Anekant Education of Society's
Tuljaram Chaturchand CollegeofArts, Science and Commerce, Baramati
Autonomous

SYLLABUS (CBCS) FOR T. Y. B. Sc. BOTANY (w.e. from June, 2021)

Class	Semester	Paper	Title of Paper	Credit
T.Y.B.Sc.	V	BOT3501	Cryptogamic Botany (Algae, Fungi, Bryophytes and Pteridophytes)	03
		BOT3502	Spermatophyta and Palaeobotany	03
		BOT3503	Cell and Molecular Biology	03
		BOT3504	Industrial Botany	03
		BOT3505	Biostatistics	03
		BOT3506	Research Methodology	03
		BOT3507	Practical based on BOT3501 to BOT3503	02
		BOT3508	Practical based on BOT3504 to BOT3506	02
		BOT3509	Project	02
	VI	BOT3601	Plant Physiology and Biochemistry	03
		BOT3602	Plant Biotechnology	03
		BOT3603	Genetics and Plant Breeding	03
		BOT3604	Plant Pathology	03
		BOT3605	Pharmacognosy	03
		BOT3606	Botanical Techniques	03
		BOT3607	Practical based on BOT3501 to BOT3505	02
		BOT3608	Practical based on BOT3601 to BOT3606	02
		BOT3609	Project	02

Class	:	**T. Y. B. Sc. (Semester - V)**
Paper Code	:	**BOT 3501**
Paper : **I**		Title of Paper : **Cryptogamic Botany** (Algae, Fungi, Bryophytes and Pteridophytes)
Credit : **3**		No. of lectures : 48

A) Learning Objectives:

1) To study the diversity in algae, fungi, bryophytes and pteridophytes.
2) To understand the taxonomy, morphology, anatomy, mode of nutrition and reproduction in cryptogams.
3) To know the agricultural, ecological, medicinal, horticultural and industrial significance of lower plants.

B) Learning Outcome:

1) Students can be confident about basic idea and comparative study of cryptogams.
2) Students can be experts in identification of lower plants.
3) Students can be start their own business based on applications of cryptogams.

Credit - I (24 L)

Unit – 1

Algae

1. General characters, classification (Chapman and Chapman, 1973) up to classes and economic importance. (2L)
2. Study of distinguishing characters of following divisions and life cycle pattern of algae with reference to taxonomic position, occurrence, thallus structure and reproduction : (10L)
   a) Cyanophyta : *Oscillatora*
   b) Rhodophyta : *Batrachospermum*
   c) Chlorophyta *Volvox*
   d) Xanthophyta : *Voucheria*
   e) Phaeophyta : *Laminaria*

Fungi

3. General characters, classification up to classes (Ainsworth, 1973) and economic importance. (2L)
4. Study of distinguishing characters of following groups and life cycle pattern of fungi with reference to taxonomic position, occurrence, thallus structure and reproduction (10L)
   a) Myxomycota : *Stemonitis*
   b) Mastigomycotina : *Pythium*
   c) Zygomycotina : *Mucor*
   d) Ascomycotina :*Unicinula*
   e) Basidiomycotina : *Agaricus*
   f) Deuteromycotina : *Alternaria*

Credit - II (12 L)

Unit – 2

Bryophytes

1. General characters, classification up to classes (G.M. Smith, 1955) and economic importance. (3L)

2. Study of distinguishing characters of following classes and life cycle pattern of bryophytes wrt. taxonomic position, occurrence, thallus structure (morphology and anatomy), reproduction and sporophyte structure (9L)
   a) Hepaticopsida : *Marchantia* and *Porella*
   b) Anthocerotopsida : *Anthoceros* and *Notothylas*
   c) Bryopsida : *Bryum* and *Polytrichum*

Credit - III (12 L)
Unit – 3
Pteridophytes (12L)

1. General characters, classification up to classes (K.R.Sporne, 1975) and economic importance (04L)
2. Study of distinguishing characters of following classes and life cycle pattern of pteridophytes wrt. taxonomic position, occurrence, morphology, anatomy, reproduction, gametophyte and sporophyte structure. (8L)
   a) Psiloptopsida : *Psilotum*
   b) Lycopsida : *Selaginella*
   c) Sphenopsida : *Equisetum*
   d) Pteropsida : *Salvinia*

Reference Books :
Algae:

1 Brodie J. and Lewis J. (2007). (Ed.) Unravelling the algae: the past, present and future of algal systematics. CRC press, New York, pp 335.
2 Bellinger E.G. and Sigee D.C. (2010). Freshwater algae: Identification and use as bioindicators, Willey-Blackwell, UK, pp. 271.
3 Cole K.M. and Sheath R.G. (1990). Biology of the red algae. Cambridge University Press.USA. pp. 503.
4 Desikachary T.V. (1959). Cyanophyta. ICAR, New Delhi.
5 Graham L.E. and Wilcox L.W. (2000). Algae.Penticce-Hall,Inc, pp. 640
6 Krishnamurthy V. (2000). Algae of India and neighboring countries I.Chlorophycota, Oxford & IBH, New Delhi.
7 Lee R.E. (2008). Phycology. Cambridge University Press, pp.547.
8 Misra J.N. (1996). Phaeophyceae in India. ICAR, New Delhi.
9 Prescott G.W. (1969). The algae.
10 Smith G.M. (1950). The fresh water algae of the United States, Mc-graw Hill NewYork. 11. Srinivasan K.S. (1969). Phycologia India.Vol.I & II, BSI, Calcutta.
11 Das Dutta and Gangulee.College Botany Vol I, Central Book Depot.
12 Vashista B.R, Sinha A.K and Singh V.P. (2005). Botany for degree students – Algae, S. Chand's Publication.
13 Sharma O.P. Algae

Fungi :

1 Ainsworth, Sussman and Sparrow (1973). The fungi. Vol IV A & IV B. Academic Press. 2. Alexopolous C.J., Minms C.W. and Blackwell M. (1999). (4th edn) Introductory Mycology. Willey, New York, Alford
2 R.A.Deacon J.W. (2006). Fungal Biology (4thEd.) Blackwell Publishing, ISBN. 1405130660.
3 Kendrick B. (1994). The fifth kingdom (paperback), North America, New York Publisher: 3rd edn, ISBN- 10: 1585100226.

4 Kirk et al. (2001). Dictionary of fungi, 9th edn, Wallingford: CABI, ISBN: 085199377X. 6. Mehrotra R.S. and Aneja K.R. (1990). An introduction to mycology. New Age Publishers, ISBN 8122400892.
5 Miguel U., Richard H., and Samuel A. (2000). Illustrated dictionary of the Mycology.Elvira Aguirre Acosta, Publisher: St. Paul, Minn: APS press, ISBN 0890542570. 8. Webster J. and Rpland W. (2007). Introduction to fungi (3rd Edn) Cambridge UniversityPress,978-0-521-80739-5.

Bryophytes:

1 Cavers F. (1976). The interrelationships of the Bryophytes. S.R. Technic, Ashok Rajpath, Patana.
2 Chopra R.N. and Kumar P.K. (1988).Biology of Bryophytes. John Wiley & Sons, New York, NY.
3 Kashyap S.R. (1929). Liverworts of the Western Himalayas and the Punjab Plain.Part 1, ChronicaBotanica, New Delhi.
4 Kashyap S.R. (1932). Liverworts of the Western Himalayas and the Punjab Plain (illustrated): Part 2. ChronicaBotanica, New Delhi.
5 Parihar N.S. (1980). Bryophytes: An Introduction to Embryophyta. Vol I. CentralBook Depot, Allahabad.
6 PremPuri(1981). Bryophytes: Morphology, Growth and Differentiation. Atma Ram and Sons, New Delhi.
7 Udar R. (1975). Bryology in India.ChronicaBotanica, New Delhi.
8 Udar R. (1970). Introduction to Bryophytes.ShashidharMalaviyaPrakashan. Lucknow.
9 Watson E.V. (1971). Structure and Life of Bryophytes.3rd Edn. Hutchinson University Library, London.
10 Vashista B.R., Sinha A.K., Kumar A. (2008). Botany for degree students – Bryophyta, S.Chands Publication.

Pteridophytes :

1. Rashid A (1999) An introduction to Pteridophyta. Vikas Publishing house Pvt.Ltd. New Delhi.
2. Sharma OP (1990) textbook of Pteridophyta. Mac Millan India Ltd. Delhi.
3. Smith GM (1955) Cryptogamic Botany Vol. II Mc Grew Hill.
4. Sporne KR (1986) The morphology of Pteridophytes. Hutchinson University Press. London.
5. SundaraRajan S. (1999) Introduction to Pteridophyta. New Age International Publishers,
New Delhi.
6. Surange KR (1966) Indian fossil Pteridophytes. Council of Scientific and Industrial
research.
7. Parihar NS (1976) Biology and morphology of the Pteridophytes. Central Book Depot.
8. Trivedi, A. N. (2002) - Advances in Pteridology
9. Bierhorst, D.W.(1971) - Morphology of Vascular plants
10. Eames, A. J. and E. M. Giffard (1950) - Comparative morphology of vascular plants
11. Rashid, A. (1978) - An introduction of Peridophytes
12. Sporne, K.R. (1966) - Morphology of Ptseridophytes
13. Bower, F. O. (1963) - The Ferns
14. Jermy, A. G. (1973) - The Phylogeny and Classification of ferns.

15. Vashishta, B.R. (1996) - Botany for degree students – Pteridophytes
16. Parihar, N.S. (1959) - An Introduction to Pteridophyta

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Class: T. Y. B. Sc. (Semester - V)
Paper Code: **BOT3502**
Paper:**II**Title of Paper:**Spermatophyta and Palaeobotany**
Credit: 3 No. of lectures: 48

A) Learning Objectives:

1. To know and understand the concepts of Gymnosperms, Angiosperm and Palaeobotany.
2. To study the details parts in different families.
3. To study tools of taxonomy.
4. To study Plant classification systems.
5. To study Plant identification keys.

B) Learning Outcomes:

1. Understanding the concepts of Gymnosperms, Angiosperm and Palaeobotany.
2. Knowledge of different families,classification systems.
3. Understanding the tools of taxonomy.

Credit-I (16 L)
Unit-I
GYMNOSPERMS

1. Introduction, general characters, and outline, classification according toChamberlain (1934) Raizda andSahani (1960) and economic importance(4L).
2. Study of life cycle of *Pinus* and *Gnetum*with reference to distribution, morphology, anatomy, reproduction, gametophyte, sporophyte, seed structure and alternation of generation. (Developmental stages of sex organs are not expected)(12 L).

Credit-II (22 L)
Unit-II
ANGIOSPERMS

1. **Origin of angiosperms :**Origin with reference to time, place and ancestry-Pteridosperms theory, Bennettitalean theory and Gnetalean theory (4L**).**
2. **Classification of angiosperms :**Review of artificial, natural andphylogenetic systems (general account),Hutchinson systems with reference to outline and assumptions, merits and limitations,Advanced Phylogenetic Group system-III (APG-III)(4 L).
3. **Study of following families according to Bentham and Hooker's System:** With reference to systematic position, distinguishing characters, economic importance,general floral formula, floral diagram of following families: Magnoliaceae,Capparidaceae,Rhamnaceae, Rutaceae, Leguminosae (Fabaceae),Asteraceae, Acanthaceae, Lamiaceae, Nyctaginaceae, Orchidaceae,Cannaceae and Poaceae (12 L).

4. **Plant identification and QR (Quick Response) :**Latin diagnosis and recent trends, use of flora, Preparation of artificial keys, practicingIndentedand bracketed keys, Plant authentication QR Code(2 L)

Credit-III (10 L)
Unit-III
PALAEOBOTANY

1. Geological time scale, Contribution of Indian Paleobotanist (02L)
2. Fossil- Definition, process of fossil formation, types of fossils- Impression,Compression, Petrifaction, Coal ball.(02L)
3. Study of following fossil groups(06 L)
   a) Psilopsida- Salient features of order Psilophytales, external and internal morphology of*Rhynia*.
   b) Lycopsida- Salient features of order Lepidodendrales, external and internal morphology of*Lepidodendron.*
   c) Sphenopsida- Salient features of Calamitales, external and internal morphology of *Calamites.*
   d) Pentoxylae- Salient feature, external and internal morphology of stem [*Pentoxylon*], Leaf [*Nipaniophyllum*].

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8. Coulter J.M. and Chamberlain C.J. 1917. Morphology of Gymnosperms, Chicago.
9. Foster A.S and Gifford E.M 1959. Comparative Morphology of Vascular Plants.
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15. Parihar N.S. 1996. Biology and Morphology of Pteridophytes. Central Book Depot,Allahabad.
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17. E.H.N.Andrews-Studies in Palaeobotany (Botany for Degree Students Vol.-V)
18. Shukla A.C. and Mishra S.P.- Essentials of Palaeobotany.
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24. Lawrence G. H. M 1955. An Introduction to Plant Taxonomy
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28. Swingle D.B. 1946. A Text book of Systematic Botany. McGraw Hill Book Co. New York.
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30. Pande B.P 1997. Taxonomy of Angiosperms. S.Chand Publication
31. Gurucharan Singh 2005- Plant systematics
32. Naik V.N. - Taxonomy of Angiosperms.
33. Yadav S.R. and Sardesai M.R.- Flora of Kolhapur District.
34. Bhagat R.B., Shimpale V.B. and Deshmukh R.B. Flora of Baramati
35. Shivrajan V.V. -Introduction to Principles plant taxonomy
36. V. V. Sivarajan, N. K. P. Robson 1991. Introduction to the Principles of Plant Taxonomy IInd Edi.
37. Theodore Cooke (1903)- The flora of The Presidency of Bombay Vol. I, II, III
38. Chopra G.L.- Angiosperms
39. Datta S.C.- A Hand Book of Systematic Botany
40. Priti Shukla and Shital Mishra- An introduction to Taxonomy of angiosperms.
41. Sharma O.P. Plant Taxonomy Tata McGraw-Hill Education
42. Singh, N.P. and S.Karthikeyn (2000) B.S.I. Calcutta. Flora of Maharashtra State,
43. Dicotyledons. Vol.I and II
44. Botanical Journal of the Linnean Society, 2009, 161, 105–121.
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Class : **T. Y. B. Sc. (Semester - V)**
Paper Code: **BOT 3503**
Paper : **III** Title of Paper : **Cell and Molecular Biology**
Credit : 3 No. of lectures:48

A) Learning Objectives:

1. To study structure of cell organelles and their functions.
2. To pertain knowledge of different cytological techniques.
3. To give knowledge about nucleic acid structure, role and synthesis of protein.

B) Learning Outcome:

1. The main outcome of this course is to acquaint students with some cytological techniques.
2. Experts required in future for genetic library of plants.
3. Acquaint the students with synthesis of nucleic acids and PCR technique.

Credit - I (20 L)

Unit - I

1. **Cell Biology: An Introduction (2L)**

1 Definition and brief history

2. Units of measurement of cell

3. Prokaryotic and Eukaryotic Cell

4. Physical nature of cytoplasmic matrix

5. Chemical organisation- organic and inorganic compounds of cytoplasmic Matrix.

2. **Plant Cell - Cytoplasmic Constituents (14L)**

   Morphology, Ultrastructure, Chemical composition, Functions of Cell wall, Plasma membrane, Endoplasmic Reticulum, Golgi apparatus, Lysosomes, Microbodies, Mitochondria, Plastids, Vacuoles, Ribosomes

3. **Plant Cell - Nucleus and Chromosomes (4L)**

   Nucleus- Morphology, Ultrastructure, Nucleoplasm, Nucleolus, Functions
   Chromosome- Number, Morphology, Structure, Karyotype and ideogram, Chemical composition, Euchromatin and Heterochromatin, Giant Chromosomes

Credit - II (12 L)

Unit - II

1. **Molecular Biology – Introduction (2L)**

   Definition, History, Scope and Importance, Central Dogma of Molecular Biology

2. **Nature of Genetic Material (4L)**

   Characteristics of genetic material, Physical and Biological evidences to prove DNA as genetic material, Watson and Cricks Model of DNA, Forms of DNA - A, B and Z, C -Value Parodox, RNA as genetic material -TMV

3. **DNA Replication (3L)**

   Introduction and types, Messelson and Stahl's Experiment

4. **DNA Damage and Repair (3L)**

   Introduction, Causes and types, DNA repair system - Photoreactivation, Dark excision repair

Credit - III (16 L)

Unit – III

1. **Gene Organization (2L)**

   Promoter-structure and function in prokaryotes and eukaryotes, Terminators, Unitsof Gene, Enhancers, Split genes, jumping genes

2. **Transcription (4L)**

   Structure and role of m-RNA, r-RNA, t-RNA, Transcription apparatus, Mechanism of Transcription in Prokaryotes

3. **Genetic Code and Translation (6L)**

   Genetic Code - Definition, Concept, Work of Nirenburg and Khorana, Properties of Genetic code

Translation- Definition, Mechanism of translation - Initiation, Elongation and Termination

4. **Gene Action and Regulation (4L)**
   Relation of Gene and Enzymes - One gene one enzyme hypothesis, regulation of metabolism, Inducible and Repressible enzymes, Gene regulation - in prokaryotes (Lac Operon Model) and eukaryotes (Britten and Davidson's Model)

References :

1. Cell and Molecular Biology , S. C. Rastogi
2. Cytology, T. S. Verma and V. K. Agarwal
3. Cell Biology, C. B. Pawar
4. Cell and Molecular Biology, P. K. Gupta
5. Fundamentals of Molecular Biology, Veer Bala Rastogi
6. Fundamentals of Molecular Biology, G. K. Pal and Ghaskadabi
7. Cell Biology, Molecular Biology, Genetic, Evolution and Ecology, Verma and Agarwal
8. Cell and Molecular Biology, Robertis and DeRobertis
9. Molecular Cell Biology, 4th Edition, Lodish S. Baltimore
10. Molecular Biology of Gene, Watson J. D.
11. Biochemistry and Molecular Biology of Plants, Buchanan B. B.
12. Molecular and Cell Biology, Wolfe S.L.
13. Fundamentals of Molecular Biology, J.K.Pal and S.S.Ghaskadabi

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Class : **T. Y. B. Sc (Semester –V)**
Paper Code : **BOT 3504**
Paper: **IV** Title of paper: **Industrial Botany**
Credit : 3 No. of Lectures: 48

A) Learning Objectives

1. Use of recent techniques.
2. Sustainable uses of techniques.
3. Industrial applications of techniques

B) Learning Outcome:

1. Preparation of different garden at personal level and to encourage people
2. Hands on techniques of packaging, harvesting and hydroponics.
3. Students can start their own business in cold storage, packing of flowers and fruits

Credit - I (16 L)
Unit - I
Hydroponics

1. History and origin of soil less Culture, its advantages and disadvantages, Nutrient Film Technique (NFT) 1L
2. Techniques :static solution culture, Continous :flow solution culture 2L
3. Aeroponics, Passive sub-irrigation, Ebb and flow or flood and drain irrigation, Run to waste, Deep water culture, Bubbleponics. 5L

4. Media used for Hydroponics: Ex-clay, Rock wool, Coir, Perlite, Pumice, Vermiculite, Sand, Gravel, Brick shards, Polystyrene packing peanuts, wood fibre. 5L
5. Nutrient Solutions – Major and Minor nutrients, role of nutrients. Commercial Aspects, Advancements 3L

Credit – II (16L)
Unit –II
Gardening

1. Definition, Principles, objectives and scope of garden designing 2L
2. Different types of gardening – roof / terrace / vertical/ guerrilla/ rock garden/ water gardens and sunken garden/ bottle / circular garden 7L
3. Indoor gardening: Bonsai, Terrarium, dish, Kokedama, Hugelkultur 5L
4. Aesthetic value of Gardens, Famous gardens of India. 2L

Credit - III (16 L)
Unit- III
Post-Harvest Technology

1. Introduction to post harvest technology of agricultural produce; Status of Production, Losses, Need, Scope and Importance 3L
2. Introduction to various post harvest operations such as Primary Processing Operation Vs. Secondary Operation, Operations like Harvesting, Handling cleaning, grading, sorting, drying, storage, milling, size reduction, expelling, extraction, blending, heat treatment, separation, material handling (transportation, conveying, elevating),washing; their functions and use in the post harvest processing. 8L
3. Post harvest treatment to increase shelf life i.e. freezing, chilling, dehydration, canning, thermal processing 3L
4. Introduction to Packaging of fruits and vegetables and types of packaging. Concept of modified atmosphere packaging. 2L

References:

1. Post-harvest handling of tropical fruit, B R Champ, E Highley& G I Johnson (eds), Australian Centre for International Agricultural Research
2. Post-harvest technology of fruits and vegetables: Handling, processing, fermentation and waste management, L R Verma and V K Joshi, Indus Publishing Company.
3. Postharvest biology and technology of tropical and subtropical fruits: Volume 1: Fundamental issues, Edited by E Yahia, Universidad Autónoma de Querétaro, Mexico, Woodhead Publishing Series in Food Science, Technology and Nutrition No. 206
4. Processing of Fruits and Vegetables for Value Addition, Vijay Sethi, B.C. Dekka, Vijay Sethi, ShrutiSethai, ShrutiSethi, Indus Publishing.
5. Post Harvest Technology of fruits & Vegetables, Thompson, CBS Publishers and Distributors
6. Handbook of Fruits and Fruit Processing, Y.H. Hui, John Wiley & Sons.
7. Advances in Fruit Processing Technologies, Sueli Rodrigues, Fabiano Andre NarcisoFernandes, CRC Press.
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10. Hand book of horticulture, ICAR, New Delhi
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12. Gardening in India, Bose and Mukherjee, Oxford
13. Introductory ornamental horticulture, Arora, Kalyani publishers
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15. Forest and Forestry, K P. Sagreiya, National Book Trust
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Class	:	**T. Y. B. Sc. (Semester- V)**		
Paper Code	:	**BOT 3505**		
Paper	:	V	Title of Paper:	**Biostatistics**
Credit	:	**3**	No. of lectures:	48

A) Learning Objectives:

1) To study the computer Techniques.
2) To study the various statistical techniques.
3) To understand basic concepts of computer and statistics useful for botany.

B) Learning Outcome:

1) Students will be expert in use of computer to solve biological problems.
2) Students can be master in solving biological problems with the help of statistics.
3) Students will apply their knowledge in various branches of biology.

Credit - I (16L)

Unit - 1

1. Introduction to Biostatistics **3L**

a) Definition
b) Statistical terms: Population, sample, primary and secondary data, qualitative and quantitative data, parameter and statistics, attributes, variables, discrete andcontinuous variables, statistical error, linear and non-linear functions of statistics,frequency, and itsdistribution
c) Scope, applications, Limitations and uses of biostatistics

2. Sample and sampling **4L**

a) Definition
b) Sampling unit, sample and population
c) Types of sampling
    i. Random sampling – with replicates, without replicates, systematics sampling, stratifiedsampling.
    ii. Non-random sampling- Purpose, quota sampling
d) Need of randomness
e) Achieving randomness
    i. Lottery methods
    ii. Use of random number table
f) Merits and demerits of sampling

3. Collection and representation of data **5L**

a) Classification of data
   i. Meaning and need of classification
   ii. Objectives of classification
   iii. Classification according to class interval
   iv. Overlapping and non-overlapping frequency table

b) Methods of representation of statistical data
   i. Essential features of tabular presentation
   ii. Advantages of tabular presentation
   iii. Graphic representation of data and its advantages
   iv. Types of graphic representation
      - Histogram
      - Frequency polygon
      - Frequency curve
      - Scatter or dot diagram
   i. Merits and limitations of graphic representation
   ii. Diagrammatic representation of data
      - Line diagram
      - Bar diagram
      - Pie diagram

4. Measures of central tendency of grouped and ungrouped data **4L**

a) Simple arithmetic mean, its merits and demerits
b) Averages of position: Median and mode, their merits and demerits

Credit - II (16 L)
Unit- 2

5. Measures of dispersion **4L**

a. Meaning of dispersion
   i. Range:Computation in individual, discrete and continuous series, coefficient of range, Merits and limitations
   ii. Mean deviation and standard deviation: computation for grouped and ungrouped data,Merits and limitation
   iii. Variance: Definition, coefficient of variance
   iv. Skewness and Kurtosis

6. Correlation and regression **4L**

a) Definition and types of correlation
b) Coefficient of correlation and its properties
c) Methods of studying correlation: Scatter diagram and Karl Pearson's Coefficient of Correlation
d) Coefficient of determination (r^2)
e) Regression analysis
   i. Definition and types of regression
   ii. Linear regression
f) Similarities and dissimilarities of correlation and regression

7. Probability and types of theoretical probability distribution **4L**

a) Concept of probability
b) Binomial distribution

c) Poisson distribution
d) Normal distribution
   i. Normal distribution curve
   ii. Relationship between normal curve area and standard deviation
   iii. Properties of normal distribution curve.

8. Tests of significance of mean **4L**

a) Introduction
b) Statistic and its standard error
c) Meaning of statistical hypothesis, level of significance, null hypothesisandalternativehypothesis
d) Student's 't' test: unpaired and paired test
e) chi Square test as a test of goodness of fit and its significance

Credit - III (16L)
Unit - 3

9. Computation of seed testing and plant growth indices **10L**

a) Seed germination and early seedling growth.
   i. Germination percentage
   ii. Mean germination time (MGT)
   iii. Germination index (GI)
   iv. Germination speed (GS)
   v. Vigor index (VI).
b) Seed germination and early seedling growth under stress
   i. Promptness index (PI)
   ii. Germination stress tolerance index (GSI),
   iii. Plant height stress tolerance index (PHSI)
   iv. Root length stress tolerance index (RLSI)
   v. Dry matter stress tolerance index (DMSI)
c) Plant growth indices
   i. Absolute Growth Rate (AGR)
   ii. Crop Growth Rate (CGR)
   iii. Relative Growth Rate (RGR)
   iv. Leaf Area Index (LAI)

10. Analysis of data on vegetation studies **6L**

a) Data obtained from quadrates and transects methods
   i. Frequency
   ii. Percent frequency
   iii. Relative frequency
   iv. Density
   v. Relative density
   vi. Abundance
   vii. Dominance
b) Computation of crop/vegetation biomass using satellite data
   i. Simple Ratio (SR) or Ratio Vegetation Index (RVI)
   ii. Difference Vegetation Index (DVI),
   iii. Normalised Difference Vegetation index (NDVI) or greenness index

NOTE – For Biostatistics, emphasis be given on methodology and numerical problem solving rather than derivations and proofs.

References:

1. Introduction to biostatistics, Pranab Kumar Banerjee.
2. Fundamentals of biostatistics, Khan and Khanum
3. Methods in Biostatistics for medical students and research workers, B K Mahajan
4. ABC of Research Methodology and Applied Biostatistics, M N Parikh and NithyaGogtay
5. Biostatistics in brief, K ViswesaraRao
6. Introduction to Biometry, S G Purohit, V D Ranade and A V Dusane
7. Biostatistics-Basic Concepts and Methodology for the Health Sciences, Wayne W Daniel
8. Basic statistics, B L Agarwal
9. Biostatistics – Principle and Practice, B Antonisamy, SolomanChrostopher and P PrasannaSamuel
10. Introduction to biostatistics and research methods, PSS SundarRao and JRichards

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Class: **T. Y. B. Sc. (Semester - V)**
Paper Code: **BOT 3506**
Paper: **VI** Title of Paper: **Research Methodology**
Credit: **3** No. of lectures: 48

A) Learning Objectives:

1. To understand the research
2. To give idea about research work
3. To aware the students about the research methodologies.

B) Learning Outcome:

On satisfying the requirements of this course, students will have:

1. Comprehensive knowledge in research areas.
2. Knowledge of preparation of Manuscript, Review article and Project Report.
3. Students will understand the basics of research.

Credit - I (16 L)

Unit – 1

1. Introduction to Research Methodology: Meaning of Research, Objectives of Research, Motivations in Research, types of Research, Research Approaches, Significance of Research, Criteria of Good Research. (8 L)
2. Defining the Research Problem: Concept and need, Identification of Research problem, defining and delimiting Research problem. (6 L)
3. Characteristics of research: Qualitative and Quantitative (2 L)

Credit - II (16 L)

Unit – 1I

4. Research Questions and Hypothesis: Variables and their linkages, characteristics of good Hypothesis. Basis for hypotheses, formulation of hypotheses-directional and non-directional hypotheses. (8 L)

5. Research design: Meaning, Need, Features of Good Design, Concepts, Types, Basic principles of Experimental Design, various methods of Research: Survey, Philosophical, Historical, Experimental, Case Studies. (8 L)

Credit - III (16 L)
Unit – III

6. Data Collection: Methods of Data Collections : Observation, Experimental and questionnaire, Primary Data, Secondary Data, Selection of appropriate method for data collection, Case Study, Reliability and validity of Research tools. (8 L)
7. Preparation of Project Report: Data Analysis and Consolidation of Photographs, Illustration, Table and Graphs, Title, Introduction, Review of Literature, Materials and Methods, Results, Discussions, Summary, References, Acknowledgment, Bibliography: Method of Citing And Arrangement of References. (8 L)

References:

1) Ackoff, Russell L., *Scientific Method,* New York: John Wiley & Sons, 1962.
2) Baker, R.P., and Howell, A.C., *The Preparation of Reports,* New York: Ronald Press, 1938.
3) Best and Kahn, Research Methodology, PHI Limited.
4) Berdie, Douglas R., and Anderson, John F., *Questionnaires: Design and Use,* Metuchen N.J.: The Scarecrow Press, Inc., 1974.
5) Gatner, Elliot S.M., and Cordasco, Francesco, *Research and Report Writing*, New York: Barnes & Noble, Inc., 1956.
6) Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.
7) Kerlinger, Foundation of Research.

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Class: T. Y. B. Sc. Practical (Based on Semester – V Theory Papers)

Paper Code: BOT 3507

Paper: Practical-I Title of Paper: Practical based on BOT3501to BOT3503

Credit: 02 No. of practical: 14

A) Learning Objectives :

1 To aware the students about lower and higher plants diversity.
2 To study different plant families.
3 To enhance the knowledge of students up to the molecular level.

B) Learning Outcome :

1 It will help to conserve the biodiversity of lower and higher plants.
2 Students will get job in gene bank, gene mapping and bioinformatics disciplines.
3 Students get expertise in identification of plants.

Practical based on BOT3501- Cryptogamic Botany

1. Study of **Algae** with respect to systematic position thallus structure and reproduction of *Oscillatora*, *Batrachospermum* and *Volvox.*
2. Study of **Fungi** respect to systematic position thallus structure and reproduction of *Mucor Unicinula* and *Agaricus*.
3. Study of **Bryophytes** with respect to systematic position thallus structure and reproduction of *Marchantia*, *Anthoceros* and *Polytrichum.*
4. Study of **Pteridophytes** with respect to systematic position, sporophyte - morphology and anatomy, reproductive structures of *Psilotum*, *Selaginella* and *Salvinia*.

   Excursion tour to study cryptogams is compulsory.

Practical based on BOT3502 - Spermatophyta and Palaeobotany

5. Study of *Pinus* with the help of permanent slides and plant material- i) External morphology, ii) T. S. of stem (Temporary double stained preparation), iii) T. S. of needle (Temporary double stained preparation), iv) Morphology of male cone – T. S. & L. S. Permanent slide, mounting of pollen grains. v) Morphology of female cone – T. S. & L. S. Permanent slide, vi) Mounting of pollen grains. vii) V. S. of mature ovule(Permanent slide) (1 P)
6. Study of *Gnetum* with the help of permanent slides and plant material. i) External morphology, ii) T. S. of stem iii) T. S. of leaf (permanent slide), iv) Morphology of male cone vi) Morphology of female cone vii) V. S. of mature ovule. (1 P)
7. Study of at least any eight families as per theory course (3P)
8. Identification of plants with the help of regional/local/suitable flora. (1 P)
9. Preparation of an artificial key based on multiple characters/ Androecium / Gynoecium/vegetative characters (at least two keys) (1P)
10. Plant identification with the help of QR Code system (1 P)
11. Study of the following with the help of slides and / or specimens. (1P)
    i) Impression ii) Compression iii) Petrifaction iv) Coal ball v) *Rhynia*
    vi) *Pentoxylon* vii) *Nipaniophyllum* vii) *Lepidodendron*

Practical based on BOT3503 - Cell and Molecular Biology

12. Study of various stages of mitosis.
13. Plant Genomic DNA extraction from Cauliflower.
14. Extraction and estimation of RNA by Orcinol Method.

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Class: T. Y. B. Sc. Practical (Based on Semester – V Theory Papers)

Paper Code: BOT 3508

Paper: Practical-II Title of Paper: Practical based on BOT3504to BOT3506

Credit: 02 No. of practical: 13

A) Learning Objectives :

1 To learn recent techniques in Botany.
2 To learn industrial applications of Botany.
3 To make students expert in data analysis.

B) Learning Outcome :

1. Students can start their own business by using this techniques.
2. Data analyser will be expert to conclude the significance of biological experiments.
3. Students will understand the basics of research.

Practical based on BOT3504 - Industrial Botany

1. Study of Media Required for Hydroponics
2. Study of Hydroponic techonology for Chilli
3. Study of bottle and circular gardening
4. Study of Bonsai Preparation

Visits : Visit to any one Hydroponics Farming unit/ Warehouses/ Packhouses / cold-storage/ hydroponic farming unit

Practical based on BOT3505 – Biostatistics

5. Computation of mean, mode, median, variance and standard deviation from the plant sample.
6. Statistical problem solving based on Student's 't' test and Chi-square test.
7. Germination of various seed lots and analysis of data with various seed germination indices.
8. Analysis of vegetation data obtained from list count quadrat method for frequency, Density, abundance, relative dominance and importance value index.
9. Analysis of satellite data collected on biomass for RVI, DVI, NDVI, TNDVI, PVI.

Practicals based on BOT3506 – Research Methodology

10. Identification of research problem and making of hypothesis.
11. How to design research experiments.
12. Methods of data collection and Compilation of data.
13. How to write research paper.

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Class: T. Y. B. Sc. Practical (Based on Semester – V Theory Papers)

Paper Code: BOT 3509

Paper: Practical-III Title of Paper: Project based on BOT3501to BOT3506

Credit: 02

A) Learning Objectives:

1. To give information of research work
2. To create awareness about innovative methods.
3. To find out new conclusions through research.

B) Learning Outcome:

1. Information acquired about research work
2. Getting of awareness of innovative methodology.
3. Significant conclusions and outputs.

Research Project
Projects will be allotted to students based on theory papers of Semester - V.

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Class : **T. Y. B. Sc. (Semester –VI)**
Paper Code : **BOT 3601**
Paper: **I** Title of paper: **Plant Physiology and Biochemistry**
Credit : 3 No. of Lectures: 48

B) Learning Objectives
1. To give knowledge of physiological processes in plants.
2. To know structure and role of biomolecules.
3. To know role of different biochemical's in plant growth and development.

B) Learning Outcome:
1. Use knowledge for improvement of agricultural yield
2. Students aware about the plant to response environmental conditions.
3. Students get knowledge of internal activities in plant.

Credit - I (16L)
Unit - I

1) **Photosynthesis:** Ultrastructure of a chloroplast, photosynthetic pigments and their role, Photosystems, Light reaction, electron transport chain, Cyclic and Non- cyclic photophosphorylation, Path of carbon in photosynthesis – C_3 (Calvin cycle), C4 (HSK pathway), CAM pathway, Photo-respiration, photoinhibition, Significanceofphotosynthesis.**(10L)**

2) **Respiration:** Ultrastructure of a mitochondrion, Respiratory substrates, Types of respiration, Mechanism of aerobic respiration – Glycolysis, TCA cycle. Electron transport system, Chemi-osmotic hypothesis of ATP synthesis, Balance sheet of ATP generation in respiration. Cyanide resistant pathway,Significance of respiration.**(6L)**

Credit – II (16L)
Unit II

1) **Translocation of organic solutes:** Definition, Path of translocation, Mechanism of translocation – Pressure flow theory, Diffusion, Uniport, Symport, Antiport, Source sink relationship, Phloem loading and unloading.**(5L)**
2) **Stress Physiology:** Definition**,** Concept of abiotic, biotic and xenobiotic stresses. Types of abiotic stress – Salinity, drought. Response of plant to biotic stress (pathogen), Effect of stresses on theplantgrowth.**(5L)**
3) **Secondary Metabolites:** Definition, Types, Metabolic pool, biosynthesis of terpens, phenols and nitrogen containing compounds, Role ofsecondarymetabolites in plant. **(6L)**

Credit – III (16L)
Unit - III

1) **Carbohydrates:** Definition, classification, Properties and functions of carbohydrates. Synthesis and breakdownofstarch. **(3L)**
2) **Amino acids:** Definition, classification, properties, functions of amino

acids**. (2L)**

3) **Proteins:** Definition, Classification of proteins on the basis of structure, properties, functionsofproteins.**(2L)**
4) **Lipids:** Definition, classification, properties and functions of lipids. Synthesis andbreakdown oflipid in plants. **(3L)**
5) **Enzymology:** Definition and nature of enzymes, active site, Classification (IUB) and properties of enzymes, Co-enzymes, Isoenzyme, Allosteric enzyme, Ribozyme. Mechanism of enzyme action-Lockandkeyhypothesis,Inducedfittheory.Factorsaffectingenzymeactivity – pH, temperature, substrate concentration, enzyme concentration. Enzyme Activator and inhibitors – Competitive,uncompetitive,non-competitive. **(6L)**

References:

1. S. N. Pandey and B. K. Sinha (2014). Plant Physiology, Vikas Publishing House Pvt. Ltd., India.
2. Buchanan B.B, Gruissem W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists Maryland, USA.
3. Salisbury F.B and Ross C.W (1992). Plant physiology (Fourth Edition) Wadsworth Publishing Company, California,USA.
4. William G. Hopkins (1995) Introduction to Plant Physiology, Published by – John Wiley and Sons, Inc.
5. Lincoln Taiz and Eduardo Zeiger (2003). Plant Physiology (3rd edition), Published by – Panima Publishing Corporation
6. R. G. S. Bidwell (revised edn.)-Plant Physiology
7. Verma S.K. and Verma Mohit (2007). A.T.B of Plant Physiology, Biochemistry
8. and Biotechnology, S.Chand Publications.
9. Leninger A.C (1987). Principles of Biochmistry, CBS Publishers and Distributers (Indian Reprint)
10. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
11. Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA.
12. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer – Verlag, New York, USA.
13. Singhal G.S., Renger G., Sopory, S.K. Irrgang K.D and Govindjee 1999. Concept in Photobiology; Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi
14. Taiz L. and Zeiger E. 1998. Plant Physiology (Second Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.
15. Verma S.K. and Mohit Verma 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.

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Class	:	**T. Y. B. Sc. (Semester- VI)**		
Paper Code	:	**BOT 3602**		
Paper	:	II	Title of Paper :	**Plant Biotechnology**
Credit	:	**3**	No. of lectures :	48

A) Learning Objectives:

1) To give advance knowledge *Bt* theory and practical and modern techniques in tissue culture for production of high yielding varieties of plants.
2) This paper explores the use of biotechnology to how factors affects at cellular level the expression of genotypes and hence to phenotypic variations.
3) During Practical students will conduct recent techniques applied to generate information and observe genetic variation.

B) Learning Outcome:

1) Learn the basic concepts, principles and techniques in plant biotechnology.
2) Knowledge acquired students will be able to apply techniques in other branches such as biological,medical, agricultural etc.
3) Use of bio techniques to explore plant to its molecular level.

Credit - I (16L)

1. Introduction to Biotechnology **2L**

Introduction and History of plant Biotechnology, pioneering work and significant achievements in Indian plant Biotechnology

2. Plant Tissue Culture **14L**

Definition of cell and tissue, structure of cell, Importance of plant tissue culture, Types of culture, basic technique of plant tissue culture, Concept, techniques and applications of callus culture, cell suspension culture, protoplast culture, somatic hybridization and cybrids, Haploid production, Micro-propagation,embryo culture-and embryo rescue

Credit - II (16 L)

3. Germplasm and Cryopreservation **4L**

In situ and **Ex situ** conservation, techniques of cryopreservation, cold storage, low pressure and low oxygen storage, applications

4. Methods of gene transfer in plants **6L**

Restriction Endonucleases, Types, Direct gene transfer methods- Electroporation, Biolystic gene transfer, Liposome mediated transfer. Vector mediated gene transfer- *Agrobacterium* mediated gene transfer in plants, Ti-plasmid: structure and functions, Ti plasmid based vectors, advantages.

5. Biotechnology of Biological Nitrogen Fixation **6L**

Non symbiotic Nitrogen Fixation-Diazotrophs and their ecology, special features, Mechanism of N2 Fixation, Nitrogenase and Hydrogenase Symbiotic N2 Fixation- establishment of symbiosis, Factors affecting and mechanism of symbiotic N2 Fixation Genetics of Diazotrophs- Nod genes, Nif gene Biofertilizers- algal, fungal, phosphate solubilising.

Credit - III (16L)

6. Biotechnology and Society **4L**

Biotechnology- Benefits, GM foods and its safety, patenting of biotechnological inventions, Biotechnology and developing countries, Recombinant foods and religious beliefs, recombinant therapeutic product for human health care,Intellectual property rights.

7. Bioinformatics **4L**

Introduction, Database and its classification**,** NCBI, Data retrieval tools, INTREZ, OMIN, BLAST, FASTA, Applications of Bioinformatics.

8. Genomics and Proteomics **4L**

Genomics- methods, types and applications, Proteomics- Concept, types and importance

9. Molecular techniques **4L**

Blotting Techniques.Southern, Northern, Western and PCR

Reference Books:

1. R. C. Dube (2008). A Text Book of Biotechnology, S. Chand
2. P.K. Gupta (2019). Elements of Biotechnology
3. U. Satyanarayana (2017). Biotechnology
4. KalyanKumar De (2020). An introduction to Plant tissue culture
5. Pal J.K. and Ghaskadabi S.S. (2008). Fundamentals of Molecular Biology.
6. Verma and Agrawal (2010). Molecular Biology
7. Devi P (2008). Principle and Methods of plant Molecular Biology, Biochemistryand
Genetics Agrobios, Jodhpur, India.
8. Glick B.R. and Tompson J.E.(1993). Methods in Plant Molecular Biology and Biotechnology CRC Press Boca Raton, Florida.
9. Hall R.D. (Ed.) 1999. Plant cell culture Protocol human press Inc., New Jersey, USA
10.Kumar H.D. (2002) A Text Book of Biotechnology 2nd Edn. Affiliated Easyt-West Press
Private Ltd New Delhi.
11. Ramawat K.G. (2003).Plant Biotechnology, S. Chand & Co. Ltd .Ramnagar New Delhi.
12. Trivedi P.C.(2000). Plant Biotechnology, Panima Publishing Carpation, NewDelhi.
13.Razdan M K (2019). Introduction to Plant tissue culture.

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Class : **T. Y. B. Sc. (Semester - VI)**
Paper Code: **BOT 3603**
Paper : **III** Title of Paper : **Genetics and Plant Breeding**
Credit : 3 No. of lectures:48

A) Learning Objectives:

1. To study the principles of genetical heredity.
2. To give knowledge of different breeding methods.
3. To acquaint the students with hybridization technique.

B) Learning Outcome:

1. Students get knowledge of genetical heredity.
2. Students become expertise in Plant Breeding Techniques.
3. Get knowledge for improving the new crop variety.

Credit - I (14 L)
Unit – 1

1. **Genetics – Introduction (1L)**
   Definition, Branches and Applications of Genetics

2. **Mendelism (3 L)**
   Mendel's contribution, Mendel's law / Law of independent assortment, Monohybrid cross, dihybrid cross, test cross, back cross.
3. **Neomendelism / Interaction of genes(4 L)**
   Complementary genes (9:7), Duplicate genes (15:1), Supplementary genes (9:3:4), Masking genes (12:3:1), Lethal genes (2:1)
4. **Multiple allelism (2 L)**
   Definition, Characters of multiple alleles, Examples – Inheritance of blood group in human, self incompatibility in ***Nicotiana.***.
5. **Quantitative and Cytoplasmic Inheritance (4 L)**
   Concept of quantitative inheritance, Inheritance of quantitative trait in Maize (Cob length), Concept of cytoplasmic inheritance, Varigation in four O'clock plants, petite mutants in yeast.

Credit - II (16 L)
Unit – I1
1. Linkage and recombination (2L)
Linkage - Definition and types, Crossing over - Definition and types, Construction of a linkage map by two and three point test crosses.
2. Sex linked inheritance (4 L)
Concept of sex chromosomes and autosomes, Inheritance of X - linked genes - eye colour in ***Drosophila,*** Inheritance of colour blindness in humans, Inheritance of Y- linked genes – Holandric genes in humans, Sex influenced genes – baldness in humans, Sex-limited genes – feathering in domestic fowl.
3.Euploidy and Aneuploidy (5L)
Euploidy-Monoploidy, morphology and uses, Polyploidy -Concept and Characteristics ofpolyploids, Autopolyploidy- Origin and production, effects of autopolyploidy, uses. Allopolyploidy- Concept, synthesized allopolyploidy (wheat and cotton).
Aneuploidy - Monosomy and nullisomy, Trisomy in **Datura** and humans

4. Chromosomal Abberations (5L)
Types of structural changes in chromosomes, Deletion: types, Duplication: types and bar eye phenotype in ***Drosophila,*** Inversion: types, Translocation: types, Variation in chromosome morphology: Isochromosomes, ring chromosomes and Robertsonian translocation.

Credit - III (18 L)
Unit – I1I
PLANT BREEDING
1. Introduction, scope and importance (1 L)
2. Plant introduction and acclimatization (1 L)
Concept , objectives, Advantage, disadvantage and achievement.
3. Selection (2 L)
Concept , types - mass, pure line and clonal selection, Advantage and disadvantages.
4. Hybridization (2 L)

Concept, difficulties and precaution, Procedure, Achievements

5. Heterosis and hybrid vigour (1 L)

Concept, Causes of heterosis- dominance hypothesis, Applications

6. Mutation breeding (3 L)

Introduction and concept, Types of Mutation, mutagens used -Chemical and physical mutagens, methods of working, Gamma gardens, Applications

7. Importance of Polyploidy and aneuploidy in crop improvement (4 L)

Properties of polyploids,Methods of obtaining polyploids, Methods used in obtaining haploids, Production of triploids in plant breeding, Applications and achievements

8.Breeding for stress tolerance (4L)

Mechanisms and genetic bases of resistance/tolerance to biotic and abioticstresses in plants,Breeding for resistance/tolerance, Characteristics evaluated for drought tolerance, Characteristics evaluated for insect/pest tolerance, Achievements

References :

1. Principles of Genetics, J. Gardner and Simmons Snustad .
2. Genetics and Cytogenetics, Gupta P. K.
3. Principles and practices of Plant Breeding, Sharma J. R.
4. Plant Breeding – Principles and methods, Singh B. D.
5. Genetics Vol. I and II, Pawar C. B.
6. The Science of Genetics, Burus and Bottino
7. Genetics, Strikberger
8. Priniples of Plant Breeding, Allard R.W.
9. Genetics, Verma P. S. and Agarwal V. K.
10. Genetics, Singh B. D.
11. Gene VII, Lewin, B.
12. Genetics, Ahluwalia K. B.
13. Plant Breeding, Fundan singh

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Class : **T. Y. B. Sc. (Semester - VI)**

Paper Code : **BOT 3604**

Paper : **IV** Title of Paper : **Plant Pathology**

Credit : **3** No. of lectures : 48

A) Learning Objectives:

1) To study the diversity among the plant diseases.
2) To understand the mechanism of diseases development.
3) To study the economic losses caused by plant diseases.
4) To study the recent techniques in plant disease management.

B) Learning Outcome:

1) Students can be understood the details of meteorological factors and pathogens involved in disease development. So, it will help as prerequisite for avoiding the disease spreading.
2) Knowledge of plant pathology will helpful to use diseases resistant varieties of crop plants and their disease management.
3) Students can be start their own business related to eco-friendly management of plant diseases and its consultancy.

Credit - I (19L)

Unit – 1

1) **Fundamentals of plant pathology :** Introduction, Important terminology- Incitants, Host, Parasite, Pathogen, Inoculum, Penetration, Infection, Incubation, Disease, Disease development, Symptoms, Sign, Endophyte, Predisposition, Suscept, Resistance, Epidemic, Etiology. Economic importance of plant diseases, History of plant pathology, Introduction to Indian Agricultural Research Institute (IARI), International Crop Research Institute for Semi Arid Tropics (ICRISAT), Contribution of Anton De Bary and Prof. B.B. Mundkur (5L).
2) **Disease Development :** Concept of disease cycle, Inoculation, Prepenetration, Penetration, Infection, Dissemination. Epidemics - Forms, Decline, Exponential model. Disease forecasting, Measurement of plant disease and yield loss(6 L).
3) **Defence Mechanisms :** Concept and Definition, Types- Preexisting- Structural and chemical, Induced Structural and Biochemical (3L).
4) **Methods of Studying Plant Diseases :** Macroscopic study, Microscopic study, Koch's postulates. Culture techniques, Media Types and Preparation, Pure culture methods- streak plate, pour plate, spread plate, serial dilution(5L).

Credit - II (16L)

Unit – 2

5) **Fungal Plant Diseases :** Introduction to fungi as plant pathogens. Study of Diseases- Club root of Cabbage, Downy Mildew of Grapes, Powdery Mildew of Teak, Stem Rust of Wheat, Red Rot of Sugar cane with reference to causal organism, symptoms and signs, disease cycle and control measures (5L).
6) **Bacterial Plant Diseases :** Introduction to bacteria as plant pathogens, Study of Diseases- Citrus Canker, Black arm of Cotton with reference to causal organism, symptoms and signs, control measures (3L).
7) **Mycoplasma Plant Diseases** Introduction to Mycoplasma as plant pathogens, Study of Diseases- Grassy shoot disease of sugarcane, Little leaf of brinjal with reference to symptoms and signs, control measures (3L).
8) **Nematodal Plant Diseases :** Introduction to Nematodes as plant pathogens. Study of Diseases- Root knot disease of vegetables, Ear cockle of Wheat with reference to causal organism, symptoms and signs, control measures (2L).
9) **Viral Plant Diseases :** Introduction to Viruses as plant pathogens. Study of Diseases- Tobacco Mosaic Disease, Bunchy top of Banana with reference to causal organism, symptoms and signs, control measures (3L).

Credit - III (13 L)

Unit – 3

10) **Non Parasitic Diseases :** The impact and abiotic causes- Temperature, Soil moisture and relative humidity, Poor oxygen, Poor light, Air pollutants, mineral deficiencies. Herbicide injury, Study of Tip burn of Paddy, Mango necrosis, Black Heart of Potato, Khaira disease of rice (4L).
11) **Principles of Plant Disease Control :** General account, Quarantine, Eradication, cultural control practices, Biological control, Curative measures,

Chemical control, Use of Effective Microorganism Solution (EMS), Microbial Pesticides, IPM (5L).

12) **Molecular Diagnostics and Transgenic in Crop Protection :** Introduction, Classical approaches, Use of antibodies, Pathogen derived resistance against bacterial and fungal diseases, Expression of vaccines in plants (4L).

References:

1. Fungi and Plant Diseases by B. B. Mundkur
2. Plant Pathology, R. S. Mehrotra
3. Principles of Plant Pathology, R. S. Singh
4. Plant Pathology, P. D. Sharma
5. Plant Disease, R. S. Singh
6. Plant Pathology, Mandal and Dasgupta
7. Plant Pathology, G. N. Agrios
8. Agricultural Microbiology, Rangaswamy and Bhagyaraj
9. Fundamentals of Plant Pathology by Ravi Chandra
10. 10.Methods of Microbial and Plant Biotechnology, L. N. Nair
11. Molecular Plant Pathology, 2003. Dickinson, Bios Scientific Publication, London, New York.

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Class: **T. Y. B. Sc. (Semester - VI)**
Paper Code: **BOT3605**
Paper: **V** Title of Paper: **Pharmacognosy**
Credit: 3 No. of lectures: 48

A) Learning Objectives:

1. To Study traditional and alternative systems of medicines.
2. To Understand Ayurveda and its importance.
3. To study drug adulteration and its evaluation methods.
4. To understand herbal drugs cultivation methods, collection, processing and marketing.
5. To create scientific approaches towards Ayurveda.

B) Learning Outcomes:

1. Knowledge of traditional and alternative systems of medicines.
2. To increase desire Ayurveda.
3. Knowledge of drug adulteration and its evaluation methods.
4. Awareness of herbal drugs cultivation methods, collection, processing and marketing.
5. Vision of scientific approach towards Ayurveda.

Credit-I (16 L)
Unit-I
1. Introduction to Pharmacognosy (06 L)
1.1 History, definition and Scope of Pharmacognosy.
1.2 Traditional and alternative systems of medicine.
1.3 Classification of crude drugs: Morphological Taxonomical, and Chemical.
1.4 Plant antioxidants: Properties of Antioxidants, Vitamins (C and E).
2. Ayurvedic Pharmacy(10 L)

2.1 Introduction to Ayurveda-History and Description.
2.2 Tridosha concept, Humoral, Indigenous systems of medicine.
(Ayurveda, Siddha, Unani, Tibi)
2.3 Ayurvedic principles- Ras, Guna, Vipaka, Virya, Prabhava.
2.4 Ayurvedic formulations: Asava, Arishta, Kvatha, Churna, Leha, Vatika, Taila, Bhasma.
2.5 Nutraceuticals &Cosmaceuticals: concept and description.

Credit-II (16 L)
Unit-II
3. Analytical Pharmacognosy (8 L)
3.1 Drug adulteration:Definition and concept and its types.
3.2 Adulteration of drugs of natural origin: Evaluation by morphological, Microscopic,Chemical, Physical, Chromatographical, Spectrophotometric.
3.3 Health hazards of adulterants, Prevention of Food Adulteration Act, 1954.
4. Cultivation, collection and processing of Crude drugs (8L)
4.1 Crude drugs Definition, Importance of herbal drug.
4.2 Cultivation methodspropagations, factors affecting of cultivation.
4.3 Collection and Processing harvesting, collection, drying, garbling, packing, storage of crudedrugs and marketing of Mentha and Eucalyptus.

Credit-III(16 L)
Unit-III
5. Study of drugs w.r.t. occurrence, distribution cultivation, macroscopic and microscopic characters, constituents, uses and adulterants (any two) of the following. .....**(12 L)**
Root Rhizome drugs: *Liquorice*, Ginger
Stem drugs: *Ephedra*, *Tinospora*
Bark drugs: *Cinnamon*, *Cinchona*
Leaf drugs: *Aloe*, *Adhatoda*
Flower drugs: *Clove*
Fruit drugs: - Amla, Coriander
Seed drugs: Fennel
Unorganized drugs: Shilajit and Acacia gum
6. Ethno botany(4L)
Ethnobotany:
Introduction, Definition, concepts and relevances.
Branches of Ethnobotany.
Sacred grooves: Concept, Importance, Present status of sacred grooves in India.
Ethnic Societies of India and world & their contribution.
Ethnobotany of *Aeglemarmelos*, *Buteamonosperma*, Neem (*Azadirachtaindica*)w.r.t. Taxonomic description, distribution, phytochemistry and uses, Social &religious practices.

References:

1) A Pharmacognosy and Pharmacobiotechnology. New Age international (P) Limited,
2) AshalotaRazario*etal*. A Hand Book of Ethno biology KalyaniPublishesr 1999.
3) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons –Chichester

4) Kokate C.K. Practical Pharmacognosy, Vallabhprakashan, New Delhi,
5) Kokate C.K. Purohit A.P. and Gokhale S.B. Pharmacognosy, NiraliPrakashan PunePublishers (formerly wileyEasterm Limited).
6) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA
7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah.
8) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India
9) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
10) S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur
11) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995. SHREE Publishers, Jaipur-1996.
12) Trease G.E. and Evans. W.C. Pharmacognosy ELBS Twelfth Edition
13) Vaidya S.S. and Dole.V.A. Bhaishyajakalpana, AnmolPrakashan, Pune
14) Wallis,T.E. Test books of pharmacognosy CBS publishers and distributors New Delhi
15) http://www.indiaenvironmentportal.org.in

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Class: **T. Y. B. Sc. (Semester - VI)**
Paper Code: **BOT 3606**
Paper: **VI** Title of Paper: **Botanical Techniques**
Credit: 3 No. of lectures: 48

A) Learning Objectives:

To enable the students:

- To have comprehensive knowledge on various analytical techniques
- To understand the significance of techniques in plants science research.
- To aware the students about the instrumentation.

B) Learning Outcome:

The course will provide a comprehensive knowledge on various techniques for understanding and exploring the plants for their bio potential. On satisfying the requirements of this course, students will have the knowledge and skills on

- Principal and types of microscopes, microtomes and various types of stains, solutions
- Various advanced methods for estimation of plant based molecules
- Techniques of analysis of soil and water samples

Credit - I (18 L)

Unit – 1

1. Microscopy: Introduction, Principle, Types - Simple, Compound, Light, Bright and dark field, Fluorescence, Phase contrast, Electron Microscope- Scanning Electron Microscope SEM and Transmission Electron Microscope (TEM), image processing- photomicrography (6 L)

2. Micrometry: Principle and measurement of microscopic objects, Microscopic measurements of cell size, calibration of ocular and stage micrometer.(2 L)
3. Aerobiology: Principal, methods of data collection, types of sampler(2 L)
4. Stains and staining- Principles of staining, preparation of stains and fixatives, simple staining, negative staining, differential staining, A brief account of histochemical staining technique (4 L)
5. Preservation techniques in cryptogams : (4L)

Credit - II (16 L)
Unit – II

6. Microtomy: Principal, Types- rotary, sledge, Techniques of microtomy, Applications (4L)
7. Chromatography: Principle; Types - Paper chromatography, Column chromatography, TLC, Applications (4 L)
8. Spectroscopy: Principle, types, general outlines of working of UV- Vis spectroscopy, Applications (4 L)
9. Centrifugation: Principle,types of rotors, types of centrifuges and types of centrifugations, Applications (4 L)

Credit - III (14L)
Unit – III

10. Buffers and Solutions: types of buffers, preparations of Buffers, functions of buffers in biological systems, Preparation of Percentage, Molar, Molal and Normal solutions. (06 L)
11. Soil Analysis: Soil sampling, importance, soil structure, soil profile, methods of analysis for Physical, Chemical and Biological properties, Water Analysis: Sampling, methods of analysis for Physico-chemical and Biological properties. (08 L)

References:

1. Douglas B. Murphy and Michael W. Davidson (2012) Fundamentals of Light Microscopy and Electronic Imaging, Wiley- Blackwell Publications
2. Kieth Wilson and John walker (2010) Principles and Techniques in Biochemistry and Molecular Biology, Cambridge University Press
3. Harry Salem and Sidney A. Katz (2016) Aerobiology: The toxicology of airborne Pathogen and Toxins, Royal society of Chemistry
4. Aakanchha Jain, Richa Jain and Sourabh Jain (2021) Basic Techniques in Biochemistry, Microbiology and Molecular BiologyPrinciples and Techniques
5. PranabDey, (2018) Basic and Advanced Laboratory technique in Histopathology, Springer
6. Rob Beynon and J Easterby (2004) Buffer solutions, Oxford University Press
7. Michael E. Essinngton (2003) Soil and water Chemistry: An integrative Approach, CRC press

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Class: T. Y. B. Sc. Practical (Based on Semester – VI Theory Papers)

Paper Code: BOT 3607

Paper: Practical-I Title of Paper: Practical based on BOT3601 to BOT3603

Credit: 2 No. of Practical: 12

A) Learning Objectives:

1 To make aware about tools and techniques required for plant analysis.
2 To give detailed idea about multiplication and production of new varieties.
3 To give hands-on training required for setting of experiments.

B) Learning Outcome:

1 Students will be expert in tissue culture techniques.
2 Students can get employment in agro-industries.
3 Expertise of students in plant pathogenecity will help to identify and eradicate pathogens which will help to enhance plant production.

Practical based on BOT3601- Plant Physiology and Biochemistry

1. Estimation of chlorophyll-a and chlorophyll-b by spectrometric method.
2. Separation of photosynthetic pigments by TLC/Paperchromatography.
3. To determine diurnal fluctuation in TAN values of CAM plants.
4. Estimation of soluble proteins by Lowery *et al.*method.

Practical based on BOT3602- Plant Biotechnology

5. Preparation of MS Medium or BGA culture Medium
6. Callus Induction using maize embryo or Isolation of Protoplast.
7. Estimation of Nitrate Reductase enzyme from Legume nodules.
8. Study of methods of gene transfer through photographs.

- Visit to Biotechnology institute and Report preparation

Practical based on BOT3603- Genetics and Plant Breeding

9. Induction of tetraploidy in onion root cells and preparation of squash for observation of tetraploid cells.
10. Genetic problems on gene mapping using three point test cross data.
11. Demonstration of Hybridization Techniques.
12. Effect of chemical mutagens on seed germination and seedling growth.

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Class: T. Y. B. Sc. Practical (Based on Semester – VI Theory Papers)

Paper Code: BOT 3608

Paper: Practical-II Title of Paper: Practical based on BOT3604 to BOT3606

Credit: 2 No. of Practical: 12

A) Learning Objectives:

1. To study the diversity among the plant diseases.
2. To study the recent techniques in plant disease management.
3. To study traditional and alternative systems of medicines.

B) Learning Outcome:

1. Students can get employment in agro-industries.
2. Expertise of students in plant pathogenecity will help to identify and eradicate pathogens which will help to enhance plant production.

3. Student get expertise in soil and water analysis.

Practical based on BOT3604- Plant Pathology

1. Preparation of any one culture media for isolation of plant pathogens.
2. Culture technique - Streak plate methods, Pour plate methods, Spread plate and Serial dilution method for preparation of pure culture.
3. Study of any two of each fungal, bacterial and mycoplasma diseases.
4. Study of any two viral and non-parasitic diseases of plants.

Visit to any Agricultural Research Institute and Plant Pathology Laboratory and submission of report.

Practical based on BOT3605- Pharmacognosy

5.Study of any six drug plants from theory syllabus (Macroscopic and Microscopic).

6. Demonstration of Plant extraction methods- Cold and Soxhlet extraction and TLC of any one drug studied in theory.
7. Qualitative analysis of Alkaloid, Glycoside and Tannin
8. Study of stomatal index and vein islet number using suitable plant material using micrometer and camera Lucida.

Visit : Survey of local flora with respect their medicinal and economic importance and submission of 10 dry specimens.

Practical based on BOT3606- Botanical Techniques

9. Micrometry of suitable botanical material.
10. Microtomy- Preparation and processing of suitable material, Sectioning, - Fixing, staining and mounting
11. Demonstrations-Rotorod sampler
12. Preparation of Stains, Buffer and molar, molal and normal solutions

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Class: T. Y. B. Sc. Practical (Based on Semester – VI Theory Papers)

Paper Code: BOT 3609

Paper: Practical-III Title of Paper: Project based on BOT3601to BOT3606

Credit: 2

A) Learning Objectives:

1. To give information of research work
2. To create awareness about innovative methods.
3. To find out new conclusions through research.

B) Learning Outcome:

1. Information acquired about research work
2. Getting of awareness of innovative methodology.
3. Significant conclusions and outputs.

Research Project

Projects will be allotted to students based on theory papers of Semester - VI.

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