biochemistry: principles & techniques (5th Edition), Cambridge University Press. ISBN 0521799651..
3. Wilhelm Gruissem Russell L. Jones, 2000, Biochemistry and molecular biology of plants. American Society of Plant Physiologists,
4. Paul, R., Graves and Timothy, A. J., 2002, 39–63
5. Haystead Molecular Biologist's Guide to Proteomics. Microbiology and Molecular Biology Reviews

SEMESTER- IV

PAPER-I: Plant Biotechnology

Unit I

Recombinant DNA technology: Restriction endonucleases, DNA Modifying enzymes, Vectors, Cloning techniques, Markers and reporter genes; Polymerase chain reaction; Gene transfer methods: direct gene transfer, Agrobacterium mediated genetic transformation, Microinjection, electroporation; Nucleic acid hybridization .

Unit II

Organization of plant genomes; Molecular markers and its application; Genomic and cDNA library; Functional genomics: Modern approaches for the analysis of plant genome and proteome, Mutagenesis, Recombinant DNA technology : Gene transfer.

Unit III

Scope of plant biotechnology in crop improvement, human welfare and industry: Genetic manipulation of pest resistance, abiotic and biotic stress tolerance, improvement of crop yield and quality; Molecular farming, Biosafety concerns in Plant Biotechnology, Transformation of chloroplast genome and its advantage

Unit IV

Plant cell and tissue culture: General introduction, history and scope; Concept of cellular differentiation and totipotency; Organogenesis and adventitious embryogenesis: Fundamental aspects of morphogenesis: somatic embryogenesis and androgenesis, Tissue culture techniques and culture media; Cryopreservation and germplasm conservation. Somatic hybridization: Protoplast isolation, culture and regeneration, Somatic hybridization and hybrid selection; Applications of plant tissues culture: clonal propagation, artificial seed, production of hybrids and soma clones, production of secondary metabolites/ natural products

Suggested readings:

1. Larry, Snyder and Wendy Champnees, Molecular Genetics of Bacteria, ASM Press Washington, DC

2. Jermy, W Dale and Simon F Park Molecular Genetics of Bacteria, IVth Edition - John Wiley and Sons Ltd.
3. Joseph ,W Lengler, Gerhart Drews and Hans G. Schlegel Biology of the Prokaryotes Blackwell Science Ltd., Oxford
4. Benjamin, Lewine- Jones and Bartlett, Genes X Publishers Sudbury, Masschusetts
5. James, D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick Molecular Biology of the Gene - VI Edition- Cold Spring
6. Stanly, R, Maloy, John Cronan and David Freifelder, Microbial Genetics Narosa Publisher, New Delhi
7. Bernard, R., Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and application of recombinant DNA ASM Press, Washington, D.C
8. T.A., Brown, Genomes - Garland Science (Taylor & Francis Group), New York & London
- 9 Molecular Biology of the Cell Alberts Bruce, Johnson Alexander, Lewis Julian, Raff Martin, Roberts Keith and Walter Peter- Garland Science (Taylor & Francis Group), New York & London
10. Lodish, Harvey, Berk Arnold, Zipursky S. Lawrence, Matsudaira Paul, Baltimore David and James E. Darnell-Molecular Cell Biology.
11. Dubey, RC.,2008, Advanced Biotechnology. S. Chand & Company. PVT. LTD.

PAPER-II: Plant Biochemistry

Unit I

Bioenergetics: Law of thermodynamics, concept of enthalpy and entropy and their significance in biological systems, Water biochemistry, high energy molecules, redox potential; Amino acids and proteins: Structure and physiochemical properties of amino acids; Proteins: Primary, secondary, tertiary and quaternary structure of proteins, physical and chemical properties of proteins and biological significance. Enzymes: Classification, physic-chemical nature, enzyme kinetics, mechanism of action and regulation

Unit II

Carbohydrates: Structure and physic-chemical properties of carbohydrates, biological significance, important, glycoprotein, Lipids: Classification, structure and properties of important lipids, biological significance of glycolipids, fatty acid biosynthesis and storage lipids and their catabolism.

Vitamins and Coenzymes: Structure and general biochemistry.

Unit III

Nucleic Acid: Structure and conformation of nucleic acids; replication and transcription of DNA, regulation of transcription, DNA damage and repair, Structure of mRNA, rRNA and tRNA, Splicing, transport of RNAs, RNA editing.

UNIT-IV

Biological Nitrogen fixation: Nitrogenase enzyme, substrates for nitrogenase, reaction mechanism, strategies to exclude oxygen and need to control hydrogen evolution.

Suggested Readings:

1. Conn, E. E., Stumpf, P. K., Bruening, G. and Doi, R. Y., 1987, Outlines of Biochemistry, 5th Edition, John Wiley and Sons, New York.
2. Nelson, D. L. and Cox, M. M., 2008, Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman & Co, New York, USA.
3. Berg, J. M., Tymoczko, J. L. & Stryer, L. 2011, Biochemistry, Seventh Edition, Freeman & Co., New York, USA.
4. Weil, J. H., 1990, General Biochemistry, Sixth Edition, Wiley Eastern Limited, New Age International Limited, New Delhi.
5. Lea P. J. and Leegood R. C., 1999, Plant Biochemistry & Molecular Biology, Second Edition John Wiley & Sons, New York.
6. Buchanan, B., Gruissem, W., & Jones, R. L., 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
7. Lodish, Harvey, Berk, Arnold, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony
8. Bretscher, Hidde Ploegh, Paul Matsudaira Molecular Cell Biology, 6th Ed. W. H. Freeman and Comp., New York
9. Bourton E. Tropp, Molecular Biology, 4th Ed., Jones & Barlett learning
10. Brown, T. A., DNA Cloning and Gene Sequencing Willey-Blackwell, Oxford
11. Genes IX by Benjamin Lewin, Jones and Barlett
12. Y. Gerld Karp, Cell and Molecular Biology 6th Ed., John Willey & Sons
13. Cooper, G. M. and Robert, E. Hausman The Cell: A Molecular Approach 5th Ed. (Co-published by ASM Press and Sinauer Assoc. Inc.)
14. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. and Richard, L. 2008. Molecular Biology of the Gene. Pearson Education Inc.
15. Murray, R., Murray, R. K., Bender, D., Gotham, K. M., Kennelly, P. J., Rodwell, V. and Weil, P. A. 2012. Harpers Illustrated Biochemistry 29th Edition. McGraw Hill.
16. Verma, P. S. 2004 Cell Biology, Genetics, Molecular Biology: Evolution and Ecology. S. Chand Limited.
17. Jain, J. L. 2004. Fundamentals of Biochemistry. S. Chand Limited.
18. Gupta, S. N., 2011. Biochemistry. Rastogi Publication., Meerut.

PAPER-III: Dissertation / Project work and Tour

The topic would be decided by the candidate in consultation with the respective supervisor. Dissertation / thesis will be based on existing branches of botany and the title will be decided keeping the view on the modern aspect in the related discipline. It will be the part of semester

IV; however, the title of dissertation / thesis will be assigned by concerned faculty member/board in the beginning of semester III to provide sufficient time to complete dissertation

The topic would be decided by the candidate in consultation with the respective supervisor. Dissertation / thesis will be based on existing branches of botany and the title will be decided keeping the view on the modern aspect in the related discipline. It will be the part of semester IV; however, the title of dissertation / thesis will be assigned by concerned faculty member/board in the beginning of semester III to provide sufficient time to complete dissertation / Project work.

PAPER-IV: Elective Paper (There shall be five special papers, and student has to opt only one)

I- Applied Phycology

Unit I

Cultivation of microalgae, culture medium and methods, Assessment of pollutants effects, bioassays, algae of polluted and unpolluted waters, influence of salt, heavy metals, radiation and pesticides on algae.

Unit II

Eutrophication, dynamics of fresh water and marine algal blooms, consequences of blooms including toxins of algae, Algal ponds for the treatment of wastewaters and role of algae in phytoremediation.

Unit III

Alga of specialized habitats: Terrestrial algae, parasitic algae, thermal algae, freshwater algae, freshwater red algae, snow algae.

Unit IV

Algae and human affairs: edible algae, algae in single cell protein production, algal biofertilisers, phycocolloids and other useful products of algae, biotechnological application of algae.

Suggested readings:

1. Lee, Robert Edeward, Phycology, Fourth edition 2008, Cambridge University Press
2. Graham Robin South and Alan Whittick, 1998, Introduction to Phycology, Blackwell Scientific Publication
3. Bold, H.C. and Wynne, M.J. ,1985, Introduction to the Algae, 2nd Edition, Prentice-Hall Inc.
4. Dixon, R. , Biology of Rhodophyta, Koelt Science Publisher, West Germany
5. Fritsch, F.E., Structure and Reproduction of Algae, Vol. I & II, Cambridge University Press, Cambridge
6. Gangulee, H.C. and Kar, A.K., 2011, College Botany Vol. II (Algae+Fungi+Brophyta+Pteridophyta) , New Central Book Agency, Kolkata
7. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae+Fungi+Brophyta+Pteridophyta) , Pub.Rastogi Publication, Meerut

II-Advanced Plant Pathology

Unit-I

General introduction to Plant Pathology, chemical weapons of pathogens – Enzymes and toxins; Role of growth hormones in plant diseases, Defense mechanism of the host, how the pathogen affects plant physiological functions.

Unit-II

Genetics of plant disease, effect of environmental factors on the plant disease development, Plant disease epidemiology: Preexisting structural and chemical defense, induced structural and chemical defense, hypersensitive reaction, role of phytoalexins and other phenolic compounds. Management of plant diseases: Cultural, chemical, biological, biopesticides, breeding for resistant varieties, plant quarantine, integrated pest management

Unit-III

Diseases caused by fungi, bacteria, viruses and mycoplasma.

Unit-IV

Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defense response to plants

Suggested readings:

1. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.
2. Agrios, G. N., 1988. Plant Pathology, Academic Press.
3. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
4. Dickinson, C. M., 2003. Molecular Plant Pathology, Bios Scientific Publisher
5. Robert, N., Trigiano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.
6. Bridge, P.D and Clarkson, J.M., 1998. Molecular Variability of Fungal Pathogens, CAB, International
7. Singh, R. S., 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd
8. Singh, R. S., 2008. Principles of Plant Pathology, Oxford and IBH Publishing Co. Pvt Ltd.
9. Dhingra, O.D. and James, B. Sinclair, 1995. Basic Plant Pathology Methods, CRC Press
10. Pelczar, JM, Chan, ECS and Krieg, MR. 1993. Microbiology. Tata McGraw Hill.
11. Bishen, PS. 2014. Microbes in Practice. I.K. International Publishing House Pvt. Ltd.
12. Aneja, KR, Jain, P and Aneja, KR. 2008. A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi.

III- Advanced Cytogenetics

Unit I

Ultrastructure of chromosomes, karyotype analysis, structural changes in chromosomes, numerical changes in chromosomes, Human karyotype.

V.A. Mishra
07-07-17

R. Kumar

Unit II

Mendelian inheritance, Epistasis, Linkage, Crossing over, non-mendelian inheritance

Unit III

Quantitative inheritance, Induced mutagenesis, Molecular basis of mutation, Mechanisms of sex determination, sex linked inheritance.

Unit IV

Gene concept, Modern concept of gene, genetic code, gene mapping, gene expression and regulation.

Plant genetic engineering-tools and techniques, Applications of genetic engineering, nif-genes.

Suggested readings:

1. Clark, M.S. and Wall, W.J. 1996, Chromosomes : The Complex Code. Chapman & Hall, London.
2. Stebbins, G.L. 1950, Variation and Evolution in Plants. Columbia Univ. Press, New York.
3. Swanson, C. P., Mertz, T.F. and Young, W.J. Cytogenetics : The Chromosomes in Division, Inheritance and Evolution (2nd Edn). Englewood Cliff, Prentice-Hall, New Jersey.
4. Sharma, A.K. and Sharma, Archana. 1985. Advances in Chromosome and Cell Genetics. Oxford & IBH Publishing Co., Calcutta.
5. Schnedl, W.. Banding patterns in chromosomes. In: International Review of Cytology (Suppl. 4).
6. Lewine, Benjamin, Jones and Bartlet, Genes X, Sudbury, Masschusetts
7. Gupta, P.K., Cytogenetics, Rastogi Publication, Meerut
8. Peter, D, Snustand and Simmons, M.J., John Wiley and Sons Inc.

IV-Advanced Plant Physiology

Unit I

Biological membrane: Structure and function of biological membrane, Experimental evidence for dynamic nature of membrane; Assimilation of nutrients: Nitrogen, sulfur, phosphorus and oxygen.

Unit II

Respiration: Respiration under aerobic and anaerobic conditions and its regulatory mechanism, significance of anaerobic respiration, Citric acid cycle and its amphibolic nature, Respiration is coupled to other pathways.

Unit III

Photosynthesis: Excitation energy and fate of excitation, Key experiments in understanding of light reaction, Repair and regulation of the photosynthetic machinery, Regulation of C₃ cycle and C₄ cycle, Photosynthetic responses to light, temperature and carbon dioxide, Experimental evidence for ATP generation.

Unit IV

Signaling pathway: Signaling pathway of Phytochrome, Auxin, Gibberellins, Cytokinins, Ethylene, Abscisic acid, Brassinosteroids; Vernalization: Vernalization and biochemical

signaling in flowering; Stress physiology: Abiotic stress - Water deficit and drought tolerance, Heat stress and heat shock, Chilling and freezing stress, salinity stress, Oxygen deficiency; Biotic stress; Oxidative stress: generation of oxidants, indicators of oxidative stress, antioxidants-enzymatic and non-enzymatic antioxidants.

Suggested readings:

1. Taiz and Zeiger, 2010, Plant Physiology, 5th Edition , Sinurer Associates
2. Hopkins, W.G. and Humer N.P.A., 2009, Introduction to Plant Physiology, 4th Edition Wiley International Edition, John Wiley & Sons, USA
3. Jones, Russell L. Buchanan, Bob B. Guissem, Wilhelm., 2002, Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.
4. Peter Scott, Physiology and Behaviour of Plants. Wiley-Blackwell.
5. Frank Boyer Salisbury and Cleon Ross, 1991, Plant Physiology, CA

V- Applied Microbiology

Unit-I

Microbial Ecology and Environmental Microbiology: Microbiology of Air, Water and Soil. Microbiology of Solid Wastes, Sewage (Waste water) and Industrial Waste, Bioleaching and Biomining

Unit-II

Food Microbiology: Microbiology of Foods, Milk and Dairy Products

UNIT III

Industrial Microbiology: Microbial production of organic acids, antibiotics, amino acids, enzymes, vitamins etc.

Unit-IV

Agricultural Microbiology: Microbes-Plant Associations, Microbial Biofertilizers and Biopesticides, Microbial Bioremediation of Agricultural Product, Biodegradation of Pesticides
Medical Microbiology: Infection and Diseases, Human Diseases caused by Fungi, Bacteria and Viruses, their diagnostics and managements.

Suggested readings:

1. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan.
2. Dubey, RC and Maheshwari, DK. 1999. A Textbook of Microbiology. S. Chand & Company Ltd.
3. Atlas, RM. 1995. Principles of Microbiology. Mobsy.
4. Lim, DV. 2003. Microbiology. Kendall/Hunt.
5. Boundless.2013. Microbiology. Boundless Learning, Incorporated.
6. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology. Lippincott Williams & Wilkins.
7. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition. McGraw-Hill.

8. Tortora, G.J., Funke, B.R., Case, C.L. 2003, Microbiology: An Introduction. Benjamin Cummins
9. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill
10. Pelczar, JM, Chan, ECS and Krieg, MR. 1993. Microbiology. Tata McGraw Hill.
11. Bishen, PS. 2014. Microbes in Practice. I.K. International Publishing House Pvt. Ltd.
12. Aneja, KR, Jain, P and Aneja, KR. 2008. A Text book of Basic and Applied Microbiology. New Age International Publishers, New Delhi.

(The Candidates are required to choose only one elective paper .)