

॥ सा विद्या या विमुक्तये ॥



# स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

“ज्ञानतीर्थ” परिसर, विष्णुपुरी, नांदेड - ४३१६०६ (महाराष्ट्र)

**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED**

“Dnyanteerth”, Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)

Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade

## ACADEMIC (1-BOARD OF STUDIES) SECTION

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संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०-२१ पासून लागू करण्याबाबत.

### प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २० जून २०२० रोजी संपन्न झालेल्या ४७व्या मा. विद्या परिषद बैठकीतील विषय क्र.११/४७-२०२०च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे खालील विषयांचे C.B.C.S. (Choice Based Credit System) Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०-२१ पासून लागू करण्यात येत आहेत.

1. M.Sc.-II Year-Botany
2. M.Sc.-II Year-Herbal Medicine
3. M.Sc.-II Year-Analytical Chemistry
4. M.Sc.-II Year-Biochemistry
5. M.Sc.-II Year-Organic Chemistry
6. M.Sc.-II Year-Physical Chemistry
7. M.Sc.-II Year-Computer Management
8. M.Sc.-II Year-Computer Science
9. M.Sc.-II Year-Information Technology
10. M.C.A. (Master of Computer Applications)-II Year
11. M.Sc.-II Year-Software Engineering
12. M.Sc.-II Year-System Administration & Networking
13. M.Sc.-II Year-Dairy Science
14. M.Sc.-II Year-Environmental Science
15. M.Sc.-II Year-Applied Mathematics
16. M.Sc.-II Year-Mathematics
17. M.Sc.-II Year-Microbiology
18. M.Sc.-II Year-Physics
19. M.Sc.-II Year-Zoology
20. M.Sc.-II Year-Biotechnology
21. M.Sc.-II Year-Bioinformatics

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या [www.srtmun.ac.in](http://www.srtmun.ac.in) या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

‘ज्ञानतीर्थ’ परिसर,

विष्णुपुरी, नांदेड - ४३१ ६०६.

जा.क्र.: शैक्षणिक-१/परिपत्रक/पदव्युत्तर-सीबीसीएस अभ्यासक्रम/  
२०२०-२१/३३५

दिनांक : १६.०७.२०२०.

प्रत माहिती व पुढील कार्यवाहीस्तव :

- १) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
- २) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
- ३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
- ४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
- ५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
- ६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

स्वाक्षरित / -

**उपकुलसचिव**

शैक्षणिक (१-अभ्यासमंडळ) विभाग



**SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED**  
**CHOICE BASED CREDIT SYSTEM (CBCS)**

**SEMESTER PATTERN**

Faculty of Science  
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**BOTANY - CURRICULUM**

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**M. Sc. SECOND YEAR**  
**SEMESTER III & IV**  
**BOTANY- CURRICULUM**

**JUNE, 2020**



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## **INTRODUCTION**

The SRTMUN is gearing up for several initiatives towards academic excellence, quality improvement and administrative reforms. In view of this priority and in-keeping with Vision and Mission; process was already initiated towards introduction of semester system, grading system and credit system. In the recent past, University had already implemented Credit based grading system to campus schools. Now University is implementing Choice Based Credit System (CBCS) for UG and PG in all the affiliated colleges. These regulations shall be called as Choice Based Course Credit System & Grading, 2014. In short it will be referred as SRTMUN CBCS REGULATION. Further, Revised Guidelines for implementation of CBCS in affiliated college w.e.f. 2019-20 were also issued.

Revision and updating of the curriculum is the continuous process to provide an updated education to the students at large. Presently there is wide diversity in the curriculum of different Indian Universities which inhibited mobility of students in other universities or states. To ensure and have uniform curriculum at UG and PG levels as per the SRTMUN CBCS REGULATION, curriculum of different Indian Universities, syllabus of NET/SET, MPSC, UPSC, forest services and the UGC model curriculum are referred to serve as a base in updating the same. The M.Sc. Botany (General) semester pattern course is running in different affiliated colleges of the SRTMUN. The course content has been designed on the basis of CBCS pattern. The course content of each theory paper is divided into units by giving appropriate titles and subtitles. For each unit, total number of periods required, weight age of maximum marks and credits are mentioned. A list of practical exercises for laboratory course work based on theory papers to be completed in the academic year is also given. A list of selected reading material and a common skeleton question paper for all the theory papers of semester-I&II are also provided at the end of the syllabus.



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**Salient Features:**

The syllabus of M. Sc. Botany has been framed to meet the requirement of Choice Based Credit System. The courses offered will train and orient the students in the specific fields of Botany. Apart from the Fundamental and applied Core Courses, the Discipline Specific Elective Courses deals with Principles of Plant Pathology, Diseases of Crop plants and their Management, Systematics of Angiosperm, Plant Structure and Reproductive Biology, Principles of Seed technology, Seed Pathology, Phytochemistry and Pharmacognosy, Seed Production and Processing, Seed Health testing and Management, Physiological and Molecular Plant Pathology, Diseases of Fruit plants and their Management.

Open Elective Courses provides an option to learn courses of their own choice across the Discipline from the other colleges or any other Institute. It also provides the option to learn online Courses of their choice like MOOC-NPTEL-SWAYAM etc.

This would help students to lay a strong foundation in the field of Botany.

The courses which deal with the environment, sustainability and ethics are Biology and Diversity of Microbes and Cryptogams, Taxonomy of Angiosperms and Gymnosperms, Plant Resource Utilization and Biodiversity Conservation, Plant Ecology and Environmental Biology and Phytogeography, Reproductive Biology and Systematics of Angiosperms. These courses create awareness about conservation of biodiversity and its relevance with the socio-economical and environmental aspects. It also aims to make the students aware of bioethics, legislations and acts prevalent to control the degradation of our environment.

Overall after completion of this course, students will acquire fundamental knowledge in Plant Science and also understand how Botany is an integral part of the human life and developments.

**Program Educational Objectives:**

**The Objectives of this program are:**



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**PEO1:** To provide an updated education to the students at large in order to know the importance and scope of the discipline and to provide mobility to students from one university or state to other.

**PEO2:** To update curriculum by introducing recent advances in the subject and enable the students to face NET, SET, UPSC and other competitive examinations successfully.

**PEO3:** To impart knowledge of plant science as the basic objective of Education

**PEO4:** To develop a scientific attitude to make students open minded, critical and curious

**PEO5:** To appreciate and apply ethical principles to plant science research and studies

**Program Outcomes:**

**PSO-1:** This program will train and orient the students in developing skill in plant sciences. They will perform experiments, handle sophisticated equipments. They will acquire the knowledge for interpretation of plant materials and data.

**PSO-2:** This program will also generate human resource for plant based and seed industries.

**PSO-3:** This program will also generate human resources for diagnosis and management of plant diseases

**PSO-4:** This program will generate expertise in the field of plant identification and phytochemistry and plant tissue culture.

**PSO-5:** This program will generate employment in the field of agriculture and seed industries, Forestry, Botanical gardens, plant breeding centers.

**Prerequisite:**

The optional courses are offered to the students registered for post-graduate programs. Such students should have the basic knowledge of Plant Science and willing to gain additional knowledge in the field of Botany.

Admissions to this program are given as per the University rules.



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**M. Sc. SECOND YEAR BOTANY**

**CURRICULUM**

**Semester-III**

An Outline:

Paper number & Title	Credits (Marks)			Periods
	External: ESE	Internal: CA	Total Credits (Marks)	
<b>Theory Paper-XI:</b> Plant Physiology	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>Theory Paper-XII:</b> Molecular Biology and Biostatistics	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>*Elective-A ( For Specialization In Plant Pathology)</b>				
<b>*Theory Paper-XIII:</b> Plant Pathology-I (Principles of Plant Pathology)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>*Theory Paper-XIV:</b> Plant Pathology-II (Diseases of Crop plants and their Management)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>OR *Elective-B ( For Specialization In Angiosperms)</b>				
<b>*Theory Paper-XIII:</b> Angiosperms-I (Systematics of Angiosperm-I)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>*Theory Paper-XIV:</b> Angiosperms-II (Plant Structure and Reproductive Biology)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>OR *Elective-C</b>				





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**M. Sc. SECOND YEAR BOTANY CURRICULUM**

**Semester-IV**

An Outline:

Paper number & Title	Credits (Marks)			Periods
	External: ESE	Internal: CA	Total Credits (Marks)	
<b>Theory Paper-XVI:</b> Biochemistry and Plant Metabolism	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>Theory Paper-XVII:</b> Biotechnology and Genetic Engineering	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>*Elective-A ( For Specialization In Plant Pathology)</b>				
<b>*Theory Paper-XVIII:</b> Plant Pathology-III (Physiological and Molecular Plant Pathology)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>*Theory Paper-XIX:</b> Plant Pathology-IV (Diseases of Fruit plants and their Management)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>OR *Elective-B ( For Specialization In Angiosperms)</b>				
<b>*Theory Paper-XVIII:</b> Angiosperms-III (Systematics of Angiosperms-II)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>*Theory Paper-XIX:</b> Angiosperms-IV (Phytochemistry and Pharmacognosy)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>OR *Elective-C (For Specialization In Seed Technology)</b>				





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Paper number & Title	Credits (Marks)			Periods
	External: ESE	Internal: CA	Total Credits (Marks)	
* <b>Theory Paper-XVIII:</b> Seed Technology-III(Seed Production and Processing)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
* <b>Theory Paper-XIX:</b> Seed Technology-IV (Seed Health testing and Management)	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Tests: 20 marks, Assignment: 05marks)	Credits: 04 (Marks:100)	60
<b>Theory Paper-XX:</b> Seminar/ MOOCs (SWAYAM/NPTEL)	-	Credit: 01 (Marks:25)	Credits: 01 (Marks:25)	-
<b>Total</b>	Credit: 12 (Marks: 300)	Credit: 05 (Marks:125)	Credits: 17 (Marks:425)	240

(ESE: End of semester examination, CA: Continuous assessment, \*: Elective papers)



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**M. Sc. SECOND YEAR BOTANY LABORATORY COURSE WORK**

**Annual Pattern**

An Outline:

Paper number & Title	Credits (Marks)			Practicals
	External: ESE	Internal: CA	Total Credits (Marks)	
<b>Laboratory Course Work-V:</b> Based on theory paper-XI&XII	Credit: 03 (Marks:75)	Credit: 01 (Marks:25)	Credits: 04 (Marks:100)	15
<b>Laboratory Course Work-VI:</b> Based on theory paper-XVI &XVII	Credit: 03 (Marks:75)	Credit: 01 (Marks:25)	Credits: 04 (Marks:100)	15
<b>*Laboratory Course Work- VII:</b> Based on theory paper-XIII, XIV, XVIII & XIX	Credit: 03 (Marks:75)	Credit: 01 (Marks:25)	Credits: 04 (Marks:100)	15
<b>*Laboratory Course Work- VIII:</b> Project Work	Credit: 03 (Marks:75)	Credit: 01 (Marks:25)	Credits: 04 (Marks:100)	15
<b>Total</b>	Credit: 12 (Marks: 300)	Credit: 05 (Marks:125)	Credits: 16 (Marks:425)	60

(ESE: End of Semester Examination, CA: Continuous Assessment, \*: Elective paper)



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**M. Sc. SECOND YEAR  
SEMESTER – III  
BOTANY**

**JUNE, 2020**



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**SEMESTER – III**

**BOTANY**

**THEORY PAPER-XI: PLANT PHYSIOLOGY**

Periods: 60

Credits: 04

**Learning Objectives**

1. To understand basic aspects plant life processes.
2. To understand role of light and hormones in plant.
3. To know process of food synthesis and its breakdown in plants

**Learning outcomes:**

1. Understanding the mechanism of different water based process in plants.
2. Able to understand role of light, hormone in controlling plant activity
3. Understand important plant process i.e. photosynthesis and respiration.

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**Unit I- Plant Water Inter-relations and Mineral Nutrition: (15 periods)**

**Introduction:** Scope and Importance of Plant Physiology; **Bioenergetics-** concept of free energy, enthalpy, entropy, basic laws of thermodynamics; Molecular Structure and Physico-chemical properties of water, Solutions, Suspensions, Colloidal System, Diffusion, Osmosis, Imbibitions, Concept of Water Potential, Water absorption, Transportation, Transpiration. Uniport, Symport, Antiport channels, Phloem transports across the plant, Mechanism of Phloem Loading and Unloading source and sink relationship. Brief Account on Macro and Micronutrient, Functions and deficiency and symptoms of different Macro and Microelements

**UNIT-II: Photobiology, Hormone Physiology and Plant Movement(15 periods)**

**Phytochromes-** Introduction, discovery and properties of Phytochromes, red and far red pigment system; Effect of Phytochromes on plant development; Phenomenon of Photoperiodism and Vernalization. Causes and methods of breaking seed dormancy

**Hormonal Physiology:** Biochemistry, Mode of actions, Mechanism of biosynthesis and Practical applications of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene, Brassinosteroides, Salicylic acid Jasmonic Acid. Role of hormone in fruit ripening, biochemical and molecular changes during ripening.

**Plant Movement:** Introduction and types of spontaneous and induced plants movement.

**Unit III Photosynthesis (15 periods)**

**Photochemistry:** Nature and Properties of light, fluorescence, phosphorescence, quantum requirement and quantum yield, Ultra structure of chloroplast, Location and organization of photosynthetic pigments, Chemistry, properties and biosynthesis of photosynthetic pigments, Mechanism of light capturing and light harvesting.

**Photosynthesis:** Van Niel Hill Reaction, two pigment system, water oxidation complex, electron transport system - Z – scheme, cyclic, non cyclic, photophosphorylation and ATP synthesis, photosynthetic carbon reduction pathways in C<sub>3</sub>, C<sub>4</sub> and CAM plants, Biochemical variants of C<sub>4</sub> pathway. Regulation of Calvin Cycle, Biochemistry and Genetics



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of RUBISCO. Photorespiration and its significance, inhibitors and uncouples of photosynthesis.

**UNIT- IV: Respiration(15 periods)**

**Cell Respiration** : Introduction to plant respiration, respiration types and locations, fermentations and its types, Mitochondrial anatomy, concept of RQ, Glycolysis: Mechanism and regulation, entry of pyruvate to Mitochondria, pyruvate dehydrogenase, formation of acetyl co-a, Kerb's cycle: Mechanism, regulation and significance, Anapleorotic reactions of TCA, Electron transport system and oxidative phosphorylation, mechanism and regulation of ATP synthesis. Pentose Phosphate Pathway and its significance, Glyoxalate pathway, Energetics of fermentation and respiration, Factors affecting on respiration Respiratory, inhibitors and uncouplers of respiration.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER XI:**

1. Determination of water potential of potato tuber.
2. Determination of osmotic potential by plasmolytic method
3. Effect of IAA on seed germination and seedling growth
4. Effect of GA on seed germination and seedling growth
5. Effect of Cytokinin on seed germination and seedling growth
6. Effect of an Inhibitor and an Un-Coupler on the Rate of Photosynthesis
7. Determination of RQ of given plant material (seeds).

Demonstration of respiratory enzymes (oxidase, peroxidase, dehydrogenase and catalase) in the plant tissues

8. Isolation of chloroplasts and its ultramicroscopic observation.
9. Isolation of mitochondria and its ultramicroscopic observation
10. Separation of pigments by paper chromatography and TLC (1 Practical)
11. To determine the chlorophyll a / chlorophyll b ratio in C3 and C4 plants.
12. Extraction of chlorophyll pigments from the leaves and preparation of absorption spectra
13. Survey of C4 plants and CAM plants from local Botanical garden/Campus vegetation
14. Visit to research centre/long/short tour.



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**M. Sc. SECOND YEAR**

**SEMESTER – III**

**BOTANY**

**THEORY PAPER-XII: MOLECULAR BIOLOGY AND BIostatISTICS**

Periods: 60

Credits: 04

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**Learning Objectives**

1. To understand DNA characters and its functions.
2. To understand organization and expression of genome.
3. To understand importance of statistics in biology

**Learning outcomes:**

1. Detailed understanding about the nucleic acid.
  2. Able to understand expression and regulation of different proteins in body
  3. Understanding and interpretation of various statistical tools in biological experiments.
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**UNIT-I: MOLECULAR BIOLOGY (15 periods)**

Basic Discoveries in molecular cytogenetics; Structure and chemical, physical, spectroscopic and thermal properties of nucleic acids (Buoyant density, melting temperature, effect of acid and alkali, UV absorption, hypo and hyperchromicity); Nuclear DNA content, Dissociation and reassociation kinetics of DNA, Cot curves, Cot  $\frac{1}{2}$  values and its significance. Unique, moderately repetitive and highly repetitive DNA, forms of DNA; Prokaryotic Transcription; Transcription unit; Promoters, Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Transcriptional regulation-Positive and negative, Eukaryotic transcription and regulation; RNA polymerase.

**UNIT-II: GENOME ORGANIZATION AND REGULATION (15 periods)**

Organization and structure of prokaryotic and eukaryotic genes; structure and role of promoters, exons, introns, terminators and enhancers. Mechanism of prokaryotic and eukaryotic DNA replication, Enzymes of DNA replications and their role, Models of replication, replication apparatus, Origins of replication, priming and DNA polymerases. Regulation of gene expression in pro-and eukaryotes, Attenuation and antitermination, Operon concept and types, DNA methylation, Heterochromatization, Regulatory sequences and transcription factors, Environmental regulation of gene expression.

**UNIT-III: PROTEIN SYNTHESIS AND BACTERIAL GENETICS (15 periods)**

Processing of tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Translation machinery; Ribosomes- Composition and assembly; Genetic Code; Mechanism of initiation, elongation and termination; Post-translational modifications; Mobile DNA - conjugative and non-conjugative plasmids, insertional sequences and transposons, Bacterial growth and Genetics, genetic transformation, conjugation and transduction in bacteria, genetic recombination, Plaque formation, Lytic and lysogenic cycles. Specialized transduction, site specific recombination, genetic map of Lambda ( $\lambda$ ) phage.



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**UNIT- IV: BIOSTATISTICS (15 periods)**

Central value- Mean, mode, median, mean deviation, standard deviation and coefficient of variation, test of significance (T-test, chi-square test)

Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X<sup>2</sup> test; Basic introduction to Multivariate statistics, Hypothesis tests, Types of errors, P-values, ANOVA.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER XII:**

1. Study of aseptic techniques, safe handling of microorganisms, storage of culture and sub-culturing, establishing pure culture (streak plate method)
2. Study of growth characteristic of *E.coli* using plating and turbidimetric method.
3. Isolation of DNA from plants and Estimation by DPA method
4. Isolation of RNA and Estimation of RNA by orcinol method
5. Isolation of plasmid from *E. coli* by alkaline lysis method and its quantification spectrophotometrically.
6. Study of bacterial transformation
7. Study of bacterial conjugation.
8. Problem based on mean, mode, median, mean deviation, standard deviation, C.V. from the data.
9. Study of frequency distribution, frequency curve and frequency histogram based on data
10. Contingency table, frequency table
11. Simple bar chart, stem and leaf plot
12. Histogram, Box and whisker plot
13. Visit to biotechnology laboratory/ field visit/long/short tour



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w. e. f. Academic Year 2020-2021

**M. Sc. SECOND YEAR**

**SEMESTER – III**

**BOTANY**

**\*Elective-A (For Specialization in Plant Pathology)**

**\*Theory Paper-XIII: PLANT PATHOLOGY-I**

**(PRINCIPLES OF PLANT PATHOLOGY)**

Periods: 60

Credits: 04

**Learning Objectives:**

1. To develop interest among the about Plant pathology
2. To understand the importance of epidemics and forecasting of plant diseases.
3. To Understand the process of infection for disease development

**Learning Outcomes:**

1. The students will be able to understand the importance of plant pathology and will helps to develop interest in Plant Pathology.
2. They will bring the awareness among the farmers for losses caused due to epidemics
3. They will opt plant pathology as a Profession

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**UNIT-I: FUNDAMENTALS OF PLANT PATHOLOGY (15 periods)**

**Scope and Importance of Plant Pathology:** Worldwide development of Plant Pathology as Profession, Careers in Plant Pathology, The Practice and Practitioners of Plant Pathology, Plant disease Clinics, Relationship of plant Pathology with other sciences. Certification of Professional Plant Pathologists, Innovations in teaching Plant Pathology. **Contributions of Scientists in the field of Plant Pathology :** Anton de Bary, E.F .Smith, E. C. Stakman, E. J. Butler, C. V. Subramanian, M. J. Thirumalachar, Prof. T. S. Sadasivan, **Survival of Plant pathogens:** Infection chains, Major factors affecting the survival of pathogens in soil, Major sources of survival, Dormancy, Survival of Fungal pathogens, Phytopathogenic bacteria, nematodes and plant viruses.

**UNIT- II: THE PATHOGENESIS (15 periods)**

Pre penetration activity of pathogen on the host surface, Path of infection: Direct penetration, Entry through intact surface (Epidermis), Entry through non cutinized surface (flower, bud and root hair). Indirect entry of pathogens into the host: through natural openings (Stomata, Lenticels and Hydathodes) and wounds. Effect of Environment on Pathogenesis: Effect of temperature, humidity, wind, light, soil reaction(pH), plant nutrition.

The biotic environment: The rhizosphere, Phylloplane, Antagonistic association, phenomenon of fungistatis, symbiotic association, synergistic association.

**UNIT-III: AEROBIOLOGY, EPIDEMIOLOGY AND DISEASE FORECASTING (15 periods)**

**Aerobiology:** Airborne pathogens, Methods for detection of Aerospora, Scope and applications of Aerobiology.





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**Epidemiology:** Concepts of epidemiology. Slow and rapid epidemics, Favorable factors for development of epidemics, Conditions for decline of epidemics, **Disease Forecasting:** General account of Plant Disease Forecast Systems with some examples.

**Dispersal of plant pathogens: Autonomous dispersal:** soil as a means of autonomous dispersal, seed as a source of autonomous dispersal, plant and plant organs as a means of autonomous dispersal. **Passive dispersal:** Dispersal by air, water, insects, nematodes, animals, man and phanerogamic plant parasites.

**UNIT- IV: DEFENCE MECHANISM IN PLANTS (15 periods)**

General account, **Structural Defence: Pre existing Structural Defence:** Waxes and cuticle, structure of epidermal cell wall, stomata, mechanical tissues. **Post inflectional Structural defence in host plants:** Formation of Cork layer, Tyloses, Abscission layers, Gum deposition,,Sheathing of hyphae. **Biochemical Defence: Pre existing biochemical defence:** Antifungal and antimicrobial compounds released by the plant in its environment, Inhibitors already present in plant cells, Deficiency of essential nutrients for growth of pathogen, Absence of common antigens. **Post infectinal Biochemical Defence:** Defence through detoxification of pathogen toxins, Defence through induced synthesis of proteins and enzymes, Defence through hypersensitivity, Toxic chemicals produced in plant in response to infection: Phenolic compounds and their role in defence, **Phytoalexins:** Synthesis, Characteristics and role, Elicitors of phytoalexins.

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**LABORATORY COURSE WORK BASED ON PAPER-XIII (A):**

1. Study of survival of fungal pathogens in soil and infected host
2. Study of dormant organs of fungal pathogens as a source of survival
3. Isolation and identification of plant pathogens from air over infected field
4. Estimation of Aerospora from infected crop field by using Tilak air Sampler
5. Study of Rhizosphere mycoflora from different soil samples of infected and healthy plants by Serial dilution technique
6. Isolation of Phylloplane mycoflora from diseased and healthy plant by leaf print method
7. Screening of suitable Carbon sources for good growth of plant pathogen.
8. Screening of suitable Carbon sources for good growth of plant pathogen.
9. Examination of host parasite relationship by using light microscopy
10. Effect of temperature on growth of plant pathogenic fungi
11. Effect of pH on growth of plant pathogenic fungi
12. Effect of Plant derived Phenols on growth of pathogens
13. Synthesis of Phytoalexins and its effect on spore germination of fungal pathogen by



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hanging drop technique.

14. Local tours or Field visits ( at least two)

15. Long excursion to visit Plant Pathology Labs. Research institutes, University etc.



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SEMESTER – III

**BOTANY**

\*Elective-A (For Specialization in Plant Pathology)

\*Theory Paper-XIV: PLANT PATHOLOGY-II

(DISEASES OF CROP PLANTS AND THEIR MANAGEMENT)

Periods: 60

Credits: 04

**Learning Objectives:**

1. To impart knowledge about different strategies for management of plant diseases.
2. To study major diseases of cereal crops, pulses, oil seeds, vegetables and their management.

**Learning Outcomes:**

1. Student will know importance of sign and symptoms for detection of pathogens and disease, integrated methods of disease management, use of biological and chemicals in disease management.
2. Students will know symptoms, etiology, disease cycle and management of major diseases of cereals, pulses, oil seeds and vegetables.

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**UNIT-I: INTRODUCTION TO PLANT PATHOLOGY (15 periods)**

History of Plant Pathology with special reference to Indian works. Nature and concept of plant disease, stages in disease development, causes of plant diseases, effect of pathogen on the plants, effect of plant diseases on human affairs. **Classification of plant diseases:** Criteria used in classification, Classification based on origin (soil, air, and seed), symptoms, causal organism and spread and severity of infection. Detection and diagnosis of plant diseases. **Methods of Studying Plant Diseases:** Field observations, isolation of plant pathogens from infected plant parts, pure culture techniques, measurement of plant disease, Koch's postulates, preservation of plant pathogens and disease specimens, microscopic techniques, staining methods.

**UNIT-I: DISEASE MANAGEMENT (15 periods)**

**Disease Management-The Principles** Bases of disease management principles, Avoidance of the pathogen, exclusion of pathogen, plant quarantines, Eradication of the pathogen, Plant protection organization in India. Protective measures. Development of resistance in the host.

**Disease Management –The Practices:** Cultural practices for disease management, production and use of disease free propagating materials. Disease management through toxic chemicals : Chemical nature and classification of fungicides- Sulphur fungicides, copper fungicides, mercury fungicides ,systemic fungicides, Antibiotics, Nematicides, Antiviral chemicals and biopesticides, mode of action and application of different fungicides, Biological control, Integrated disease management (IDM),



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**Unit-III: DISEASES OF IMPORTANT CEREALS AND PULSES: (15 periods)**

History, symptomology, causal organism, etiology and management of the following diseases: **Cereals: Jowar:** Grain smut, head smut, rust, leaf spot, **Wheat:** Black /stem rust, loose smut, Leaf blight, **Bajra:** Green ear/ downy mildew, ergot, rust, **Rice:** Brown leaf spot, blast, Bacterial blight, **Maize:** Leaf blight, smut, **Pluses: Pigeon pea:** Wilt, sterility mosaic, **Gram:** Wilt, Ascochyta blight, rust, **Bean:** Anthracnose, bean mosaic, **Black gram:** Powdery mildew.

**UNIT-IV: DISEASES OF IMPORTANT OIL SEEDS AND VEGETABLES (15 periods)**

History, symptomology, causal organism, etiology and management of the following diseases: **Oil seeds: Ground nut:** Leaf spot, rust, **Sunflower:** Leaf spot, downy mildew, rust, **Safflower:** Rust, **Sesame:** Sesamum phyllody, **Mustard:** White rust, **Soybean:** Rust **Vegetables: Tomato:** Early blight, leaf curl, **Potato:** Early blight, late blight, brown rot, **Brinjal:** Little leaf, Root Knot, Wilt, **Chilli:** Die back, leaf curl, **Bhendi:** Yellow vein mosaic, powdery mildew, **Spinach:** Leaf spot **Cabbage:** Leaf spot, damping off, **Onion:** Leaf blight.

**LABORATORY COURSE WORK BASED ON PAPER-XIV (A):**

1. Preservation of disease specimen, use of micrometer and camera lucida.
2. Study of spraying and dusting equipments.
3. Collection and preservation of diseased specimens and plant pathogens.
4. Isolation of plant pathogens from infected plant parts.
5. *In vitro* and *in vivo* evaluation of fungicides against plant pathogens; ED and MIC values.
6. Preparation of Bordeaux mixture, Burgundy mixture and Bordeaux paste.
7. Evaluation of antibiotics against a pathogenic fungus/bacterium (zone of inhibition).
8. Isolation, characterization and maintenance of antagonists, methods of study of antagonism and antibiosis, application of antagonists against pathogen *in-vivo* conditions.
9. Study on antagonism between isolate antagonists and plant pathogens.
10. Evaluation of biopesticides (neem, turmeric and garlic) against some plant pathogens (food poison technique).
11. Study of diseases of cereals.
12. Study of diseases of pulses.
13. Study of diseases of oil seeds.
14. Study of diseases of vegetables.
15. Visit to at least two plant protection research stations and three short excursions for collection of diseased specimens and at least one long excursion.



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SEMESTER – III

**BOTANY**

**\*ELECTIVE-B (For Specialization in Angiosperms)**

**THEORY PAPER-XIII: ANGIOSPERMS-I**

**(SYSTEMATICS OF ANGIOSPERMS-I)**

Periods: 60

Credits: 04

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**Learning Objectives**

1. To know general evolutionary trends in angiosperms
2. To know the interrelationships of families included in the order

**Learning outcomes:**

1. Understand the pre and post Darwinian concept of classification
2. Learn the floral and vegetative characters of plants belonging to families
3. Able to identify plants belonging to angiosperms

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**UNIT-I: FUNDAMENTALS OF TAXONOMY (15 periods)**

Time and place of origin of Angiosperms. Probable ancestors of angiosperms (different theories of origin of angiosperms). General Evolutionary Trends in Angiosperms: i) Habitat and growth habit ii) Leaf structure: Simple and compound; phyllotaxy, iii) Evolution of inflorescence, iv) Concept of primitive flower, v) Primitive stamen, vi) Primitive carpel, vii) Nature of inferior ovary: Foliar Appendicular and receptacular (Axial) theories; viii) Evolution of fruit, ix) Monophyletic and Polyphyletic origin of angiosperms.

**UNIT-II: NOMENCLATURE AND CLASSIFICATION (15 periods)**

International code of Botanical Nomenclature: Principles, Type method, valid publication, Rule of priority, Author citation, Provisions and Appendices. General account of Pre-Darwinian Classification: Andrea Caesalpino, John Ray, de Jussieu and A. P. de Candolle; General account of Post Darwinian Classification: Charles E. Bessey, Armen L. Takhtajan, R. M. T. Dahlgren, Robert Thorne and APG classification.

**UNIT-III: SYSTEMATICS OF ANGIOSPERMS-I (15 periods)**

Comparative account of floral morphology, interrelationship of plant families belonging to following orders as per Engler and Prantl's system of classification.

1. **Rhoeadales** :Papaveraceae, Capparidaceae, Cruciferae and Moringaceae
2. **Malvales** :Elaeocarpaceae, Tiliaceae, Malvaceae, Bombacaceae, Sturculiaceae
3. **Contortae**: Oleaceae, Loganiaceae, Gentianaceae, Apocynaceae
4. **Geraniales**:Geraniaceae, Oxalidaceae, Zygophyllaceae, Rutaceae, Meliaceae

**UNIT-IV: SYSTEMATICS OF ANGIOSPERMS-II (15 periods)**

Comparative account of floral morphology, interrelationship of plant families belonging to following orders as per Engler and Prantl's system of classification

1. **Pandanales**: Typhaceae, Sparganiaceae and Pandanaceae
2. **Glumiflorae**: Gramineae and Cyperaceae



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3. **Liliflorae:** Juncaceae, Liliaceae, Amaryllidaceae, Dioscoriaceae, Iridaceae
4. **Microspermae:** Burmanniaceae, Orchidaceae

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**LABORATORY COURSE WORK BASED ON PAPER-XIII (B):**

1. Descriptions and Identification of flowering plants up to genus and species level with their sketches and floral diagrams belonging to different families of respective orders as prescribed in theory paper-XIII (15 practical)
2. Preparation of bracketed/indented dichotomous keys based on vegetative and reproductive characters. (05 practical)
3. Botanical excursions to the forest (at least two) and Preparation of field notes of collected plants (05 practical).

**Note:** Student must attend at least one long and two short botanical excursion arranged by the department and must submit report on plant diversity at the time of practical examination.



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**SEMESTER – III**

**BOTANY**

**\*ELECTIVE-B (For Specialization in Angiosperms)**

**THEORY PAPER-XIV: ANGIOSPERMS-II**

**(PLANT STRUCTURE AND REPRODUCTIVE BIOLOGY)**

Periods: 60

Credits: 04

**Learning Objectives**

1. To know the internal organization of root and shoot
2. To understand the development and differentiation of various plant parts
3. To study and impart the knowledge of anatomy and reproductive biology of angiosperms

**Learning outcomes:**

1. Understand the organization of Root and Stem Apical Meristem
2. Learn the basic and applied embryological aspects of angiosperms

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**UNIT-I: PLANT ANATOMY-I (15 periods)**

Theories of Organization of Root Apical Meristem (RAM) and Shoot Apical Meristem (SAM): Apical cell theory, Tunica corpus theory, Histogen theory, Korper Kappe theory. Cytological and molecular analysis of SAM. Root: Development of adventitious roots, Lateral roots and Root hairs, Primary and Secondary growth of root (Monocot and Dicot). Concept of Quiescent centre, Cell fates and lineages,

**UNIT-II: PLANT ANATOMY-II (15 periods)**

Development, differentiation and Histology of Monocot and Dicot leaf; Anatomy of node and its significance; Leaf venation pattern; Types of stomata and trichomes; Secretary Tissues and laticifers. Wood Anatomy: Hard wood and sap wood, porous & non porous wood, distribution and types of wood parenchyma. Vascular tissue differentiation related to xylem and phloem. Vascular anatomy of flower. General account of anatomy of fruit and Seed.

**UNIT-III: REPRODUCTIVE BIOLOGY-I (15 periods)**

Means of reproduction in flowering plants, Anther structure: Biochemical and Ultra structural aspects, structure and function of tapetum, Microsporogenesis, pollen tetrad development and types, pollen wall morphogenesis, biochemical, physiological and genetic events involved in pollen development. Ultra structure of Pollen morphology, pollen wall sculpturing, NPC classification. Pollen viability. Male sterility: genetic and cytoplasmic male sterility

**UNIT-IV: REPRODUCTIVE BIOLOGY-II (15 periods)**

Pistil: Structure and function of stigma and style. Types of stigma, stigma receptivity and its importance, biochemical aspects. Stylar tissue. Types of Pollination mechanism, Pollen-pistil interaction. Sporophytic and Gametophytic self-incompatibility. Incompatibility and its significance. Pollen adhesion and germination on stigma, pollen tube development. Megasporogenesis, Types of ovules, ovule development and structure, embryo sac



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development and structure. Double fertilization and triple fusion, development of embryo, endosperm and seed. Dynamics of fruit growth, biology of fruit maturation.

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**LABORATORY COURSE WORK BASED ON PAPER-XIV (B):**

1. Study of xylem elements of roots and stem of at least five plants by using maceration technique (3 practical)
2. Study of dermal structures, types of stomata and trichomes (3 practical)
3. Study of stomatal index and frequency (2 practical)
4. Study of T.S. of Dicot and Monocot root and stem (4 practical)
5. Study of nodal anatomy of at least five plants (2 practical)
6. Study of floral anatomy with the help of microtome (at two dicot & two monocot plants)
7. Study of pollens grains of locally available plants
8. Study of RAM and SAM by using apical meristem.
9. Study of secretary and laticiferous tissues.
10. Study venation pattern from Dicot and Monocot plants of at least five plants from each group (2 practical)





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**SEMESTER – III**

**BOTANY**

**\*ELECTIVE-C (For Specialization in Seed Technology)**

**THEORY PAPER-XIII: Seed Technology-I**

**(PRINCIPLES OF SEED TECHNOLOGY)**

Periods: 60

Credits: 04

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**Learning Objectives**

1. To understand how to test purity and vigour of seeds
2. To know the suitable storage conditions for storage of seeds

**Learning outcomes:**

1. Student will adopt the skill of purity, viability and vigour testing
  2. Student will properly maintain the storage conditions of seeds
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**UNIT-I: SEED BIOLOGY (15 periods)**

Introduction : Definition of seed technology, History and development of seed technology, seed testing in India and its importance to agriculture; Seed biology: Exomorphic characters, gross internal structure, seed development, seed physiology and composition during maturation, structure of main groups of angiosperms, identification and structure of seeds of main field crops, identification and characterization of common weed seeds Floral biology, mode of reproduction, sporogenesis, pollination, fertilization, embryogenesis, fruit and seed development, Apomixis, parthenocarpy, polyembryony and somatic embryoids and synthetic seeds, Seed structure of monocot and dicot, Seed maturation and longevity in orthodox and recalcitrant seed, Chemical composition of seed.

**UNIT-II: SEED GERMINATION, VIABILITY AND VIGOUR TESTING (15 periods)**

Seed Germination: importance; definitions; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; working sample and choice of method; general procedure for each type of method; duration of test; seedling evaluation; calculation and reporting of results; dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy.

Viability and Vigour Testing: definition and importance of viability tests; different viability tests; quick viability test (TZ- test) - advantages, principle, preparation of seeds and solutions, procedure, evaluation and calculation of test results. Vigour testing: concept, historical development, definitions, principles and procedures of different methods used for testing vigour.

**UNIT-III: PHYSICAL AND GENETIC PURITY TESTING (15 periods)**

Definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions



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applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds; determination of weed seed and other seed by number per kilogram; determination of other distinguishable 60 varieties (ODV); determination of test weight and application of heterogeneity test.

Genetic purity testing: objective and criteria for genetic purity testing; types of test; laboratory, Growth Chamber and field testing based on seed, seedling and mature plant morphology; principles and procedures of chemical, biochemical and molecular tests.

**UNIT-IV: SEED STORAGE AND SEED MOISTURE (15 periods)**

Seed storage structure: Construction, operation and maintenance, insulation, storage aeration, air conditioning, dehumidification and stacking, moisture and heat roofing of seed storage structures, seed storage management. Physiological, biochemical and cytological changes in seed during storage. Causes of seed deterioration. Concepts and significance of moisture equilibrium, methods of maintaining safe seed moisture content. Thumb rule and its relevance,

**Seed moisture content:** importance of moisture content; equilibrium moisture content; principles and methods of moisture estimation - types, instruments and devices used; predrying and grinding requirements, procedural steps in moisture estimation; calculation and reporting of results.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER-XIII (C)**

1. Structure of monocot and dicot seeds of important plant species.
2. Identification and handling of instruments used in seed testing laboratory.
3. Identification of seeds of weeds and crops.
4. Physical purity analysis of samples of different crops;
5. Estimation of seed moisture content (oven method);
6. Seed dormancy breaking methods
7. Seed germination testing in different agri-horticultural crops.
8. Seedling evaluation.
9. Viability testing by tetrazolium test in different crops;
10. Seed and seedling vigour tests applicable in various crops;
11. Genetic purity testing by chemical, biochemical and molecular methods;
12. Effect of Temperature and Moisture on seed viability



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13. Evaluation of seedling vigour by seedling growth rate and determination of seed vigour index.
14. Visit to Seed industry and Seed Research institutes.



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**SEMESTER – III**

**BOTANY**

\*ELECTIVE-C (For Specialization in Seed Technology)

**THEORY PAPER-XIV: Seed Technology-II**

**(SEED PATHOLOGY)**

Periods: 60

Credits: 04

**Learning Objectives**

1. To know the skill of identification of seed borne pathogens
2. To understand the diagnosis and control of seed borne diseases.

**Learning outcomes:**

1. Student will identify seed borne pathogens
2. Student will recommend the control measures for seed borne diseases.

**UNIT-I: INTRODUCTION TO SEED PATHOLOGY (15 periods).**

History of seed pathology and with reference to recent seed pathology work in India. Contribution of seed pathologists-Paul Neergaard, D. K. Jha, D. Suryanarayana; plant quarantine and SPS under WTO, Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds, Recent advances in the establishment and subsequent cause of disease development in seed and seedling, **Importance of seed borne microorganisms:** kind of seed borne Inoculum, role of seed microorganisms in agriculture, losses caused by seed borne diseases Procedures for seed health test and rules. Externally and internally seed - borne pathogens, mode of infection, development and spread, methods of detection of seed borne diseases.

**UNIT-II: SEED INFECTION (15 periods).**

Significance of seed health, Externally and internally seed - borne pathogens, mode of infection, methods of detection of seed borne diseases.. Significance of Seed infection, environmental factors affecting infection and its establishment Inoculum density, its assessment in relation to plant infection, seed borne Inoculum and epidemics, Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection. Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Relationship between seed-borne infection and expression of the disease in the field

**UNIT-III: SEED BORNE DISEASES OF CEREALS (15 periods)**

**Jowar:** Grain smut, grain mould, leaf blight, seed rot, seedling blight, black rot, charcoal rot(seedling blight and hollow stem); **Bajra:** Green ear, ergot, **Wheat:** Loose smut, black point, Alternaria leaf blight, Helminthosporium leaf blight, Ear cockle

**UNIT-IV: SEED BORNE DISEASES OF PULSES (15 periods)**



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**Pea:** Powdery mildew, **Pigeon pea:** Wilt; **Gram:** Ascochyta blight, wilt, Botrytis grey mould; **Black gram:** Powdery mildew, **Green gram:** Mosaic, powdery mildew

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**LABORATORY COURSE WORK BASED ON PAPER-XIV (C):**

1. Inspection of dry seed samples.
2. Examination of seed washing and estimation of spore load on seed sample)
3. Symptoms caused by seed borne viruses
4. Isolation and observation of nematodes from seeds
5. Diseases of cereals Jowar: Grain smut, grain mould, leaf blight, seed rot, seedling blight, black rot, charcoal rot (seedling blight and hollow stem), Bajra: Green ear, ergot, Wheat: Loose smut, black point, Alternaria leaf blight, Helminthosporium leaf blight. Ear cockle
6. Diseases of pulses Pea: Powdery mildew, Pigeon pea: Wilt, Gram: Ascochyta blight, wilt, Botrytis grey mould, Black gram: Powdery mildew, Green gram: Mosaic, powdery mildew



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**BOTANY - CURRICULUM**

w. e. f. Academic Year 2020-2021

M. Sc. SECOND YEAR

SEMESTER – IV

**BOTANY**

**THEORY PAPER- XVI: BIOCHEMISTRY AND PLANT METABOLISM**

Periods: 60

Credits: 04

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**Learning Objectives**

1. To understand biochemistry of amino acids, proteins and enzymes.
2. To know importance of nitrogen, sulphur and phosphorous in plant life.
3. To understand carbohydrate and lipid metabolism in plants.

**Learning outcomes:**

1. Understanding the biochemistry and metabolism of amino acids, proteins including enzyme kinetics.
2. Able to understand nitrogen, sulphur and phosphorous metabolism in plant.
3. Understand role and importance of carbohydrate and lipids in plants.

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**UNIT-I: AMINO ACIDS AND PROTEIN METABOLISM (15 periods)**

Amino Acids-Structure Classification and various physicochemical properties of amino acids, Protein and Non Protein amino acids, Essential and non essential amino acids Transamination, diminution, Reductive amination, Amino acid families, Bio- Synthesis of amino acids. Van der Waal's forces, electrostatic interactions, hydrogen bonding and hydrophobic interactions, Primary structure of proteins Conformation of proteins and polypeptides (secondary, tertiary, quaternary and domain structure), Ramachandran plot, Protein metabolism- Mechanism of synthesis and breakdown of proteins.

**UNIT II: ENZYMOLOGY (15 Periods)**

Introduction, Classification and properties and structure of enzyme, active site, Enzyme Specificity, mechanism of enzyme catalyzed reaction, Enzyme kinetics, Effect of temp, pH, on enzyme activity, Michaelis-Menten equation, Significance of  $K_m$  and  $V_{max}$ , Enzyme inhibition and its types, Allosteric enzymes, Regulation of enzyme activity, activators and inhibitors, Coenzymes, relation between co-enzymes and vitamins, co-factors, Isozymes, Ribozymes and Abzymes

**UNIT-III: NITROGEN, PHOSPHOROUS & SULPHUR METABOLISM (15 periods)**

**Nitrogen Metabolism:** Role of nitrogen in plants, sources of nitrogen, nitrogen fixation, Range of nitrogen fixing organisms - Legume - Rhizobium symbiosis, biochemistry and physiology of Nitrogenase, characteristics and functions of Leghaemoglobin; Nitrate reduction, assimilation of ammonia. Mechanism of non-biological and biological nitrogen fixation. **Phosphorous metabolism:** Role of phosphorous in plants Sources of phosphorous, uptake transport and mechanism of phosphorous metabolism in plants. **Sulphur Metabolism:** Role of sulphur in plants, Sulphur chemistry and fixation, uptake and transport, reductive sulphate assimilation pathways, synthesis and function of glutathione and its derivatives

**UNIT- IV: CARBOHYDRATE AND LIPID METABOLISM (15 Periods)**



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**Carbohydrate:** Introduction, Carbohydrates in plants, classification and chemistry of carbohydrates, (Monosaccharides, Oligosaccharides, Polysaccharides), Chemical properties of carbohydrates, Interconversion of aldehyde and keto sugar, Structure and properties of Sucrose, Cellulose and Starch. Glycogen: Biosynthesis, degradation and its regulation, Gluconeogenesis and its biological significance. Synthesis and degradation of sucrose, starch, cellulose and pectic substances. Role of carbohydrate in cell wall synthesis.

**Lipid metabolism :** Introduction, Classification of lipids - simple lipids, compound lipids, sterols and terpenoids, Biosynthesis and breakdown of triglycerides, Fatty acids, role of Acetyl Co-A in biosynthesis, lipoproteins, Fatty acid Oxidation : activation, Carnitine Shuttle,  $\alpha$  and  $\beta$  oxidation of fatty acid.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER XVI:**

1. Detection of amino acids by chromatography.
2. Extraction of proteins from plant tissue and their quantitative estimation by Lowery's method
3. Effect of pH on enzyme activity
4. Effect of temperature on enzyme activity
5. Effect of substrate concentration on amylase activity and determination of its  $K_m$  value by Michalis – Menton Curve.
6. Estimation of reducing, Non-reducing and total sugars from plant parts
7. Estimation of Ascorbic Acid in the given material.
8. Isolation of Nitrogen fixing bacteria from root nodule
9. Estimation of carbohydrates by suitable method
10. Extraction and estimation of starch from plant material
11. Extraction and estimation of fats from plant material by Soxhlet extractor
12. Analysis of plant proteins by SDS PAGE
13. Visit to research centre/long/short tour.





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SEMESTER – IV

**BOTANY**

**THEORY PAPER- XVII: BIOTECHNOLOGY AND GENETIC ENGINEERING**

Periods: 60

Credits: 04

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**Learning Objectives**

1. To understand scope and importance of biotechnology.
2. To understand process of plant tissue culture
3. To know basic techniques of molecular genetics and rDNA technology.

**Learning outcomes:**

1. Understanding basic principle and process of tissue culture.
2. Large scale industrial application of plant tissue culture.
3. Able to understand the technique and process of cloning.

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**UNIT-I: BIOTECHNOLOGY - I (15 periods)**

Scope and importance of Biotechnology, History of Plant Tissue Culture, Cellular Differentiation and Totipotency, Culture Media, Aseptic Culture Technique .

**Organogenesis:** Techniques and Utility of Organogenesis, Callus Cultures, Characteristics of Organogenesis, Factors Affecting Organogenesis.

**Micropropagation:** Explants used in micropropagation, Stages in micropropagation. Advantages and Disadvantages of micropropagation.

**Somaclonal variation:** Introduction, Applications of somaclonal variations

**Somatic Embryogenesis:** Introduction, Principle Importance of Somatic Embryogenesis Factors affecting Somatic Embryogenesis .Practical applications of somatic embryogenesis

**UNIT-II: BIOTECHNOLOGY –II (15 periods)**

**Protoplast Culture:** Isolation of Protoplast, Methods of protoplast culture, Applications of Protoplast Culture.

**Somatic Hybridization:** Protoplast Fusion, Poly Ethelene Glycol (PEG) Treatment, Regeneration of Hybrid Plants, Applications of Somatic Hybridization

**Synthetic Seeds:** Method for making Artificial Seeds and their Applications

**Haploid Culture:** Anther, Pollen and Ovule Culture Application of Anther and Microspors Culture Merits & Demerits and Limitations Applications of Ovule Culture

**Applications of Plant Tissue Culture:** Production of Disease Resistant Plant, Embryo Culture, Production of Secondary Metabolites and Germplasm Storage.

**UNIT –III: GENETIC ENGINEERING (15 Periods)**

Techniques in Molecular Genetics: Basic techniques, Restriction digestion, production of recombinant DNA molecules, amplification using vectors, construction of genomic libraries, cDNA libraries and screening DNA libraries for genes of interest; The manipulation of cloned DNA sequences: in vitro, using phagemid vectors; In vitro site specific mutagenesis, Molecular analysis of Genes and Chromosomes: PCR, Physical maps of DNA molecules



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based on RFLP and Fine structure maps, Regulation of expression, Genome sequencing strategies and programs, methods for sequencing, microarrays and their applications; gene tagging; gene and promoter trapping; knockout and knock-down mutants;

**UNIT- III: r-DNA TECHNOLOGY (15 periods)**

Restriction and nucleic acid modifying enzymes; restriction mapping, Vectors in gene cloning and their choice ; plasmids, phages, cosmids, plant viruses, synthetic DNA vectors; Isolation of specific genes from bacteria and higher plants; cloning; Genome sequencing strategies and programs, methods for sequencing, microarrays and their applications; gene tagging; gene and promoter trapping; knockout and knock-down mutants; Comparative genomics of model plants and related crop species; RNA and gene silencing, genome imprinting, small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER XVII:**

1. Study of set up of tissue culture laboratory and various aseptic and sterilization techniques
2. Preparation and sterilization of tissue culture media and inoculation of plant material for callus formation.
3. Demonstration of technique of micro propagation by using different explants (axillary buds and meristem)
4. Isolation of protoplast from different tissues using commercially available enzymes (e.g. Tobacco, Petunia) and estimation of their yield.
5. Demonstration of the technique of anther culture (e.g. Dhatura)
6. Isolation of DNA from plant material
7. PCR amplification of DNA
8. Restriction digestion and Electrophoresis of DNA
9. Isolation of plasmid from bacteria
10. Molecular analysis of Genes and Chromosomes by PCR technique.
11. Study of restriction digestion of the plasmid and estimation of the size of various DNA fragments
12. Visit to plant tissue culture laboratory.
13. Visit to Biotechnology Research centre



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**BOTANY**

**\*ELECTIVE-A (For Specialization in Plant Pathology)**

**\*THEORY PAPER-XVIII: PLANT PATHOLOGY-III  
(PHYSIOLOGICAL AND MOLECULAR PLANT PATHOLOGY)**

Periods: 60

Credits: 04

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**Learning Objectives**

1. To understand the changes in host due to infection
2. To know which type of enzymes and toxins involved in pathogenesis .
3. To Understand the variability in pathogens and gene transfer in plant .

**Learning Outcomes:**

1. The students will be realize about physiological and molecular changes brought about in host plants
  2. Student will think how to prevent the production of enzymes and toxins of plant pathogens.
  3. They will understand how resistant varieties are developed against different pathogens
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**UNIT-I: PHYSIOLOGICAL AND MOLECULAR CHANGES IN DISEASED PLANTS (15 periods)**

**Physiological changes** : Composition of Plant cell wall, Changes in host cell walls, Effect of pathogens on permeability of cell membranes, Effect of infection on Photosynthesis, Respiration, Translocation of water and Nutrients, Phenol metabolism and Growth regulators (Auxins, Gibberellins and Cytokinins and Ethylene) in diseased plants. **Changes in the Molecular level**-Nucleic acid metabolism, Protein metabolism, Effect of pathogens on Transcription and Translation.

**UNIT-II: ENZYMES AND TOXINS IN PLANT PATHOGENESIS (15 periods)**

**Enzymes in Pathogenesis** : Cellulolytic enzymes- Types, mode of action and Role. Pectolytic enzymes: Types, mode of action and Role of Pectolytic enzymes in pathogenesis. Macerating enzymes, General account of Hemicellulases, Lignolytic enzymes, Proteolytic enzymes and Lipolytic enzymes.

**Toxins in Pathogenesis**: Classification of Toxins- Pathotoxins, Vivotoxins and Phytotoxins, Chemical nature and mode of action of Victorin, Lycomarasmin, Fusaric acid, Wild fire toxin, General account of Pyricularin, Alternaric acid and Cercosporin..Effect of toxins on plant tissues, General account of Aflatoxins.

**UNIT-III: GENETICS AND BIOTECHNOLOGY IN RELATION TO PLANT PATHOLOGY (15 periods)**

**Genetic Variability in Plant pathogens**: Genetic variability in Bacteria, Viruses and Fungi.



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Mechanisms of variability in plant pathogens:-Hybridization, Mutation and Cytoplasmic inheritance. **Genetics of host-parasite interaction**, Evolution of parasitism, Resistance and Susceptibility, Gene for gene relationship, **Types of Plant Resistance**: Horizontal and Vertical Resistance. Inheritance of Resistance in the Host. Loss of virulence in plant pathogens, Physiological specialization and production of new races..

**Biotechnology in relation to Plant Pathology**: Role of Biotechnology in plant disease management, Development of disease free plant by Meristem tip culture.

**UNIT-IV: MOLECULAR PLANT PATHOLOGY (15 periods)**

Introduction of Molecular plant Pathology, **Molecular diagnostics**: Identification of pathogens by molecular techniques: Southern, Northern and Western hybridization, PCR based method. **Molecular Biology of Plant Pathogens**: **Gene Cloning**: Properties of a Good Cloning Vectors, Vectors for Gene cloning in plants (Ti-Plasmid). **Restriction Enzymes**-Classification of Restriction Endonucleases and Applications. **Molecular Markers in pathogen populations**: Properties of Molecular Markers, Types of DNA Markers (RFLP and RAPD Markers). Applications of Molecular Markers. **Transgenic plant disease management**: Strategies for Development of Transgenic: Methods of gene transfer, Genetically Modified plants and their goal. Application of molecular biology to plant disease control.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER XVIII (A):**

1. Estimation of chlorophyll-a & b, total chlorophylls from diseased and healthy plant parts
2. Detection of sugars from healthy and infected leaves by paper chromatography technique.
3. Estimation of total phenols from diseased plant parts
4. Estimation of Pectolytic enzyme activity by Viscometric method
5. Estimation of Cellulolytic enzyme activity by Viscometric method
6. Estimation of CMCase enzyme activity by Dinitrosalicylic Acid (DNS) method
7. Extraction and Separation of Aflatoxins from infected seeds
8. Effect of Fusaric acid produced by *Fusarium* sp on wilting of plants
9. Study of Genetic variability in fungi/bacteria by induced mutation
10. Development of disease free plant by meristem tip culture
11. Isolation of Plasmid from *Agrobacterium tumefaciens*
12. Detection of a specific DNA sequence in DNA samples by Southern Blotting technique
13. Method of gene transfer for development of transgenic plant



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14. Short tour to visit Plant pathology laboratories, University departments & Tissue Culture Lab.
15. Long Excursion to visit Research institute /Molecular biology Laboratories/ Biotechnology laboratories.



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SEMESTER – IV

**BOTANY**

**\*ELECTIVE-A (For Specialization in Plant Pathology)**

**\*THEORY PAPER-XIX: PLANT PATHOLOGY-IV**

**(Diseases of Fruit Plants and their Management)**

Periods: 60

Credits: 04

**Learning objective**

1. To impart knowledge of pathogens, diseases and their management of fruit plants.
2. To aware students with post harvest diseases of fruit plants and their ecofriendly management

**Learning outcome**

1. Students will know common pathogens, symptoms, etiology, disease cycle and management of major diseases of fruit plants.
2. Students will know common pathogens, symptoms, etiology, disease cycle and management of post harvest diseases of fruit plants.

**Unit-I: DISEASES OF MANGO AND BANANA (15 periods)**

History, symptomology, causal organism, etiology and management of the following diseases: **Mango-** Die back / Fruit Stem end rot, powdery mildew, grey leaf blight, mango leaf black spot / canker. **Banana-**Fusarium wilt/panama wilt, Sigatoka leaf spot, bacterial wilt or malformation, bacterial moko disease, banana bunchy top disease.

**Unit-II: DISEASES OF CITRUS AND GRAPES (15 periods)**

History, symptomology, causal organism, etiology and management of the following diseases: **Citrus-** Canker, gummosis, decline, greening. Citrus Tristeza disease, scab. **Grapes-** Powdery mildew, downy mildew, anthracnose or bird's eye disease, bacterial leaf spot, Alternaria blight.

**Unit-III: DISEASES OF PAPAYA, POMEGRANATE AND GUAVA (15 periods)**

History, symptomology, causal organism, etiology and management of the following diseases: **Papaya-** Mosaic, foot rot, leaf curl, ring spot. **Pomgranate-** Alternaria fruit spot, anthracnose, bacterial blight, Cercospora fruit spot, wilt. **Guava-** Wilt, die-back and anthracnose, fruit canker.

**Unit-IV: POST HARVEST DISEASES OF FRUITS AND THEIR MANAGEMENT (15 periods)**

**Mango-** Anthracnose, black mould. **Banana-** Anthracnose, black end. **Citrus-** Blue mould, green mould. **Grape-** Grey mould, blue mould. **Pomgranate-** Soft rot, Aspergillus rots. **Papaya-** Fusarium rot, Aspergillus rot, Rhizopus rot. **Guava-** Rhizopus rot, Alternaria rot. Concept of post harvest disease, causes of post harvest disease, principles of plant disease management as post-harvest, merits and demerits of biological/phytoextracts in



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controlling post-harvest diseases, factors governing post harvest problems both as biotic and abiotic, role of physical environment, agro ecosystem leading to quiescent infection.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER- XIX (A):**

1. Study of diseases of mango.
2. Study of diseases of banana.
3. Study of diseases of citrus.
4. Study of diseases of grapes.
5. Study of diseases of papaya.
6. Study of diseases of pomegranate.
7. Study of diseases of guava.
8. Isolation, characterization and maintenance of pathogens from different fruits.
9. Role of different storage conditions on post harvest disease development.
10. Application of antagonists against pathogens *in vivo* -conditions.
11. Comparative efficacy of different chemicals, fungicides, phytoextracts and bioagents against pathogens.



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**SEMESTER – IV**

**BOTANY**

**\*ELECTIVE-B (For Specialization in Angiosperms)**

**THEORY PAPER-XVIII: ANGIOSPERMS-III**

**(SYSTEMATICS OF ANGIOSPERMS-II)**

Periods: 60

Credits: 04

**Learning Objectives**

1. To know the isolating mechanism leads to species evolution
2. To know the applications of taxonomy in various fields of botany

**Learning outcomes:**

1. Understand the interrelationship and general characters of families belonging to orders
2. Learn the various concepts of species
3. Able to understand evolutionary aspects of angiosperms

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**UNIT-I: TAXONOMY-I (15 periods).**

Plant Speciation: Allopatric, Parapatric, sympatric, abrupt or gradual speciation.

Isolating Mechanisms: Geographical and Ecological, Seasonal and Temporal, Mechanical and Ethological, Internal barriers. Concept of Species: Nominalistic, Typological and Biological. Types of Keys: Punched cards and dichotomous keys. Taxonomic literature- floras, monographs and icons

**UNIT-II: TAXONOMY-II (15 periods).**

1. Concept of taxonomic Characters: synthetic v/s analytic characters, Qualitative v/s Quantitative characters. Homology and Analogy, Parallelism and Convergence, Monophyly and Polyphyly.
2. Taxonomic Evidences: Numerical taxonomy, Chemotaxonomy, Cytotaxonomy, Palynology, and Embryology in relation to taxonomy.
3. Molecular Systematics: Molecular diagnostic tools, Restriction fragment length polymorphism (RFLP's), Random amplified polymorphic DNA (RAPD), applications of RAPD in molecular systematics.

**UNIT-III: SYSTEMATICS-I (15 periods)**

Comparative account of floral morphology, interrelationship of plant families belonging to following orders as per Engler and Prantl's system of classification

1. **Centrospermae:** Chenopodiaceae, Amaranthaceae, Aizoaceae, Portulacaceae and Caryophyllaceae
2. **Rosales:** Podostemaceae, Crassulaceae, Hamamelidaceae, Rosaceae, Leguminosae
3. **Sapindales:** Anacardiaceae, Celastraceae, Salvadoraceae, Sapindaceae, Balsaminaceae
4. **Tubiflorae:** Convolvulaceae, Boraginaceae, Verbenaceae, Scrophulariaceae, Bignoniaceae

**UNIT-IV: SYSTEMATICS-II (15 periods).**





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Comparative account of floral morphology, interrelationship of plant families belonging to the order as per Engler and Prantl's system of classification

1. **Helobiae:** Potamogetonaceae, Najadaceae, Allismataceae, Butomaceae, Hydrocharitaceae
2. **Spathiflorae:** Araceae and Lemnaceae
3. **Farinosae:** Eriocauliaceae, Bromeliaceae, Commelianaceae, Potenderiaceae
4. **Scitaminae:** Musaceae, Zingiberaceae, Cannaceae, Marantaceae

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**LABORATORY COURSE WORK BASED ON PAPER-XVIII (B):**

1. Description and identification of flowering plants belonging to different families of the orders prescribed in theory paper-XVIII (Unit- III & IV) up to genus and species level with their sketches and floral diagrams.
2. Practical based on Numerical taxonomy. Study of qualitative and quantitative characters of plants (at least five)
3. Study of analytic and synthetic characters of plants (at least two)
4. Palynological study of some selected taxa (either family or a genus)
5. Use of cytological data in Taxonomic studies - Karyotype analysis. Preparation of Karyograms and Idiograms (to be done with the help of permanent preparation / diagram / photoplate).
6. Botanical excursions to the nearby forest area (at least two) and Preparation of field notes of collected plants (05 practicals).

**Note:** Student must attend at least one long and two short botanical excursion arranged by the department and must submit report on plant diversity at the time of practical examination.



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**\*ELECTIVE-B (For Specialization in Angiosperms)**

**THEORY PAPER-XIX: ANGIOSPERMS-IV**

**(PHYTOCHEMISTRY AND PHARMACOGNOSY)**

Periods: 60

Credits: 04

**Learning Objectives**

1. To know the medicinal properties of secondary metabolites in plants
2. To know the characters and cultivation practices of herbal drugs

**Learning outcomes:**

1. Understand the concept of drug adulteration
2. Learn the pharmacognostical aspects of common drug plants
3. Understand the knowledge of important medicinal plants

**UNIT-I: PHYTOCHEMISTRY-I (15 periods)**

Brief outline of occurrence, distribution and synthesis, chemistry and biological activity of major secondary metabolites Alkaloids, Flavonoids, Simple Phenolics, Phenolic Glycosides, Tannins, Anthroquinones, Saponins, Steroids, Pigments (anthocyanin and betacyanin), Resins, Gums and Volatile oils. Methods of extraction, isolation, purification, identification and estimation of Secondary metabolites.

**UNIT-II: PHYTOCHEMISTRY-II (15 periods)**

Phytochemistry in relation to taxonomy. Proteins and taxonomy: seed proteins, analysis of amino acid sequence and its significance in systematic. Serology and taxonomy: history, precipitation reaction, techniques. Application of serological data in plant systematics. Ethnobotany: Concept and classification. Methods and techniques used in ethnobotany. Floristic diversity and medicinal plant research scenario in Maharashtra.

**UNIT-III: PHARMACOGNOSY-I (15 periods)**

History, Definition and scope of Pharmacognosy; Classification of crude drugs: Taxonomical, morphological Chemical and Pharmacological (Therapeutic) classification; Methods of cultivation, harvesting, drying and storage of drug plants. Quality control of Herbal drugs: Drug adulteration and their types, detection of adulterants by organoleptic and microscopic methods.

**UNIT-IV: PHARMACOGNOSY-II (15 periods)**

Pharmacognostic studies (Nomenclature, Morphology, Anatomy, Chemistry, Uses and Adulterants) of following drug plants:

1. Root drugs: *Asparagus*, *Withania*,
2. Rhizome drugs: *Zingiber*, *Curcuma*
3. Bark drugs: *Acacia*, *Cassia*
4. Leaf drug: *Adhatoda*, *Vitex*



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5. Flowers: Clove, *Artemisia annua*
6. Fruits and Seeds: Coriander, Castor
7. Essential oils: *Eucalyptus*, *Citronella*
8. Fatty oils: *Sesamum*, Safflower

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**LABORATORY COURSE WORK BASED ON PAPER-XIX (B):**

1. Study of methods of detection of adulterants in drug
2. Study of macro and microscopic characters of plant parts powder of drug of plants mentioned in syllabus
3. Study of essential oils (*Eucalyptus*, *Citronella*) and fatty oils (*Sesamum*, Safflower) with the help of Soxhlet apparatus.
4. Qualitative detection of secondary metabolites in plant material by phytochemical tests.
5. Quantitative estimation of secondary metabolites from plants mentioned in syllabus
6. Study of anatomical characters of plant parts used in medicine mentioned in syllabus
7. Study of morphology, medicinal properties and uses of plants as prescribed in theory paper-XIX (B)
8. Qualitative mineral estimation and ash values of ash prepared from drugs.
9. Qualitative detection of Gums and Resins by using standard phytochemical test
10. Separation and Identification of phytoconstituents using standard compounds by Thin layer chromatography or Paper chromatography



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\*ELECTIVE-C (For Specialization in Seed Technology)

**THEORY PAPER-XVIIIIC: Seed Technology-III**

**(Seed Production and Processing)**

Periods: 60

Credits: 04

**Learning Objectives**

1. To impart a comprehensive knowledge of seed production in field crops with adequate practical training.
2. To know the skill of seed processing and marketing

**Learning outcomes:**

1. Student will produce hybrid seeds in field crops
2. Student will adopt the skills of seed processing and handling of equipments

**UNIT-I: PRINCIPLES OF SEED PRODUCTION (15 periods)**

Basic principles in seed production and importance of quality seed. Floral structure, breeding and pollination mechanism in self-pollinated cereals and millets viz, wheat, paddy, maize, Sorghum, bajra. Floral structure, breeding and pollination mechanism; methods and techniques of seed production in pulses (pigeon pea, chick pea, green gram, peas). Floral structure, breeding and pollination mechanism; methods and techniques of seed production in major oil seeds (groundnut, sunflower, safflower, mustard, sesame). Floral structure, breeding and pollination mechanism; methods and techniques of seed production in commercial fibers (cotton, jute,) and vegetatively propagated crops like sugar cane and potato. Seed quality control system and organization, seed village concept; Seed production agencies, seed industry and custom seed production in India.

**UNIT-II: PRODUCTION OF HYBRID SEEDS (15 periods)**

Principles of hybrid seed production, isolation distance, synchronization of flowering, roguing etc. male sterility and incompatibility system in hybrid seed production, role of pollinators and their management. Seed multiplication ratios, seed replacement rate, demand and supply; suitable areas of seed production and storage, agronomy of seed production agro climatic requirements and their influence on quality seed production; generation system of seed multiplication; maintenance of Nucleus seed, production of Breeder, Foundation and Certified seed– criteria involved; life span of a variety and causes for its deterioration; certification standards for self and cross pollinated and vegetatively propagated crops.

**UNIT-III: SEED PROCESSING (15 periods)**

Seed cleaning equipment and their functions: Preparing seed for processing; functions of scalper debearder, scarifier, huller, seed cleaner and grader. Screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines;



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seed blending. Seed treatment equipment, shury seed treater, mist-o-matic seed treater, parts of the machines, construction and operation.

Principles of seed processing; methods of seed drying including dehumidification and its impact on seed quality.

**UNIT-IV: PACKAGING AND MARKETING OF SEEDS (15 periods)**

Importance and scope of seed industries, Demand and Production of seeds, Packaging and marketing seeds, bagger, weigher, bag closing, portable and conveyor type bag closers, leveling and maintaining lot identity, lot numbers, seed pellets, handling and stacking, maintenance of seed processing records. Cost of seed production and returns, Pricing and price policies, Market structure of seed, marketing organizations, Marketing channels, Marketing margins, analysis of problems of marketing, agencies responsible for determining the rate of quality sees.

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**LABORATORY COURSE WORK BASED ON THEORY PAPER-XVIIIIC:**

1. Planning of Seed Production, requirements for different classes of seeds in field crops - unit area and rate;
2. Seed production in cross pollinated crops with special reference to land, isolation, planting ratio of male and female lines, Hand masculation and pollination in Cotton,
3. Pollen collection, storage, viability and stigma receptivity
4. Operation and handling of mechanical drying equipments;
5. Effect of drying temperature and duration on seed germination and storability with particular reference to oil seeds;
6. Study of seed extraction methods; seed processing equipments; seed treating equipments; Seed quality upgradation; measurement of processing efficiency; Seed blending, bag closures;
7. Study of orthodox, intermediary and recalcitrant seeds;
8. Evaluating seed viability at different RH and temperature levels and packaging materials;
9. Visit to seed processing plant, seed production plots and commercial controlled and uncontrolled Seed Stores;



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SEMESTER – IV

**BOTANY**

**\*ELECTIVE-C (For Specialization in Seed Technology)**

**THEORY PAPER-XIXC: Seed Technology-IV**

**(Seed Health Testing and Management)**

Periods: 60

Credits: 04

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**Learning Objectives**

1. To understand some basic techniques of seed health testing
2. To develop interest for management of seed borne diseases

**Learning outcomes:**

1. Student will acquire skill for identification of seed borne pathogens
2. Students will recommend the control measures of seed borne diseases.

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**UNIT-I: SEED BORNE PATHOGENS (15 periods)**

Field fungi and storage fungi, harmful effect of storage fungi- discoloration of seed, reduction in seed germination, deterioration of seed (biochemical changes), enzymes in seed deterioration, types of mycotoxins and their effect on animal and human health, Transmission of seed borne pathogens: Methods of transmission of seed borne pathogens- seed to plants, plant to seed, seed to seed and plant to plant.

General characters of Important seed borne fungi: Alternaria, Drechslera, Cercospora, Curvularia, Fusarium, Colletitrichum, Botrytis, Ascochyta, Cephalosporium, Macrophomina, Phoma, Pyricularia, Aspergillus, Penicillium, Rhizopus ;

**UNIT-II: METHODS OF SEED HEALTH TESTING (15 periods)**

Objectives of seed health tests , equipment , sampling , examination of ungerminated seed , inspection of dry seed , examination of suspensions obtained from washings of seed , examination after washing of seed, and sedimentation , the whole embryo count method ,Incubation tests : the blotter test , the agar plate test-examination of colonies developed from seeds plated on agar media ,the freezing method , the water agar plate method for detection of bacteria , seedling symptom tests.

**UNIT-III: MANAGEMENT OF SEED BORNE DISEASES (15 periods)**

Seed treatment equipment, shury seed treater, mist-o-matic seed treater, parts of the machines, construction and operation. Labeling of treated seeds and related precautions, storage of treated seeds, machine operators and seed users safety.

Seed treatment : Importance of seed treatment, Advantages Methods of seed treatments (physical, chemical, biological), Use of pesticides, botanicals, mycotoxins for seed treatments, Carry over infestation, principles of fumigation and safe use of fumigants. Important storage pests, their identification, monitoring and detection, ET value, nature and extent of damage, natural enemies and management

**UNIT-IV: SEED CERTIFICATION AND SEED LEGISLATION (15 periods)**



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Seed certification: Definition, development of certification concept, minimum seed certification standards, general and specific crop standards, field inspection, Seed certification and tolerance limits, Importance and principles of quarantine regulations Quarantine and International procedures of phytosanitary certificates, plant quarantine in India ISTA certificates, Seed legislation: Legislation and seed laws (regulation), the seed act of 1966, seed rules 1968 with amendments, the seed control order 1983, export-import order of seeds 1989 .

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**LABORATORY COURSE WORK BASED ON PAPER-XIXC:**

1. Identification of common seed borne fungi
2. Study of seed borne mycoflora by standard blotter paper method
3. Study of seed borne mycoflora by paper towel method
4. Study of seed borne mycoflora by standard agar plate method
5. Isolation and culture of seed borne bacteria (staining technique)
6. Demonstration of the study of ISTA and phytosanitary certification process
7. Effect of toxins on seed germination, leaf necrosis and seedling growth
8. Seed treatments (chemical and biological)
9. Detection of aflatoxin contamination in stored seed sample by UV light
10. Determination of aflatoxin contents in seeds by TLC
11. Visits to seed production fields, seed testing laboratories, seed industries, seed storage, NSC, SSC, quarantine centers



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SEMESTER – III

**BOTANY**

**Theory Paper-XI: Plant Physiology**

**Suggested Readings:**

1. Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists Maryland, USA.
2. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
3. Galstone A.W. 1989. Life processes in Plants. Scientific American Library, Springer Verlag, New York, USA..
4. Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones Springer –Verlag, New York, USA.
5. Nobel P.S 1999. Physiochemical and Environmental Plant Physiology (Second Edition) Academic Press, San Diego, USA.
6. Salisbury F.B and Ross C.W 1992. Plant physiology (Fourth Edition) Wadsworth Publishing Company, California, USA.
7. 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.
8. Taiz L. and Zeiger E. 1998. Plant Physiology (Second Edition). Sinauer Associates, Inc. Publishes, Massachusetts, USA.
9. Thomas B. and Vince-Prue D. 1997. Photoperiodism in Plants (Second Edition) Academic Press, San Diego, USA.
10. Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.
11. Leninger A.C 1987. Principles of Biochemistry, CBS Publishers and Distributors (Indian Reprint)
12. Devilin and Witham. 2001 Plant physiology. CBS Publisher and distributor New Delhi.
13. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
14. Jain J. L. 2010 Fundamentals of Biochemistry, S.Chand Publications.
15. Jain V. K 2005. Fundamentals of plant physiology S. Chand Publications
16. Sadasivam, S. and Manickam A., 1996. Biochemical methods (2nd Edition). New Age International Publisher publishers New Delhi
17. Plummer, D.T. 1988. An Introduction to practical Biochemistry. Tata McGraw Hill Publishing Co.Ltd.New Delhi

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**Theory Paper-XII: Molecular Biology and Biostatistics**

**Suggested Readings :**





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1. Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. Maryland, USA
2. Jain J. L. 2010 Fundamentals of Biochemistry, S.Chand Publications.
3. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D., and Darnell, J. 2000. Molecular Cell Biology (fourth edition). W.H. Freeman and Company, New York, USA
4. Plummer, D.T. 1988. An Introduction to practical Biochemistry. Tata McGraw Hill Publishing Co.Ltd.New Delhi.
5. Sadasivam, S. and Manickam A., 1996. Biochemical methods (2nd Edition). New Age International Publishers New Delhi
6. Sambrook J and Russell DW (2001). Molecular Cloning – A Laboratory Manual, Vols I – III, Cold Spring Harbor Laboratory, USA.
7. Hammes GD (2005) Spectroscopy for the Biological Sciences; Wiley Interscience, USA.
8. Harlow and Lane D (Eds.) (1988) Antibodies – A Laboratory Manual; Cold Spring Harbor Laboratory, USA.
9. David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press, New Jersey, USA. David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press, New Jersey, USA.
10. Kulas JT (2008) SPSS Essential: Managing and Analyzing Social Science Data. John Wiley & Sons, New York.
11. Pagano M, Gauvreau K (2007) Principles of Biostatistics. Thomson India Edition, New Delhi.
12. Randal Schwartz, Tom Phoenix and Brian d Foy (2005) Learning Perl (4th edition), O'Reilly & Associates, ISBN: 0-596-10105-8.
13. Singer M and Berg P (1991). Genes and Genomes: A Changing Perspective; University Science Books, CA, USA.
14. Atherly, A.G., Girton, J.R. and McDonald, J.F 1999. The Science of Genetics Saunders College Publishing, Frot Worth, USA.
15. Busch, H. and Rothblum. L 1982. Volume X. The Cell Nucleus rDNA part A. Academic Press.
16. Karp, G. 1999. Cell and Molecular Biology : Concept and Experiments. John Wiley and Sons, Inc., USA.
17. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.
18. Lewis, R. 1997. Human Genetics : Concepts and Application (Second Edition). WCB McGraw Hill, USA.
19. Malacinski, G.M and Freifelder, D. 1998 : Essentials of Molecular Biology (Third Edition). Jones and B. Artlet Publisher, Inc., London.
20. Gardner and Simmons Snustad 2005 (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
21. Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai.



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22. Verma and Agarwal, Genetics, S. Chand Co, New Delhi..
23. Singh B.D 2004. Genetics. Kalyani Publication, Ludhiana.
24. Gupta P.K Genetics and Cytogenetics, Rastogi Publications.
25. Biostatistics, Anil Mungikar, Aurangabad
26. Bhojwani, S.S. (1990) Plant Tissue Culture. Elsevier Science Publisher, The Netherlands.
27. Galun, E. and Breiman, A. (1997) Transgenic Plants. Imperial College Press, UK.
28. George, E.F. (1996) Plant Propagation by Tissue Culture Part 1 & Part II. Exegetics Ltd., UK.
29. Glick, B.R. and Pasternak, J.J. (2003) Molecular Biotechnology. ASM Press American Society for Microbiology, USA.
30. Halford, N. (2006) Plant Biotechnology. John Wiley & Sons Ltd., Wiley-VCH Verlag GmbH & Co., Germany.

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**Theory Paper-XIII (A): Plant Pathology-I (Principles of Plant Pathology)**

**Suggested Readings :**

1. Agrios GN. (2005). Plant Pathology. 5th Ed. Academic Press, New York.
2. Alexopoulos, C.J., C.M.Mims. Introductory Mycology:, Wiley Eastern Ltd. New Delhi, Bangalore, Bombay, Calcutta, Madras, Hyderabad.
3. Aneja K.R. 4th Ed.( 2007). Experiments In Microbiology, Plant Pathology And Biotechnology.New Age International.
4. Bilgrami K S & H C Dube .A Text book of Modern Plant pathology.Vikaspubli.housepvt.Ltd. New Delhi.11004
5. Cruickshank, I. A. M. (1963).Phytoalexins.Annu. Rev. Phytopathol. 1, 351–374.
6. Deverall BJ. (1977). Defence Mechanisms in Plants. Cambridge Univ. Press, Cambridge, NewYork.
7. Dhingra OD & Sinclair JB. (1986) .Basic Plant Pathology Methods. CRC Press, London,Tokyo.
8. Duncan, J. M., and Torrance, L. (1992).“Techniques for the Rapid Detection of Plant Pathogens.” Blackwell, Oxford.
9. Fokkemma MJ. (1986). Microbiology of the Phyllosphere. Cambridge Univ. Press, Cambridge.
10. Goto, M. (1992).“Fundamentals of Bacterial Plant Pathology.” Academic Press, San Diego.
11. John William Harshberger. A Text-book of Mycology and Plant Pathology. Paul Y.S. (2014). Textbook of Mycology and Plant Pathology.Kalyani Publishers,
12. Keitt, G. W. (1959). History of plant pathology. In “Plant Pathology” (J. G. Horsfall and A. E. Dimond, eds.), Vol. 1, pp. 61–97. Academic Press, New York.
13. Mehrotra RS & Aggarwal A. (2003).Plant Pathology.2nd Ed. Oxford & IBH, New Delhi.
14. Pandey B.P.(2016) Plant pathology .S.Chand&co.Pvt.LtdNew delhi-110055



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15. Pathak V.N. (1984). Laboratory Manual of Plant Pathology. Oxford & IBH, New Delhi. Gurr SJ, Mc
16. Pathak V N and C N Khatri. Fundamentals of Plant Pathology
17. Rangaswami, G., D.J. Bagyaraj. Agricultural Microbiology: - prentice Hall of India .Pvt .Ltd. New Delhi. 110001
18. Rangaswami ,G and A. Mahadevan (2006). Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd. New Delhi 110001.
19. Ravichandra N.G.(2013). Fundamentals of Plant Pathology. PHI Learning PVT.LTD. delhi- 110092.
20. Singh RS. (2002) .Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.
21. Sharma P.D. Plant Pathology: Rastogi Publication, Shivaji Road Meerut. 25002 (India)
22. Pandey, B.P. Plant Pathology, Pathogens And Plant Diseases, S.Chand and Company Pvt.Ltd. Ramngar, New Delhi 110055
23. Shrivastav, A.K. Principles of plant pathology & Diseases. Pragati Prakashan, Meerut 250001 (India).
24. Singh US, Mukhopadhyay AN, Kumar J & Chaube HS.(1992). Plant Diseases of International Importance. Vol. I. Diseases of Cereals and Pulses. Prentice Hall, Englewood Cliffs, New Jersey.
25. Stakman E.C. and J.G. Harrar (1957). Principles of Plant Pathology, Ronald Press New York.
26. Subbarao N S .Soil microorganisms and plant growth

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**\*Theory Paper-XIII (B): Angiosperms-I (Systematics of Angiosperm-I)**

**Suggested Readings:**

1. A Punched card key to the Dicot Families of South India: Saldhana C. & C.K. Rao, Arvind Publishers, Bangalore.
2. An Integrated System of Classification of flowering Plants: Cronquist, A., Columbia University Press.
3. Anatomy of the Dicotyledons, Second edition: Vol. I & II, Metcalfe, C.R. & L. Chalk, Oxford Science Distributors.
4. Biochemical systematics: Alston, R.E. & B.L. Turner, Prentice Hall.
5. Chromosome Atlas of the Flowering Plants of the Indian Subcontinent: Kumar, International Book.
6. Evolution and Phylogeny of flowering plants: Hutchinson, J., Academic Press.
7. Evolution and Systematics: Solbrig, O.T., McMillan.
8. Flowering Plants Origin & Dispersal: Takhtajan, A., Oliver & Boyd.
9. International Code of Botanical Nomenclature, Voss, E.C. (Ed.), Regnum Vegetabile Utrecht.
10. Manual of Cultivated Plants: 2nd Ed., Bailey, L.H., Macmillan.
11. Morphology of Angiosperms: Sporne, K.R., Hutchinson, London.



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12. Morphology of the Angiosperms, Eames, A.J., MC Graw Hill.
13. Numerical Taxonomy: Sneath, P.H.A. & R.R.Sokal, W.H.Freeman & Co.San Fransisco.
14. Origin and Early Evolution of Angiosperms, Breek C.B. (Ed),Columbia University Press.
15. Palaeobiology of Angiosperms Origin: Hughes, N.H., CambridgeUniversity Press.
16. Plant Chemototaxonomy: Harborne J.B. and B.L.Turner, Academic Press.
17. Plant systematics, a phylogenetic approach - Jude, Campell, Kellog& Stevans, Sionaur Association Inc.USA.
18. Pollen Morphology & Taxonomy of Angiosperms: Eradtman, G.,Almvist & Wiksei Stockholm.
19. Principles of Angiosperms Taxonomy : Davis H. & V.H, Heywood,Von Nostrand.
20. Taxonomy & Ecology: Heywood, V.H.Ed., Acadenue Press.
21. Taxonomy of Angiosperms, Naik: V.N., Tata McGraw Hill.
22. Taxonomy of Vascular Plants, Lawrence: H.M., MC Millan.
23. The families of flowering plants Vol. I & II: Hutchinson, J., HutchinsuLondon.
24. The Seeds of Dicotyledons Vols. I & II, Corner, E.J.H., CambridgeUniversity Press.

**\*Theory Paper-XIV(A): Plant Pathology-II (Diseases of crop plants and their management)**

- Fry WE. (1982). *Principles of Plant Disease Management*. Academic Press, New York.
2. Dhingra OD & Sinclair JB. (1986) . *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.
  3. Goodman, R.N., Z. Kiraly, and K.R. Wood (1986). *The Biochemistry and Physiology of Plant Diseases*. University of Missouri Press, Columbia, MO, p.433.
  4. Marcel Dekker. *Fungal Pathogenesis in Plants and Crops: Molecular Biology and Host Defense Mechanisms*, , New York p.553.
  5. Burges HD & Hussey NW. (Eds.). (1971). *Microbial Control of Insects and Mites*. Academic Press,London.
  6. Vidhyasekaran, P. (1988). *Physiology of Disease Resistance in Plants*. Vol. II., CRC Press, Florida, p.127.
  7. Mehrotra RS & Aggarwal A. (2003). *Plant Pathology*. 2<sup>nd</sup> Ed. Oxford & IBH, New Delhi.
  8. Dube H C. (2012). *Modern plant pathology*, Agrobios Publ.
  9. Singh R.S. *Introduction to Principles of Plant Pathology* (3<sup>rd</sup> edition).
  10. D Alice, C Jeyalakshmi (2014). *Plant Pathology* . Ae Publications.
  11. Singh DP & Singh A. (2007). *Disease and Insect Resistance in Plants*. Oxford & IBH, New Delhi.
  12. Upadhyay RK & Mukherjee KG. (1997). *Toxins in Plant Disease Development and Evolving Biotechnology*. Oxford & IBH, New Delhi.
  13. Singh R.S.*Principles of Plant Pathology*.
  14. Heitefuss R & Williams PH. (1976). *Physiological Plant Pathology*. Springer Verlag, Berlin, New York.



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- 15 Lalithakumari D. (2000). *Fungal Protoplast: A Biotechnological Tool*. Oxford and IBH Publishing Co. Pvt.Ltd.
- 16 Noordam D. (1973). *Identification of Plant Viruses, Methods and Experiments*. Oxford & IBH, New Delhi.
17. Van der Plank JE. (1982). *Host Pathogen Interactions in Plant Disease*. Academic Press, New York.
18. Bos L. (1964) . *Symptoms of Virus Diseases in Plants*. Oxford & IBH., New Delhi.
19. Van der Plank JE. (1984). *Disease Resistance in Plants*. Academic Press, New York.
20. Agrios GN. (2005). *Plant Pathology*. 5<sup>th</sup> Ed. Academic Press, New York.
21. Verma JP, Varma A & Kumar D. (Eds). (1995). *Detection of Plant Pathogens and their Management*. Angkor Publ., New Delhi.
- 22 Van der Plank JE. (1975).. *Principles of Plant Infection*. Academic Press, New York.
23. Singh RS. (1982). *Plant Pathogens – The Fungi*. Oxford & IBH, New Delhi.
24. Singh RS. (2002) . *Introduction to Principles of Plant Pathology*. Oxford & IBH, New Delhi.
25. Shrivastav, A.K.. *Principles of plant pathology & Diseases*: Pragati Prakashan, Meerut
26. Gupta, G.P. *Plant Pathology*. Discovery publishing House, New Delhi, 11002.
27. Sharma P.D. *Plant Pathology*: Rastogi Publication, Shivaji Road Meerut. 25002
28. Pandey, B.P. *Plant Pathology, Pathogens And Plant Diseases*, S.Chand and Company Pvt.Ltd. Ramngar, New Delhi 110055
29. Pandey, B.P. *Pathogens and plant diseases*: - S.Chand and company pvt.Ltd. Ramnagar New Delhi 110055
30. Mehrotra, R.S. *The Fungi*: Oxford & IBH publ. company, New Delhi, Bombay,
31. Alexopoulos, C.J., C.M. Mims. *Introductory Mycology*: Wiley Eastern Ltd. New Delhi, Bangalore, Bombay, Calcutta, Madras, Hyderabad.
32. Bennett, F.T. *Outline of Fungi & Plant Diseases*: Ambey Publi. Delhi (India).
33. Bilgrami K S & H C Dube . *A Text book of modern Plant pathology*. Vikas 52 public.house pvt.Ltd. New Delhi. 11004
34. Pandey B.P. *Plant Pathology, Pathogens and Plant Diseases*. S.Chand and Company Pvt.Ltd. Ramngar, New Delhi 110055
35. Rangaswami, G., D.J. Bagyaraj. *Agricultural Microbiology*: - prentice Hall of India .Pvt .Ltd. New Delhi. 110001
36. Shrivastav, A.K. *Principles of plant pathology & Diseases*. Pragati Prakashan, Meerut 250001 (India).
37. Hutchins JD & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21<sup>st</sup> Century*. CABI, Wallington.
38. Sharma P.D. *The Fungi*: Rastogi Publication, Shivaji Road Meerut. 25002 (India)
39. Agarwal VK & JB Sinclair. (1993). *Principles of Seed Pathology*. Vols. I & II, CBS Publ., New Delhi.



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40. Agrios G.N. *Plant Pathology*. Published by Elsevier, India Pvt. Ltd. Lajpathnagar – IV New Delhi – 110024
41. Rangaswami, G and A. Mahadevan (2006). *Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd. New Delhi 110001.
42. Rangaswami G. (1999). *Diseases of Crop Plants in India*. 4<sup>th</sup> Ed.. Prentice Hall of India, New Delhi.
43. Rajeev K & Mukherjee RC. (1996). *Role of Plant Quarantine in IPM*. Aditya Books.
44. Rhower GG. (1991). *Regulatory Plant Pest Management. A Handbook of Pest Management in Agriculture*. 2<sup>nd</sup> Ed. Vol. II. (Ed. David Pimental). CRC Press.
45. Burges HD & Hussey NW. (1971). *Microbial Control of Insects and Mites*. Academic Press, London.
46. Coppel HC & James WM. (1977) *Biological Insect Pest Suppression*. Springer Verlag, Berlin..
47. De Bach P. Chapman & Hall (1964). *Biological Control of Insect Pests and Weeds*. London.
48. Dhaliwal, GS & Koul O. (2007). *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.
49. Gerson H & Smiley RL. (1990). *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.
50. Huffaker CB & Messenger PS. (1976). *Theory and Practices of Biological Control*. Academic Press, London. 51.
51. Dhaliwal GS & Arora R. (2003). *Integrated Pest Management – Concepts and Approaches*. Kalyani Publ., New Delhi.
52. Dhaliwal GS, Singh R & Chhillar BS (2006). *Essentials of Agricultural Entomology*. Kalyani Publ., New Delhi.
53. Flint MC & Bosch RV. (1981). *Introductions to Integrated Pest Management*. Springer, Berlin.
54. Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.
55. Koul O, Dhaliwal GS & Curperus GW. (2004). *Integrated Pest Management – Potential, Constraints and Challenges*. CABI, London
56. Maredia KM, Dakouo D & Mota-Sanchez D. (2003). *Integrated Pest Management in the Global Arena*. CABI, London.
57. Metcalf RL & Luckman WH. (1982). *Introduction of Insect Pest Management*. John Wiley & Sons, New York.
58. Prentice Norris RF, Caswell-Chen EP & Kogan M. (2002). *Concept in Integrated Pest Management*.
59. Pedigo RL. (1996). *Entomology and Pest Management*. Prentice Hall, New Delhi.
60. Marcel Dekker, Subramanian B & Hagstrum DW. (1995). *Integrated Management of Insects in Stored Products*. New York.



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61. Baudoin ABAM, Hooper G R, Mathre D E & Carroll R B. (1990). *Laboratory Exercises in Plant Pathology: An Instructional Kit*. Scientific Publ., Jodhpur.
62. Dhingra O D & Sinclair J B. (1986). *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.
63. CABI Wallington. Fox R T V. (1993). *Principles of Diagnostic Techniques in Plant Pathology*.
64. Mathews R E F. (1993). *Diagnosis of Plant Virus Diseases*. CRC Press, Boca Raton, Tokyo.
65. Pathak V N. (1984). *Laboratory Manual of Plant Pathology*. Oxford & IBH, New Delhi.
66. Paul Neergaard. (1988) . *Seed Pathology*. MacMillan, London.
67. Matthews R E F. (1993). *Diagnosis of Plant Virus Diseases*. CRC Press, Florida.
68. Noordam D. (1973). *Identification of Plant Viruses, Methods and Experiments*. Cent. Agric. Pub. Doc. Wageningen.
69. Trigliano R N, Windham M T & Windham A S.(2004) *Plant Pathology- Concepts and Laboratory Exercises*. CRC Press, Florida.
69. Chakravarti B P. (2005). *Methods of Bacterial Plant Pathology*. Agrotech, Udaipur.
70. Agrios GN. (2005). *Plant Pathology*. 5<sup>th</sup> Ed. Academic Press, New York.
71. Heitefuss R & Williams PH. (1976). *Physiological Plant Pathology*. Springer Verlag, Berlin, New York.
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**\*Theory Paper-XIV (B): Angiosperms-II (Plant Structure and Reproductive Biology)**

**Suggested Readings:**

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**THEORY PAPER-XIIIC & XIVC: SEED TECHNOLOGY-III**

**Suggested Readings:**

1. Introduction to Principles of Plant Pathology (3rd edition)-R.S.singh.
2. Plant Pathology - R.S.Mehrotra
3. Principles of Plant Pathology -C.E.Owens
4. Plant Pathology (2nd edition) George N.Agrios.
5. Plant Diseases - R.S.Singh
6. Plant Deseases -G.Rangaswamy



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  17. Principles of plant pathology & Diseases :-A.K. Shrivastav, Pragati Prakashan, Meerut 250001 (India).
  18. Plant Pathology G.P, Gupta, Discovery publishing House,New Delhi, 11002.
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  20. Plant pathology, pathogens and plant diseases B.P. Pandey,.S.Chand and CompanyPvt.Ltd.Ramngar,New Delhi 110055
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**M. Sc. Second YEAR**  
**SEMESTER – IV**  
**BOTANY**

**Theory Paper-XVI: Biochemistry and Plant Metabolism**

**Suggested Readings :**

1. Buchanan B.B, Gruissem W. and Jones R.L 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists Maryland, USA.
2. Dennis D.T., Turpin, D.H. Lefebvre D.D. and Layzell D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
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  10. Verma S.K. and Verma Mohit 2007. A.T.B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications.
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**Theory Paper-XVII: Biotechnology and Genetic Engineering**

**Suggested Readings :**

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2. Jain J. L. 2010 Fundamentals of Biochemistry, S.Chand Publications.
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**\*Theory Paper-XVIII (A): Plant Pathology-III (Physiological and Molecular Plant pathology)**

**Suggested Readings :**



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**\*Theory Paper-XIX (A): Plant Pathology-IV (Diseases of Fruit plants and their management)**

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162. Mills Dallice *et al.*(1996). *Molecular Aspects of Pathogenicity and Resistance: Requirement for Signal Transduction*. APS, St Paul, Minnesota.
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**\*Theory Paper-XIX (B): Angiosperms-IV (Phytochemistry and Pharmacognosy)**

**Suggested Readings :**

1. Anatomy of the Dicotyledons, Second edition: Vol. I & II, Metcalfe, C.R. & L.Chalk, Oxford Science Distributors.
2. Biochemical systematics: Alston, R.E. & B.L.Turner, Prentice Hall.
3. Chemistry in Botanical classification - Nobel symposia medicine and natural science, Benz, G. and J.Santesson, Academic Press.
4. Chromosome Atlas of the Flowering Plants of the Indian Subcontinent: Kumar, International Book.
5. Comparative Phytochemistry - Swain, T., Academic Press.
6. Morphology of the Angiosperms, Eames, A.J., MC Graw Hill.
7. Numerical Taxonomy: Sneath, P.H.A. & R.R.Sokal, W.H.Freeman & Co.San Fransisco.
8. Origin and Early Evolution of Angiosperms, Breek C.B. (Ed), Columbia University Press.
9. Pharmacognosy - Kokate C.K., A.P.Purohit and S.B.Gokhale, Nirali Prakashan.
10. Phytochemistry and Angiosperm Phylogeny: Young D.J., & Siegler, Prager.
11. Plant Chemototaxonomy: Harborne J.B. and B.L.Turner, Academic Press.
12. Plant systematics, a phylogenetic approach - Jude, Campell, Kellog & Stevans, Sionaur Association Inc.USA.



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13. Taxonomy & Ecology: Heywood, V.H.Ed., Academic Press.
14. The Seeds of Dicotyledons Vols. I & II, Corner, E.J.H., Cambridge University Press.
15. Trease and Evan's Pharmacognosy : W.C.Evans, Saunders.

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**THEORY PAPER-XVIIIIC & XIXC:SEED TECHNOLOGY-III**

**Suggested Readings:**

1. Introduction to Principles of Plant Pathology (3rd edition)-R.S.singh.
2. Plant Pathology - R.S.Mehrotra
3. Principles of Plant Pathology -C.E.Owens
4. Plant Pathology (2nd edition) George N.Agrios.
5. Plant Diseases - R.S.Singh
6. Plant Diseases -G.Rangaswamy
7. D. Lalithakumari (2000): Fungal Protoplast: A Biotechnological Tool: Oxford and IBH Publishing Co.Pvt.Ltd.
8. R.E.F. Mathews (1970) : Plant Virology.
9. S.T.Tilak (1998):Aerobiology. 4. Kenneth M. Smith (1968): Plant Viruses.
10. F.C.Bawden (1964): Plant Viruses and Virus Diseases.
11. Mehrotra R.S.(1980): Plant Pathology
12. Agrios, G.N.(2006): Plant Pathology (5thEdition).
13. Ny Vall, R.F.(1979): Field Crop Diseases Handbook.
14. Singh, R.S.(1963): Plant Diseases.
15. Padoley, S.K. and P.B.Mistry: A manual of Plant pathology.
16. Gangopadhyay, S.(1984): Clinical Plant Pathology.
17. Principles of plant pathology & Diseases :-A.K. Shrivastav, Pragati Prakashan, Meerut
18. Plant Pathology G.P, Gupta, Discovery publishing House,New Delhi, 11002.
19. Plant Pathology: - P.D.Sharma Rastogi Publication, Shivaji Road Meerut. 25002 (India)
20. Plant pathology, pathogens and plant diseases B.P. Pandey,.S.Chand and Company Pvt.Ltd.Ramngar,New Delhi 110055
21. Agrawal RL. 1996. Seed Technology. Oxford Publ.
22. Barton LV. 1985. Seed Preservation and Longevity. International Books and Periodicals Supply Service, New Delhi.
23. Hall CW. 1966. Drying of Farms Crops. Lyall Book Depot.
24. Justice OL & Bass LN. 1978. Principles and Practices of Seed Storage. Castle House Publ. Ltd.
25. Mathews RK, Welch GB, Delouche JC & Dougherty GM. 1969. Drying, Processing and Storage of Corn seed in Tropical and Subtropical Regions. Proc. Am. Agric. Eng. St. Joseph, Mich. Paper No. 69-67.
26. Sahay KM & Singh K K. 1991. Unit Operations in Food Engineering. Vikas Publ.
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28. Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants. Dept. of Plant Breeding CCS HAU, Hisar.
  29. Desai BB. 2004. Seeds Handbook.
  30. Marcel Dekker. Kelly AF. 1988. Seed Production of Agricultural Crops. Longman.
  31. McDonald MB Jr & Copeland LO. 1997. Seed Production: Principles and Practices. Chapman & Hall.
  32. Musil AF. 1967. Identification of Crop and Weed Seeds. Handbook No. 219, USDA, Washington, DC, USA.
  33. Poehlman JM & Sleper DA. 2006. Breeding Field Crops. Blackwell.
  34. Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani.
  35. Singhal NC. 2003. Hybrid Seed Production in Field Crops. Kalyani.
  36. Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.
  37. Tunwar NS & Singh SV. 1985. Handbook of Cultivars. CSCB, GOI.
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**BOTANY - CURRICULUM**

w. e. f. Academic Year 2020-2021

**SKELETON OF THEORY QUESTION PAPER**

(All Theory Papers)

**M. Sc. SECOND YEAR, SEMESTER –III & IV**

**BOTANY**

**Time: Three Hours**

**Max.Marks:75**

**Note :**

- i) Attempt all questions
- ii) All questions are compulsory and carry equal marks.
- iii) Draw neat and well labelled diagrams wherever necessary

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<b>Q – 1)</b> Long answer question (Unit -I)	15
<b>OR</b>	
Long answer question (Unit -I)	
<b>Q – 2)</b> Long answer question (Unit -II)	15
<b>OR</b>	
Long answer question (Unit -II)	
<b>Q – 3)</b> Long answer question (Unit -III)	15
<b>OR</b>	
Long answer question (Unit -III)	
<b>Q – 4)</b> Long answer question (Unit -IV)	15
<b>OR</b>	
Long answer question (Unit -IV)	
<b>Q – 5)</b> Write Short Notes on <b>Any three</b> (3 x 5 marks)	15
a) (Unit -I)	
b) (Unit -II)	
c) (Unit -III)	
d) (Unit -IV)	

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**BOTANY - CURRICULUM**

w. e. f. Academic Year 2020-2021

**SKELETON OF PRACTICAL QUESTION PAPER**

**M. Sc. SECOND YEAR, SEMESTER – III**

**BOTANY**

**LABORATORY COURSE WORK-V**

**BASED ON THEORY PAPER – XI & XII**

**(Compulsory Papers)**

**Maximum Marks: 75**

**Time: 06 Hours**

**Credits: 03**

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**Note:** (i) Attempt all questions  
(ii) Draw neat and well labelled diagrams wherever necessary

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<b>Q1.</b>	Major Experiment	<b>(PAPER – XI)</b>	15
<b>Q2.</b>	Minor Experiment	<b>(PAPER – XI)</b>	10
<b>Q3.</b>	Major Experiment	<b>(PAPER –XII)</b>	15
<b>Q4.</b>	Minor Experiment	<b>(PAPER –XII)</b>	10
<b>Q5.</b>	Spotting (4 spots)		10
<b>Q6.</b>	i) Record book		10
	ii) Viva voce		05

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**BOTANY - CURRICULUM**

w. e. f. Academic Year 2020-2021

**SKELETON OF PRACTICAL QUESTION PAPER**

**M. Sc. SECOND YEAR, SEMESTER – IV**

**BOTANY**

**LABORATORY COURSE WORK-VI**

**BASED ON THEORY PAPER – XVI & XVII**

**(Compulsory Papers)**

**Maximum Marks: 75**

**Time: 06 Hours**

**Credits: 03**

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**Note:** (i) Attempt all questions

(ii) Draw neat and well labelled diagrams wherever necessary

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<b>Q1.</b>	Major Experiment	<b>(PAPER – XVI)</b>	15
<b>Q2.</b>	Minor Experiment	<b>(PAPER – XVI)</b>	10
<b>Q3.</b>	Major Experiment	<b>(PAPER –XVII)</b>	15
<b>Q4.</b>	Minor Experiment	<b>(PAPER –XVII)</b>	10
<b>Q5.</b>	Spotting (4 spots)		10
<b>Q6.</b>	i) Record book		10
	ii) Viva voce		05

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**BOTANY - CURRICULUM**

w. e. f. Academic Year 2020-2021

**SKELETON OF PRACTICAL QUESTION PAPER**

**M. Sc. SECOND YEAR, SEMESTER – III & IV**

**BOTANY**

**LABORATORY COURSE WORK-VII**

**BASED ON THEORY PAPER –XIII +XIV and XVIII+XIX**

**(Elective Papers)**

**Credits: 03**

**Maximum Marks: 75**

**Time: 06 Hours**

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**Note:** (i) Attempt all questions  
(ii) Draw neat and well labelled diagrams wherever necessary

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<b>Q1.</b>	Major Experiment	<b>(PAPER –XIII)</b>	12
<b>Q2.</b>	Major Experiment	<b>(PAPER – XIV)</b>	12
<b>Q3.</b>	Major Experiment	<b>(PAPER –XVIII)</b>	12
<b>Q4.</b>	Major Experiment	<b>(PAPER –XIX )</b>	12
<b>Q5.</b>	Spotting (4 spots)		08
<b>Q6.</b>	i) Record book		10
	ii) Viva voce		05
	iii)Submission		04

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**BOTANY - CURRICULUM**

w. e. f. Academic Year 2020-2021

**SKELETON OF PRACTICAL QUESTION PAPER**

**M. Sc. SECOND YEAR, SEMESTER –IV**

**BOTANY**

**LABORATORY COURSE WORK-VIII**

**PROJECT WORK**

**Maximum Marks: 75**

**Credits: 03**

**ASSESSMENT OF PROJECT REPORT**

S. No.	Content	Max. Marks	Marks Obtained
1	Introduction	10	
2	Review Of Literature	10	
3	Material And Methods	10	
4	Observations & Results	15	
5	Discussion	10	
6	Conclusion	10	
7	Viva-Voce/Presentation	10	
Total		75	

Signature of Internal Examiner-----

Signature of External Examiner-----

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