

# ADIKAVI NANNAYA UNIVERSITY

## DEPARTMENT OF BOTANY



## SYLLABUS

2019 – 2020 ADMITTED BATCH

**ADIKAVI NANNAYA UNIVERSITY, RAJAMAHENDRAVARAM**

**M.Sc. Botany – Course Structure**

<b>Paper code</b>	<b>Title of the paper</b>	<b>hours per week</b>	<b>Duration of exam (hrs)</b>	<b>Max marks</b>	<b>Internal marks</b>	<b>Total marks</b>	<b>Credits</b>
<b>Semester - I</b>							
<b>Theory</b>							
101	Cryptogams and Gymnosperms	4	3	75	25	100	4
102	Microbiology	4	3	75	25	100	4
103	Cell biology of plants	4	3	75	25	100	4
104	Cytology and Cytogenetics	4	3	75	25	100	4
<b>Practicals</b>							
105	Cryptogams and Gymnosperms	3	3	38	12	50	2
106	Microbiology	3	3	38	12	50	2
107	Cell biology of plants	3	3	38	12	50	2
108	Cytology and Cytogenetics	3	3	38	12	50	2
<b>Total Marks and Credits for I Semester</b>						<b>600</b>	<b>24</b>
<b>Semester - II</b>							
<b>Theory</b>							
201	Genetics	4	3	75	25	100	4
202	Molecular Biology of Plants	4	3	75	25	100	4
203	Plant Developmental Biology and Embryology	4	3	75	25	100	4
204	Molecular Plant Pathology	4	3	75	25	100	4
<b>Practicals</b>							
205	Genetics	3	3	38	12	50	2
206	Molecular Biology of Plants	3	3	38	12	50	2
207	Plant Developmental Biology and Embryology	3	3	38	12	50	2
208	Molecular Plant Pathology	3	3	38	12	50	2
<b>Total Marks and Credits for II Semester</b>						<b>600</b>	<b>24</b>

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**M.Sc. Botany – Course Structure**

<b>Paper code</b>	<b>Title of the paper</b>	<b>hours per week</b>	<b>Duration of exam (hrs)</b>	<b>Max marks</b>	<b>Internal marks</b>	<b>Total marks</b>	<b>Credits</b>
<b>Semester - III</b>							
<b>Theory</b>							
301	Taxonomy of Angiosperms and Plant resource utilization	4	3	75	25	100	4
302	<i>Invitro</i> Plant Biology	4	3	75	25	100	4
303	Ecology and Phytogeography	4	3	75	25	100	4
304	Plant Physiology	4	3	75	25	100	4
<b>Practicals</b>							
305	Taxonomy of Angiosperms and Plant resource utilization	3	3	38	12	50	2
306	<i>Invitro</i> Plant Biology	3	3	38	12	50	2
307	Ecology and Phytogeography	3	3	38	12	50	2
308	Plant Physiology	3	3	38	12	50	2
<b>Total Marks and Credits for III Semester</b>						<b>600</b>	<b>24</b>
<b>Semester - IV</b>							
<b>Theory</b>							
401	Genetic Engineering of Plants and Microbes	4	3	75	25	100	4
402	Evolution and Plant Breeding	4	3	75	25	100	4
403	Environmental Biology and Biodiversity	4	3	75	25	100	4
404	Plant Metabolism	4	3	75	25	100	4
<b>Practicals</b>							
405	Genetic Engineering of Plants and Microbes	3	3	38	12	50	2
406	Evolution and Plant Breeding	3	3	38	12	50	2
407	Environmental Biology and Biodiversity	3	3	38	12	50	2
408	Plant Metabolism	3	3	38	12	50	2
409	Comprehensive viva					100	4
<b>Total Marks and Credits for IV Semester</b>						<b>700</b>	<b>28</b>
<b>Grand total marks and credits for I, II, III &amp; IV semesters</b>						<b>2500</b>	<b>100</b>
<b>Scheme of examination at the end of the each semester</b>							
Theory pass minimum : 40%							
Practical pass minimum: 50% (External 19/38) (Total marks must be 25)							
Aggregate : 50%							

## BREAKUP DETAILS OF INTERNAL/LAB/PROJECT

For Ex: Internal Theory Examination marks be given in the following manner.

- |    |  |   |           |
|----|--|---|-----------|
| a. | Two mid-exams average                              | - | :10 Marks |
| b. | Attendance Marks                                   | - | :05 Marks |
| c. | Presentations/Assignments/comprehensive viva, etc. | - | :05 Marks |
| d. | Swatchhata/Vanam-Manam Marks                       | - | :05 Marks |

Internal Theory Exam		Internal Lab exam		External Practical/Lab exam		External Marks	Project
Activity	Marks	Activity	Marks	Activity	Marks	Activity	Marks
Essay question	07	Major	05	Major	12	Comprehensive Viva	100
Short question	03	Minor	03	Minor	08		
		Spotters	02	Spotters	10		
		Record	01	Record	04		
		Viva voce	01	Viva voce	04		
Total marks: 10		Total marks: 12		Total marks: 38		Total marks:	100

## SEMESTER – I

### PAPER CODE: 101: CRYPTOGAMS AND GYMNOSPERMS

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

#### Theory

##### UNIT I (ALGAE)

General account, Criteria employed in Classification. Classification given by Fritsch, Bold and Wynne. Thallus organization, reproduction and life cycles in algae, General account on structure and reproduction of Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta and Cyanophyta, Economic importance of Algae.

##### UNIT II (BRYOPHYTES)

General account, Classification of Bryophytes, Classification, general characters, range of thallus organization and reproduction in Hepaticopsida, Anthcerotopsida and Bryopsida. Evolutionary trends in gametophytes and sporophytes of Bryophytes, Ecological and Economic importance.

##### UNIT - III (PTERIDOPHYTES)

General characters and classification of Pteridophytes. Salient features of Psilophytopsida, Psilotopsida, Lycopsidea, Sphenopsida and Pteropsida.

Origin and phylogeny of pteridophytes - Stellar Evolution, Heterospory and seed habit. Economic importance of Pteridophytes.

##### UNIT - IV (GYMNOSPERMS)

General account and classification of Gymnosperms Geological periods, fossil formation and their types. General account of Pteridospermales, Bennettitales, Pentoxylales, Cordaitales. Structure and Reproduction of living Gymnosperms: Cycadales, Coniferales and Gnetales; their economic importance .

#### Suggested Readings & Text Books

1. Bold, H.C and Wynne.M.J. 1978. Introduction to the algae
2. Chapman, V.J.1962. The Algae
3. Graham, J.E, Lee W. Wilcox &L.E.Graham 2008. Algae. 2nd ed. Benjamin Cummings
4. Britsch,F.E.1945. The structure and reproduction of Algae Vols. 1& II. Cambridge University Press, London
5. Kumar, H.D.1988.Introductory Phycology
6. Kashyap, S. 1929. Liverworts of the Western Himalayas and Punjab Plains Part I and Part II.
7. Lewin,R.A. 1962. Physiology and Biochemistry of Algae
8. Morris, I 1967. An Introduction to the Algae
9. Prescott, G.W. 1969. The Algae- a review
10. Bernard Goffinet& A. Jonathan Shaw. 2008. Bryophyte Biology. 2nd ed. Cambridge
11. Parihar, N.S. 1991. Bryophyta
12. Puri,P. 1980. Bryophytes
13. Round, E.E. 1986. The Biology of Algae
14. Round, E.E. 1962. Ecology of algae
15. Smith, G.M. 1955. Cryptogamic Botany Vol. II

16. Chopra, R.N. & P.K. Kumar, 1988. Biology of Bryophytes. Wiley Eastern.
17. Arnold, C.A. 1974. An introduction to Paleobotany, New York
18. Agashe, S.N. 1995. Palaeobotany. Oxford & IBH, New Delhi.
19. Bhatnagar, S.P. & Alok Mitra 1997. Gymnosperms. New Age Int. (P) Ltd.
20. Charles C. Beck and Charles B. Beck (Ed.). 1988. Origin and Evolution of Gymnosperms. CUP.
21. Kramer, K.U., P. S. Green & Erich Gvtz. 2008. Pteridophytes and Gymnosperms. Springer.
22. Sambamurthy AVSS. 2005. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. Ik International Pvt Ltd.
23. Vashista, P.C. 2005. Gymnosperms. S. Chand & Co, New Delhi.
24. Vashista, P.C. 2005. Pteridophyta. Rev. ed. By Sinha & Anil, S. Chand & Co, New Delhi.
25. Saxena P and Pathak C. 2012. A Text Book of Pteridophyta., Wisdom Press, New Delhi.
26. Chamberlain, C.J. 1935. Gymnosperms structure and evolution, University of Chicago Press
27. Coulter, J.M. and Chamberlain, C.J. Morphology of Gymnosperms, Central Book Depot, Allahabad
28. Evans, A.J. 1936. Morphology of Vascular Plants (Lower groups) McGraw Hill Book Company, New York
29. Maheswari, P. and Vasil, V. Genetum CSIR ( Monographs)
30. Parihar, N.S. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad
31. Sporne, K.R. 1962. The Morphology of Pteridophytes, Hutchinson University Library

## PAPER CODE: 102: MICROBIOLOGY

### Theory

#### UNIT – I

Introduction: Discovery and Evolution of microbiology as a discipline. A brief idea of microbial diversity. General account of Archaeobacteria, Eubacteria, Cyanobacteria, Fungi. Fungal classification and phylogeny.

Cell wall of Bacteria – Gram+ve and Gram-ve bacterial cell walls, cell wall of Fungi. Viruses: Structure, Isolation and purification of viruses, Replication and transmission of Viruses.

#### UNIT – II

Nutritional requirements of microorganisms: types (autotrophs and heterotrophs), requirements, uptake of nutrients and types of nutrient media. Nutrition of Fungi : Saprobic, biotrophic, and symbiotic.

Microbial growth: Principles of growth, Kinetics of growth methods of measuring growth, Batch and continuous growth, Synchronous culture and Diauxic growth.

#### UNIT - III

Genetics of Bacteria: An overview of genetic recombination; Mechanism of transformation, conjugation and transduction in bacteria. Lytic cycle in T even phages and lysogenic cycle in lambda phage. A brief account on virioids and prions.

Reproduction in Fungi : Vegetative, Asexual and Sexual. Heterothallism, Heterokaryosis and Parasexuality.

#### UNIT - IV

Microbial ecology, Denitrification, free living nitrogen fixation, symbiotic nitrogen fixation, plant-microbe interactions, mycorrhizae.

Basic design of a Fermentor, Biosensors, Bioremediation. Mushroom cultivation. Economic importance of Microbes.

#### Suggested Readings & Text Books

1. Kaursethi I and Surinder KW 2011. **Text Book of Fungi and their Allies**. Macmillan publishers, New Delhi, India.
2. Ram Reddy S & Reddy SM 2007. **Essentials of Virology**. Scientific publishers, Jodhpur, India.
3. Sharma K 2005. **Manual of Microbiology Tools and Techniques**. Ane Book, New Delhi, India.
4. Matthew RH 2004. **Plant virology**. 4th edition. Academic press an imprint of Elsevier, California, USA.
5. Prescott et al. 2003. **Microbiology**. McGraw Hill Education, New York.
6. Aneja KR 2003. **Experiments in Microbiology, Plant pathology and Biotechnology**. New Age International publishers, New Delhi.
7. Verma HN 2003. **Basics of plant Virology**. IBH publishing co. Pvt. Ltd., New Delhi.
8. Mehrotra KS and Aneja KR 2003. **An Introduction to Mycology**. New Age International Publishers, New Delhi.
9. Sullia SB and Shantharam S 2001. **General Microbiology**. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
10. Reddy SM and Ram Reddy S 2000. **Microbiology a Laboratory Manual**. BSC Publishers and Distributors, Hyderabad.
11. Flint SJ, Enquist LW, Krug RM, Racaniello VR, Skalka AM 2000. Principles of Virology,

Molecular Biology, Pathogenesis and Control. ASM press, Washington DC.

12. Rao AS 1999. **Introduction to Microbiology**. Prentice Hall of India Pvt. Ltd., Delhi.
13. Paul S 1995. **Bacteria in Biology**, Biotechnology and Medicine. 5th edition. John Wiley and son Ltd., UK.
14. Pelczar, Chan and Krieg 1993. **Microbiology**. 5th edition. McGraw Hill Education, New York.
15. Stainer RT, Ingraham JL, Wheelis ML and Painter PR 1987. **General Microbiology**. 5th Edition. Macmillan, London.
16. Smith KM 1968. **Plant viruses**. Elsevier, New York.
17. Rangaswamy G 1962. **Bacterial Plant disease in India**. Asia Publishing House, Bombay.
18. Agrios, G.N. 2005. **Plant pathology**. 5th ed. Academic press.
19. Allen T. Bull.2004. **Microbial diversity and Bioprospecting**. ASM Press, Washington.
20. Brock, T.D. & Madigan. 1991. **Biology of Microorganisms**. Prentice-Hall.
21. Dube, R.C. & D.K.Maheswari 2005. **Microbiology**. S.Chand & Co. Ltd., New Delhi.
22. Gilbert, O.L.2000. **Lichens**. Collins New Naturalist.
23. Ainsworth, G.C. Sparrow, F.K. and Susman, A.S. 1973. **The Fungi-An advances treatise**, Vol. I to VIB.
24. Alexopoulos, C.J. Mims, C.W. and Blackwel, M. 1996. **Introductory Mycology**, John Wiley & Sons Inc.
25. Ananthanarayanan, R. and Dayaram Panikar, C.K. 1998. **A textbook of Microbiology**, VI edition Orient Longman
26. Carpenter, 1977. **Microbiology**
27. Clifton, A. 1958. **Introduction to the Bacteria**, McGraw-Hill Book Co. New York
28. Landecker, E.M. 1972. **Fundamentals of the Fungi** Mehrota, R.S. and Aneja, R.S. 1998. **An introduction to microbiology**, Prentice Hall of India Pvt.Ltd., New Delhi.

## PAPER CODE: 103: CELL BIOLOGY OF PLANTS

### Theory

#### UNIT - I

The Cell theory : Origin and development of cell biology as a separate branch. Structure and organization of Prokaryotic and Eukaryotic cells. Specialized cell types.

Chemical Foundation: Macromolecules - Structure, shape and information. Non- covalent interactions in relation to function of Nucleic acids and Proteins. Biochemical energetics : Laws of thermodynamics as applicable to biological systems.

#### UNIT – II

Cell wall: Structure and functions, Cell wall architecture, Biogenesis and Growth.

Plasmodesmata : Structure and function, Plasmodesmata in comparison with gap junctions of animal cells.

Plasma membrane: Structure, models and functions, ATPases, Receptors, Carriers, Channels and Pumps. Vacuole structure and function, Vacuolar ATPases, Transporters.

Cytoskeleton: Microtubules and Microfilaments, their role in cell division and motility; Intermediate filaments role in providing strength.

#### UNIT - III

Chloroplast and Mitochondria : Structure and function, Genome organization, Nucleo-cytoplasmic interactions, RNA editing.

Other organelles : Structure and functions of Endoplasmic reticulum, Golgi apparatus, Lysosomes, Ribosomes, Microbodies and Peroxisomes.

#### UNIT - IV

Tools in cell Biology I - Microscopy : Working principles of Light Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, STEM. Preparation of specimens for Microscopy Freeze fracture and Freeze etching techniques.

Tools in Cell Biology II- Subcellular fractionation - Principles of centrifugation. Spectroscopic techniques: principles and applications of UV- visible, ESR, Nuclear Magnetic Resonance, Spectrofluorimetry, Circular Dichroism (CD).

### Suggested Readings & Text Books

1. Alberts B, Breyer D, Hopkin K, Johnson AD, Lewis J, Raff M, Roberts K and Watter P 2014. **Essential Cell Biology**. 4th Edition. Garland publishers, New York.
2. Sharp D, Ploppe G and Sikorski E 2014. **Lewin's Cells**. 3rd Edition. Viva Books, New Delhi.
3. Cooper GM, Hausman RE 2013. **The Cell – A Molecular Approach**. 6th Edition. Sinauer Associates, Incorporated, USA.
4. Karp G 2013. **Cell and Molecular Biology – Concepts and Experiments**. 7th Edition. Wiley Global Education, USA
5. McLennan A, Bates A, Turner P, White M 2013. **Bios Instant Notes in Molecular Biology**. 4th Edition. Garland publishers, New York.
6. Cowling G, Allen T 2011. **The Cell. A very Short Introduction**. Oxford University Press, USA.
7. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walker P 2007. **Molecular Biology of the Cell**. 5th Edition. Garland publishers, New York.
8. Schaffer SW 2007. **Mitochondria: The Dynamic Organelle**. 1st Edition. Springer Verlag.
9. Wilson J, Hunt T 2007. **Molecular Biology of the Cell** 5th edition. **The Problems Book**. 2nd Edition. Garland publishers, New York..
10. Celis JE (ed) 2006. **Cell Biology–A Laboratory Hand Book**. 3rd Edition. Elsevier, USA.
11. Lodish H, Berk A, Kaiser CA, Kreiger M, Scott P M, Bretcher A, Ploegh H, Matsudaira P. 2004.

- Molecular Cell Biology.** 5<sup>th</sup> edition. W. H. Freeman and Company, New York.
12. Alberts, B. Bray D. Lewis J. Ralf, M. Roberts, K. and Watson, J.D. 1999: *Molecular Biology of the Cell*, Garland Publishing Inc., New York.
  13. De, D.N. 2000: *Plant Cell Vacuoles. An Introduction*. CSIRO Publication. Collingwood, Australia.
  14. C.J. Avers 1986: *Molecular Cell Biology*. Addison Wesley Publishing Company.
  15. Lodish, Berk A, Zipursky, S.L. Matsdaira P, Baltimore D and Darnell, J. 2000; *Molecular Cell Biology* (4<sup>th</sup> Edition) W.H. Freeman and Co., New York, USA.
  16. Krishna Murthy, K.V. 2000: *Methods in cell wall cytochemistry* CPC Press, Boca Raton, Florida.
  17. Kleinsmith, L.J. and Kish, V.M. 1995: *Principles of Cell and Molecular Biology* (2<sup>nd</sup> Edition) Harper Collins College Publishes, New York, USA.

## PAPER CODE: 104: CYTOLOGY AND CYTOGENETICS

### Theory

#### Unit I:

Nucleus – Structure of nuclear membrane, Nuclear pore complex; Chromosome structure, molecular organization of chromatin, centromeres and telomeres; Special types of chromosomes (lampbrush, Polytene). Chromosome identification - Karyotype analysis; Chromosome banding techniques; Flow cytometry and confocal microscopy in karyotype analysis; computer assisted karyotype analysis – chromosome micro-dissection and micro-cloning

#### Unit II:

Chromosomal structural aberrations: Origin, meiosis and breeding behavior of duplications, deficiencies and inversions and interchanges; types of inversions. Robertsonian translocations; Basic concept of Complex translocation heterozygotes. Chromosomal numerical aberrations I – Classification of numerical aberrations; Aneuploids–Trisomics (Primary, Secondary, Tertiary), Monosomic and nullisomics – meiotic behavior and chromosome mapping

#### Unit III:

Chromosomal numerical aberration II: Polyploids – Origin and production of auto and allopolyploids; Meiosis in autotetraploid ; Genome analysis in *Tobacco*, wheat and *Arabidopsis*. Nuclear DNA content – C-value paradox, hyperchromicity, Cot curves and significance- Molecular organization of nuclear genome

#### Unit IV:

Cell Cycle and its regulation – check points, cyclins and cyclin dependent kinases, experimental control of cell division. Apoptosis - mechanism and significance; Initiation of cancer at cellular level – proto oncogenes and oncogenes

### Text Books

1. C. B. Powar. 1992. Cell Biology. Himalaya Publishers, New Delhi
2. Gupta, P.K. 1995. Cytogenetics. Rastogi & Company, Meerut
3. Swanson, Merz and Young. Cytogenetics. Prentice Hall. India
4. Sybenga, J. 1973. General Cytogenetics. North Hall and American Elsevier
5. De Robertis E.D.P and E.M.F. De Robertis. Cell and Molecular Biology 2001. CBS Publishers and Distributors

### Reference Books

1. David M. Prescott. Cells. 1988. Jones and Bartlett Publ. Boston
2. Pierce BA. 2013. Genetics: A Conceptual Approach. 5th Edition. W. H. Freeman, California.
3. Darnell, Lodish and Baltimore: Molecular Biology, Scientific American Books, New York
4. Bass H and Birchler J. 2011. Plant cytogenetics: Genome structure and chromosome Function. Springer, New York

## **PAPER CODE: 105: CRYPTOGAMS AND GYMNOSPERMS**

### **Suggested Laboratory Exercises**

- 1 Examination of vegetative and reproductive morphology of Chlophyceae members.
- 2 Examination of Thallus structure and reproductive bodies of Xanthophyceae, Bacillariophyceae and Phaeophyceae members.
- 3 Examination of external and internal structure and reproductive organs of Rhodophyceae and Cyanophyceae members.
- 4 Field work to get acquaintance with locally available algae.

### **Bryophytes**

1 . An examination of the external and internal structure and reproductive organs of the genera, Riccia, Targionia,, Plagiochasma, Marchantia, Peltia, Porella, Anthoceras, Notothylus, Sphagnum, Funaria, Polytrichum.

### **Pteridophytes**

01. Examination of the external features, anatomy and reproductive structures of Psilotum, Lycopodium, Selaginella, Isoetes, Equisetum, Adiantum, Salvinia and Azolla. Observations of the slides of the following fossil plants: Rhynia, Lepidodendron, Lepidocarpon, Miadnesia, Sphenophyllum, Calamites.

### **Gymnosperms**

02. Examination of the external features, anatomy (TS, TLS&RLS) and reproductive structures of Ginkgo, Pinus, Cupressus, Cryptomeria, Araucaria, Ephedra & Gnetum. Study of fossil gymnosperms from prepared slides. Lyginopteris, Lagenostoma, Medullosa, Trigonocarpus, Conostoma, Heterangium, Cordaites

## **PAPER CODE: 106: MICROBIOLOGY**

### **Suggested Laboratory Exercises**

1. Microbiological culture techniques
2. Types of media, Preparation of media and stains
3. Sterilization methods
4. Gram staining of bacteria
5. Morphological study of Stemonitis, Saprolegnia, Mucor, Morchella, Aspergillus, Agaricus, Cyathus, Synchronium, Helminthosporium

## **PAPER CODE: 107: CELL BIOLOGY OF PLANTS**

### **Suggested Laboratory Exercises**

1. Staining techniques – Study of mitosis using acetocarmine.
2. Isolation of mitochondria and the activity of its marker enzyme, Succinate dehydrogenase (SDM).
3. Isolation of chloroplasts and photographs SDS – PAGE technique and photographs - profile of proteins to demonstrate (2) the two subunits of Rubisco.
4. Isolation of nuclei and identification of histones by SDS-PAGE technique.
5. Fluorescence staining with FDA for cell viability and wall staining with calcofluor.
6. Immunofluorescence technique –observation of cytoskeleton.
7. Demonstration Photographs of SEM and TEM.

**PAPER CODE: 108: CYTOLOGY AND CYTOGENETICS**

**Suggested Laboratory Exercises**

1. Observation and identification of meiotic stages
2. Preparation of karyotypes and construction of idiograms
3. Observation of slides/photographs showing structural and numerical aberrations and chromosome banding.

**SEMESTER – II**  
**PAPER CODE: 201: GENETICS**

**Theory**

**Unit I:**

Concept of Genetic markers and their types – application of probability Laws of Mendelian principles. Chi-square testing for goodness of fit. Allelic and gene interactions; Multiple allelism – Penetrance and expressivity – Pleiotropism, pseudoalleles, phenocopies

**Unit II:**

Gene mapping methods based on test-cross and F<sub>2</sub> progenies; LOD score analysis; Tetrad analysis and its significance; somatic cell genetics and its use in mapping; correlation of genetic and physical maps; Sex-linked inheritance, sex-influenced and sex-limited characters. Recombination and its molecular mechanism; role of rec A,B,C,D enzymes; Holliday's model

**Unit III:**

Mutations – types – molecular basis; site-directed mutagenesis – DNA damage and repair mechanisms; examples of inherited defects in DNA repair. Multigene families and their organization and significance; Transposable elements in pro-and eukaryotes, Mechanism of transposition; significance of transposable elements

**Unit IV:**

Mapping in bacteria and phages – methods using conjugation; Transformation and transduction; Fine structure analysis of gene - Benzer's work; concept of gene; Nature and variant forms of eukaryotic genes. Maternal inheritance – Distinction between nuclear and cytoplasmic types of inheritances-Distinction - Genetics of mitochondrial and chloroplast characters; Male sterility, types and significance

**Text Books**

1. Strickberger, Genetics, Prentice Hall
2. Lewin, B. 2008. Gene IX. Jones and Barlette publishers, London
3. Brooker R. 2008. Genetics, Analysis and Principles. 3rd edition. McGraw Hill science
4. Snustad, D.P. and Simons, M.J., 2000. Principles of Genetics John Wiley and Sons Inc., USA
5. Russel PJ. 2009. Genetics–A Molecular Approach. 3rd Edition. Pearson Benjamin Cummings, San Francisco, USA
6. William K, Cummings S, Spencer MR and Charlotte A. 2013. Essentials of Genetics. Pearson Books, Delhi
7. P.S. Verma and V.K. Agarwal, 2005. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand and Company Ltd, New Delhi
8. Pierce BA. 2013. Genetics: A Conceptual Approach. 5th Edition. W. H. Freeman, California

**Reference Books**

1. Griffiths, A.J.F., Miller, H.T., Suzuki, Lewontin, Gelbart Intd. Genetic analysis, H.F. Freeman and Co.
2. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4<sup>th</sup> edition) Jones and Bartlett Publishers, Massachusetts, USA
3. Lewis, R. 1997. Human Genetics: Concepts and Applications, WCB Mc Graw Hill,
4. Malacinski, G.M. and Freifelder, D. 1998. Essentials of Molecular Biology (3<sup>rd</sup> edition). Jones and Bartlett Publishers Inc. London
5. Jeremy W. Dale and Malcolm van Schantz, 2002. From Genes to Genomes – Concepts and Application of DNA Technology, John Wiley and Sons Ltd, England

## PAPER CODE: 202: MOLECULAR BIOLOGY OF PLANTS

### Theory

#### UNIT - I

Composition and structure of Biomolecules: Carbohydrates, Lipids and Proteins (Ramachandran plot, secondary structures, domains, motifs and folds).

Nucleic acids, DNA structure and duplex model. A, B and Z forms of DNA. Types of small RNAs – Si RNA, micro RNA and catalytic RNA

#### UNIT - II

DNA replication, Semi-conservative, Semi-discontinuous and uni and bi directional mode of replication. RNA Priming, Enzymes for DNA replication Helicases, SSBs, Topoisomerases and Polymerases. Mechanism of DNA replication. Rolling circle and Theta mode of replication. Replication of ends of chromosomes

Transcription Promoters, Activators, Transcription factors and Mechanism of Transcription in Prokaryotes and Eukaryotes. Post Transcriptional modifications.

#### UNIT - III

Translation : Structure of tRNA, Ribosome as a Translation factory, Genetic code, Mechanism of Translation - Initiation, elongation and termination. Post translational modifications

Protein sorting and targeting of proteins into Chloroplasts, Mitochondria, Vacuoles and Peroxisomes. Protein trafficking.

#### UNIT – IV

Regulation of gene expression in Prokaryotes. Basic models: Lac, Arabinose and Tryp operons. Positive and Negative controls. Regulation in Viruses : Lytic and Lysogenic cycle.

Regulation of gene expression in Eukaryotes. Britten Davidson model. Role of chromatin in gene expression. DNA methylation. Temporal and spatial regulation. Gene silencing

#### Suggested Readings & Text Books

1. Alberts B, D. R. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. 2004. *Molecular Biology of the Cell* Garland Publishing New York and London
2. Fritsch, E.F. and J. Sambrook. 1992. *Molecular cloning: Laboratory Manual*. Maniatis, Cold Spring Harbor Laboratory New York.
3. George M. Malacinski & D. Freifeilder 2005. *Essentials of Molecular Biology*.
4. Scheclif, R.F. and P.C. Wensik 1991. *Practical Methods in Molecular Biology* Springer-Verlag
5. Walker, J. and W. Castra. 1992. *Techniques in Molecular Biology*. Goom Helns, London.
6. Buchaman B.B., Gruissem W and Jones R.I. 2000. *Biochemistry and Molecular Biology of Plants: American Societies of plant Physiologists, Maryland USA*
7. Gupta, P.K. 2002. *Cell and Molecular Biology*, 3<sup>rd</sup> Edition, Rastogi Publications, Shivaji Road, Meerut, India
8. Glick, B.R. and Thompson J.E. 1992. *Methods in Plant Molecular Biology and Biotechnology*, CRC Press, Boc Raton Florida.
9. Lodish, B.A, Zipursky S.L, Matsdaira P, Baltimore D. and Darnell J. 2000. *Molecular Cell Biology* (4th edition). W.H. Freeman & co. New York, USA.
10. Lewin B, 2000. *Genes VII* Oxford University Press, New York.
11. R F Weaver 1999, *Molecular Biology*, WCB McGraw-Hill.
12. Shaw, C.H. 1998. *Plant Molecular Biology. A practical approach*, IRL Press, Oxford.
13. Raghavan V. 1997. **Molecular Biology of Flowering plants**. Cambridge University press, New York, USA.

## **PAPER CODE: 203: PLANT DEVELOPMENTAL BIOLOGY AND EMBRYOLOGY**

### **Unit I:**

Introduction- comparison of Plant and animal development, Plant Cell Division and Expansion, Plant cell cycle- Endoreduplication and control of plant cell size, Plant Architecture, Theories of Organization of meristems; Root growth and Development: Root apical meristem (RAM); Tissue Differentiation, Root hair and Lateral roots formation.

### **Unit II:**

Stem growth and development: organization of the shoot apex; cytological and molecular analysis of shoot apical meristems. Leaf and flower development: Development of leaf and Phyllotaxy, specialized cells and tissue differentiation. Development and Anatomy of flower, including transition to Flowering and reproductive shoot apex.

### **Unit III:**

Reproduction and Flower: Vegetative options and reproduction; Genes controlling floral organ Differentiation. Male Gametophyte: Structure of Anther, Microsporogenesis, Role of Tapetum; Pollen development, Pollen germination, Pollen tube growth and Guidance; Pollen storage. Female Gametophyte: Ovule- Structure and development; Megasporogenesis; Development and Organization of the mature Embryo sac; Structure of the Embryo sac cells; Embryo sac haustoria.

### **Unit IV:**

Fertilization, Seed and Fruit Development: Pollination mechanisms and Vectors; Structure of the Pistil; Pollen- Stigma Interactions, Sporophytic and Gametophytic Self-Incompatibility; Double Fertilization. Endosperm development; Types of Endosperm; Functions; Embryogenesis-Dicot types; Monocot embryo; Polyembryony; Apomixis; Parthenocarpy, Dynamics of Fruit growth and Seed Development. Outlines of Experimental Embryology.

### **Text Books:**

1. Pullaih, T., Naidu, K. C., Lakshminarayana, K. & Hanumantha Rao, B. 2007. Plant Development. Regency Publications, New Delhi.
2. Fahh, A. 1982. Plant Anatomy (3rdEd.), Pergamon Press, Oxford.
3. Murphy, T.M. and Thompson, W.F. 1988. Molecular Plant Development, Prentice Hall, New Jersey.
4. Bhojwani, S. S. and Bhatnagar, S.P. 2000. The embryology of Angiosperms (4th Revised and Enlarged Ed.). Vikas Publishing House, New Delhi.
5. Pullaiah, T. Lakshminarayana, K. & Hanumantha rao, B. 2008. plant reproduction. Scientific publishers, Jodhpur.

### **Reference Books:**

1. Biochemistry & Molecular Biology of Plants by Bob Buchanan, Gruissen W and Jones R L
2. Howell, S.H. 1998. Molecular Genetics of Plant Development, Cambridge Univ. Press, Cambridge.
3. The plant cell. Special issue on Reproductive Biology of Plants, Vol. 5. 1993. The American Society of plant physiologist, Rockville, Maryland, USA.
4. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology, A Laboratory Manual. Springer-Verlag, Berlin

## **PAPER CODE: 204: MOLECULAR PLANT PATHOLOGY**

### **Theory**

#### **UNIT-I**

An overview on plant diseases. A brief history, terminology involved. Flor's hypothesis, Koch postulates. Causal agents- Bacteria, Viruses, Fungi, phytoplasmas.

Colonization of pathogen in host – Different stages: Inoculum, Penetration, infection, invasion, Reproduction, Spread and survival of pathogens.

#### **UNIT-II**

Plant Defense mechanisms: performed, induced, biochemical and physiological responses, Host-pathogen interactions, disease signaling, pathogen recognition and signal transduction. Physiological changes in diseased plants.

Molecular determinants of pathogenicity, virulence, effectors, elicitors, defensins, phytoalexins, common phenolics, plant cell wall degrading enzymes, host specific toxins, host non-specific toxins, hormones and their role in cell signaling and immunity.

#### **UNIT-III**

Symptoms, etiology, epidemiology and control measures of certain plant diseases: Citrus canker, Bacterial leaf blight of rice, Angular leaf spot of cotton, Grassy shoot disease of sugarcane, Little leaf of Brinjal, Rice tungro, Club root of Crucifers, Damping off of seedlings, Whip smut of Sugarcane, Coffee rust, Bean rust, Wilt of Cotton, Leaf spot of Turmeric.

#### **UNIT-IV**

Plant Disease management: Plant Quarantine, Cultural practices, Chemical control, Biological control, Integrated Pest Management (IPM). Plant Disease resistance, classes of resistance genes. Transgenic and genetic manipulation approaches, molecular marker to tag disease resistance and avirulence genes. Use of databases and application of bioinformatics in plant pathology.

#### **Suggested Readings & Text Books**

01. Agrios GN 2001. **Plant Pathology**. Academic Press, London.
02. Richard N Strange 2003. **Introduction to Plant Pathology**. Springer.
03. Lucas 2001. **Host Pathogen Interactions**. Blackwell.
04. Bilgrami KS and Dube HC 2000. **A Text Book of Modern Plant Pathology**. Vikas Publications, New Delhi.
05. Rangaswami G 1988. **Disease of Crop Plants in India**. Prentice-Hall of India.
06. Wood RKS 1967. **Physiological Plant Pathology**.
07. Kelman A 1967. **Source Book of Laboratory Exercise in Plant Pathology**.
08. Mehrotra RS 1994. **Plant Pathology**.
09. Mukerji KG and Garg KL 1993. **Bio-control of Plant Diseases**. Vol.I&II CBS Publishers and Distributors Delhi.
10. Butler EJ 1973. **Fungi and Diseases in Plants**.
11. Roberts RR and Booth Royd LR 1972. **Fundamentals of Plant Pathology**.

## PAPER CODE: 205: GENETICS

### Suggested Laboratory Exercises

1. Observation of types of chlorophyll mutants
2. Problems in Mendelian Genetics, Gene interactions and Epistasis
3. Probability Laws and Chi-Square test
4. Chromosome Mapping and Tetrad Analysis

## PAPER CODE: 206: MOLECULAR BIOLOGY OF PLANTS

### Suggested Laboratory Exercises

1. Isolation of DNA from Onion bulbs/Banana
2. Isolation of DNA using CTAB method
3. Biochemical Tests of Carbohydrates, Proteins and Fats in the plant cells
4. 4.Assignments on problems related to DNA replication, Transcription, Translation and Gene regulation
5. Electrophoresis of seed proteins
6. Diagrams/Photographs display related to all units

## PAPER CODE: 207: PLANT DEVELOPMENTAL BIOLOGY AND EMBRYOLOGY

### Suggested Laboratory Exercises

#### Plant Development

1. Representative types of roots -Diarch, Triarch, and Polyarch types — transverse sections with double staining, ex. *Vicia*, *Ficus*, *Tinospora* (aerial root), *Vanda* (velamen root).
2. Types of Stems: For transverse sections with double staining methods — showing Primary and Abnormal Secondary Growth. Ex. *Aristolochia*, *Bignonia*, *Amaranthus*, *Achyranthus*, *Boerhaavia*, *Dracaena*.
3. Maceration of wood: For observation of Individual Xylem elements with single staining.
4. Leaf types: Dorsiventral leaf, Isobilateral leaf, Xeromorphic leaves - *Nerium*, *Casuarina*, *Ficus* leaves, *Nymphaea*, leaves. *Sorghum* and *Saccharum* leaves for C4 anatomy.

#### Plant Reproduction

1. Examination of Modes of Anther Dehiscence and collection of Pollen grains for microscopic examination (Maize, Grasses, *Cannabis sativa*, *Crotalaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanum melongena* etc).
2. Tests for Pollen Viability using stains and in vitro Germination. Pollen Germination using Hanging drop and Sitting drop cultures, Suspension culture and Surface culture.
3. Estimation of Percentage and Average Pollen tube Growth *in vitro*.
4. Field study of several types of flowers with different pollination mechanisms (Wind Pollination, Thrips pollination, Bee / Butterfly Pollination, Bird Pollination).
5. Study of Nuclear and Cellular endosperm through dissections and staining.
6. Isolation of Zygotic Globular, Heart-shaped, Torpedo stage and mature embryos from suitable seeds.
7. Polyembryony in Citrus, Jamun (*Syzygium cumin*) etc. by Dissections.

## PAPER CODE: 208: MOLECULAR PLANT PATHOLOGY

### Suggested Laboratory Exercises:

1. Acquaintance with general techniques used in phytopathological work.
2. Study of symptoms, microscopic examination of diseased parts and identification of the pathogens involved in different plant diseases included in the theory part of syllabus.
3. Isolation and Identification of pathogens.

## SEMESTER – III

### PAPER CODE: 301: TAXONOMY OF ANGIOSPERMS AND PLANT RESOURCE UTILIZATION

#### Theory

#### Taxonomy of Angiosperms

##### UNIT-I

Taxonomic hierarchy, species, genus, family and other categories; Principles used in assessing relationship delimitation of taxa and attribution of rank; Species concepts Nomenclature and ICBN Rules

##### UNIT - II

Systems of angiosperm classification: Phenetic versus phylogenetic system; Cladistics in taxonomy; relative merits and demerits of major systems of classification Takhtajan, Cronquist, Thorne and Dahlgren, APG system,  $\alpha$ , and  $\omega$  taxonomy

##### UNIT – III

Brief analysis of evolutionary tendencies: Ranales (Magnoliaceae, Nymphaeaceae), Rosales (Fabaceae, Apiaceae), Centrospermae (Caryophyllaceae, Nyctaginaceae) Tubiflorae (Asteraceae, Lamiaceae) Amentiferae (Casuarinaceae), Helobiales (Najadaceae, Anismataceae), Liliflorae (Liliaceae, Amaryllidaceae), Glumiflorae (Poaceae, Cyperaceae).

Modern trends in Taxonomy: Embryology, Palynology, Microanatomy, Cytology, Phytochemistry.

#### Plant Resources Utilization and Diversity

##### UNIT - IV

Origin, Evolution, Botany and uses of

1.	Food Crops	:	Rice, Sugarcane, Maize
2.	Pulses	:	Red gram, Black gram
3.	Fibre Crops	:	Cotton, Sunhemp
4.	Medicinal and aromatic crops	:	<i>Catheranthus</i> , <i>Withania</i> , <i>Cymbopogan</i>
5.	Oil yielding crops	:	Groundnut, Castor, <i>Brassica</i>

#### Suggested Readings & Text Books

##### Taxonomy of Angiosperms

1. Cole, A.J. 1969. Numerical Taxonomy, Academic Press, London
2. Davis, P.H. and Heywood, V.H. 1973. Principles of Angiosperms Taxonomy. Robert E Kreiger Pub Co New York
3. Harrison, H.J. 1971. New concepts in Flowering Plant Taxonomy, Hieman Educational Books Ltd., London
4. Simpson MG. 2006. **Plant Systematics**. Elsevier Academic Press, California, USA
5. Heywood, V.H. and Moore, D.M. 1984. Current concepts in Plant Taxonomy, Academic Press, London
6. Nordenstam BEI, Lazily G and Kassas M. 2000. **Plant systematic for 2<sup>nd</sup> Century**. Portland Press Ltd., London.
7. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2<sup>nd</sup> Edition) McGraw Hill Book Co., New York
8. Angiosperm Phylogeny Group website. 2012. consult [www.apgweb](http://www.apgweb).
9. Heywood, V.H., RK Brummitt, A. Culham, O. Seberg 2007. *Flowering Plant Families of the World*. Firefly books Ltd. New York.
10. Judd, W.S, Christopher S. Campbell, Elizabeth A. Kellogg, Peter F. Stevens, and

Michael J. Donoghue. 2007. *Plant Systematics: A Phylogenetic Approach*, 3<sup>rd</sup> ed. Sinauer.

11. Lawrence, G.H.M 1951. *Taxonomy of vascular plants*. McMillan, New York.
12. Simpson, Michael G. 2006. *Plant Systematics*. Elsevier & Academic Press.
13. Sivarajan, V.V. 1991. *Introduction to principles of Plant Taxonomy*. Oxford & IBH.

#### **Plant Resources Utilization and Diversity**

1. Baker, H.G. 1978. *Plants and Civilization* (3<sup>rd</sup> Edition) C.A. Wadsworth, Belmont  
Chrispeels, M.J. and Sadava, D. 1977. *Plants, Food and People*. W.H. Freeman and Co., San Francisco
2. Cinway, G. 1999. *The Doubly Green Revolution. Food for All in the 21st Century*, Penguin Books.
3. Council of Scientific & Industrial Research 1986. *The useful plants of India*. Publications and Information Directorate. CSIR, New Delhi
4. Council of scientific and industrial research (1948-1976). *The wealth of India. A dictionary of Indian Raw materials and industrial products*, New Delhi, Raw materials I-XII revised Vol.I-III (1985-1992) supplement (2000)
5. Pinstrup – Anderson P et al. 1999. *World Food Prospects: Critical Issues for the early 21st Century*. International food policy Research Institute, Washington, DC, USA
6. Paroda, R.S. and Arora, R.K. 1991. *Plant Genetic Resources Conservation and Management*. IPGRI (Publication) South Asia Office, C/o. NBPGR Pusa Campus, New Delhi

## PAPER CODE: 302: *IN VITRO* PLANT BIOLOGY

### Theory

#### Unit I:

Plant Tissue Culture: Historical developments and landmarks in plant tissue culture, Basic concepts in plant tissue culture, Concept of totipotency. Molecular basis of totipotency, Formulation of media for plant tissue culture, Plant growth regulators – Involvement in differentiation and morphogenesis, Methods of Sterilization, Inoculation, Incubation and hardening.

#### Unit II:

Fundamental aspects of Morphogenesis, Organogenesis – process, inducing factors, molecular basis of Organogenesis; Somatic Embryogenesis – Induction, Controlling factors, cytological and molecular changes; Production of haploids and its Significance in Crop improvement (Androgenic and Gynogenic haploid production) Double haploids and its applications in agriculture, embryo rescue.

#### Unit III:

Cell Culture and Cell cloning – Isolation of cells, preparation of pure culture, cell cloning techniques and its applications, plating efficiency. Secondary metabolite production through Cell and Organ cultures-Hairy roots, Somatic hybridization: Protoplast isolation, Fusion and culture, Hybrid selection and characterization of hybrids, Symmetric, Asymmetric hybrids and Cybrids, significant achievements and limitations of Protoplast research.

#### Unit IV:

Applications of Plant Tissue culture: Modes, stages and Application of Micro propagation, synthetic seeds production and uses, Origin, Molecular basis and application of Somaclonal variation, Cryopreservation methods and *in vitro* conservation of Germplasm.

#### Text Books:

1. Kalyan Kumar De. 1997. *Plant Tissue Culture*. NCB Agency, Kolkata.
2. Razdan, M.K. 2003. *An Introduction to Plant Tissue Culture*. Oxford & IBH, New Delhi.
3. Bhojwani, S.S. and Razdan, M.K. 1996. *Plant tissue culture: Theory and Practice* (a revised edition) Elsevier Science Publishers, New York, USA.

#### Reference Books:

1. Vasil IK and Thorpe TA. 1994. *Plant Cell Tissue Culture*. Kluwer Academic Publishers, Dordrecht, Netherlands.
2. Callow, J.A. Ford-Lloyd, B.V. and Newbury, H.J. 1997. *Biotechnology and Plant Genetic Resources: Conservation and use*. CAB International, UK, Oxon.
3. Collin, H.A. and Edwards, S. 1998. *Plant Cell Culture*, Bioscientific Publishers, Oxford, UK.

## PAPER CODE 303: ECOLOGY AND PHYTOGEOGRAPHY

### Theory

#### Unit I:

Ecology – Concepts and levels of organization. Population Ecology: Population structure, characteristics of population; population density, Natality, Mortality, Age distribution, Biotic potential, Population growth forms and curves. Population fluctuation and population dispersal. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, prey – predator, parasitism, symbiosis

#### Unit II

Community ecology: Methods of study of plant communities, qualitative study of plants communities. Stratification of Life forms and physiognomy; normal biological spectrum. Quantitative study of plant communities, distribution pattern frequency, density, canopy, basal area and cover. Synthetic characters of Community: Similarity Index, clemensian classification of communities

#### Unit III

Ecosystem organization: Structure and functions; primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow pathways, ecological efficiencies); Litter fall and decomposition; comparative account of nutrient cycles- C, N, P, S and H<sub>2</sub>O; Homeostasis and self regulation

#### Unit IV

Phytogeography: Basic Principles, Age and Area Theory, Good's Principles. Phytogeographical regions of the world, biogeography theory, continental drift, continuous and discontinuous distribution, endemic distribution - floristic regions of India. Major Biomes of the World

#### Text Books

1. Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia
2. Odum.E.P. & Gary W.Barrett. 2005. Ecology.Tomson Brooks/Cole, Singapore
3. Sharma, P.D. 2016. Ecology and Environment, Rastogi Publications, Meerut
4. Kormondy, E.J. 1996. Concepts of Ecology. Prentice-Hall of India Pvt.Ltd. New Delhi
5. Purohit, S.S. and Ashok Agrawal. 2007. Ecology and Environmental Biology, Student Edition, Jodhpur
6. Russell, P.J., Wolfe, S.L., Hertz, P.E., Starr, C. and Mc Million B. 2008. Ecology, Cengage Learning India Pvt. Ltd., New Delhi
7. Ambasht, R.S. and Ambasht, N.K. 1999. A text book of Ecology. CBS Pubi. & Distr. New Delhi.

#### Reference Books

1. Campman, J.L. and Reiss, M.J. 1988. Ecology. Principles and Applications, Cambridge University Press, U.K
2. Krebs, C.J. 1989. Ecological Methodology. Harper and Row, New York, USA
3. Moore, P.W. and Chapman, S.B. 1986. Methods in Plant Ecology Blackwell Scientific Publication
4. Molles, M.C. 2005. Ecology-concepts and applications. Mc GrawHill. Boston
5. Ricklefs, R.E. & Gary L. Miller. 2000. *Ecology*. 4<sup>th</sup> ed. W.H. Freeman and Company. New York

## PAPER CODE: 304: PLANT PHYSIOLOGY

### Theory

#### UNIT - I

Plant water Relations: Thermodynamic concepts of plant water relations, free energy and chemical, osmotic and water potential, active and passive absorption of water, stomatal physiology and stomatal opening and closing, Soil-plant-atmosphere-continuum concept (SPAC) and mechanism of water transport

Mineral Nutrition: Passive and active uptake of ions, translocation of minerals in plants, essential elements, their functions and symptoms of mineral deficiency, importance of foliar nutrition and use of chelates in agriculture, root microbe interactions in facilitating nutrient uptake and mechanism of assimilation

#### UNIT - II

The physiology of flowering: Phytochrome structure, photochemical and biochemical properties and role in photomorphogenesis, photoperiodism and its significance, mechanisms of floral induction, role of vernalization, morphological, biochemical and metabolic changes accompanying seed germination, causes and methods of breaking seed dormancy

#### UNIT - III

Plant growth regulators and Elicitors: Biosynthesis, physiological effects and mechanism of action auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, polyamines, jasmonic acid and salicylic acid, role in agri-horticulture, and hormone receptors

#### UNIT - IV

Stress Physiology: Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, metal toxicity, heat stress and oxidative stress

### Suggested Readings & Text Books

1. Sinha SK 2014. **A text book of Plant Physiology**. Centrum Press, New Delhi.
2. Seema Yadav 2014. **Plant Physiology**. SBW publishers, New Delhi.
3. Heribert H and Kazuo S (eds) 2010. **Plant responses to abiotic stress. Series Topics in Current Genetics, Vol 4**. Springer, Berlin.
4. Philip Stewart and Schine Gobig 2011. **Plant Physiology**. CRC Press.
5. Moore TC. 2011. **Biochemistry and Physiology of Plant Hormones**. Springer, New York.
6. Mohr H and Schopfer P. 1995. **Plant Physiology**. Springer-Verlag, New York.
7. Witham FH and Devlin RM. 1986. **Plant Physiology**. CBS Publishers and Distributors, Bangalore.
8. Wilkins MD. 1987. **Advanced Plant Physiology**. English Language Book Society, Longman Scientific and Technical, Harlow, UK.
9. Ting IP. 1982. **Plant Physiology**. Addison-Wesley, Reading, MA.
10. Murthy HNK. 1981. **Plant growth substances including applications in Agriculture**. Tata McGraw Hill Publishing Company Ltd., New Delhi.
11. Kramer PM and Kozlowski TT. 1980. **Physiology of Woody Plants**. Academic Press, New York.
12. Hillman WS. 1963. **Physiology of Flowering**. Holt, Reinhart and Winston, New York. Kocchar and Gujral. 2012. **Comprehensive Plant Physiology**. McMillan Pub
13. Salisbury F. B. & C. W. Ross 1992 *Plant Physiology*. 4 th Edn. Wadsworth Publishing Co., Belmont,
14. Wiltmer, C.M. & M. Fricker. 1996. *Stomata*. 2nd Ed. Chapman Hall. U. K.
15. Audus, L.J. 1972. *Plant Growth Substances, Volume 1. Chemistry and Physiology*. Leonard
16. Hill, UK. Bewley, J.D. and Black, M. 1982. *Physiology and Biochemistry of seed in relation to germination and dormancy. Volume 1& 2*, Springer – Verlag, Berlin

17. Devlin, R.M. and Witham, F.H. 1986. Plant Physiology
18. Davies, P.J. (Ed) 1987. Plant hormones and their role in Plant Growth and Development. Mertinus Nijhoff Publishers, The Netherlands
19. Epstein, E. 1972. Mineral nutrition of plants, Principles and prospectus, John Willey&Sons, INC, New York
20. Frank Boyer Salisbury, Cleon Ross. Plant Physiology, 5<sup>th</sup> Edition. Hess, D. 1974. Plant Physiology
20. Hewit, E.J. and T.A. Smith, 1975. Plant Mineral Nutrition
21. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (Eds.) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elsevier, Amsterdam, The Netherlands
22. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons Including New York, USA
23. Hopkins, W.G. 2009. Introduction to Plant Physiology. John Wiley & Sons Including New York, US, 4<sup>th</sup> Edition.
24. Konrad Mengel, Ernest A. Kirkby, Harald Kosegarten, Thomas Appel. Principles of Plant Nutrition, 5<sup>th</sup> Edition
25. Khan, A.A. 1982. The Physiology and Biochemistry of Seed Development, Dormancy and Germination. Elsevier, Amsterdam, The Netherlands
26. H.N. Krishna Murthy. 1981. Plant growth substances including applications in Agriculture. Tata McGraw – Hill Publishing Company Ltd
27. Irwin P. Ting, Plant Physiology, 1982, Addison-Wesley Publishing Company.
28. Leopold, A.C. 1964. Plant growth and development. Mc Graw Hill Book Company, Inc, New York.
29. Meyer, A.M. and A. Poljakoff Mayber. 1975. The germination of Seeds
30. Noggle, G.R. and G.J. Fritz. 1991. Introductory plant physiology (2<sup>nd</sup> edition) Prentice hall of India Limited
31. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4<sup>th</sup> edition). Wordsworth Publishing Company, Belmont, California, USA
32. Slayter, R.O. 1967. Plant Water Relationships. Academic Press, New York
33. Sutcliffe, J.F. 1962. Mineral slats absorption in plants, Bergamen, Press, Oxford, London
34. Taiz, L. and Zeiger, E. 1998. Plant Physiology (2<sup>nd</sup> edition). Sinauer Associates including Publishers, Massachusetts, USA
35. Thomas and Vince – Prue, D. 1997. PhotoPeriodism in Plants (2<sup>nd</sup> edition). Academic Press, Sandeigo, USA
36. Wilkins, M.D. 1987. Advanced Plant Physiology. English Language Book Society, Longman
37. Wisthoff, P. 1998. Molecular Plant Development from Gene to Plant. Oxford University Press, Oxford, UK

**PAPER CODE: 305: TAXONOMY OF ANGIOSPERMS AND PLANT RESOURCE UTILIZATION**

**Suggested Laboratory Exercises**

**Taxonomy of Angiosperms & Plant Resources Utilization and Diversity**

1. Description of a Taxa /Species from representative and locally available families
2. Description of various species of a genus: Preparation of key character at genus level
3. Preparation of key characters and use of keys at family level
4. Field trips: Compilation of field notes and preparation of herbarium wild or cultivated
5. Training in using floras and herbaria for identification of specimens wild and cultivated
6. Taxonomic description of the following cultivated Crops
  1. Food crops : Rice, Maize
  2. Pluses : Red gram, Black gram
  3. Fiber crops : Cotton, Sunhemp
  4. Oil yielding : Groundnut , Castor, *Brassica*
  5. Medicinal & Aromatic : *Catheranthus*, *Eucalyptus*

**PAPER CODE: 306: IN VITRO PLANT BIOLOGY**

**Suggested Laboratory Exercises**

1. General out lay of PTC laboratory
2. Preparation of Stock solutions and Media.
3. Callus induction – Carrot
4. Direct organogenesis and somatic embryogenesis from Tobacco explants.
5. Androgenesis and production of haploids from *Datura* flower buds.
6. Embryo culture – Ground nut
7. Establishment of Cell cultures and determination of plating efficiency.
8. Enzymatic isolation and culture of protoplasts.
9. Fusion of protoplasts using PEG.
10. Clonal propagation through meristem culture
11. Preparation of synthetic seeds using sodium alginate.

**PAPER CODE 307: ECOLOGY AND PHYTOGEOGRAPHY**

**Suggested Laboratory Exercises**

1. Study of vegetation in the local forest
2. To classify the vegetation into different life forms and prepare a biological spectrum
3. To determine the minimal size and number of quadrates required for quantitative study of the plant community
4. Quantitative analysis of vegetation: relative frequency, density, relative density, basal area and IVI
5. Ecological adaptations of plants: hydrophytes, xerophytes and succulents

**PAPER CODE: 308: PLANT PHYSIOLOGY**

**Suggested Laboratory Exercises**

1. Effects of high and low temperatures on the permeability of the cytoplasmic membranes
2. Determination of suction force in transpiration
3. Stomatal frequency and Stomatal index of leaves
4. Rate of transpiration in leaves by Cobalt chloride paper method
5. Mechanism of opening and closing of stomata

**SEMESTER – IV**  
**PAPER CODE: 401: GENETIC ENGINEERING OF PLANTS AND MICROBES**

**Theory**

**UNIT – I**

Basics of rDNA technology: Restriction enzymes: Types, Nomenclature, Mechanism of action: Methodology of rDNA molecule synthesis: Polylinkers. Vectors: Features and types: Cloning vectors - Plasmids, Viral DNA, Cosmids, Artificial chromosomes - Bacterial and Yeast artificial chromosomes(BACs and YACs); Expression vectors

Bacterial transformation, *In-vitro* packaging, Recognition of transformants: Antibiotic resistance, Lac Z gene based selection. Genomic library, cDNA library

**UNIT - II**

Blotting techniques: Southern, Northern and Western blotting, Properties of radio isotopes. Carbon, Phosphorus and Sulphur: *In-situ* Hybridization: Radioactive and non-radioactive probes: Enzyme and fluorescence detection methods (FISH), Types and Applications of PCR technique. DNA sequencing: Basic principle of Sanger's method, sequencing genomes Automated DNA sequencing, High throughput DNA sequencing; Sequencing genomes: Whole genome, Shot gun sequencing.

**UNIT - III**

DNA fingerprinting: RFLP; RAPD, AFLP; Chromosome mapping, Restriction maps and Genetic markers, QTL mapping analysis; Introgression of useful traits using DNA markers. Microarray and its applications

Methods of gene transfer in plants: Physical and Biological methods. *Agrobacterium* mediated: Binary and co integrative vector based. Chloroplast transformation.

**UNIT - IV**

Transgenic plants: Fungal, Bacterial, Viral and Insect tolerant (BT and proteinase inhibitors) transgenics. Herbicide tolerate, Abiotic stress tolerate, Male sterility: Barnase-Barstar.

Quality improvement: Golden rice, Late ripening tomatoes (Flavr Savr)

Genetic improvement of industrially important microbes as Biopesticides, Biofertilizers and Antibiotics

Applications of Bioinformatics in Genetic engineering and their importance. IPRs, Ethical and Environmental issues

**Suggested Readings & Text Books**

1. Glick BR, Pasternak JJ and Patten CL. 2010. **Molecular Biotechnology Principles and**
2. Attwood TK, Smith DJP and Phukan S. 2009. **Introduction to Bioinformatics**. Pearson Education Ltd., UK.
3. Watson JD. 2007. **Recombinant DNA: Genes and Genomes: A short course**. W. H. Freeman, USA.
4. Lewin B. 2004. **Genes VIII**. Pearson Prentice Hall, New Jersey.
5. Balasubramanian, D. 2005. Concepts of Biotechnology New edition.
6. Old and S BPrimrose 2002. Principles of Gene Manipulation by Blackwell, Oxford.
7. Brown, T.A. 2002. *Gene cloning – DNA Analysis* – Blackwell, London.
8. Davies, J.A. and WS Reznikoff. 1992. *Milestones in Biotechnology*.
9. Glick and Pasternock 2002. *Molecular Biotechnology*, Panima
10. Mickloss, D.A. and GA Freyer 1990. *DNA Science. A first Course in Recombinant Technology*, Cold Spring Harbor Laboratory Press, New York
11. Primrose, S.B. 1994. *Molecular Biotechnology* (2nd Edn), Blackwell Scietific Pub. Oxford.

- Sambrook, J., E. Frisch and T. Maniatis 2000. *Molecular Cloning: Laboratory manual* , Cold Spring Harbor Laboratory Press New York.
12. Sambrook, J., E. Frisch and T. Maniatis 2000. *Molecular Cloning: Laboratory manual* , Cold Spring Harbor Laboratory Press New York.
  13. Satyanarayana U 2005 Biotechnology.
  14. Glick BR, Pasternak JJ and Patten CL. 2010. *Molecular Biotechnology Principles and Applications of rDNA*. ASM Press, USA
  15. Benjamin Lewin , *Genes X* 2004 Pearson Prentice Hall International Edition
  16. Channarayappa, *Molecular Biotechnology Principles and practices* 2006 University
  17. Chawla, H S. 2002. *Introduction to Plant Biotechnology* Oxford and I B H Publishers
  18. Primrose, S B and RM Twyman 2006. *Principles of Genome Analysis and genomics* Blackwell publishers
  19. Sateesh, M K. 2008. *Bioethics and Biosafety* I K International

## **PAPER CODE: 402: EVOLUTION AND PLANT BREEDING**

### **Theory**

#### **Unit I:**

Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells.

Theories of Evolution: Lamarckism, Darwinism, Natural Selection, Mutation theory, modern synthetic theory, Polygenic inheritance, heritability and its measurements.

#### **Unit II:**

The Mechanisms: Population Genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

#### **Unit III:**

Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

Plant breeding: Introduction and scope, Pure line selection - Mass selection, pedigree method, Bulk method, Back cross method and Clonal selection and hybridization, Heterosis and Hybrid Vigor.

#### **Unit IV:**

BioStatistical Methods: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance;  $X^2$  test;; Basic introduction to Multivariate statistics.

#### **Text Books:**

1. Organic Evolution ,Veer Bala Rastogi
2. Singh, B.D.: Plant Breeding
3. Genetics M.W. Stickberger, Macmillan Company, New York

#### **Reference Books:**

1. Alalrd, R.W. 1961: Principles of Plant Breeding
2. Jones & Wilkins – Variation and adaptation in plant species. Heinemann Educational
3. Books Ltd., Londoan
4. Stebbins, J.L. – Chromosomal evolution in Higher Plants. Edward Arnold
5. Publishers Ltd., London.

## PAPER CODE: 403: ENVIRONMENTAL BIOLOGY AND BIODIVERSITY

### Theory

#### Unit I

Ecosystem stability: Concept (resistance and resilience) ecological perturbations (Material and anthropogenic) and their impact on plants and ecosystems

Environmental impact assessments. Ecosystem restoration

Climate: Koppen – Thorntwait's classification of climate

Climate change: Greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub>, NO<sub>2</sub>, CFCS sources trends and role) Ozone layer, Ozone hole and consequences of climate change (CO<sub>2</sub>, fertilization, global warming, sea level rise, UV radiation)

#### Unit II

Composition of soil. Factors affecting soil formation and soil profile (Laterization podsolization, gleixation, mineralization and soil classification, soil water, soil solution). Soil organic matter or humus and soil organisms

Pollution: Air, Water and Soil, kinds, sources, quality parameters, effects on plants and ecosystems.

Plant Biodiversity: Concept, levels of biodiversity, Magnitude and distribution, Mega diversity centers, Status of BD in India.

#### Unit III

The role of biodiversity in Ecosystem functions and stability, speciation and extinction, global patterns of terrestrial bio-diversity

Hotspots, Keystone species, Umbrella and Indicator species.

Threats to Biodiversity, Utilization and concerns, IUCN categories of threat.

World Centers of primary diversity of domesticated plants. The Indo Burmese Centre, plant introduction and secondary centers.

#### Unit IV

Principles of Conservation: Strategies for conservation, *in situ* conservation, protected areas network, Biosphere reserves, wetlands, mangroves strategies for conservation – *ex situ* conservation. Principles and practices. Botanical gardens, BSI, ICAR and CSIR.

Remote Sensing Applications in biodiversity conservation: Remote sensing-Concept, Principles, Applications and Role in study and Identification of Phyto Diversity and Natural Resources using GIS.

Sustainable development: concept and strategies; SD goals (SDGs/Millennium Development Goals)

### Text Books

1. Mahua Basu and S. Xavier 2017. Fundamental of Environmental Studies. Cambridge publishers
2. Dr. D.K Singh 2006. Environmental Science. S. Chand publish
3. Sharma, P.D. 2016. Ecology and Environment, Rastogi Publications, Meerut
4. Purohit, S.S. and Ashok Agrawal. 2007. Ecology and Environmental Biology, Student Edition, Jodhpur
5. Russell, P.J., Wolfe, S.L., Hertz, P.E., Starr, C. and Mc Million B. 2008. Ecology, Cengage Learning India Pvt. Ltd., New Delhi
6. Odum.E.P. & Gary W.Barrett. 2005. *Ecology*. Tomson Brooks/Cole, Singapore
7. Erach Barucha 2002. Biodiversity of India. Mapin publishing in association with TATA Power company Pvt. Ltd

8. Krishnamurthy, K.V. 2004. Advanced Textbook On Biodiversity: Principles And Practice. Oxford Lillesand.
9. Sinha, R. K. Biodiversity -Global Concerns.1996. Commonwealth Publishers, New Delhi
10. Negi, S. S. 2005. Biodiversity & Its Conservation in India. Indus Publishing Company. New Delhi
11. Ravi Prasad Rao, B. 2005. Remote Sensing and Image Interpretation. 7th ed. Wiley.
12. Basudev Bhatta 2008. Remote Sensing and GIS. Oxford University Press

**Reference Books**

1. APHA – Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, DC
2. Frankel, OH. Brown, A.H.D. & Burdon, J.J. 1995. The conservation of Plant Diversity, Cambridge University Press, Cambridge, UK
3. Horpes and Row, N.Y; Batra, N.K. & Sharma, K.K. 1990. A Treatise on Plant Ecology. Pradeep Publications
4. Molles, M.C. 2005. Ecology-concepts and applications. Mc GrawHill. Boston
5. Magurran, A.E. 1988. Ecological Diversity and its measurement. Chapman and Hall, London
6. Chuvieco, E. and Uete, A.H. 2010. Fundamentals of Satellite Remote sensing
7. Gabriel Melchias. 2001. Biodiversity and Conservation. Oxford IBH Publishers, New Delhi
8. Walter, K.S. and Gillett, H.J. 1998. 1997 IUCN Red List of Threatened Plants. IUCN, the World conservation Union. IUCN, Gland, Switzerland, and Cambridge, U.K.
9. *Kevin J. Gaston & John I. Spicer. 2004. Biodiversity, an introduction. Blackwell*  
Christian Leveque, Jean-claude Mounolou and Vivien Reuter. 2004. *Biodiversity*. John Wiley
10. *Jensen, John R. 2007. Remote Sensing of the Environment: An Earth Resource Perspective*. PHI
11. Heywood, V.M. and Watson, R.T. 1985. Global Biodiversity Assessment, Cambridge Univ. Press, Cambridge

## **PAPER CODE: 404: PLANT METABOLISM**

### **Theory**

#### **UNIT - I**

Fundamental of Enzymology: General aspects, allosteric mechanism, regulatory and active sites, isozymes, mechanism of enzyme action, kinetics of enzymatic catalysis, Michaelis-Menten Equation and its significance

Signal transduction: Receptors and G protein, Phospholipid signaling, role of cyclic nucleotides, Calcium-calmodulin cascade, diversity in protein kinases and phosphatases, Two-component sensor-regulator system in bacteria and plants, source sensing mechanism

#### **UNIT - II**

Photochemistry and Photosynthesis: General concepts and historical back ground, evolution of photosynthetic apparatus, Redox reactions, photosynthetic pigments and light harvesting complexes, photooxidation of water, mechanisms of electron and proton transport, structure, synthesis and function of ATP, Carbon assimilation-the Calvin cycle, photorespiration and its significance, C<sub>4</sub> cycle and CAM pathway, biosynthesis of starch and sucrose, physiological and ecological considerations

#### **UNIT - III**

Respiration and Lipid metabolism : Plant respiration, glycolysis, TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system, structure and function of lipids, fatty acid biosynthesis of membrane lipids, structural lipids and storage lipids and their catabolism

#### **UNIT - IV**

Nitrogen fixation and nitrogen metabolism: Biological nitrogen fixation, nodule formation and nod factors, biosynthesis of amino acids and proteins, mechanism of nitrate uptake and reduction, ammonium assimilation, sulphate uptake, transport and assimilation

### **Suggested Readings & Text Books**

1. Bob B. Buchanan, Wilhelm Gruissem, and Russell L. Jones. 2002. Biochemistry and molecular biology of Plants
2. Devlin, R.M. and Witham, F.H. 1986. Plant Physiology
3. Frank Boyer Salisbury, Cleon Ross. Plant Physiology, 5<sup>th</sup> Edition.
4. Hess, D. 1974. Plant Physiology
5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons Including New York, USA
6. Hopkins, W.G. 2009. Introduction to Plant Physiology. John Wiley & Sons Including New York, USA, 4<sup>th</sup> Edition.
7. Irwin P. Ting, Plant Physiology, 1982, Addison-Wesley Publishing Company.
8. Lehninger, A.L. 1982. Principles of Biochemistry, Worth, New York
9. Noggle, G.R. and G.J. Fritz. 1991. Introductory plant physiology (2<sup>nd</sup> edition) Prentice hall of India Limited
10. Postgate John, R. 1975. The physiology and genetics of Nitrogen fixation, Plenum, Press, London
11. Postgate John, R. 1982. the fundamentals of Nitrogen fixation, Cambridge Univ., Press, Cambridge.
12. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4<sup>th</sup> edition). Wordsworth Publishing Company, California, USA

13. Subba Rao, N.S. 1979. recent Advances in Biological Nitrogen Fixation, Pub., Oxford&IBH publishing Co., New delhi
14. Stryer, L. 1995. Biochemistry 4<sup>th</sup> Edition, W.H. Freeman, New York
15. Taiz, L. and Zeiger, E. 1998. Plant Physiology (2<sup>nd</sup> edition). Sinauer Associates including Publishers, Massachusetts, USA
16. Stumpt, P.K. and Conn, E.E. 1980. BiOochemistry of Plants . Lipids, Vol-4, Acad., Press, New York.
17. Wilkins, M.D. 1987. Advanced Plant Physiology. English Language Book Society, Longman
18. Wisthoff, P. 1998. Molecular Plant Development from Gene to Plant. Oxford University Press, Oxford, UK
19. Govindjee, ed. 1982-83. *Photosynthesis*. Vol. I & II. Academic Press Inc. New York
20. Dennis, D.T. D. B. Layzell, D. D. Lefebyre & D. Turpin. 1997. *Plant Metabolism*. 2nd Ed. Addison- Wesely Pub Co. New York.
21. Raghavendra, S.. 1988. *Photosynthesis; A Comprehensive Treatise*. Cambridge University Press, Cambridge, U. K.

## **PAPER CODE: 405: GENETIC ENGINEERING OF PLANTS AND MICROBES**

### **Suggested Laboratory Exercises**

1. Isolation of plasmid DNA
2. Bacterial transformation and identification of transformation
3. Restriction enzyme digestion and gel electrophoresis
4. Genetic engineering assignments

## **PAPER CODE: 406: EVOLUTION AND PLANT BREEDING**

### **Suggested Laboratory Exercises:**

1. Assignment containing problems on topics mentioned in the theory syllabus.
2. Floral biology
3. Pollination mechanisms
4. Vegetative propagation techniques
  - a) Cutting b) Layering c) Budding d) Grafting
5. Breeding techniques of Rice, Maize, Sorghum, Bajra, Brassica, Chilli and Solanum

## **PAPER CODE: 407: ENVIRONMENTAL BIOLOGY AND BIODIVERSITY**

### **Suggested Laboratory Exercises**

1. Ombrotherms and Climatograms
2. Analyses of water and soil physico-chemical characteristics
3. Estimation of Chlorophyll content in control and polluted sites
4. Determination of plant diversity among different forest areas studied
5. Assignments on Biodiversity
6. To estimate rate of Carbon dioxide evolution from different soils using soda lime or alkali absorption method
7. Scientific visits:  
A protected areas or Biosphere reserve or national park or sanctuary  
A wetland, Mangrove, NBPGR (National Bureau of Plant Genetic Resources – New Delhi); BSI, CSIR Laboratories, FRI and Tropical Botanical Gardens

## **PAPER CODE: 408: PLANT METABOLISM**

### **Suggested Laboratory Exercises**

1. Determination of amylase activity
2. Extraction and separation of chloroplast pigments by paper chromatographic method
3. Determine chlorophyll a / chlorophyll b contents in C<sub>3</sub> and C<sub>4</sub> plants by spectrophotometric method
4. Determination of catalase activity
5. Demonstration of Polyphenol oxidase
6. Determination of reducing sugars
7. Estimation of free acids in *Bryophyllum* in terms of milliequivalents of NaOH
8. Extraction and estimation of seed proteins depending upon the solubility
9. SDS – PAGE for soluble proteins extracted from the given plant materials
10. Separation of amino acids and carbohydrates through two dimensional chromatographic method

**Model Paper**  
**M.Sc., Botany: Semester – I**  
**PAPER CODE: 101: CRYPTOGAMS AND GYMNOSPERMS**  
(With Effective from 2019-2020 Admitted Batch)

Time: Three Hours

Maximum Marks: 75

**SECTION – A**

Answer ALL questions

(15X4 = 60 Marks)

1. (a) Elaborate on the thallus diversity in Algae.  
OR  
(b) Criteria used in classification of Algae with special reference to Fritsch classification  
OR
2. (a) Detail the development of Antheridium, Archegonium in the order Anthocerotopsida.  
OR  
(b) Evolution of Sporophyte in Bryophytes.
3. (a) Describe salient features and classification of Pteridophyta  
OR  
(b) Discuss the significance of Heterospory and seed habit.  
OR
4. (a) Give an account of Bennettitales.  
OR  
(b) Give an account on structure and reproduction of Gnetales.

**SECTION – B**

Answer any FIVE

(5x3 =15 Marks)

5. Economic importance of algae
6. Carposporophyte
7. Protonema
8. Thallus types in Marchantiales
9. Stele in Pteridophytes
10. Economic importance of pteridophytes
11. Geological periods
12. Cordaites

**Model Paper**  
**M.Sc Botany Semester I**  
**PAPER CODE 102 : MICROBIOLOGY**  
(With effective from the Admitted batch of 2019-20)

**Time: Three Hours**

**Maximum Marks: 75**

**Section – A**

Answer **ALL** Questions

(15 × 4 = 60 Marks)

1. (a). Give an account on Archae and Cyanobacteria.  
Or  
(b). Discuss the cell wall walls of Bacteria and fungi.
2. (a). Write an account on microbial growth kinetics.  
Or  
(b). Give an account on nutritional requirements of microbes with emphasis on nutrition in fungi.
3. (a). Give an account on reproduction in bacteria.  
Or  
(b). Reproduction in fungi.  
Or
4. (a). Give an account on Plant-microbe interactions.  
Or  
(b). Economic importance of microorganisms.

**Section – B**

Answer any **FIVE**

(5 × 3 = 15 Marks)

5. Phylogeny of Fungi
6. Transmission of viruses
7. Types of nutrient media
8. Synchronous culture
9. Recombination
10. Virioids and Prions
11. Biosensors
12. Fermentor

**Model Paper**  
**M.Sc., Botany: Semester – I**  
**PAPER CODE: 103: CELL BIOLOGY OF PLANTS**  
**(With effective from 2019-2020 Admitted Batch)**

**Time: Three Hours**

**Maximum Marks: 75**

**Section A**

**Answer all Questions**

**(15 x 4 = 60)**

1. (a) Describe the Non covalent interactions in relation to function of Nucleic acids and Proteins

OR

(b) Write about the structure and organization of Prokaryotic and Eukaryotic Cells.

2. (a) Give an account of different models of Plasma membrane, which model is more appropriate and why?

OR

(b) What is cytoskeleton? Explain in detail about the role of microtubules in motility and cell division.

3. (a) Write in detail about Genome organization of mitochondria and its function.

OR

(b) Give an account on structure and function of Golgi apparatus.

4. (a) Write in detail about principles, methodology and application of ESR and NMR.

OR

(b) Explain the working principles of Light Microscopy, SEM and TEM.

**Section – B**

**Answer any FIVE**

**(5 x 3 = 15 Marks)**

5. Specialized Cell types
6. Laws of Thermodynamics as applicable to biological systems
7. Structure and function of Plasmodesmata
8. Vacuole structure and function
9. Lysosomes
10. RNA editing
11. Freeze fracture Technique
12. Circular Dichroism

**Model Paper**  
**M.Sc., Botany: Semester – I**  
**PAPER 104: CYTOLOGY AND CYTOGENETICS**  
**(With effective from the Admitted batch of 2019-20)**

**Time: 3 Hrs**

**Max Marks: 75**

**Section – A**

**15 X 4 = 60**

Each question carries 15 marks.

Answer four questions, choosing ONE from each Unit

1. Explain the molecular organization of centromeres and telomeres  
**OR**
2. Give an account of chromosome banding and its applications
3. Give a brief account of chromosomal structural aberrations and explain their meiotic behavior  
**OR**
4. Elaborate on Aneuploids and their significance in human genetics
5. Give a brief account of the origin and production of autopolyploids  
**OR**
6. Give an account on molecular organization of nuclear genome
7. Write briefly about cell cycle and its regulation  
**OR**
8. Write about the mechanism of apoptosis giving its significance

**Section –B**

**5 X 3 = 15**

Each question carries 3 marks (Covering all units)

Answer any five of the following

9. Karyotype
10. Polytene chromosome
11. Robertsonian translocation
12. Trisomics
13. C value paradox
14. Arabidopsis
15. Cyclins and cdks
16. Differentiate Proto-oncogenes and Oncogenes

**Model Paper**  
**M.Sc., Botany: Semester – II**  
**PAPER CODE: 201: GENETICS**  
**(With effective from 2019-2020 Admitted batch)**

**Time: Three Hours**

**Maximum Marks: 75**

**Section A**

**15x4=60Marks**

Each question carries 15 marks.

Answer four questions, choosing ONE from each Unit

1. What are genetic markers and elaborate on their types  
**OR**
2. Explain multiple allelic inheritance and its significance
3. Write about tetrad analysis and its significance  
**OR**
4. Write an account on Recombination and its molecular mechanism
5. Detail the DNA damage and the different repair mechanisms  
**OR**
6. Describe the organization and importance of Multigene families
7. Describe the genetic basis of mitochondrial and chloroplast related characters  
**OR**
8. What are the different methods of gene mapping in bacteriophages

**Section –B**

**5 X 3 = 15**

Each question carries 3 marks (Covering all units)

Answer any five of the following

9. Chi square test
10. Penetrance and Expressivity
11. Three point test cross
12. Holliday model
13. Site directed Mutagenesis
14. Transposons
15. Maternal inheritance
16. Male sterility

**Model Paper**  
**M.Sc., Botany: Semester – II**  
**PAPER CODE: 202: MOLECULAR BIOLOGY OF PLANTS**  
**(With effective from 2019-2020 Admitted Batch)**

**Time: Three Hours**

**Maximum Marks: 75**

**SECTION – A**

**(15 x 4 = 60 Marks)**

**Answer ALL questions.**

1. (a) Describe the composition and structure of Proteins.

OR

(b) Give detailed account on composition and structure of DNA.

2. (a) Describe the mechanism of DNA Replication.

OR

(b) Explain the process and enzymes involved in Transcription and post transcription activities.

3. (a) Describe the mechanism of Translation.

OR

(b) What is meant by Protein sorting? Discuss the process of targeting of proteins into chloroplasts.

4. (a) Give a critical account on regulation of gene expression in Eukaryotes.

OR

(b) Write an essay on regulation of gene expression with special reference to Lac & Tryp operons.

**Section – B**

**Answer any FIVE**

**(5 x 3 = 15 Marks)**

5. Ramachandran plot
6. Micro RNA
7. Okazaki fragments
8. Replication of ends of Chromosomes
9. Structure of tRNA
10. Protein trafficking
11. Gene silencing
12. Lytic and Lysogenic cycle

**Model Paper**  
**M.Sc., Botany: Semester – II**  
**PAPER CODE 203: PLANT DEVELOPMENTAL BIOLOGY AND EMBRYOLOGY**  
**(With effective from the Admitted batch of 2019-20)**

Time: 3 Hrs

Max Marks: 75 Marks

Section – A

15 X 4 = 60

Each question carried 15 marks.

Answer four questions, choosing ONE from each Unit.

1. Give a concise account on plant Architecture.  
**OR**
2. Write an account on development and organization of root apex and different theories related to root apex.
3. Write in detail about SAM and its cytological and molecular aspects.  
**OR**
4. Explain the origin and mechanism of differentiation of epidermis and mesophyll.
5. Write an essay on the ultra structure of Tapetum and its functions.  
**OR**
6. Describe about development and Organization of the mature Embryo sac.
7. Write in detail about double fertilization and triple fusion.  
**OR**
8. Discuss about Polyembryony and mention its practical applications.

Section –B

5 X 3 = 15

Each question carries 3 marks (Covering all units)

Answer any five of the following

9. Plant cell division
10. Root hair
11. Bulliform cells
12. Anatomy of Flower
13. Microsporogenesis
14. Epistase
15. SSI
16. Monocot embryo

**Model Paper**  
**M.Sc Botany Semester II**  
**PAPER CODE 204: MOLECULAR PLANT PATHOLOGY**  
**(With effective from the Admitted batch of 2019-20)**

**Time: Three Hours**

**Maximum Marks: 75**

**Section – A**

Answer **ALL** Questions

(15 × 4 = 60 Marks)

1. (a). Give an account on causal agents of plant diseases  
Or  
(b). Discuss the process of colonization of pathogen in host
2. (a). Describe Host-Pathogen interactions  
Or  
(b). Discuss the physiological changes in plants
3. (a). Give an account on viral diseases of plants  
Or  
(b). Discuss symptoms, etiology, epidemiology and control measures of any one of the fungal diseases that you have studied.
4. (a). Give an account on transgenic and genetic manipulation approaches in plant disease management.  
Or  
(b). Discuss plant disease management

**Section – B**

Answer any **FIVE**

(5 × 3 = 15 Marks)

5. Koch Postulates
6. Phytoplasmas
7. Phytoalexins
8. Disease signaling in plants
9. Citrus canker
10. Club root of Crucifers
11. IPM
12. Role of bioinformatics in plant pathology

**Model Paper**  
**M. Sc Botany Semester III**  
**PAPER CODE 301: TAXONOMY OF ANGIOSPERMS AND PLANT RESOURCE**  
**UTILISATION**

(With effective from the Admitted batch of 2019-20)

**Maximum Marks: 75**

**Time : Three Hours**

**Section A**

**Answer all Questions**

**15x4=60**

1. (a). Discuss the different Species Concept  
(OR)  
(b). Give an account of International Code of Nomenclature
2. (a). What is APG System of classification. Discuss about its significance  
(OR)  
(b). Discuss Cronquist's classification with its merits and demerits
3. (a). Elaborate on the evolutionary tendencies in Tubiflorae  
(OR)  
(b). Discuss on the role of Phytochemistry in Taxonomy
4. (a). Explain the origin, evolution and cultivation of Rice  
(OR)  
(b). Give an account of cultivation practices in oil yielding crops with an example

**Section B**

**Answer any Five**

**5x3=15**

5. Taxonomic hierarchies
6. Nomenclature
7. Cladistic analysis
8.  $\alpha$ -Taxonomy
9. Amentiferae
10. Microanatomy
11. Indian Cotton
12. Withania

**Model Paper**  
**M.Sc., Botany: Semester – III**  
**PAPER CODE 302: *IN VITRO* PLANT BIOLOGY**  
**(With effective from the Admitted batch of 2019-20)**

Time: 3 Hrs

Max Marks: 75 Marks

Section – A

15 X 4 = 60

Each question carried 15 marks

Answer four questions, choosing ONE from each Unit.

1. Give an account on various plant growth hormones and their role in plant growth and development.

**OR**

2. What is sterilization? Explain different types of sterilization methods.
3. What is somatic embryogenesis? Describe the various sources of formation of somatic embryos and add a note on the factors affecting it.

**OR**

4. Describe the methods of Androgenic and Gynogenic haploid production.
5. Describe various methods used for culture and growth of single cell.

**OR**

6. Define somatic hybridization. Enumerate achievements, limitations, merits and demerits of protoplast fusion studies.
7. Elucidate the method of clonal propagation and give its importance.

**OR**

8. Give an account of Somaclonal variations and its applications.

Section –B

5 X 3 = 15

Each question carries 3 marks (Covering all units)

Answer any five of the following

9. Totipotency
10. Basic concepts of tissue culture
11. Organogenesis
12. Embryo rescue
13. Plating efficiency
14. Secondary metabolites
15. Artificial seeds
16. Germplasm of conservation

**Model Paper**  
**M. Sc Botany Semester III**  
**PAPER CODE 303: ECOLOGY AND PHYTOGEOGRAPHY**  
**(With effective from the Admitted batch of 2019-20)**

Time: 3 Hrs

Max Marks: 75

Section – A

15 X 4 = 60

Each question carries 15 marks.

Answer four questions, choosing ONE from each Unit

1. Detail the Population structure and characteristics

**OR**

2. What is species interactions. Enumerate the different types

3. What are different quantitative characters used to characterize a plant community

**OR**

4. Discuss the different methods employed to study a plant community

5. Give a brief account of structure and function of an Ecosystem

**OR**

6. Discuss the importance of Bio-geochemical cycles with the help of two edaphic elements

7. Give a detailed account of the basic Principles of Phytogeography

**OR**

8. Give an account of Major Biomes of the World

Section –B

5 X 3 = 15

Each question carries 3 marks (Covering all units)

Answer any five of the following

9. Concepts of Ecology

10. Biotic potential

11. Clements' classification of community

12. Biological spectrum

13. Ecological productivity

14. Litter fall and decomposition

15. Continental drift

16. Floristic regions

**Model Paper**  
**M. Sc Botany Semester III**  
**PAPER CODE 304: PLANT PHYSIOLOGY**  
**(With effective from the Admitted batch of 2019-20)**

**Maximum Marks: 75**

**Time : Three Hours**

**Section A**

**Answer all Questions**

**(15 x 4 = 60)**

1. (a) Write a detected account on SPAC.

OR

- (b) Describe the mechanism of Mineral ion uptake by plants.

2. (a) What is Phyto chrome? Discuss its structure and role in the physiology of flowering.

OR

- (b) Describe the types of Seed dormancy and its relieving methods.

3. (a) Describe the biosynthesis of Gibberellins and their physiological effects in plants.

OR

- (b) What is Brassinosteroid? Discuss the biosynthetic pathway of Brassinosteroids.

4. (a) Different Biotic and abiotic stress and explain the effects of various stresses on morphological, anatomical and bio chemical changes in plants.

OR

- (b) What are plant responses to Water stress? Explain the mechanisms of drought tolerance in plants.

**SECTION B**

**Answer any FIVE**

**(5 x 3 = 15 Marks)**

5. Stomatal physiology.
6. Root microbe interactions.
7. Photoperiodism.
8. Vernalization.
9. Elicitors
10. Hormone receptors
11. Heat stress
12. Salinity stress

**Model Paper**  
**M. Sc Botany Semester IV**  
**PAPER CODE 401: GENETIC ENGINEERING OF PLANTS AND MICROBES**  
**(With effective from the Admitted batch of 2019-20)**

**Maximum Marks: 75**

**Time : Three Hours**  
**Section A**

**Answer all Questions**

**15x4=60**

1. (a) What are Restriction enzymes? What is their role in rDNA technology?  

OR

What is Bacterial transformation? Discuss how to recognize transformation.
2. (a) Distinguish between Northern and Southern blotting techniques.  

OR

Write down the types and applications of PCR techniques.
3. (a) What is Microarray Technique? Explain the principles and applications.  

OR

(b) Describe the methods of Gene transfer in plants.
4. (a) What are Transgenic plants? Discuss the Fungal and Insect tolerant transgenic.  

OR

(b). Give an account of applications of Bioinformatics in Genetic Engineering and their importance.

**Section – B**

**Answer any Five**

**(5 x 3 = 15 Marks)**

5. BAC s
6. cDNA LIBRARY
7. FISH
8. Basic principle of Sangers method
9. RFLP
10. Chloroplast transformation.
11. Barnase – Barstar
12. Golden Rice

**Model Paper**  
**M. Sc Botany Semester IV**  
**Paper code 402: EVOLUTION AND PLANT BREEDING**  
**(With effective from the Admitted batch of 2019-20)**

Time: 3 Hrs  
Section – A

Max Marks: 75 Marks  
15 X 4 = 60

Each question carried 15 marks.

Answer four questions, choosing ONE from each Unit.

1. Describe the concepts of origin of life  
**OR**
2. What is natural selection? Discuss
3. Write in detail about Hrdy- Weinberg law  
**OR**
4. Discuss about isolation mechanisms and their role in speciation.
5. Explain molecular evolution  
**OR**
6. Correlate heterosis and hybrid vigour in plants.
7. Differentiate between Binomial and Normal distribution with sample data.  
**OR**
8. Give an account on types of errors and levels of significance.

Section –B

5 X 3 = 15

Each question carries 3 marks (Covering all units)

Answer any five of the following

9. Oparin and Haldane concept
10. Neo Darwinism
11. Genetic drift
12. Co evolution
13. Molecular clocks
14. Back cross method
15.  $X^2$  test
16. ANOVA

**Model Paper**  
**M. Sc Botany Semester IV**  
**PAPER CODE 403: ENVIRONMENTAL BIOLOGY AND BIODIVERSITY**  
**(With effective from the Admitted batch of 2019-20)**

Time: 3 Hrs

Max Marks: 75

Section – A

15 X 4 = 60

Each question carries 15 marks.

Answer four questions, choosing ONE from each Unit

1. Discuss on the impact of Ecological perturbations on plants and ecosystem  
**OR**
2. Role of Green house gases in Climate change
3. Elaborate on the factors affecting soil formation  
**OR**
4. Enumerate the types and sources of Pollution and its effect on Ecosystem
5. Define biodiversity and discuss on the importance of its studies  
**OR**
6. Discuss about the World centres of domesticated plants
7. Distinguish between the different strategies of Conservation  
**OR**
8. Illustrate the principles of Remote sensing and its application in biodiversity conservation

Section –B

5 X 3 = 15

Each question carries 3 marks (Covering all units)

Answer any five of the following

9. Environmental Impact Assessment
10. Climate classification
11. Humus
12. Water Pollution
13. Hot spots
14. IUCN Categories of threat
15. BSI
16. Sustainable Development

**Model Paper**  
**M. Sc Botany Semester IV**  
**PAPER CODE 404: PLANT METABOLISM**  
**(With effective from the Admitted batch of 2019-20)**

**Time : Three Hours**

**Maximum Marks: 75**

**SECTION – A**

Answer ALL questions

(15x4 = 60 Marks)

1. (a) Describe Michaelis – Menten equation and Write down its significance.  
OR  
(b) Write about signal transduction in higher plants.
2. (a) Describe the mechanisms of electron and proton transport structure, synthesis & function of ATP.  
OR  
(b) Write a detailed account on C3, C4 and CAM plants in relation to physiological and Ecological considerations
3. (a) Describe Glycolysis and TCA cycle.  
OR  
(b) Give an account on structure & function of storage and membrane lipids.
4. (a) What is diazotrophication and write a detailed account on symbiotic Nitrogen fixation.  
OR  
(b) Describe the mechanism of sulphate uptake, transport and assimilation.

**Section – B**

Answer any FIVE

(5 x 3 = 15 Marks)

5. Allosteric enzymes
6. Calcium – Calmodulin cascade.
7. Photosynthetic pigmentation.
8. Photo oxidation of water.
9. Pentose phosphate pathway.
10. Structural lipids.
11. Biosynthesis of Amino Acids.
12. Nod factors