



SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED
CHOICE BASED CREDIT SYSTEM (CBCS) PATTERN
BOTANY- CURRICULUM
CLASS: M.Sc. SECOND YEAR
(w. e. f. June, 2015)

CURRICULUM DESIGNING COMMITTEE

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| 1. Dr. Bodke S.S.
Yeshwant Mahavidyalaya, Nanded | Chairman |
| 2. Dr. Kadam A.S.
D.S.M. Mahavidyalaya, Jintur | Member |
| 3. Dr. Mandge S.V.
Shri. SGM College, Loha | Member |
| 4. Dr. Gawai D.U.
Science College, Nanded | Member |
| 5. Dr. Dakore H.G.
P.N.College, Nanded | Member |
| 6. Dr. Aithal S.V.
Vai. D.M.Mahavidyalaya, Degloor | Member |
| 7. Dr. Biradar S.D.
D.S.M.College, Parbhani | Member |
| 8. Dr. Bhadraiah B.
Osmania University, Hyderabad | Member |
| 9. Dr. Patil D.A.
SSVP's Dr. Ghogre Science College, Dhule | Member |
| 10. Dr. Mukadam D.S.
Green Gold seeds Ltd., Walunj | Member |
| 11. Dr. Gacche R.N.
SRTM University, Nanded | Member |



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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 going one step ahead to implement Cumulative Grade Point Average (**CGPA**) system for UG and Choice Based Credit System (**CBCS**) for PG in all the affiliated colleges from the academic year **2014-2015**. These regulations shall be called as Choice Based Course Credit System & Grading, 2014. In short it will be referred as **SRTMUN CBCS REGULATION**.

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 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.

Dr. BODKE SHRIRANG SATWAJI
Chairman, BOS in Botany,
SRTMU Nanded



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OBJECTIVES

1. 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.
2. To update curriculum by introducing recent advances in the subject and enable the students to face NET, SET, UPSC and other competitive examinations successfully.
3. To impart knowledge of plant science as the basic objective of Education
4. To develop a scientific attitude to make students open minded, critical and curious
5. To develop an ability to work on their own and to make them fit for the society
6. To expose themselves to the diversity amongst life forms
7. To develop skill in practical work, experiments, equipments and laboratory use along with collection and interpretation of plant materials and data
8. To make aware of natural resources and environment and the importance of conserving the same
9. To develop ability for the application of the acquired knowledge in the fields of life so as to make our country self reliant and self sufficient
10. To appreciate and apply ethical principles to plant science research and studies

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Semester-III

An Outline:

Paper number & Title	Credits (Marks)			Periods
	External: ESE	Internal: CA	Total Credits (Marks)	
Theory Paper-XI: Plant physiology and Metabolism	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
Theory Paper-XII: Molecular Biology and Plant Biotechnology	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Elective-A (For Specialization In Plant Pathology)				
*Theory Paper-XIIIA: Principles of Plant pathology	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Theory Paper-XIVA: Basic Plant Pathology and Plant Diseases	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
OR				
*Elective-B (For Specialization In Angiosperms)				
*Theory Paper-XIIIB: Taxonomy and Systematics-I	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Theory Paper-XIVB: Plant Anatomy and Pharmacognosy-I	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
OR				
*Elective-C (For Specialization In Seed Technology)				



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Paper number & Title	Credits (Marks)			Periods
	External: ESE	Internal: CA	Total Credits (Marks)	
*Theory Paper-XIIIC: Seed Biology and Seed production	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Theory Paper-XIVC: Seed infection and Seed borne diseases	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
Theory Paper-XV: Seminar	-	Credit: 01 (Marks:25)	Credits: 01 (Marks:25)	-
Total	Credit: 12 (Marks: 300)	Credit: 05 (Marks:125)	Credits: 17 (Marks:425)	240

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



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Semester-IV

An Outline:

Paper number & Title	Credits (Marks)			Periods
	External: ESE	Internal: CA	Total Credits (Marks)	
Theory Paper-XVI: Plant Biochemistry and Metabolism	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
Theory Paper-XVII: Genetic Engineering and Biostatistics	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Elective-A (For Specialization In Plant Pathology)				
*Theory Paper-XVIIIA: Physiological and Molecular Plant pathology	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Theory Paper-XIXA: Diseases of crop plants and their Management	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
OR *Elective-B (For Specialization In Angiosperms)				
*Theory Paper-XVIIIB: Taxonomy and Systematics-II	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Theory Paper-XIXB: Plant Anatomy and Pharmacognosy-II	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
OR *Elective-C (For Specialization In Seed Technology)				



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Paper number & Title	Credits (Marks)			Periods
	External: ESE	Internal: CA	Total Credits (Marks)	
*Theory Paper-XVIIIIC: Seed science and general seed technology	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
*Theory Paper-XIXC: Seed health Management and Seed Certification	Credit: 03 (Marks:75)	Credit: 01 (Marks:25) (2 Test: 15 marks, Assignments: 10marks)	Credits: 04 (Marks:100)	60
Theory Paper-XX: Seminar	-	Credit: 01 (Marks:25)	Credits: 01 (Marks:25)	-
Total	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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LABORATORY COURSE WORK
(ANNUAL PATTERN)

An Outline:

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

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SEMESTER-III

THEORY PAPER-XI: PLANT PHYSIOLOGY AND METABOLISM

Periods: 60

Credits: 04

UNIT-I: PLANT WATER RELATIONS AND BIOENERGETICS (15 periods)

Scope and Importance of Plant Physiology; **Bioenergetics**- concept of free energy, enthalpy, entropy, basic laws of thermodynamics; Ultra structure and chemistry of plant cell; Molecular Structure and Physico-chemical properties of water, pH, buffers; Solutions, Suspensions, Colloidal System, Diffusion, Osmosis, Imbibitions, DPD and Concept of Water Potential, Water absorption, Transportation, Transpiration and heat transfer; Phloem transports across the plant, Mechanism of Phloem Loading and Unloading source and sink relationship.

UNIT-II: HORMONAL PHYSIOLOGY AND PHOTOBIOLOGY (15 periods)

Introduction of various plant growth Hormones, Mode of actions, mechanism of biosynthesis and practical applications of Auxins, Gibberellins, Cytokinins, Abscisic acid, ethylene, Brassinosteroides, Salicylic acid Jasmonic Acid .Effect of phytohormones on growth and differentiation of plant; Effect of hormones on seed germination, causes and methods of breaking seed dormancy; Phytochromes, discovery and properties of Phytochromes, red and far red pigment system; Effect of Phytochromes on plant development; Phenomenon of Photoperiodism and Vernalization

UNIT-III: STRESS PHYSIOLOGY, SENESCENCE AND RIPENING (15 periods)

Stress physiology: Plant responses to abiotic stresses, mechanisms of abiotic stress tolerance, water deficit and drought tolerance, salinity stress, metal toxicity, freezing and heat stress; **Senescence and PCD:** Mechanism, physiology of senescence; role of hormones, biochemical aspects of senescence; **Fruit ripening-** Climacteric and non climacteric fruit, biochemical and molecular changes during ripening, Mechanism of ripening, role of hormone in fruit ripening.

UNIT-IV: 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; **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. **Phosphorous metabolism:** Role of phosphorous in plants Sources of phosphorous, uptake transport and mechanism of phosphorous metabolism in plants

LABORATORY COURSE WORK BASED ON PAPER-XI:

1. Determination of water potential of potato tuber.
2. Estimation of Ascorbic Acid in the given material.
3. Estimation of reducing, Non-reducing and total sugars from plant parts
4. Effect of various salts on the permeability of the plasma membrane.
5. Determination of osmotic potential by plasmolytic method
6. Extraction and detection of IAA by TLC from Plants parts
7. Extraction and detection of GA by TLC from plants parts.
8. Detection of organic acids from plant parts by chromatographic method.
9. Extraction of proteins from plant tissue and their quantitative estimation by Lowery's method
10. Effect of GA/IAA on seed germination and seedling growth.
11. Detection of NPK from soil sample



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12. Effect of Biofertilizer on seed germination and seedling growth
13. Studies on effect of different physical factors on seed germination.
14. Studies on effect of different chemical factors on seed germination

15. Visit to research centre/long/short tour.

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SEMESTER-III

THEORY PAPER-XII: MOLECULAR BIOLOGY AND PLANT BIOTECHNOLOGY

Periods: 60

Credits: 04

UNIT-I: MOLECULAR CYTOGENETICS (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; Processing of RNA, Eukaryotic transcription and regulation; RNA polymerase structure and assembly.

UNIT-II: GENOME ORGANIZATION AND REGULATION OF GENE EXPRESSION (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. Enzymes of DNA replications and their role; 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, BACTERIAL AND PHAGE 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, antibiotic resistance cassettes, multiple antibiotic resistant bacteria, genetic transformation, conjugation and transduction in bacteria, genetic recombination, mapping of bacterial genome. Plaque formation, phage mutants, Lytic and lysogenic cycles. specialized transduction, site specific recombination, mapping the bacteriophage genome, genetic map of Lambda (λ) phage.

UNIT-IV: BIOTECHNOLOGY (15 periods)

Scope and importance of Biotechnology, basic principles of Biotechnology; Plant cell and tissue culture: General introduction, history, scope, concept of cellular differentiation, totipotency Organogenesis and adventives embryogenesis, Fundamental aspect of morphogenesis, somatic embryogenesis, mechanisms, technique and utility of cell and tissue culture in plants, Primary culture, Cell line, Cell clones, Callus cultures, Somaclonal variation, Micropropagation, Haploidy, Protoplast isolation, fusion and culture, hybrid selection and regeneration, somatic hybridization, Cybrids, Gene transfer methods in plants and in animals, Transgenic plants, Allopheny, Artificial seeds, Hybridoma technology

LABORATORY COURSE WORK BASED ON PAPER-XII:

1. Study of aseptic techniques, safe handling of microorganisms, storage of culture and subculturing, 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



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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. Preparation and sterilization of tissue culture media and inoculation of plant material for callus formation.
 9. Demonstration of technique of micro propagation by using different explants (axillary buds and meristem)
 10. Isolation of protoplast from different tissues using commercially available enzymes (e.g. Tobacco, Petunia) and estimation of their yield.
 11. Demonstration of the technique of anther culture (e.g. Dhatura)
 12. Visit to plant tissue culture laboratory.
 13. Visit to Biotechnology Research center.
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SEMESTER – III

***THEORY PAPER–XIIIA: PRINCIPLES OF PLANT PATHOLOGY**

(*Elective-A: Specialization in plant pathology)

Periods: 60

Credits: 04

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

Scope and Importance of Plant Pathology; Contributions of E.F .Smith E. C.S takman, S. D. Garrett, E. J. Butler, K.C.Mehta, M.J. Thirumalachar, in the field of plant pathology. Development of Plant Pathology as a Profession , Careers in Plant Pathology The Practice and Practitioners of Plant Pathology .Certification of Professional Plant Pathologists .Plant Pathology as a Part of Plant Medicine; the Doctor of Plant Medicine Program. **Aerobiology:** Scope and applications of aerobiology. Airborne pathogens, Methods for detection of aerospora,

UNIT II: THE PATHOGENESIS (15 periods)

Process of infection - Pre penetration activity of the pathogen on the host surface, Penetration Mode of entry through Epidermis, stomata, lenticels, hydathodes, wounds, buds and hairs, Rhizosphere and phyllosphere population in relation to infection, **Effect of Environment on Pathogenesis** : Effect of temperature, humidity, wind, light, rainfall, soil reaction(pH), plant nutrition. The biotic environment: Antagonistic association, phenomenon of fungistasis, symbiotic association, synergistic association, **Dispersal of plant pathogens:** Dispersal by air, water, insects, animals and man

UNIT III: EPIDEMIOLOGY AND PLANT DISEASE FORECASTING (15 periods)

Epidemiology: Concepts of epidemiology. Slow and rapid epidemics, favourable factors for development of epidemics, conditions for decline of epidemics, Role of environment and meteorological factors in the development of plant disease epidemics, **Disease Forecasting:** General account of Plant Disease Forecast Systems with examples, Methods of Plant disease **forecasting:** Forecasts Based on Amount of Initial Inoculum - On Weather Conditions Favouring Development of Secondary Inoculum - On Amounts of Initial and Secondary Inoculum.

Unit-IV: Defence mechanism in plants (15 periods)

Pre existing and post inflectional Structural defence in host plants, Pre existing Biochemical defence, Post inflectional biochemical defence, defence through detoxification of pathogen toxins, Defence through the Hypersensitive Response, Defence through Lack of Essential Substances for the Pathogen. Defence through Genetically Engineering Disease-Resistant Plants. Phytoalexins : Synthesis, characteristics and role, elicitors of phytoalexins.

LABORATORY COURSE WORK BASED ON PAPER-XIIIA:

1. Isolation and identification of plant pathogens from air over infected field
2. Use of Aerobiological technique to study fungal flora of different localities by Tilak air Sampler
3. Study of rhizosphere mycoflora from different soil samples of infected and healthy plants by serial dilution technique
4. Antagonistic association
5. Effect of Carbon sources on the growth of plant pathogen..
6. Effect of Nitrogen sources on the growth of plant pathogen.
7. Examination of host parasite relationship by using light microscopy
8. Effect of temperature on growth of plant pathogenic fungi
9. Effect of pH on growth of plant pathogenic fungi
10. Study of Phyllosphere mycoflora of infected and healthy plants by leaf print method.



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11. Bioassay of phytoalexins by spore germination method
 12. Visit to research centers, plant pathology laboratories, agriculture universities, two short and one long excursions
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SEMESTER – III

***THEORY PAPER–XIVA: BASIC PLANT PATHOLOGY AND PLANT DISEASES**

(*Elective-A: Specialization in plant pathology)

Periods: 60

Credits: 04

UNIT-I: INTRODUCTION (15 periods)

History of Plant Pathology with special reference to Indian works. Nature and concept of plant disease, effect of plant diseases on human affairs, Nature and cause of diseases in plants, **Classification of plant diseases:** Criteria used in classification, Classification based on origin (soil, air, and seed), symptoms, causal organism and diagnosis of plant diseases.

Methods of Studying Plant Diseases : Field observations, isolation of plant pathogens from infected plant parts, pure culture techniques, methods of inoculation, measurement of plant disease, Koch's postulates, preservation of plant pathogens and disease specimens, microscopic techniques ,staining methods.

UNIT-II: SEED PATHOLOGY (15 periods)

Significance of seed health, Seed borne pathogens, methods for detection of fungi, bacteria and viruses, transmission of seed borne pathogens, biochemical changes in seeds due to infection, spoilage of grains in storage; Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, Recent advances in the establishment and subsequent cause of disease development in seed and seedling, Control of seed borne diseases, seed treatments, seed certification

UNIT-III: DISEASES OF CROP PLANTS- I (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, **Bajra:** Green ear, ergot, rust, smut, **Rice:** Brown leaf spot, blast, **Maize:** Leaf blight, smut

Pluses: Pigeon pea: Wilt, sterility mosaic, **Gram:** Wilt, Ascochyta blight, **Bean:** Anthracnose, Bean mosaic, **Black gram:** Powdery mildew

UNIT-IV: DISEASES OF CROP PLANTS – II (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:** Leaf spot, **Sesame:** Sesamum phyllody, **Mustard:** White rust, **Soybean:** Rust

Vegetables: Tomato: Early blight, leaf curl, **Potato:** Early blight, late blight, soft rot, **Brinjal:** Little leaf, Root Knot, **Chilli:** Die back, leaf curl, **Bhendi:** Yellow vein mosaic, powdery mildew, **Spinach:** Leaf spot **Cabbage:** Leaf spot

LABORATORY COURSE WORK BASED ON PAPER-XIVA:

1. Isolation of plant pathogens from infected plant parts
2. Study of common effect of pollutants- SO_2 , NO_2 , and NH_3 on the leaves of common crop plants
3. Study of mineral deficiency symptoms of important micro / macro nutrients in plants.
4. Study of leaf area affected due to infection in leaf spot and leaf blight diseases
5. Collection and preservation of diseased specimens and plant pathogens.
6. Isolation and identification of seed mycoflora by blotter and agar plate method
7. Estimation of proteins from infected seeds

Study of plant diseases as per theory syllabus with respect to host, symptoms, causal organism and management



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8. Diseases of cereals
 9. Diseases of pulses
 10. Diseases of vegetables
 11. Diseases of oil seed crops
 12. 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

***THEORY PAPER–XIIIB: TAXONOMY AND SYSTEMATICS-I**

(*Elective-B: Specialization in Angiosperms)

Periods: 60

Credits: 04

UNIT-I: TAXONOMY-I (15 periods)

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; ix) Evolution of fruit; **Origin of Angiosperms:** Bennettitalean and Pteridosperm theory, Monophyletic and Polyphyletic origin of angiosperms.

UNIT-II: TAXONOMY-II (15 periods)

Comparative account of Pre-Darwinian Classification: Andrea Cesalpino, John Ray, B. de Jussieu and A. P. de Candolle; **Comparative account of Post Darwinian Classification:** Charles E. Bessey, Armen L. Takhtajan, R. M. T. Dahlgren, Robert Thorne and, APG III (2009) classification.

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

UNIT-IV: SYSTEMATICS-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 and Pandanaceae)
2. **Glumiflorae**: (Gramineae, Cyperaceae)
3. **Liliflorae**: (Juncaceae, Liliaceae, Amaryllidaceae, Dioscoriaceae, Iridaceae)
4. **Microspermae**: (Burmanniaceae, Orchidaceae)

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LABORATORY COURSE WORK BASED ON PAPER-XIIIB:

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-XIIIB **(12 practices)**
2. Preparation of keys of locally available plants **(03 practices)**
3. Botanical excursions to the forest (at least two) and Preparation of field notes of collected plants **(05 practices)**.

Note: Student must attend at least one long and one 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

***THEORY PAPER–XIVB: PLANT ANATOMY AND PHARMACOGNOSY-I**
(*Elective-B: Specialization in Angiosperms)

Periods: 60

Credits: 04

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

Organisation of Root Apical Meristem (RAM): Apical cell theory, Histogen theory, Korper Kappe theory, Concept of Quiescent centre; **Root development:** Cell fates and lineages, Vascular tissue differentiation, Development of adventitious roots, Lateral roots and Root hairs, Primary and Secondary growth of root (Monocot and Dicot)

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

Development, differentiation and Histology of Monocot and Dicot leaf tissues; Anatomy of node and its significance; Leaf venation pattern; Study of stomatal types and trichomes; **Wood Anatomy:** Hard wood and sap wood, porous & non porous wood, distribution and types of wood parenchyma

UNIT-III: PHARMACOGNOSY-I (15 periods)

History, Definition and scope of Pharmacognosy; **Classification of crude drugs:** Taxonomical, morphological Chemical and Pharmacological (Therapeutic) classification; Scheme for Pharmacognostic studies of a crude drug; Floristic diversity and medicinal plant research scenario in Maharashtra.

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. **Fruits and Seeds:** Coriander, Castor

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LABORATORY COURSE WORK BASED ON PAPER-XIVB:

1. Study of vessel elements of roots and stem of at least five plants **(4 practicales)**
 2. Study of dermal structures, stomata and trichomes **(3 practicales)**
 3. Study of stomatal index and frequency **(2 practicales)**
 4. Study of T.S. of dicot. and monocot root **(2 practicales)**
 5. Study of nodal anatomy of at least five plants **(2 practicales)**
 6. Study venation pattern from dicot and monocot plants of at least five plants from each group **(5 practicales)**
 7. Study of morphology, anatomy, medicinal properties and uses of plants as prescribed in theory paper-XIVB
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SEMESTER – III

***THEORY PAPER–XIIIC: SEED BIOLOGY AND SEED PRODUCTION**
(*Elective-C: Specialization in seed technology)

Periods: 60

Credits: 04

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: PHYSIOLOGY OF SEED GERMINATION (15 periods)

Seed dormancy - types, causes and mechanisms of induction and release, factors affecting, methods to overcome dormancy and its significance in agriculture, Seed germination - requirements, Imbibition pattern, physiological and biochemical changes, and role of hormones, water uptake (imbibitions), mobilization of food reserves, factors affecting germination.

UNIT-III: SEED PRODUCTION (15 periods)

Introduction to crop breeding methods, Variety testing, release and notification, Genetic purity concept and factors responsible for deterioration of varieties, Maintenance breeding, General system of seed multiplication, Seed production agencies, Identification of seed production areas and factors affecting it, Compact area approach in seed production, Seed production planning, equipment, input and manpower requirement. Factors affecting pollination and seed set viz., temperature, humidity, wind velocity, insect pollinators, and supplementary pollination. Male sterility, self-incompatibility and their role in hybrid seed production. Principles and methods of seed production of varieties and hybrids of cereals like wheat, ,sorghum, and maize; pulses like chickpea, pigeon pea, and soybean; oilseeds like groundnut, sesame and sunflower fibre crops like cotton and jute; vegetables crops like tomato, brinjal, okra, chilli,

UNIT-IV: SEED PROCESSING (15 periods)

Principles of seed processing, Seed drying principles and methods. Precleaning, grading, treatment, pelleting and packaging, Seed invigoration and enhancement treatment and their applications, Seed processing machines like cleaner cum grader, specific gravity separator, indented cylinder, seed treater, weighing and bagging machines, their operation and maintenance. Seed quality maintenance during processing

LABORATORY COURSE WORK BASED ON PAPER-XIIIC:

1. Preparation of working samples using mechanical seed divider / Trier /repeated method
2. Detection of seed dormancy in different seed samples and study of breaking hardens, dormancy and physiological dormancy
3. Study of exomorphic and endomorphic features of important field crops
4. Identification and study of common weed crop seeds using seed atlas / manuals, photographs
5. Verification of different cultivars through tests at seed level of cultivars of a field crop
6. Study of seed germinability of two crop seed by top paper (TP) and paper towel (PT) methods



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7. Study of seed viability test of one each cereal and legume crops by tetrazolium (TZ) test
 8. Evaluation of seedling vigour by seedling growth rate and determination of seed vigour index
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SEMESTER – III

***THEORY PAPER–XIVC: SEED INFECTION AND SEED BORNE DISEASES**
(*Elective-C: Specialization in seed technology)

Periods: 60

Credits: 04

UNIT-I: INTRODUCTION (15 periods).

History of seed pathology and economic importance of seed pathology in seed industry,: Early work on seed borne nature of pathogens development of seed dressing chemicals, development of seed testing institutes, 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)

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

LABORATORY COURSE WORK BASED ON PAPER-XIVC:

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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SEMESTER – IV

THEORY PAPER-XVI: PLANT BIOCHEMISTRY AND METABOLISM

Periods: 60

Credits: 04

UNIT-I: PLANT BIOCHEMISTRY-I (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. Proteomics- an introduction to protein engineering, Leaf protein concentrates, seed protein.

UNIT- II: PLANT BIOCHEMISTRY-II (15 periods)

Enzymology- Introduction, Classification and properties and structure of enzyme, active site, mechanism of enzyme catalyzed reaction, Enzyme kinetics, Michaelis-Menten equation, Significance of K_m and V_{max} Enzyme inhibition, allosteric enzymes, activators and inhibitors, Coenzymes, relation between co-enzymes and vitamins, co-factors, Isozymes, ribozymes and abzymes

UNIT- III: PLANT METABOLISM-I (15 periods)

Photochemistry: Nature and Properties of light, states of atom, fluorescence, phosphoresce, quantum requirement and quantum yield, Ultra structure of chloroplast, Location of photosynthetic pigments, Chemistry, properties and synthesis 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 cyclic mechanism, photosynthetic carbon reduction pathways in C3, C4 and CAM plants, Biochemical variants of C4 pathway. Biochemistry and Genetics of RUBISCO, Carbon dioxide concentration mechanism in C4 plants, photorespiration and its significance, inhibitors and uncouples of photosynthesis.

UNIT- IV: PLANT METABOLISM-II (15 periods)

Cell Respiration : Introduction to plant respiration, respiration types and locations, fermentations, ultra structure of mitochondria, concept of RQ, Glycolysis , Kerb's cycle and its significance, Electron transport system and oxidative phosphorylation, mechanism of ATP synthesis, Energetics of respiration, Oxidative pentose phosphate pathway, Respiratory inhibitors and uncouplers, Cyanide resistant respiration.

Plant lipid metabolism: Biosynthesis and breakdown of triglycerides and fatty acids, Glyoxalate pathway, Gluconeogenesis, biological significance.

LABORATORY COURSE WORK BASED ON PAPER-XVI:

1. Isolation of chloroplasts and its ultramicroscopic observation.
2. Isolation of mitochondria and its ultramicroscopic observation
3. Effect of substrate concentration on enzyme kinetics for determination of K_m value.
4. Effect of pH and temperature on enzyme kinetics.
5. Study of amylase activity in germinating seeds.
6. Extraction of chlorophyll pigments from the leaves and preparation of absorption spectra.
7. Estimation of carbon dioxide liberated during respiration.



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8. Determination of RQ of given plant material (seeds).
 9. Detection of amino acids by chromatography.
 10. Estimation of total fats from oil seeds.
 11. Effect of DPJ on seed germination.
 12. Analysis of plant proteins by SDS PAGE
 13. Visit to research centre/long/short tour.
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SEMESTER – IV

THEORY PAPER-XVII: GENETIC ENGINEERING AND BIostatISTICS

Periods: 60

Credits: 04

UNIT –I: TECHNIQUES IN MOLECULAR GENETICS (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 based on RFLP and Fine structure maps Regulation of expression (Transcriptional, Post transcriptional, translational, post translational and compartment specific control)

UNIT- II: 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.

UNIT- III: GENOMICS AND PROTEOMICS (15 periods)

Introduction to genomics and proteomics, Use of vectors for over-expression of proteins, Protein extraction/purification techniques viz., electrophoresis and column chromatography, Proteomics as a tool for plant genetics, breeding and diversity studies. Analysis of proteins by different biochemical and biophysical procedures like CD (Circular Dichroism), NMR, UV/Visible and fluorescent spectroscopy, 1-D and 2-D gel electrophoresis for proteome analysis, Mass spectrometry based method for protein identification like PMF (protein mass fingerprinting) and LCMS; Image analysis of 2D gels: Data acquisition, spot detection & quantization, gel matching, protein chips and arrays, future directions in proteomics, scope of functional proteomics.

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) Probability- Definition, mutually exclusive events and addition rule, independent events and multiplication rule. Sampling: Reasons for sampling, methods of sampling, SRS, Systematic, Stratified, Cluster, NPS. Probability distribution: Binomial, Poisson, Gaussian, Standard normal distribution. Drawing inferences from data: Confidence intervals, Confidence limits, Hypothesis tests, Types of errors, P-values, ANOVA

LABORATORY COURSE WORK BASED ON PAPER-XVII:

1. Isolation of plasmid from bacteria
2. Molecular analysis of Genes and Chromosomes by PCR technique.
3. Separation of protein samples by SDS PAGE
4. Column chromatography of proteins samples
5. Study of restriction digestion of the plasmid and estimation of the size of various DNA fragments.
6. Problem based on mean, mode, median, mean deviation, standard deviation, C.V. from the data.
7. Study of frequency distribution, frequency curve and frequency histogram based on data.



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8. Contingency table, frequency table
 9. Simple bar chart, stem and leaf plot
 10. Histogram, Box and whisker plot
 11. Visit to biotechnology laboratory/ field visit/long/short tour.
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SEMESTER – IV

***THEORY PAPER-XVIII: PHYSIOLOGICAL AND MOLECULAR PLANT PATHOLOGY**

(*Elective-A: Specialization in plant pathology)

Periods: 60

Credits: 04

UNIT-I: PHYSIOLOGICAL AND MOLECULAR CHANGES IN DISEASED PLANTS (15 periods)

Changes in host cell walls, Effect of pathogens on permeability of cell membranes, Effect of infection on Photosynthesis, Respiration, Translocation of water and minerals, Phenol metabolism, Nitrogen metabolism and Growth regulators (Auxins, gibberellins and cytokinins) in diseased plants. Changes in the Molecular level - Nucleic acids, Proteins, Effect of pathogens on Transcription and Translation.

UNIT-II: HOST -PATHOGEN INTERACTION (15 periods)

Cell wall composition, **Enzymes:** Cellulolytic enzymes- Types, mode of action and Role. **Pectolytic enzymes:** Types, mode of action and Role of Pectolytic enzymes in pathogenesis and maceration, **Toxins:** Classification of Toxins- Pathotoxins, vivotoxins and phytotoxins, chemical nature and mode of action of Victorin, Lycoperasmin, Fusaric acid, Wild fire toxin, effect of toxins on plant tissues, Role of toxins in pathogenesis, Aflatoxins

UNIT-III: GENETICS AND BIOTECHNOLOGICAL APPROACHES IN PLANT PATHOLOGY (15 periods)

Genetics of host-parasite interaction, Genetic variability of bacteria, viruses and Fungi, Mechanism of variability, loss of virulence in plant pathogen, Physiological specialization and production of new races, Inheritance of resistance in the host, **Biotechnological approaches in plant pathology:** Development of virus free plants by meristem tip culture, single cell culture, strategies for development of transgenic plants.

UNIT-IV: MOLECULAR PLANT PATHOLOGY (15 periods)

Molecular diagnostics: Serological and molecular techniques for detection of plant pathogens (soil, seeds and other planting materials), Identification of the pathogens by Southern, Northern and Western hybridization, PCR based method, Methods for isolation of DNA and RNA from plant pathogens (Fungi and Bacteria), Molecular basis of host parasite interaction, Gene for gene relationship, Criteria for Gene for gene type of relationship, **Genetic engineering of plants for disease resistance:** Methods of gene transfer, Application of molecular biology to plant disease control,

LABORATORY COURSE WORK BASED ON PAPER-XVIII:

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. Production and assay of pectolytic enzymes by Viscometric method
5. Measurement of CMCase enzyme activity by Dinitrosalicylic Acid (DNS) method
6. Extraction and separation of aflatoxins from seeds
7. Detection of plant pathogens from soil/ seeds / other planting materials by Serological techniques
8. Separation and detection of DNA from bacteria/fungi by Agarose Gel Electrophoresis
9. Isolation of RNA from bacteria/fungi and Determining RNA Concentration by a Spectrophotometer
10. Production of pathogen free plant through meristem culture
11. Visit to research institute / biotechnology laboratories, plant pathology laboratories, at least two local and one long excursions



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SEMESTER – IV

***THEORY PAPER-XIXA: DISEASES OF CROP PLANTS AND THEIR MANAGEMENT**

(*Elective-A: Specialization in plant pathology)

Periods: 60

Credits: 04

UNIT-I: DISEASES OF CASH CROPS AND FRUIT CROPS (15 periods)

History, symptomology, causal organism etiology and management of **Cash crops:** Cotton- Wilt, black arm, brown leaf spot; Sugarcane- Red rot, grassy shoot, whip smut, Turmeric- Brown leaf spot, **Fruit crops:** Grape- Downy mildew, powdery mildew, Banana-Leaf spot, Citrus-Canker, gummosis, decline, Papaya- Mosaic, leaf curl, **Trees:** Teak- powdery mildew, Mango- Anthracnose, Mango malformation, Bacterial canker

UNIT-II: PARASITIC AND NON-PARASITIC DISEASES (15 periods)

Parasitic diseases caused by Nematodes- Root knot of tomato, Soyabean cyst, **Parasitic diseases caused by Phanerogams-**Dodder, Witch weed, Broomrapes and their management, **Diseases due to unfavourable conditions of** - Soil, drought, flood, stress and mineral deficiencies, Pollutants in air, **Post harvest diseases:** caused by *Alternaria*, *Botrytis*, *Fusarium*, *Geotrichum*, *Penicillium*, *Sclerotinia* and their management. Post harvest decays of grain and legume seeds.

UNIT-III: DISEASE MANAGEMENT- THE PRINCIPLES (15 periods)

Management planning against a disease, disease cycle-disease control relationship, bases of disease management principles, avoidance, exclusion of Pathogen- plant quarantines, quarantine restrictions in the movement of agricultural produce, seed and planting material, history of quarantine legislation, contamination of food with toxigens, symptomatic diagnosis of and other techniques to detect pests/pathogens, infestations, eradication of plant pathogen, sanitary and phytosanitary issues under WTO, TRIPS & PRA.

UNIT-IV: DISEASE MANAGEMENT –THE PRACTICES (15 periods)

Cultural practices for disease management, production and use of disease free Seeds and propagating materials. Chemical nature and classification of fungicides, antibiotics, nematicides, antiviral chemicals and botanicals, formulations, mode of action and application of different fungicides, phytotoxicity of different fungicides, precautions during handling, health hazards, fungicidal resistance in plant pathogens. Biological control-merits and demerits, integrated disease management (IDM), spraying and dusting equipments and their care-maintenance.

LABORATORY COURSE WORK BASED ON PAPER-XIXA:

1. Study of plant protection equipments with respect to principle, parts, working, uses and maintenance – any two available spray pumps.
2. Evaluation of contact fungicides (any two) against a pathogenic fungus by food poison technique.
3. Evaluation of systemic fungicides (any two) against a pathogenic fungus by spore germination method.
4. Study of fungicides as per theory syllabus with respect to properties, formulations, colour code, methods of application, mode of action and uses. (Sulphur, Copper, Mercury, Antibiotics, Systemic fungicides.).
5. Preparation of Bordeaux mixture, Burgundy mixture and Bordeaux paste.
6. Evaluation of antibiotics against a pathogenic fungus/bacterium (zone of inhibition).
7. Evaluation of biopesticides (Neem, turmeric and garlic) against some plant pathogens (food Poison technique).

Study of plant diseases as per theory syllabus with respect to host, symptoms, causal organism, any one stage in the life cycle and management



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8. Diseases of fruit plants
 9. Diseases of forest trees.
 10. Study of symptomology, causal organism of crop plants caused by phanerogamic plant Parasites.
 11. Study of symptomology of crop diseases caused by nematodes.
 12. Visit to research institute / biotechnology laboratories, plant pathology Laboratories, at least two local and one long excursion.
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SEMESTER – IV

***THEORY PAPER–XVIIIIB: TAXONOMY AND SYSTEMATICS-II**
(*Elective-B: Specialization in Angiosperms)

Periods: 60

Credits: 04

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

1. Plant Speciation: Allopatric, Parapatric, Stasipatric, sympatric, abrupt or gradual speciation.
2. Isolating Mechanisms: Geographical and Ecological, Seasonal and Temporal, Mechanical and Ethological, Internal barriers
3. Concept of Species: Nominalistic, Typological and Biological

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.
2. Taxonomic Evidences: Numerical taxonomy, Chemotaxonomy, Cytotaxonomy; Palynology, and Embryology in relation to taxonomy.
3. Types of Keys: Punched cards and dichotomous keys

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, Nyctaginaceae, Phytolacaceae, Aizoaceae, Portulacaceae and Caryophyllaceae,)
2. **Rosales:** (Podostemaceae, Crassulaceae, Saxifragaceae, Hamamelidaceae, Rosaceae, Leguminosae)
3. **Sapindales:** (Anacardiaceae, Celastraceae, Salvadoraceae, Sapindaceae, Melianthaceae and Balsaminaceae)
4. **Ebenales:** (Sapotaceae and Ebenaceae)

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

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, Aponogetonaceae, Allismataceae, Butomaceae, Hydrocharitaceae)
2. **Spathiflorae:** (Araceae and Lemnaceae)
3. **Farinosae:** (Eriocauliaceae, Bromeliaceae, Commelianaceae, Potenderiaceae)
4. **Scitaminae:** (Musaceae, Zingiberaceae, Cannaceae, Marantaceae)

LABORATORY COURSE WORK BASED ON PAPER-XVIIIIB:

1-10. Description and identification of flowering plants belonging to different families of the orders prescribed in theory paper-VIIB (elective-I, Unit- III &IV) up to genus and species level with their sketches and floral diagrams.

11-14. Practical based on Numerical taxonomy. Study of qualitative and quantitative characters of plants (at least five)

15-17. Study of analytic and synthetic characters of plants (at least two)

18-20. Preparation of bracketed/indented dichotomous keys based on vegetative and reproductive characters.

20-22. Palynological study of some selected taxa (either family, tribe or a genus)



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SEMESTER – IV

***THEORY PAPER–XIXB: PLANT ANATOMY AND PHARMACOGNOSY-II**

(*Elective-B: Specialization in Angiosperms)

Periods: 60

Credits: 04

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

1. Organization of Shoot Apical Meristem (SAM): Apical theory, Tunica corpus theory, Histogenic layer theory
2. Cytological and molecular analysis of SAM,
3. Control of cell division and cell to cell communication, Control of tissue differentiation, specially xylem and phloem, secretory ducts and laticifers,
4. Root stem transition

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

1. Development of flower, Vascular anatomy of flower, Transition to flowering
2. General account of anatomy of fruit
3. General account of anatomy of seed

UNIT-III: PHARMACOGNOSY-I (15 periods)

1. Methods of cultivation, harvesting, drying and storage of drug plants,
2. Quality control of Herbal drugs: Drug adulteration and their types, detection adulterants by organoleptic and microscopic.
3. General introduction to secondary metabolites of plant origin with their properties.

UNIT-IV: PHARMACOGNOSY-II (15 periods)

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

1. Leaf drug: *Adhatoda* , *Vitex*,
2. Essential oils: *Eucalyptus*, *Citronella*
3. Fatty oils: Sesamum, Safflower
4. Flowers: Clove, *Artemisia annua*

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LABORATORY COURSE WORK BASED ON PAPER-XIXB:

- 1-3. Study of floral anatomy with the help of microtome (at two dicot & two monocot plants)
 - 4-6. Study of tracheary elements by using maceration technique.
 - 7-8. Study of shoot apical meristem.
 - 9-12. Study of secretory and laticiferous tissues.
 - 13-16. Study of methods of detection of adulterants
 - 16-17. Study of macro and microscopic characters of plant parts leaf powder of drug of *Adhatoda*, and *Vitex*.
 - 18-20. Study of essential oils (*Eucalyptus*, *Citronella*) and fatty oils (*Sessamum*, *Safflower*) with the help of Soxhlet apparatus
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SEMESTER – IV

***THEORY PAPER-XVIIIC: SEED HEALTH MANAGEMENT AND SEED CERTIFICATION**

(*Elective-C: Specialization in seed technology)

Periods: 60

Credits: 04

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

UNIT-II: DISEASES OF OIL SEEDS, VEGETABLES AND CASH CROPS (15 periods)

Groundnut: Tikka, Rust, Collar rot, Root rot, **Sunflower:** Leaf spot, rust, grey mould, **Soyabean:** Purple stain, pod blight, Rust, **Cowpea:** Cowpea mosaic, **Bean:** Anthracnose, bean mosaic, **Cotton:** Black arm, anthracnose, **Sugarcane:** Red rot, whip smut, Grassy shoot.

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

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)

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 and the plant variety act (PVP) 1993, seed law enforcement, limitations of the act and seed frauds

LABORATORY COURSE WORK BASED ON PAPER-XVIIIC:

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. Role of enzymes of seed borne fungi on bio deterioration of seed
7. Estimation of reducing sugars, starch, proteins, crude fat in seeds
8. Demonstration of the study of ISTA and phytosanitary certification process
9. Diseases of oil seeds, vegetables and cash crops
10. **Groundnut:** Tikka, **Sunflower:** Leaf spot, rust, **Bean:** Bean mosaic
11. **Cotton:** Black arm, **Sugarcane:** Red rot, whip smut
12. Effect of toxins on seed germination, leaf necrosis and seedling growth
13. Seed treatments (chemical and biological)
14. Detection of aflatoxin contamination in stored seed sample by UV light
15. Determination of aflatoxin contents in seeds by TLC
16. Visits to seed production fields, seed testing laboratories, seed industries, seed storage, NSC, SSC, quarantine centres



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SEMESTER – IV

***THEORY PAPER-XIXC: SEED TESTING AND SEED QUALITY CONTROL**

(*Elective-C: Specialization in seed technology)

Periods: 60

Credits: 04

UNIT-I: SEED TESTING (15 periods)

Objectives, ISTA Laboratories, prescriptions and recommendations, seed samples and sampling types, seed purity and analysis, genetic purity and determination (lab and field tests), seed moisture content and its effects, methods to determine seed moisture content, seed viability tests, seed and seedling vigour, seedling evaluation Methods of seed health testing for fungi, bacteria, viruses and nematodes General characters of Important seed borne fungi: Alternaria, Drechslera, Cercospora, Curvulari, Fusarium, Colletitrichum, Botrytis, Ascochyta, Cephalosporium, Macrophomina, Phoma, Pyricularia, Aspergillus, Penicillium, Rhizopus ;

UNIT- III: SEED STORAGE (15 periods)

Requirements and types of seed storage, Factors affecting seed storage and role of moisture, temperature, RH and moisture equilibrium, Viability monographs, Seed deterioration causes and methods of control, Physiological, biochemical and molecular changes in seed ageing, Seed drying and Packaging needs. Storage structures, Methods of stacking and their impact. Short and medium term storage, Controlled storage, Germplasm storage, Cryopreservation, Design features of short, medium and long-term seed storage buildings, Operation and management of seed stores.

UNIT-IV: SEED INDUSTRY DEVELOPMENT AND MARKETING (15 periods)

Trends in National and International seed industry development. International Seed Trade Federation (ISF) and Indian seed associations, Economics of seed production, Market survey, demand forecasting, pricing policies, marketing channels, planning and sales promotion, Buyer behaviour and role of Government, semi Government, cooperative and private sectors in seed trade, Responsibilities of seed companies and dealers in Seed Act, Seed import and export

UNIT-IV: SEED QUALITY CONTROL (15 periods)

Seed legislation- Seeds Act 1966, Seed Rules 1969 and New Seed Bill 2004, Seed Law Enforcement, Seed certification – history, concept, organization, phases and minimum certification standards, Field inspection principles and methods, Inspection at harvesting, threshing and processing, Pre- and post quality testing or genetic purity, Seed Certification Schemes, concepts and procedures, Seed Testing concepts and objectives, its role in seed quality control, Seed sampling, seed moisture testing, purity analysis, germination testing, tolerance tests and equipment, Seed testing procedures for principal agro horticultural crops, Quick viability tests, Seed vigour, its significance and testing methods, International Seed Testing Association (ISTA), its role in development of seed testing procedures, rules and seed quality assurance for international seed trade.

LABORATORY COURSE WORK BASED ON PAPER-XIXC:

- 1 Determination of physical purity of three field crop seed samples by physical purity analysis by number
- 2 Determination of physical purity of three field crop seed samples by physical purity analysis by weight
- 3 Determination of moisture content of seed samples by oven dry method
- 4 Determination of hard and fresh ungerminated seeds for suitable seed sample of a field crop
- 5 Estimation of starch by spectrophotometer /colorimeter from different varieties of a cereal crop
- 6 Estimation of protein using a standard graph from different varieties of a leguminous crop
- 7 Estimation of oil content from vegetable oil crops by titrimetric / soxlet extraction



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11. Principles of Plant Pathology - C.E. Owens
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- 35 Agricultural Microbiology : - G.Rangaswami, D.J. Bagyaraj, prentice Hall of India .Pvt .Ltd. New Delhi. 110001
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SKELETON QUESTION PAPER

Maximum Marks: 75

Credits: 03

Time: 03 Hours

Note:

1. Attempt all questions
2. All question carry equal marks
3. Draw neat and well labeled diagrams wherever necessary

Q1. Long answer type question (Based on Unit-I) (15)

OR

a. Short answer type question (Based on Unit-I) (08)

b. Short answer type question (Based on Unit-I) (07)

Q2. Long answer type question (Based on Unit-II) (15)

OR

a. Short answer type question (Based on Unit-II) (08)

b. Short answer type question (Based on Unit-II) (07)

Q3. Long answer type question (Based on Unit-III) (15)

OR

a. Short answer type question (Based on Unit-III) (08)

b. Short answer type question (Based on Unit-III) (07)

Q4. Long answer type question (Based on Unit-IV) (15)

OR

a. Short answer type question (Based on Unit-IV) (08)

b. Short answer type question (Based on Unit-IV) (07)

Q5. Write short notes on any three of the following (15)

1. (Based on Unit-I)

2. (Based on Unit-II)

3. (Based on Unit-III)

4. (Based on Unit-IV)

5. (Based on Unit-I/II/III/IV)

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स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ

नांदेड- ४३१६०६ (महाराष्ट्र)

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY

NANDED-431606, MAHARASHTRA STATE, INDIA.

स्वामी रामानंद तीर्थ
मराठवाडा विद्यापीठ, नांदेड.

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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परिपत्रक

सर्व संबंधितांना या परिपत्रकान्वये कळविण्यात येते की, प्रस्तुत विद्यापीठाच्या विज्ञान विद्याशाखेतर्गत M.Sc. Botany आणि M.Sc. Herbal Medicine द्वितीय वर्ष अभ्यासक्रमातील Laboratory Course मध्ये खालीलप्रमाणे दुरुस्ती करण्यात येवून शैक्षणिक वर्ष २०१५-१६ पासून लागू करण्यास मा. कुलगुरुंनी मा. विद्या परिषदेच्या वतिने मान्यता प्रदान करण्यात आली आहे.

Laboratory Course Work for M.Sc. Botany & M.Sc. Herbal Medicine Second Year (Annual Pattern)

Paper number & Title	Credits (Marks)			Practical's
	External: ESE	Internal: CA	Total Credits (Marks)	
Laboratory Course Work-V: Based on theory paper- XI & XII	Credit:03 (Marks:75)	Credit:01 (Marks:25)	Credit:04 (Marks:100)	15
Laboratory Course Work-VI: Based on theory paper-XVI & XVII	Credit:03 (Marks:75)	Credit:01 (Marks:25)	Credit:04 (Marks:100)	15
* Laboratory Course Work-VII: Based on theory paper- XIII, XIV, XVIII & XIX	Credit:03 (Marks:75)	Credit:01 (Marks:25)	Credit:04 (Marks:100)	15
* Laboratory Course Work-VIII: Project Work	Credit:03 (Marks:75)	Credit:01 (Marks:25)	Credit:04 (Marks:100)	15
Total	Credit:12 (Marks:300)	Credit:04 (Marks:100)	Credit:16 (Marks:400)	60

(ESE: End of Semester examination, CA: Continuous Assessment, *: Elective Paper)

तरी सदरील बाब सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

“ज्ञानतीर्थ” परिसर

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विष्णुपूरी, नांदेड.

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जा.क्र.शैक्षणिक/०१/अभ्यासक्रम/

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स्वा/—

/२०१५-२०१६/४४८०

)

संचालक

दिनांक : २९/०२/२०१६

)

महाविद्यालय व विद्यापीठ विकास मंडळ

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) प्राचार्य, सर्व संबंधित महाविद्यालये, प्रस्तुत विद्यापीठ.

२) परीक्षा नियंत्रक, प्रस्तुत विद्यापीठ.

३) कुलसचिव (निवडणूक व सभा कक्ष) यांचे कार्यालय, प्रस्तुत विद्यापीठ.

४) उपकुलसचिव, पदव्युत्तर विभाग व पात्रता विभाग, प्रस्तुत विद्यापीठ.