DEPARTMENT OF B.SC BOTANY

1	B.SC	MICROBIAL DIVERSITY AND LOWER PLANTS
2	B.SC	PLANT ANATOMY AND EMBRYOLOGY

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B.Sc., BOTANY

First Year, I -Semester

Paper-I

Microbial Diversity and Lower Plants

DSC - 1A (4 hrs./week) **Credits- 4**

Theory Syllabus **(60 hours)**

UNIT – I **(15 hours)**

1) **Bacteria**: Structure, nutrition, reproduction and economic importance. Brief account of Archaebacteria, Actinomycetes and Mycoplasma with reference to little leaf of Brinjal and Papaya leaf curl

2) **Viruses**: Structure, replication and transmission; plant diseases caused by viruses and their control with reference to Tobacco Mosaic and Rice Tungro.

3) An outline of plant diseases of important crop plants caused by bacteria and their control with reference to Angular leaf spot of cotton and Bacterial blight of Rice.

UNIT-II **(15 hours)**

1) General characters, structure, reproduction and classification of algae (Fritsch)

2) **Cyanobacteria**: General characters, cell structure their significance as biofertilizers with special reference to Oscillatoria, Nostoc and Anabaena.

3) Structure and reproduction of the following:
Chlorophyceae- Volvox, Oedogonium and Chara.
Phaeophyceae- Ectocarpus
Rhodophyceae- Polysiphonia.

UNIT-III **(15 hours)**

1) General characters and classification of fungi (Ainsworth).

2) Structure and reproduction of the following:
   (a) Mastigimycotina- Albugo
   (b) Zygomycotina- Mucor
   (c) Ascomycotina- Saccharomyces and Penicillium.
   (d) Basidiomycotina- Puccinia
   (e) Deuteromycotina- Cercospora.

3) Economic importance of lichens

UNIT-IV **(15 hours)**

1) **Bryophytes:** Structure, reproduction, life cycle and systematic position of Marchantia, Anthoceros and Polytrichum, Evolution of Sporophyte in Bryophytes.

2) **Pteridophytes**: Structure, reproduction, life cycle and systematic position of Rhynia, Lycopodium, Equisetum and Marsilea.

3) Stelar evolution, heterospory and seed habit in Pteridophytes.

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References:

1) Alexopolous, J. and W. M. Charles. 1988. Introduction to Mycology. Wiley Eastern, New Delhi.
2) Mckane, L. and K. Judy. 1996. Microbiology – Essentials and Applications. McGraw Hill, New York.
3) Pandey, B. P. 2001. College Botany, Vol. I: Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S. Chand & Company Ltd, New Delhi.
4) Pandey, B. P. 2007. Botany for Degree Students: Diversity of Microbes, Cryptogams, Cell Biology and Genetics. S. Chand & Company Ltd, New Delhi.
5) Sambamurthy, A. V. S. S. 2006. A Textbook of Plant Pathology. I. K. International Pvt. Ltd., New Delhi.
6) Sambamurthy, A. V. S. S. 2006. A Textbook of Algae. I. K. International Pvt. Ltd., New Delhi.
7) Sharma, O. P. 1992. Textbook of Thallophyta. McGraw Hill Publishing Co., New Delhi.
8) Thakur, A. K. and S. K. Bassi. 2008. A Textbook of Botany: Diversity of Microbes and Cryptogams. S. Chand & Company Ltd, New Delhi.
9) Vashishta, B. R., A. K. Sinha and V. P. Singh. 2008. Botany for Degree Students: Algae. S. Chand& Company Ltd, New Delhi.
10) Vashishta, B. R. 1990. Botany for Degree Students: Fungi, S. Chand & Company Ltd, New Delhi.
11) Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
12) Watson, E. V. 1974. The structure and life of Bryophytes, B. I. Publications, New Delhi.
13) Pandey, B. P. 2006. College Botany, Vol. II: Pteridophyta, Gymnosperms and Palcobotany. S. Chand & Company Ltd, New Delhi.
14) Vashishta, P. C., A. K. Sinha and Anil Kumar. 2006. Botany - Pteridophyta (Vascular Cryptogams). . Chand & Company Ltd, New Delhi.
15) Pandey, B. P. 2001. College Botany, Vol. I: Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S. Chand & Company Ltd, New Delhi.
16) Pandey, B. P. 2007. Botany for Degree Students: Diversity of Microbes, Cryptogams, Cell Biology and Genetics. S. Chand & Company Ltd, New Delhi.
17) Thakur, A. K. and S. K. Bassi. 2008. A Textbook of Botany: Diversity of Microbes and Cryptogams. S. Chand & Company Ltd, New Delhi.
18) Vashishta, B. R., A. K. Sinha and Adarsha Kumar. 2008. Botany for Degree Students: Bryophyta. S. Chand & Company Ltd, New Delhi.

Practical Syllabus (45 hours)

1. Study of viruses and bacteria using electron micrographs (photographs).
2. Gram staining of Bacteria.
3. Study of symptoms of plant diseases caused by viruses, bacteria, Mycoplasma and fungi:
   Viruses: Tobacco mosaic
   Bacteria: Angular leaf spot of cotton and Rice tungro.
   Mycoplasma: Little leaf of Brinjal and Leaf curl of papaya
   Fungi: White rust on Crucifers, Rust on wheat & Tikka disease of Groundnut.
4. Vegetative and reproductive structures of the following taxa:
   Algae: Oscillatoria, Nostoc, Volvox, Oedogonium,Chara ,Ectocarpus and Polysiphonia.
   Fungi: Albugo, Mucor,Saccharomyces, Penicillium, Puccinia and Cercospora
5. Section cutting of diseased material infected by Fungi and identification of pathogens as per theory syllabus. White rust of Crucifers, Rust on wheat & Tikka disease of Groundnut.
6. Lichens: Different types of thalli and their external morphology
7. Examination of important microbial, fungal and algal products:
   Biofertilizers, protein capsules, antibiotics, mushrooms, Agar-agar etc.
8. Field visits to places of algal / microbial / fungal interest (e.g. Mushroom cultivation, water bodies).
9. Study of Morphology (vegetative and reproductive structures) and anatomy of the following Bryophytes: Marchantia, Anthoceros and Polytrichum.
10. Study of Morphology (vegetative and reproductive structures) and anatomy of the following Pteridophytes: Lycopodium, Equisetum and Marsilea.
11. Study of Anatomical features of Lycopodium stem, Equisetum stem and Marsilea petiole & rhizome by preparing double stained permanent mounts.

Practical Model Paper

Max. Marks: 25

Time : 3 hrs

1. Identify the given components **'A'&'B'** in the algal mixture .
   Describe with neat labeled diagrams & give reasons for the classifications. 2 X 2 = 4M
2. Classify the given bacterial culture **'D'** using Gram – staining technique. 3M
3. Take a thin transverse section of given diseased material **'E'**.
   Identify & describe the symptoms caused by the pathogen. 4M
4. Identify the given specimens **'F', 'G' & 'H'** by giving reasons .
   (Fungal-1, Bacteria-1 & Viral-1) 3 X 1 = 3M
5. Comment on the given slides **'I' & 'J'** (Algae-1, Fungi-1) 2 X 2 = 4M
6. Identify the given specimen **'K' &** slide **'L'** (Bryophytes & Pteridophytes) 2 X 2 = 4M
7. Record 3M

B.Sc., BOTANY

First Year, II -Semester

Paper-II
Gymnosperms, Taxonomy of Angiosperms and Ecology

DSC-1B **Credits-4**

Theory Syllabus

UNIT-I

1) Gymnosperms: General characters, structure, reproduction and classification (Sporne's). Distribution and economic importance of Gymnosperms.
2) Morphology of vegetative and reproductive parts, systematic position and life cycle of Pinus and Gnetum,
3) Geological time scale Introduction to Palaeobotany, Types of fossils and fossilization, Importance of fossils.

(15 hours)

UNIT-II

1) Introduction: Principles of plant 4ystematic, Types of classification: Artificial, Natural and Phylogenetic; Systems of classification: Salient features and comparative account of Bentham & Hooker and Engler & Prantl classification systems. An introduction to Angiosperm Phylogeny Group (APG).
2) Current concepts in Angiosperm Taxonomy: Embryology in relation to taxonomy Cytotaxonomy, Chemotaxonomy and Numerical Taxonomy.
3) Nomenclature and Taxonomic resources: An introduction to ICN, Shenzhen code – a brief account. Herbarium: Concept, techniques and applications.

(15 hours)

UNIT-III

1) Systematic study and economic importance of plants belonging to the following families: Polypetalae Annonaceae, Capparidaceae, Rutaceae, Fabaceae (Faboideae/Papilionoideae, Caesalpinioideae, Mimosoideae), Cucurbitaceae
2) Gamopetalae: Apiaceae, Asteraceae, Asclepiadaceae, Lamiaceae, Monochalmydeae: Amaranthaceae, Euphorbiaceae
3) Monocotyledons: Orchidaceae, Poaceae and Zingeberaceae.

(15 hours)

UNIT-IV

1. Component of eco system, energy flow, food chain and food webs.
2. Plants and environment, ecological adaptations of plants, Hydrophytes, Xerophytes and Mesophytes
3. Plant Succession serial stages, modification of environment, climax formation with reference to Hydrosere and Xerosere.

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Practical Syllabus (45 hours)

1. Study of viruses and bacteria using electron micrographs (photographs).
2. Gram staining of Bacteria.
3. Study of symptoms of plant diseases caused by viruses, bacteria, Mycoplasma and fungi:
   Viruses: Tobacco mosaic
   Bacteria: Angular leaf spot of cotton and Rice tungro.
   Mycoplasma: Little leaf of Brinjal and Leaf curl of papaya
   Fungi: White rust on Crucifers, Rust on wheat & Tikka disease of Groundnut.
4. Vegetative and reproductive structures of the following taxa:
   Algae: Oscillatoria, Nostoc, Volvox, Oedogonium,Chara ,Ectocarpus and Polysiphonia.
   Fungi: Albugo, Mucor,Saccharomyces, Penicillium, Puccinia and Cercospora
5. Section cutting of diseased material infected by Fungi and identification of pathogens as per theory syllabus. White rust of Crucifers, Rust on wheat & Tikka disease of Groundnut.
6. Lichens: Different types of thalli and their external morphology
7. Examination of important microbial, fungal and algal products:
   Biofertilizers, protein capsules, antibiotics, mushrooms, Agar-agar etc.
8. Field visits to places of algal / microbial / fungal interest (e.g. Mushroom cultivation, water bodies).
9. Study of Morphology (vegetative and reproductive structures) and anatomy of the following
   Bryophytes: Marchantia, Anthoceros and Polytrichum.
10. Study of Morphology (vegetative and reproductive structures) and anatomy of the following
    Pteridophytes: Lycopodium, Equisetum and Marsilea.
11. Study of Anatomical features of Lycopodium stem, Equisetum stem and Marsilea petiole & rhizome by preparing double stained permanent mounts.

Practical Model Paper

Max. Marks: 25

Time ; 3 hrs

1. Identify the given components **'A'&'B'** in the algal mixture .
   Describe with neat labeled diagrams & give reasons for the classifications. 2 X 2 = 4M
2. Classify the given bacterial culture **'D'** using Gram – staining technique. 3M
3. Take a thin transverse section of given diseased material **'E'**.
   Identify & describe the symptoms caused by the pathogen. 4M
4. Identify the given specimens **'F', 'G' & 'H'** by giving reasons .
   (Fungal-1, Bacteria-1 & Viral-1) 3 X 1 = 3M
5. Comment on the given slides **'I' & 'J'** (Algae-1, Fungi-1) 2 X 2 = 4M
6. Identify the given specimen **'K' &** slide **'L'** (Bryophytes & Pteridophytes) 2 X 2 = 4M
7. Record 3M

References:

1. Watson, E. V. 1974. The structure and life of Bryophytes, B. I. Publications, New Delhi.
2. Pandey, B. P. 2006. College Botany, Vol. II: Pteridophyta, Gymnosperms and Paleobotany. S. Chand & Company Ltd, New Delhi.
3. Sporne, K. R. 1965. Morphology of Gymnosperms. Hutchinson Co., Ltd., London.
4. Vashishta, P. C., A. K. Sinha and Anil Kumar. 2006. Botany - Pteridophyta (Vascular Cryptogams). . Chand & Company Ltd, New Delhi.
5. Pandey, B. P. 2001. College Botany, Vol. I: Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S. Chand & Company Ltd, New Delhi.
6. Pandey, B. P. 2007. Botany for Degree Students: Diversity of Microbes, Cryptogams, Cell Biology and Genetics. S. Chand & Company Ltd, New Delhi.
7. Thakur, A. K. and S. K. Bassi. 2008. A Textbook of Botany: Diversity of Microbes and Cryptogams. S. Chand & Company Ltd, New Delhi.
8. Vashishta, B. R., A. K. Sinha and Adarsha Kumar. 2008. Botany for Degree Students: Bryophyta. S. Chand & Company Ltd, New Delhi.
9. Vashishta, P. C., A. K. Sinha and Anil Kumar. 2006. Botany for Degree Students: Gymnosperms. Chand & Company Ltd, New Delhi.
10. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
11. Pandey, B. P. 2007. Botany for Degree Students: Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd, New Delhi
12. Stace, C. A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London.
13. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.
14. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
15. Davis, P. H. and V. H. Heywood. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
16. Heywood, V. H. 1965 . Plant Taxonomy. ELBS , London.
17. Heywood, V. H. and D. M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
18. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge. London.
19. Michael, S. 1996, Ecology, Oxford University Press, London
20. Odum, E.P. 1983. Basics of Ecology, Saunder's International Students Edition, Philadelphia.
21. Sharma P.D. 1989. Elements of Ecology, Rastogi Publications, Meerut

Practical Syllabus (45 hours)

1. Study of Morphology (vegetative and reproductive structures) of the following taxa:
   Gymnosperms - Pinus and Gnetum.
2. Study of Anatomical features of Pinus needle and Gnetum stem by preparing double stained permanent mounts.
3. Fossil forms using permanent slides / photographs: Cycadeoidea.
   Systematic study of locally available plants belonging to the families prescribed in theory Syllabus (Minimum of one plant representative for each family)
4. Study of morphological and anatomical characteristics of locally available plant species (Eichhorinia, Hydrilla, Pistia, Nymphaea, Asparagus, Opuntia, Euphorbia melii)
5. Demonstration of herbarium techniques.
6. Candidate has to submit at least 30 herbarium sheets.

Practical Model Paper

Time : 3 hrs **Max. Marks: 50**

1. Prepare a mount of the given material ' **A** ' (Hydrophytes /Xerophytes)
   Draw diagram & give reasons for identification. 8M
2. Prepare a double stained permanent mount of the given material ' **B** ' (Gymnosperms)
   Draw diagram & give reasons for identification. 10M
3. Identify the given specimens **C & D** (Gymnosperms /Xerophytes) 2 X 4 =8M
4. Identify the given slides **E&F** (Gymnosperms /Xerophytes) 2 X 4 =8M
5. Technical description of the given plant twig ' A ' 10M
6. Herbarium 3M
7. Record 3M

KAKATIYA UNIVERSITY - WARANGAL - TELANGANA
Under Graduate Courses (Under CBCS 2020 – 2021 onwards)
B.Sc. BOTANY II Year
SEMESTER – III

PLANT ANATOMY AND EMBRYOLOGY

Theory:	4 Hours/Week;	Credits: 4	Marks: 100 (Internal: 20; External: 80)
Practical:	3 Hours/Week	Credits: 1	Marks: 25

UNIT – I

Meristems: Types, histological organization of shoot and root apices and theories.

1. Tissues and Tissue Systems: Simple, complex and special tissues.
2. Leaf: Ontogeny, diversity of internal structure; stomata and epidermal outgrowths.

UNIT –II

4. Stem and root anatomy: Vascular cambium - Formation and function.
5. Anomalous secondary growth of Stem -*Achyranthes, Boerhaavia, Bignonia, Dracaena;* Root— *Beta vulgaris.*
6. Wood structure: General account. Study of local timbers — Teak *(Tectona grandis),* Rosewood, *(Dalbergia latefolia),* Red sanders, *(Pterocarpus santalinus)* Nallamaddi *(Terminalia tomentosa)* and Neem *(Azadirachta indica).*

UNIT-III

7. History and importance of Embryology.
8. Another structure, Microsporogenesis and development of male gametophyte.
9. Ovule structure and types; Megasporogenesis; types and development of female gametophyte.

UNIT- IV

10. Pollen morphology, pollination and fertilization, Pollination Types, Pollen - pistil interaction, Double fertilization.
11. Seed - structure appendages and dispersal mechanisms.
12. Endosperm - Development and types. Embryo - development and types; Polyembryony and Apomixis -- an outline.

References:

1. Bhattacharya et. al. 2007. A textbook of Palynology, Central, New Delhi.
2. Bhojwani, S. S. and S. P. Bhatnagar. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, Delhi.
3. M.R.Saxena- A textbook of Palynology.
4. Vashista- A textbook of Anatomy.
5. P.K.K.Nair- A textbook of Palynology.
6. Esau, K. 1971. Anatomy of Seed Plants. John Wiley and Son, USA.
7. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verleg, Berlin.
8. Kapil, R. P. 1986. Pollination Biology. Inter India Publishers, New Delhi.
9. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London.
10. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press

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B.Sc. BOTANY II Year
SEMESTER – III

PLANT ANATOMY AND EMBRYOLOGY
PRACTICAL

1. Demonstration of double stain technique.
2. Preparation of double stained Permanent slides

   Primary structure: Root - *Cicer, Canna;* Stem — *Tridax, Sorghum*

   Secondary structure: Root — *Tridax* sp.; Stem —*Pongarnia*

   Anomalous secondary structure:

   Stem: *Achyranthes, Boerhavia, Bignonia, Dracaena*

   Root*: Beta vulgaris*
3. Stomatal types using epidermal peels (Dicots).
4. Structure of anther and microsporogenesis using permanent slides.
5. Structure of pollen grains using whole mounts - *Hibiscus, Acacia* and Grass).
6. Pollen viability test using Evans Blue — *Hibiscus*
7. Study of ovule types and developmental stages of embryo sac.
8. Structure of endosperm (nuclear and cellular); Developmental stages of dicot and monocot embryos using permanent slides.
9. Isolation and mounting of embryo (using *Cymopsis / Senna / Crotalaria)*

KAKATIYA UNIVERSITY - WARANGAL - TELANGANA

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B.Sc. BOTANY II Year

SEMESTER – IV

CELL BIOLOGY AND PLANT PHYSIOLOGY

Theory: 4 Hours/Week Credits: 4 Marks: 100 (Internal: 20; External: 80)
Practical: 3 Hours/Week Credits: 1 Marks: 25

UNIT I: Plant cell envelops: Ultra structure of cell wall, molecular organization of cell membranes.

1. Models of membrane structure, Functions, fluidity and Selective permeability of the membranes.
2. Cell Organelles: Structure and semiautonomous nature of Mitochondria and Chloroplast.
3. Structure and role of endoplamic reticulum, ribosomes, golgi complex, lysosomes, peroxisomes and glyoxisomes.

UNIT-II

Nucleus: Ultra structure, types and functions of DNA & RNA.

4. Chromosomes: Morphology, organization of DNA in a chromosome, Euchromatin and Heterochromatin, Karyotype. Special types of chromosomes: Lampbrush and Polytene chromosomes.
5. Extra nuclear genome: Mitochondrial DNA and Plastid DNA.. Plasmids.
8. Cell division: Cell and its regulation; mitosis, meiosis and their significance

UNIT- III

9. Plant -Water Relations: Physical properties of water, diffusion, imbibitions, osmosis; osmotic and pressure Potential, absorption and transport of water.
10. Mineral Nutrition: Essential macro and micro mineral nutrients, and symptoms of mineral deficiency.
11. Transpiration; Stomatal structure and movement. Mechanism of phloem transport. Mechanism of phloem transport.
12. Enzymes: Nomenclature, Characteristics, Classification and factors regulating enzyme activity.

UNIT- IV

13. Photosynthesis: Photosynthetic pigments, Mechanism of photosynthetic electron transport and evolution of oxygen, Photophosphorylation . Carbon assimilation pathways: C3, C4 and CAM.
14. Respiration: Aerobic and Anaerobic; Glycolysis, Krebs cycle and electron transport system.
15. Nitrogen Metabolism: Biological nitrogen fixation
16. Physiological effects of Phytohormones: Auxins, gibberellins, cytokinins, ABA, ethylene and Brassinosteroids

References:

1. Sharma, A. K. and A. Sharma. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering. Harward Academic Publishers, Australia.
2. Shukla, R. S. and P. S. Chandel. 2007. Cytogenetics, Evolution, Biostatistics and Plant Breeding. S.Chand & Company Ltd., New Delhi.
3. Verma, P. S. and V. K. Agrawal. 2004. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd., New Delhi. 1. Hopkins, W. G. 1995.
4. Introduction to Plant Physiology. John Wiley & Sons Inc., New York, USA
5. Jain, J.L., S. Jain and Nitin Jain. 2008. Fundamentals of Biochemistry. S. Chand & Company Ltd., New Delhi.
6. Pandey, B. P. 2007. Botany for Degree Students: Plant Physiology, Biochemistry, Biotechnology, Ecology and Utilization of Plants. S. Chand & Company Ltd., New Delhi.
7. Salisbury, F. B. and C. W. Ross. 1992. Plant Physiology. 4th edn. (India Edition), Wordsworth, Thomson Learning Inc.,USA.
8. Taiz, L. and E. Zeiger. 1998. Plant Physiology (2nd Ed.). Sinauer Associates, Inc., Publishers, Massachusetts, USA.
9. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.

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B.Sc. BOTANY II Year

SEMESTER – IV

CELL BIOLOGY AND PLANT PHYSIOLOGY PRACTICAL

1. Demonstration of cytochemical methods: Fixation of plant material and nuclear staining for mitotic and meiotic studies.
2. Study of various stages of mitosis using cytological preparation of Onion root tips.
3. Study of various stages of meiosis using cytological preparation of onion flower buds.
4. Study of ultra structure of cell organelles using photographs. Chloroplast, Mitochondria, Nucleus, Ribosomes, Endoplasmic reticulum and Golgi complex.
5. Study of Special types of Chromosomes (Polytene chromosome and Lampbrush chromosomes-Permanent slide) ✓
6. Determination of osmotic potential of vacuolar sap by Plasmolytic method using leaves of *Rheodiscolor / Tradescantia.*
7. Determinion of rate of transpiration using Cobalt chloride method
8. Determination of stomatal frequency using leaf epidermal peelings / impressions
9. Determination of catalase activity using potato tubers by titration method
10. Separation of chloroplast pigments using paper chromatography technique
11. Estimation of protein by Biurette method
12. Mineral deficiency- Detail study of Micronutrients and Macro nutrients
13. Identification of C_3,C_4 and CAM plants.

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KAKATIYA UNIVERSITY - WARANGAL - TELANGANA

UNDER GRADUATE COURSES (UNDER CBCS 2021 – 2022 ONWARDS)

B.SC. BOTANY III YEAR

SEMESTER – V

PAPER – V: (A) BIODIVERSITY & CONSERVATION

(DSE-1: ELECTIVE)

Theory: 4 Hours/Week; Credits: 4 Marks: 100 (Internal: 20; External: 80)

Practical 3 Hours/Week Credits: 1 Marks: 25

UNIT – I

1. Plant diversity and its scope: Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agro biodiversity and cultivated plant taxa, wild taxa.
2. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.

UNIT-II

3. Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agro biodiversity, Projected scenario for biodiversity loss.
4. Management of Plant Biodiversity: Organizations associated with biodiversity, management- Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR.
5. Biodiversity legislation and conservation, Biodiversity information management and communication.

UNIT-III:

7. Conservation of Biodiversity: Conservation of genetic diversity, species diversityand ecosystem Diversity
8. Principles of conservation :*In -situ* and *Ex-situ* conservation. Sacred groove, Botanical garden, Biosphere reserves, Sanctuaries, National parks (*In-situ*) and Tissue culture, Gene / seed / pollen banks and Cryopreservation (*Ex-situ*).

UNIT-IV:

9. Role of plants in relation to Human Welfare; Importance of forestry, their utilization and commercial aspects, Avenue trees, Ornamental plants of India.
10. Alcoholic beverages through ages. Fruits and nuts, Important fruit crops and their commercial importance. Wood and its uses.

References:

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

2. Bharucha, E. 2005. Textbook of Environmental Studies for Undergraduate Courses. Universities Press (India) Private Limited, Hyderabad.

3. Odum, E. P. 1983. Basics of Ecology. Saunder's International Students Edition, Philadelphia.

4. Sharma, P. D. 1989. Elements of Ecology. Rastogi Publications, Meerut.

KAKATIYA UNIVERSITY - WARANGAL - TELANGANA
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B.SC. BOTANY III YEAR
SEMESTER – V

PAPER – V:: (A) BIODIVERSITY & CONSERVATION PRACTICAL
(DSE-1: ELECTIVE)

1. Study on local biodiversity: Herbs, shrubs and trees; Seasonal, Annual, biennial and perennial plants.
2. Study of morphological characteristics of plant communities: Hydrophytes (*Eichhornia, Hydrilla, Pistia, Nymphaea, Vallisneria*), Xerophytes: (*Asparagus, Opuntia, Euphorbia milii, Casuarina, Calotropis*).
3. Assessment of biodiversity
   i) Avenue trees: *Pongamiapinnata*, *Butea monosperma, Spathodea* sp., *Delonix regia*, *Jacaranda mimosifolia*, *Cassia fistula*, *Mimusopselengi*, *Acacia leucophloea*, and *Albizialebbeck.*
   ii) Ornamental Plants: Any five locally available ornamental plants.
   iii) Timber Value: *Acacianilotica*, *Tectonagrandis*and *Azardirachtaindica*
   iv) Fruits: *Mangiferaindica*(Mango), *Ziziphusmauritiana*, *Psidium guajava*(Guava), *Annona squamosa*
   v) Nuts: *Anacardiumoccidentale*(Cashew), *Terminalia catappa*(Badam)
   vi) Beverages: *Madhucaindica*, *Camellia sinensis*(Tea),*Coffea arabica*(Coffee), *Borassusflabellifer*
   (Toddy palm) and *Caryotaurens*
   vii Medicinal value: *Catharanthus roseus*, *Tinosporacordifolia*and *Phyllanthus emblica*, *Ocimumsp.*, and *Azardirachta indica*
4. Field trip: Collection of plants from the field, identification and preparation of Herbarium.

D. Calitha Ki

KAKATIYA UNIVERSITY - WARANGAL - TELANGANA
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B.SC. BOTANY III YEAR
SEMESTER – V

PAPER – V: (B) ECONOMIC BOTANY
(DSE-1: ELECTIVE)

Theory: 4 Hours/Week; Credits: 4 Marks: 100 (Internal: 20; External: 80)
Practical 3 Hours/Week; Credits: 1 Marks: 25

UNIT - I

Origin of Cultivated Plants: Major plants introduction, Crop domestication and examples of crops / varieties

1. Vegetables: Nutritional and Commercial values of root crops, leafy and fruit vegetables.
2. Millets: Nutrient significance of Sorghum, Finger millet, Pearl millet, Foxtail millet.
3. Cereals: Rice, Wheat and maize - Origin, morphology and uses.

UNIT – II

4. Legumes: General account, importance to man and ecosystem.
5. Fruits and nuts: Commercial and nutritional value of South Indian fruits. Cashew nut, Almond and Walnut.
6. Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.
7. Spices: Listing of important spices, part used, economic importance with special reference to fennel, saffron, clove and black pepper

UNIT – III

8. Beverages: Tea, Coffee (morphology, processing & uses)
9. Edible oils & Fats: General description, extraction, uses and health implications of groundnut, sunflower, coconut, linseed, and mustard.
10. Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.
11. Natural Rubber: Para-rubber - tapping, processing and uses.

UNIT – IV

12. Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis, Papaver* and *Cannabis.*
13. Tobacco processing, uses and health hazards
14. Timber plants: General account with special reference to teak and pine
15. Fibres: Classification based on the origin of fibres, extraction methods and uses of Cotton and Jute.

B. Lalitha Ki

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publishers.
4. B.P. Pandey (2007). Economic Botany, S. Chand & Company Ltd. New Delhi. 17/e.

KAKATIYA UNIVERSITY - WARANGAL - TELANGANA
UNDER GRADUATE COURSES (UNDER CBCS 2021 – 2022 ONWARDS)
B.SC. BOTANY III YEAR
SEMESTER – V

PAPER – V:: (B) ECONOMIC BOTANY PRACTICAL
(DSE-1: ELECTIVE)

1. Study of economically important plants: Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests.
2. Identification and study on nutrient values of locally available vegetables, millets and cereals.
3. Study on nutrient values and commercial status of Cashew nut, Almond and Walnut.
4. Uses and health implications of groundnut, sunflower, coconut, linseed, Brassica and Coconut.
5. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
6. Study of products of economic importance included unit wise.
7. Collection vegetable twigs and preparation of Herbarium.
8. Identification of starch granules.
9. Estimation of iodine number of different oils.
10. Quantitative estimation and comparative study of proteins in millets and cereals.

B. Lalitakri

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B.SC. BOTANY III YEAR
SEMESTER – V

PAPER – V:: (C) SEED TECHNOLOGY
(DSE-1: ELECTIVE)

Theory: 4 Hours/Week; Credits: 4 Marks: 100 (Internal: 20; External: 80)
Practical 3 Hours/Week; Credits: 1 Marks: 25

UNIT- I

1. Seed: Structure and types. Seed development in cultivated plants, seed quality concept, importance of genetic purity of seed. Hybrid seed production and Heterosis.
2. Cross pollination, Emasculation, role of pollinators and their management.
3. Collection and storage of pollen for artificial pollination.

UNIT-II

4. Seed germination: Internal and external factors affecting germination.
5. Physiological processes during seed germination; seed respiration, breakdown and mobilization of stored seed reserves.
6. Seed dormancy: Types, causes and methods of breaking dormancy. Role of Phytochrome.

UNIT-III

7. Cultural practices and harvesting of Seed: Isolation, Sowing, Cultural practices, harvesting and threshing of the following crops: a) Rice b) Cotton c) Sunflower
8. Seed treatment to control seed borne disease –General account
9. Seed testing- Procedures of seed testing, seed testing laboratories and importance of seed testing.

UNIT-IV

10. Seed viability, factors affecting seed viability and genetic erosion.
11. Seed storage: Long term and short term storage. Orthodox and recalcitrant seeds. Packing of seeds – Principles, practices, bagging and labelling.
12. Seed banks- National, International and Millennium seed banks. Seed certification- History, Seed certification agency, Indian millennium, general and specific seed certification standard.

Reference:

1. Agrawal, P. K. 1993. Hand Book of Seed Technology. Dept. of Agriculture and Cooperation. National Seed Corporation Ltd., New Delhi
2. Balasubramanian, D., C. F. A. Bryce, K. Dharmalingam, J. Green and K. Jayaraman. 2004. Biotechnology. Universities Press (India) Private Limited, Hyderabad.
3. Bedell, Y. E. Seed Science and Technology. Indian Forest Species. Allied Publishers Limited, New Delhi.
4. Channarayappa. 2007. Molecular Biotechnology – Principles and Practices. Universities Press (India) Private Limited, Hyderabad.
5. Chawala, H. S. 2002. Introduction to Plant Biotechnology. Oxford & IBH Publishing Company, New Delhi.
6. Dubey, R. C. 2001. A Textbook of Biotechnology. S. Chand & Company Ltd., New Delhi
7. Edmond, J. B., T. L. Senn, F. S. Adrews and R. J. Halfacre. 1977..
8. Hartman, H. T. and D. E. Kestler. 1976. Plant Propagation: Principles and Practices. Prentice & Hall of India, New Delhi.
9. Jha, T.B. and B. Ghosh. 2005. Plant Tissue Culture – Basic and Applied. Universities Press (India) Private Limited, Hyderabad..
10. Ramawat, K. G. 2008. Plant Biotechnology. S. Chand & Company Ltd., New Delhi.
11. Salisbury, F. B. and C. W. Ross. 1992. Plant Physiology. 4th edn. (India Edition), Wordsworth, Thomson Learning Inc., USA..
12. Tiwari, G. N. and R. K. Goal. Green House Technology – Fundamentals, Design, Modelling and Application. Narosa Publishing House, New Delhi.
13. Tunwar, N. S. and S. V. Singh. 1988. Indian Minimum Seed Certification Standards. The Central Seed Certification Board, Govt. of India, New Delhi.
14 Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.
15. Baskin CC & Baskin JM. 1998. Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination. Academic Press. Basra AS. 2006. Handbook of Seed Science and Technology. Food Product Press.
16. Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. Food Product Press. Bewley JD & Black M. 1982. Physiology and Biochemistry of Seeds in Relation to Germination. Vols. I, II. Springer Verlag.
17. Bewley JD & Black M. 1985. Seed: Physiology of Seed Development and Germination. Plenum Press.
18. Copeland LO & Mc Donald MB. 1995. *Principles of Seed Science and Technology*. 3rd Ed. Chapman & Hall.
19. Khan AA. 1977. Physiology and Biochemistry of Seed Dormancy and Germination. North Holland Co.
20. Kigel J & Galili G. (Eds.). *Seed Development and Germination*. Marcel Dekker.
21. Murray DR. 1984. *Seed Physiology*. Vols. I, II. Academic Press. Sadasivam S & Manickam A. 1996. *Biochemical Methods*. 2nd Ed. New Age.

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B.SC. BOTANY III YEAR

SEMESTER – VI

PAPER-2A: PLANT MOLECULAR BIOLOGY

(DSE-2: ELECTIVE)

Theory: 4 Hours/Week; Credits: 4 Marks: 100 (Internal: 20; External: 80)

Practical: 3 Hours/Week Credits: 1 Marks: 25

UNIT- I

1. Nucleic acids: Carriers of genetic information, types of genetic material, DNA as the carrier of genetic information.
2. .Structures of DNA: Salient features and Types of DNA, Organization of DNA in Prokaryotes. Mitochondrial and chloroplast DNA.
3. .Structure of RNA: Structure and Types of RNA's (mRNA, rRNA and tRNA).

UNIT-II

4. Nucleosome, Chromatin structure- Euchromatin, Heterochromatin; Constitutive and Facultative heterochromatin.
5. Replication of DNA: Chemistry of DNA synthesis, general principles, Semi-conservative replication of DNA, replication of linear ds-DNA, replication of the 5'end of linear chromosome.
6. Central dogma and genetic code: Central Dogma (Adaptor hypothesis and discovery of mRNA template), salient features of Genetic code.

UNIT –III

7. Mechanism of Transcription: Transcription in prokaryotes and eukaryotes; Split genes-concept of introns and exons, removal of introns, eukaryotic mRNA processing (5' cap, 3' polyA tail).
8. RNA editing and mRNA transport.

UNIT -IV

9. Translation in prokaryotes: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation.
10. Transcriptional regulation in prokaryotes, Regulation of lactose metabolism *(Lac* operon) and tryptophan *(Trp* operon) synthesis in *E.coli.*

B. Lalitha Rao

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, Joh Wiley & sons,India.8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
5. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
6. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
8. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
9. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

B. Calcutta

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B.SC. BOTANY III YEAR

SEMESTER – VI

PAPER-2A: PLANT MOLECULAR BIOLOGY PRACTICAL

(DSE-2: ELECTIVE)

1. Isolation of genomic DNA from E.Coli.
2. DNA isolation from cauliflower head./tomato fruit
3. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
4. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
5. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
6. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
7. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.
8. Estimation of size of a DNA fragment after electrophoresis using DNA markers (through photographs).

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B.SC. BOTANY III YEAR

SEMESTER – VI

PAPER-2B: TISSUE CULTURE AND BIOTECHNOLOGY

(DSE-2: ELECTIVE)

Theory:	4 Hours/Week;	Credits: 4	Marks: 100 (Internal: 20; External: 80)
Practical:	3 Hours/Week	Credits: 1	Marks: 25

UNIT - I

1. Tissue culture: Introduction, sterilization procedures, explants, culture media- composition and preparation; Nutrients and hormone requirements. Micropropagation.
2. Organ culture: Totipotency, Induction of callus, Shoot, leaf culture, Anther culture, Ovule and Embryo culture.
3. Callus culture and isolation and fusionof protoplast culture
4 Organogenesis, Somatic and Zygotic embryogenesis

UNIT- II

5. Applications of tissue culture: Production of pathogen free plants and stress resistant plants, somaclonal variants and synthetic seeds.
6. Induction of hairy roots and its applications in production of secondary metabolites.
7. Haploidy and triploids,Cryopreservation and Germplasm Conservation.
8 .Somatic hybrids and Cybrid

UNIT- III

9. Biotechnology: Introduction, history, scope and applications.
10. rDNA technology: Basic aspect of gene cloning, Enzymes used in gene cloning. Restriction enzymes, Ligases, Polymerases.
11. Gene cloning: Recombinant DNA, Bacterial Transformation and selection of recombinant clones, vectors- cloning vehicles (Plasmid, Cosmids, Bacteriophages, & Phasmids; Eukaryotic Vectors (YAC) Gene Construct; Applications of rDNA technology.

UNIT - IV:

10. Gene Libraries: construction of genomic and cDNA libraries, Polymerase Chain Reaction (PCR) and its applications.
11. Methods of gene transfer-*Agrobacterium* mediated Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment.

12. Application of transgenics in improvement of crop productivity and quality traits. Pest resistant transgenic crops (Bt-cotton & Bt-brinjal); herbicide resistant plants (Roundup Ready soybean); crops with quality traits (Flavr Savr tomato, Golden rice).

References:

1. Balasubramanian, D., C. F. A. Bryce, K. Dharmalingam, J. Green and K. Jayaraman. 2004.
2. Biotechnology. Universities Press (India) Private Limited, Hyderabad.
3. Channarayappa. 2007. Molecular Biotechnology – Principles and Practices. Universities Press (India) Private Limited, Hyderabad.
4. Chawala, H. S. 2002. Introduction to Plant Biotechnology. Oxford & IBH Publishing Company, New Delhi.
5. Dubey, R. C. 2001. A Textbook of Biotechnology. S. Chand & Company Ltd., New Delhi
6. Edmond, J. B., T. L. Senn, F. S. Adrews and R. J. Halfacre. 1977..
7. Jha, T.B. and B. Ghosh. 2005. Plant Tissue Culture – Basic and Applied. Universities Press (India). Private Limited, Hyderabad..
8. Ramawat, K. G. 2008. Plant Biotechnology. S. Chand & Company Ltd., New Delhi.
9. Salisbury, F. B. and C. W. Ross. 1992. Plant Physiology. 4th edn. (India Edition), Wordsworth, Thomson Learning Inc., USA.
10. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
12. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
13. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
14. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K.5th edition.
15. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

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B.SC. BOTANY III YEAR

SEMESTER – VI

PAPER-2B: TISSUE CULTURE AND BIOTECHNOLOGY PRACTICAL

(DSE-2: ELECTIVE)

Major Experiments

1. Isolation of plant DNA (Tomato)
2. Production of synthetic seeds /Encapsulation of embryo
3. Preparation of plant tissue culture medium - MS medium
4. Isolation of protoplasts.

Minor Experiments

1. Callus induction
2. Demonstration of Micropropagation/multiple shoots
3. Anther culture
4. PCR – Demonstration
5. Study of biotechnology products: Samples of antibiotics and vaccines
6. Photographs of Gene transfer methods.
7. Instruments used in Biotechnology lab- Autoclave, Laminar air flow, Hot air oven and Incubator.
8. Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.

Spotting

1. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
2. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
3. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
4. Restriction digestion and gel electrophoresis of plasmid DNA.

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B.SC. BOTANY III YEAR

SEMESTER – VI

PAPER-2C: ANALYTICAL TECHNIQUES IN PLANT SCIENCES

(DSE-2: ELECTIVE)

Theory:	4 Hours/Week;	Credits: 4	Marks: 100 (Internal: 20; External: 80)
Practical:	3 Hours/Week	Credits: 1	Marks: 25

Unit -I

1. Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy.
2. Use of fluorochromes: Fluorescence-activated cell sorting (FACS); Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting.
3. Transmission and Scanning electron microscopy - sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit II:

4. Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, , analytical centrifugation, ultracentrifugation, marker enzymes.
5. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.
6. Spectrophotometry: Principle and its application in biological research.

Unit –III

7. Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Affinity chromatography.
8. Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids;
9. Electrophoresis: PAGE, SDS-PAGE

Unit IV:

10. Biostatistics: Statistics, , population, samples, parameters;
11. Representation of Data: Tabular, Graphical; Measures of central tendency:
12. Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGrawHill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

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SEMESTER – VI

PAPER-2C: ANALYTICAL TECHNIQUES IN PLANT SCIENCES PRACTICALS

(DSE-2: ELECTIVE)

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separate DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).