ST. XAVIER'S COLLEGE, RANCHI
(AN AUTONOMOUS COLLEGE OF RANCHI UNIVERSITY)

NEP PG

1-YEAR CURRICULUM

M.SC BOTANY PROGRAMME

SUBJECT CODE = BOT

FOR POST GRADUATE COURSES

Implemented w.e.f. Academic session 2026-2027

Head
Department of Botany
St. Xavier's College
Ranchi

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   Department of Botany, St. Xavier's College, Ranchi

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   MANISHA KUMARI,
   PG Botany Batch 2022-2024,
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HIGHLIGHTS OF NEP PG CURRICULUM

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over a semester (minimum 15 weeks).

a) One hour of teaching/ Lectures or two hours of laboratory /practical work will be assigned per class/interaction.

One credit for Theory = 15 Hours of Teaching
One credit for Practical = 30 Hours of Practical work
One credit for Internship = 02 Weeks of Practical experience

b) For credit determination, instruction is divided into three major components:
Hours (L) – Classroom Hours of one hour duration.
Tutorials (T) – Special, elaborate instructions on specific topics of one hour duration
Practical (P) – Laboratory or field exercises in which the student has to do experiments or other practical work of a two-hour duration.

Internship – For the Exit option after 1st year of the 2-year P.G. Programme for the award of P.G. Diploma, Level 6.5, Students can either complete two 4-week internships worth 2 credits each or one 8-week internship for all 4 credits. This practical experience connects academic learning with real-world applications, offering valuable exposure to professional environments in their fields of stud.

PG CURRICULUM

01. The PG Curriculum will be either of 1-year duration for students who studied the four-year UG Programme (FYUGP) or a 2-year duration for students who studied a three-year UG programme from a CBCS/LOCF/FYUGP Curriculum.
02. There is a flexible mode in the PG programme offered to the students of Ranchi University, Ranchi. The total credit for any semester will be 20 credits.
03. One-year PG curriculum: The Courses in the 1-year PG programme and the second year of the 2-year PG programme are the same.
    a. Course work only: There will be 5 courses at level 500 of 4 credits each in every semester for the
    coursework offered in the programme.
    b. Course work and Research: There will be 5 courses at the level 500 bearing 4 credits each in the
    first semester of a 1-year PG or in the third semester of a 2-year PG. Research work will be offered in the next semester for this mode of the programme. The eligibility for this mode is available in the NEP PG curriculum of Ranchi University, Ranchi.
    c. Research work only: The eligible student will be offered this mode to conduct extensive research under the supervision of a guide. Each semester will be equivalent to 20 credits. The selection of a candidate for the research mode will depend upon the eligibility of the student, availability of the guide and seat in the department/institution of Ranchi University, Ranchi.

PROMOTION CRITERIA

One Year Post-graduation programme having coursework only:

i. Each course shall be of 100 marks, having two components: 30 marks for Sessional Internal Assessment (SIA), conducted by the Department/College and 70 marks shall be assigned to the End Semester University Examination (ESUE), conducted by the University.
ii. The marks of SIA shall further break into 20 for Internal Written Examinations, 05 for Written Assignment/ Seminar presentation and 05 for overall performance of a student, including regularity in
the classroom lectures and other activities of the Department/College.
iii. The Requisite Marks obtained by a student in a particular subject will be the criterion for promotion to
the next Semester.
iv. There shall be two written internal examinations, each of 1 hour duration and each of 20 marks, in a
semester, out of which the 'better of the two' shall be taken for computation of marks under SIA.
v. If a student failed to secure pass marks in the Mid Semester Examination, he/she has to reappear in Mid & End Semester Examinations, of the following year.
vi. In case a student fails to secure pass marks in End Semester Examination, then he/she has to appear only in the End Semester Examination of the following session within the period of Upper Limit of Two Years and the Marks of the Mid Semester will be carried for the preparation of the result.
vii. Students' final marks and the result will be based on the marks obtained in the Mid Semester and End Semester Examination taken together.
viii. The pass marks in the programme will be 45% of the total marks obtained in each Core/ Elective/ Other Courses offered.
ix. In absolute terms of marks obtained in a course, a minimum of 28 marks is essential in the ESUE and a minimum of 17 marks is to be secured in the SIA to clear the course. In other words, a student shall have to pass separately in the ESUE and in the SIA by securing the minimum marks prescribed here.
x. Every candidate seeking to appear in the ESUE shall be issued an Admit Card by the University. No candidate will be permitted to appear in the examination without a valid admit card.
xi. A candidate shall be permitted to proceed in the next Semester (2nd), provided he/she has passed at least 3 courses out of 5 courses in the respective semester in theory and practical/ project courses taken together.
xii. A student will have to clear all his/her papers within a maximum of Two Years of duration to qualify for the degree.

However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

VALUE-ADDED COURSES

1. The Value-added course will be of 2 credits to be covered during the first semester.
2. The End Semester University Examination (ESUE) of this course will comprise 50 objective-type questions of 1 mark each.
3. ESUE shall be OMR-based and the correct option is to be marked by a black ballpoint pen.
4. For the 50 Marks Examination, the student will be provided two hours to mark their responses.
5. Students are not allowed to choose or repeat courses already undergone at the undergraduate level in
the proposed major and minor streams.
6. The performance in this course will not influence the SGPA or CGPA of the PG Programme wherein
the student is registered to obtain the Master's Degree. However, it will be mandatory to secure minimum pass marks in the course before exiting the Programme.
7. If a student fails to secure the minimum pass marks in this course in the first semester, he/she must
reappear in the examination of the said course with the following batch of the next session.
8. The student may appear in the examination of the said course further if they could not clear the course
in the following attempt, subject to the date of validation of the Registration.

COURSE STRUCTURE FOR 'PG COURSEWORK/ COURSEWORK WITH RESEARCH/ RESEARCH ONLY'

Table 1: Credit Framework for One Year Postgraduate Programme [Total Credits = 40]

Academic Level	Level of Courses	Semester	Coursework Level 400	Coursework Level 500	Research Preparedness	Research thesis/ Project/ Patent	Total Credits
YEAR I							
Level 6.5	Coursework	III	—	4+4+4+4+4	—	—	20
		IV	—	4+4+4+4+4	—	—	20
OR							
Level 6.5	Coursework + Research	III	—	4+4+4+4+4	—	—	20
		IV	—	—	20	—	20
OR							
Level 6.5	Research	III	—	—	20	—	20
		IV	—	—	—	20	20
							Total Credits= 40

Note: **Every student has to take any one Value-added course of 2-credits compulsorily in the 1st Semester of PG programme. There is no provision of 'Exit' in the 1-Year PG Programme.**

AIMS OF MASTER'S DEGREE PROGRAMME IN BOTANY

The aim of the Master's degree programme in Botany is to provide:

The Master's Degree Programme in Botany is designed to provide students with advanced knowledge, technical skills, and research aptitude in the diverse areas of plant science. The programme aims to build a strong foundation in classical botany while integrating modern concepts and technologies to address contemporary challenges in plant biology, agriculture, environment, and biotechnology.

1. Academic and Knowledge Advancement

- To deepen understanding of plant morphology, anatomy, taxonomy, physiology, genetics, ecology, and evolution.
- To impart up-to-date knowledge of emerging fields such as molecular biology, plant biotechnology, genomics,
  bioinformatics, and climate change biology.
- To encourage critical thinking and analytical skills for interpreting scientific data and concepts.

2. Research Competence and Innovation

- To train students in designing, conducting, and presenting independent research projects in various branches of botany.
- To develop expertise in modern laboratory techniques, instrumentation, and fieldwork methodologies.
- To cultivate problem-solving abilities for addressing issues related to plant productivity, biodiversity conservation,
  and sustainable resource management.

3. Environmental and Societal Relevance

- To enhance understanding of the role of plants in ecosystem services, environmental balance, and human welfare.
- To promote awareness of biodiversity conservation, sustainable agriculture, and mitigation strategies for environmental degradation.
- To integrate botanical knowledge into policy-making, community development, and industrial applications.

4. Professional and Career Development

- To prepare students for diverse career opportunities in academia, research institutions, botanical gardens, environmental organisations, agriculture, forestry, pharmaceuticals, and biotechnology industries.
- To strengthen communication, teamwork, and leadership skills for professional success.
- To encourage ethical conduct and a responsible approach in scientific research and environmental stewardship.

5. Lifelong Learning and Global Perspective

- To instill a commitment to continuous learning and adaptability in the rapidly evolving field of plant sciences.
- To foster a global outlook by connecting local plant science issues to international research and conservation efforts.

PROGRAMME LEARNING OUTCOMES

The broad aims of Master's degree programme in Botany are:

The Postgraduate Programme in Botany equips students with advanced theoretical knowledge, practical skills, and research competencies to excel in plant sciences. Upon successful completion of the programme, graduates will be able to:

1. Knowledge and Understanding

- Demonstrate comprehensive knowledge of plant biology, covering taxonomy, anatomy, physiology, ecology, genetics, evolution, and biodiversity.
- Explain advanced concepts in molecular biology, plant biotechnology, bioinformatics, environmental science, and plant pathology.
- Correlate traditional botanical knowledge with modern interdisciplinary approaches to address scientific and societal challenges.

2. Research Skills and Scientific Temper

- Design and execute independent research projects, including formulation of hypotheses, experimental design, data collection, and statistical analysis.
- Apply advanced laboratory techniques, field survey methods, and modern instrumentation relevant to plant sciences.
- Critically evaluate scientific literature, synthesize information, and present research outcomes effectively in oral and written formats.

3. Problem-Solving and Application

- Develop innovative solutions for issues in agriculture, forestry, biodiversity conservation, and environmental sustainability.
- Integrate knowledge of plant sciences in biotechnology, pharmaceuticals, and industrial applications.
- Address plant-related problems in the context of climate change, habitat loss, and resource **management.**

4. Professional and Ethical Competence

- Exhibit professional integrity, ethical research practices, and respect for biodiversity and intellectual property rights.
- Demonstrate leadership, teamwork, and communication skills in multidisciplinary and multicultural environments.
- Apply botanical knowledge for societal benefit, policy-making, and public awareness.

5. Lifelong Learning and Global Perspective

- Engage in continuous professional development to adapt to evolving scientific advancements.
- Relate local and regional botanical issues to global environmental and conservation contexts.
- Contribute to the advancement of plant sciences through collaborative national and international research initiatives.

Through these outcomes, the programme aims to produce highly skilled, research-oriented, and socially responsible botanists capable of contributing to academia, industry, environmental management, and policy formulation, thereby addressing both local and global challenges in plant science.

The Courses in One Year P.G. Programme and in the Second year of Two years P.G. Programs are Common.

Table 2: Semester-wise Course Code and Credit Points

Sem	Core, AC/GE/DC/EC & Compulsory Courses				Examination Structure		
	Paper	Paper Code	Credit	Name of Paper	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical/ Viva (F.M.)
I	Core Course	CCBOT311	4	IKS in Botany	30	70	—
	Skill Enhancement Course	ECBOT312	4	A. Biofertrilizers/ B. Mushroom Cultivation	30	70	—
	Core Course	CCBOT313	4	Plant Physiology and Biochemistry	30	70	—
	Core Course	CCBOT314	4	Fundamental and Applied Ecology	30	70	—
	Practicals on Core	CPBOT315	4	Practical	—	—	100
II	Elective	ECBOT411B	4	Microbiology and Plant Pathology I	30	70	—
		ECBOT411E	4	Plant Taxonomy, Ethnobotany and Medicinal Plants I			
	Elective	ECBOT412B	4	Microbiology and Plant Pathology II	30	70	—
		ECBOT412E	4	Plant Taxonomy, Ethnobotany and Medicinal Plants I			
	Core Course	CCBOT413	4	Laboratory Safety, Regulations and Research Ethics	30	70	—
	Practicals on Elective	EPBOT414B	4	Practical- Microbiology and Plant Pathology	—	—	100
		EPBOT414E	4	Practical- Plant Taxonomy, Ethnobotany and Medicinal Plants			
	PROJECT	PRBOT415B	4	Dissertation/Project/ Teaching Aptitude-Microbiology and Plant Pathology	—	—	100
		PRBOT415E	4	Dissertation/Project/ Teaching Aptitude-Plant Taxonomy, Ethnobotany and Medicinal Plant	—	—	100

FORMAT OF QUESTION PAPER FOR MID/ END SEMESTER EXAMINATIONS

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **70 Marks**:

Subject/ Code

F.M. =70 **Time**=3HrS. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

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SEMESTER I

I. CORE COURSE [CCBOT311]

INDIAN KNOWLEDGE SYSTEM (IKS) IN BOTANY

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objective:

1. To explore classical and indigenous knowledge of plants in Indian traditions.
2. To apply IKS concepts in agriculture, herbal medicine, environmental conservation, and sustainable living.
3. To bridge classical knowledge with contemporary scientific research and technologies.
4. To equip students with critical tools for integrating IKS into policy, innovation, and entrepreneurship.

Course Learning Outcomes: After completing this course, students will be able to:

1. Identify and interpret key IKS-based botanical knowledge.
2. Translate IKS concepts into real-world solutions in agriculture, health, and conservation.
3. Critically assess traditional vs modern plant science applications.
4. Build interdisciplinary and culturally-sensitive research models.

Course Outlines:

Unit I: Traditional Botanical Systems in Ancient India
Historical roots of Botany in Indian scriptures and treatises. Study of Vrikshayurveda, Charaka Samhita, Sushruta Samhita, Nighantus, and Samhitas. Indian plant classification: morphological, medicinal, and ecological bases. Sanskrit terminologies of botanical relevance.

Unit II: Ethnobotany and Indigenous Plant Knowledge
Regional and tribal plant knowledge systems across India. Ethnopharmacology and ethnomedicine. Cultural and spiritual associations with plants. IPR, TKDL (Traditional Knowledge Digital Library), and legal protections.

Unit III: Medicinal Plants and Ayurvedic Applications
Medicinal plant classification in Ayurveda (Rasa, Guna, Virya, Vipaka).
Ayurvedic pharmacognosy and pharmacodynamics. Role of plants in Panchakarma, Rasayana, and daily health. Comparison of Ayurvedic formulations with modern phytomedicine.

Unit IV: Traditional Agriculture and Sustainable Practices
Indigenous farming techniques: Rishi Krishi, Homa farming, Vedic agriculture. Organic inputs: Panchagavya, Jeevamrutha, biofertilizers. Climate-resilient crops and seed conservation. Water harvesting and soil health in ancient systems.

Unit V: Sacred Groves, Conservation Ethics, and Modern Integration
Sacred groves as community-based biodiversity reserves. Ritual and temple gardens: ecosystem ethics. Biocultural conservation models. Integration of IKS with AI, GIS, and environmental policy frameworks.

Unit V: Economic Botany related to IKS
Fibre yielding plants: Timber yielding plants; Oil Yielding plants and Drug yielding plants. Role of IKS in textile industry.

Reference Books:

1. Vrikshayurveda by Surapala – Translated by Nalini Sadhale (Agri-History Foundation)
2. Indian Medicinal Plants – K.M. Nadkarni
3. Dravyaguna Vigyana – P.V. Sharma (Vol. 1 & 2)
4. The Cultural History of Plants – Ghani, A.
5. Ethnobotany: Principles and Applications – C.M. Cotton
6. The Sacred Groves of India – M.D. Subash Chandran
7. Biology in the Vedas – B.G. Matapurkar
8. Vedic Botany – N. Sivarajan
9. Textbook of Pharmacognosy – Trease & Evans

II. SKILL ENHANCEMENT COURSE -A [ECBOT312A]

BIOFERTILIZERS

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives:

1. To impart fundamental and advanced knowledge of biofertilizers and their role in sustainable agriculture.
2. To understand the biology, production, and application of different microbial inoculants.
3. To evaluate the significance of microbial interactions in soil fertility and plant growth promotion.
4. To develop practical understanding of biofertilizer formulation, quality control, and field application.
5. To equip students with skills for research and entrepreneurship in the biofertilizer industry.

Course Learning Outcomes: Upon successful completion of this course, students will be able to:

1. Explain the role of various beneficial microbes in nutrient cycling and plant productivity.
2. Identify and characterize key microbial groups used as biofertilizers.
3. Demonstrate knowledge of biofertilizer formulation, quality control, and field-level application.
4. Evaluate the benefits and limitations of biofertilizers in sustainable farming systems.
5. Apply the acquired knowledge in research, extension, and agri-based entrepreneurship.

Course Contents:

Unit I: Introduction to Biofertilizers and Soil Microbial Ecology (12 Lectures)
Definition, scope, and history of biofertilizers.
Types and classification: nitrogen fixers, phosphate solubilizers, potassium solubilizers, and plant growth-promoting rhizobacteria (PGPR). Soil microbial ecology: Rhizosphere, phyllosphere, symbiotic endophytic associations; Rhizospheric engineering. Role of biofertilizers in soil health and organic farming. Comparative advantages over chemical fertilizers.

Unit II: Nitrogen Fixing Microorganisms (14 Lectures)
Symbiotic Nitrogen Fixers: *Rhizobium*: Mechanism of nodule formation, nitrogenase enzyme, leghaemoglobin. *Frankia*-actinorhizal symbiosis.
Non-Symbiotic Nitrogen Fixers: *Azotobacter, Azospirillum, Clostridium.*
Cyanobacteria: Role of *Anabaena*, *Nostoc* in paddy fields; heterocyst differentiation and function.
Molecular basis of nitrogen fixation (nif genes, regulation).
Biofertilizer production and application techniques for nitrogen-fixing microbes.

Unit III: Phosphate, Potassium Solubilizing Microorganisms and Mycorrhizae (12 Lectures)
Phosphate Solubilizers: *Bacillus, Pseudomonas, Aspergillus*, mechanism of organic acid production.
Potassium Solubilizers: Role of silicate-solubilizing bacteria and fungi in agriculture.
Mycorrhizae: Types: Ectomycorrhiza, endomycorrhiza (arbuscular mycorrhiza - AMF).
Role in nutrient uptake, drought resistance, and plant protection.
Mass multiplication and field application techniques.

Unit IV: Biofertilizer Technology and Quality Control (10 Lectures)
Isolation, identification, and characterization of microbial inoculants.
Carrier materials and formulation techniques. Liquid vs carrier-based biofertilizers. Quality standards (BIS norms), shelf life, contamination testing. Role of biotechnology in strain improvement and biofertilizer development.
Pilot plant setup and commercialization strategies.

Unit V: Applications and Policy Perspectives (12 Lectures)
Field application techniques: seed treatment, soil application, foliar spray. Integrated Nutrient Management (INM) and biofertilizer combinations.
Role of biofertilizers in climate-resilient and organic agriculture.
National policies, subsidy schemes, and biofertilizer promotion programs in India. Challenges and future prospects in biofertilizer research and entrepreneurship. Case studies: Biofertilizer success stories in Indian agriculture (Jharkhand focus).

Reference Books:

1. Subba Rao, N.S. (2000). Soil Microorganisms and Plant Growth. Oxford & IBH Publishing.
2. Dubey, R.C. & Maheshwari, D.K. (2013). A Textbook of Microbiology. S. Chand & Co.
3. Kannaiyan, S. (2002). Biofertilizers for Sustainable Agriculture and Forestry. Scientific Publishers.
4. Vessey, J.K. (2003). Plant Growth Promoting Rhizobacteria as Biofertilizers. Plant and Soil Journal.
5. Smith, S.E. & Read, D.J. (2008). Mycorrhizal Symbiosis. Academic Press.
6. Directorate of Extension, Ministry of Agriculture, Govt. of India. Manual on Biofertilizer Production and Use.
7. Bagyaraj, D.J. & Ashwin R. (2017). Microbial Biotechnology for Sustainable Agriculture. I.K. International Publishing.
8. BIS Standards IS 13641:1993 and IS 14846:2000 for Rhizobium, Azotobacter, PSB, etc.

OR SKILL ENHANCEMENT COURSE -B [ECBOT312B]

MUSHROOM CULTIVATION

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives:

1. To provide theoretical and practical knowledge of edible and medicinal mushroom cultivation.
2. To understand fungal biology, taxonomy, and physiology of economically important mushrooms.
3. To develop skills in spawn production, substrate preparation, and post-harvest management.
4. To explore the nutritional, medicinal, and biotechnological applications of mushrooms.
5. To promote entrepreneurship and rural employment through mushroom technology.

Course Learning Outcomes: After successful completion of this course, students will be able to:

1. Identify and differentiate important edible and medicinal mushroom species.
2. Understand the biology, physiology, and ecological roles of fungi.
3. Demonstrate techniques for spawn preparation, substrate handling, and mushroom cropping.
4. Apply post-harvest and value addition techniques for product development.
5. Design small-scale mushroom cultivation units and apply knowledge for entrepreneurship.

Course Contents:

Unit I: Introduction to Mushroom Science and Fungal Biology (10 Lectures)
History, scope and significance of mushroom cultivation in India and Jharkhand.
General characteristics and classification of fungi.
Morphology and anatomy of mushrooms (basidiocarps and ascomycetes).
Life cycle and reproductive structures of edible mushrooms (*Agaricus, Pleurotus, Volvariella*).
Ecological role of fungi and their importance in biodegradation and nutrient cycling.

Unit II: Cultivable Mushrooms and Their Biology (14 Lectures)
Edible Mushrooms: *Agaricus bisporus* (Button mushroom), *Pleurotus* spp. (Oyster mushroom), *Volvariella volvacea* (Paddy straw mushroom), *Calocybe indica* (Milky mushroom)
Medicinal Mushrooms: *Ganoderma lucidum* (Reishi), *Lentinula edodes* (Shiitake), *Cordyceps militaris*
Nutritional and medicinal value: proteins, polysaccharides, antioxidants, immunomodulators.

Unit III: Mushroom Cultivation Techniques (14 Lectures)
Infrastructure: spawn lab, cropping room, compost yard, sterilization setup.
Substrate preparation: composting, pasteurization, sterilization methods.
Spawn types: grain spawn, sawdust spawn, liquid spawn.
Cultivation process of major species: substrate selection, spawning, cropping conditions (temperature, humidity, light). Harvesting, yield optimization and crop cycles. Organic and indoor mushroom production techniques.

Unit IV: Post-Harvest Technology and Value Addition (10 Lectures)
Drying, preservation, packaging and storage of fresh mushrooms.
Processing: pickles, soup powders, nuggets, snacks. Quality control, shelf life, and safety standards.
Food safety and HACCP in mushroom processing units. Value chain management and market trends.

Unit V: Mushroom Industry, Research and Entrepreneurship (12 Lectures)
Economics of mushroom production: cost-benefit analysis. Training, extension and entrepreneurship opportunities. Government schemes and subsidies (NABARD, RKVY, SFAC).
Common pests and diseases (green mold, mites, flies), their control and organic solutions.
Recent advances: mushroom biotechnology, genetic improvement, mycoremediation.
Case studies: successful mushroom farmers and startups in Jharkhand and India.

Reference Books:

1. Chang, S.T. & Miles, P.G. (2004). Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact. CRC Press.
2. Kumar, S. & Sharma, S.R. (2018). Mushroom Cultivation in India. DIPA, ICAR, New Delhi.
3. Singh, M., Vijay, B., Kamal, S. & Wakchaure, G.C. (2011). Mushroom Cultivation Technology. National Research Centre for Mushrooms (ICAR), Solan.
4. Sharma, V.P. (2021). Textbook of Mushroom Production Technology. Daya Publishing House.
5. Nita Bahl (2000). Handbook of Mushrooms. Oxford & IBH.
6. Verma, R.N. (2016). Technical Manual on Mushroom Cultivation. ICAR-NRCP, Solan.
7. Zied, D.C. & Pardo-Giménez, A. (2017). Edible and Medicinal Mushrooms: Technology and Applications. Wiley.
8. Directorate of Mushroom Research (DMR), Solan – Technical Bulletins.

III. CORE COURSE [CCBOT313]

PLANT PHYSIOLOGY AND BIOCHEMISTRY

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100 **Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives:

1. To understand the fundamental physiological and biochemical processes in plants.
2. To explore metabolic pathways, enzymology, and molecular interactions in plant metabolism.
3. To examine plant responses to abiotic and biotic stresses and mechanisms of stress tolerance.
4. To relate physiological and biochemical processes to applications in agriculture, biotechnology, and climate resilience.

Course Learning Outcomes: After completing this course, students will be able to:

1. Comprehend and interpret the physiological and biochemical mechanisms regulating plant growth and metabolism.
2. Analyse the role of macromolecules, enzymes, and secondary metabolites in plant development and stress responses.
3. Explore the physiological adaptations of plants to abiotic and biotic stresses.
4. Apply knowledge of plant physiology in crop improvement and stress management strategies.

Course Contents:

GROUP-A: Plant Physiology (25 Lectures)

1. **Transpiration:** Types of Transpiration, Evaporation and Transpiration, Mechanism of Transpiration and Stomatal, Physiology, Factors Affecting the Rate of Transpiration, Significance of Transpiration, Antitranspirant, Measurement of Transpiration.
2. **Translocation in Plant:** Phloem Transport; Phloem Sap Composition, Movement in Plant, Direction of Movement, Bidirectional Movement, Lateral Movement, Source – Sink relationship, Phloem loading, Phloem Unloading, Mechanism of Phloem Transport – Electro-osmosis, Protoplasmic, Streaming, Contractile Protein Variants, Mass Flow Hypothesis, Factors Affecting Translocation.
3. **Phytohormone:** History, Structure, Biosynthesis Physiological Response and Mechanism of Action of Auxins.
4. **Physiology of Flowering:** Photoperiodism and Vernalization.
5. **Seed Dormancy and Germination:** Definition, Types, Mechanism and Methods of Breaking the Dormancy.

GROUP-B: Plant Biochemistry (25 Lectures)

6. **Photosynthesis:** The Pigment System, Light Reaction, Dark (C3 Cycle), Hatch and Slack Pathway (C4 Cycle), Photorespiration and Factors Affecting Rate of Photosynthesis and molecular mechanism.
7. **Respiration:** Glycolysis, Fermentation, Krebs Cycle, Electron Transport System, Hexose Monophosphate Shunt, Theories of Phosphorylation – The Chemical Coupling Theory, Conformational Coupling Theory, Chemiosmotic Theory, Factors Affecting the Rate of Respiration.
8. **Enzymes:** Nomenclature and Classification, Nature, Properties, Enzyme Energetic, Mode and Mechanism of Action, Factors Affecting Enzyme Activities.
9. **Nitrogen Metabolism:** Nitrogen Fixation; Non-biological Fixation; Biological Fixation – Symbiotic Nitrogen Fixers, Non-symbiotic Nitrogen Fixers, Biochemistry of Nitrogen Fixation.
10. **Lipid Metabolism:** Simple Lipids, Complex Lipid, Neutral Fats, B-Oxidation of Fatty Acid and Biosynthesis of Fatty Acids.
11. **Secondary Metabolites:** Types, Biosynthesis pathway and role in defence mechanism.

GROUP-C: Stress Physiology and Adaptation (10 Lectures)

12. Abiotic stresses: drought, salinity, high and low temperature, heavy metals
13. Bioticstress:pathogensandherbivory–systemicacquiredresistance(SAR)andinducedsystemicresistance(ISR) 14. Oxidative stress and antioxidant defence mechanisms (ROS, SOD, catalase, peroxidase)
15. Role of phytohormones (ABA, SA, JA, ethylene) in stress signaling
16. Molecular and genetic approaches to improve stress tolerance
17. Use of omics (transcriptomics, proteomics, metabolomics) in stress physiology

Reference Books:

1. Taiz, L., Zeiger, E., Møller, I.M., & Murphy, A. – Plant Physiology and Development (Sinauer/ Oxford University Press)
2. Buchanan, B.B., Gruissem, W., & Jones, R.L. – Biochemistry & Molecular Biology of Plants (Wiley)
3. Hopkins, W.G. & Hüner, N.P.A. – Introduction to Plant Physiology (Wiley)
4. Jain, V.K. – Fundamentals of Plant Physiology (S. Chand)
5. Levitt, J. – Responses of Plants to Environmental Stresses
6. Ahmad, P. & Prasad, M.N.V. – Abiotic Stress Responses in Plants (Springer)
7. Parida, A. & Das, A.B. – Salt Tolerance and Salinity Effects in Plants
8. Hirt, H. & Shinozaki, K. – Plant Responses to Abiotic Stress (Springer)

30/5/26 Manisha 30/5/26 30/5/26 30/5/26 30/05/26 30.05.26 30/5/26 30/5/26

IV. CORE COURSE [CCBOT314]

FUNDAMENTAL AND APPLIED ECOLOGY

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives:

1. To understand core principles of ecological organisation and processes across biotic and abiotic systems.
2. To integrate ecological knowledge with advanced tools and applied strategies in restoration, conservation, climate resilience, and industry.
3. To enable the application of ecological models, indicators, and technologies in natural resource management, urban ecology, agriculture, and biotechnology.

Course Learning Outcomes: After completing this course, students will be able to:

1. Analyse ecological interactions, ecosystem functions, and biogeochemical cycles.
2. Apply modern tools like GIS, remote sensing, and ecological modeling.
3. Understand ecological responses to climate change, invasive species, pollution, and habitat loss.
4. Design solutions for conservation, ecosystem restoration, and ecological entrepreneurship.

Course Contents:

1. Ecological factors; Climatic, Topographic, Edaphic and Biotic.
2. Population and Community ecology: population characteristics, Population dynamics, Community characteristics, composition, structure, origin and development of a community, methods of study of community.
3. Ecological succession: Types and mechanisms of ecological successions (Hydrosere and Xerosere); Changes in ecological properties during succession.
4. Ecosystem organisation: Types, Structure and Function, Flow of energy; Bio-geochemical cycles of C, N, P, S; mineral cycles (Pathway, Processes); Primary production, Decomposition and Feed chain, Food web of different types of ecosystems; Terrestrial (Forest and Grassland) and Aquatic (Freshwater); and Ecological pyramids.
5. Ecological adaptations: Hydrophytes, Xerophytes and Halophytes.
6. Phytogeography: Major plant communities of the world; Phytogeographic regions of the world; Floristic regions of India, vegetation of India.
7. Air, Water, Soil, Sound and Radiation Pollutions: Kinds, Sources, Quality parameters, Effects on plants & Ecosystem and control measures.
8. Climate Change (Global Environmental Problems): Global warming, Green house Gases (CO_2, CH_4, O_3, CFC5, N_2O), Sources, Trends & Role); Environmental effects of Global warming, Ozone depletion, Damage to the Ozone layer & Hole, Health effects of Ozone depletion and increased UV Radiation, Saving the Ozone layer.
9. Non-conventional source of energy: Solar, Wind, Nuclear, Biogas and Petroplants.
10. Strategies of Plant conservation: In situ conservation – Sanctuaries, National parks and sacred groves and Ex situ conservation – Botanical gardens, Gene bank, Seed banks and tissue culture techniques.
11. Natural resources and their Managements: Land resource, water resource, Air resource, agriculture and forestry resources and their management.
12. Indian Biological Diversity Act. Convention of Biological Diversity (CBD), People's Biodiversity Register, Green Book, Red Book, Blue Book.
13. Bioremediation: Definition need and scope of bioremediation Phytoremediation, Microremediation.
14. **Industrial, Environmental and Climate Applications: Industrial ecology:** Circular economy, green technologies, ecological engineering;
    Climate change ecology: Impacts on biodiversity, ecosystems, and phenology;
    Carbon sequestration, REDD+, CDM, net-zero ecology;
    Pollution ecology: Bioindicators and biomonitoring (algae, lichens, macroinvertebrates);
    Policy and governance: Biodiversity Act 2002, Ramsar Convention, CBD, Environmental Impact Assessment (EIA)

Suggested Reference Books:

1. Odum, E.P. – Fundamentals of Ecology
2. Smith, R.L. & Smith, T.M. – Elements of Ecology
3. Begon, M., Townsend, C.R., & Harper, J.L. – Ecology: From Individuals to Ecosystems
4. Singh, J.S., Singh, S.P. & Gupta, S.R. – Ecology, Environment and Resource Conservation
5. Dasmann, R. – Environmental Conservation
6. Sodhi, N.S., & Ehrlich, P.R. – Conservation Biology for All
7. Krebs, C.J. – Ecological Methodology
8. Withgott, J. & Laposata, M. – Environment: The Science Behind the Stories

V. CORE COURSE [CPBOT315]
PRACTICAL

Marks: 100 (ESE Pr: 6 Hrs) = 100	**Pass Marks: 45**

(Credits: Theory-04, 120 hours)

Course Objectives:

1. To impart hands-on experience in physiological and biochemical processes in plants.
2. To understand chromosome behaviour, and genetic principles through experimentation.
3. To analyse ecological interactions, environmental parameters, and their influence on plant communities.
4. To develop critical laboratory skills in plant experimentation, data recording, and environmental assessments.

Course Learning Outcomes: Upon successful completion of the course, students will be able to:

1. Measure and interpret physiological responses of plants under various conditions.
2. Understand mitosis and chromosomal behaviours.
3. Perform ecological sampling and evaluate biodiversity and productivity.
4. Use analytical techniques in plant biochemistry and cytogenetics.
5. Conduct experiments and interpret scientific results in the context of plant-environment interactions.

Course Content:

I: Plant Physiology and Biochemistry
Estimation of chlorophyll and carotenoid content in leaves.
Experiment on osmosis and plasmolysis.
Estimation of total soluble sugars in a plant.
Estimation of total proteins in a plant.
Study of enzyme activity: amylase/catalase under different pH and temperature.
Separation of amino acids or plant pigments by paper chromatography.

II: Cytogenetics
Study of mitosis from root tips (e.g., *Allium cepa* L.).
Study of polyploidy using colchicine-treated root tips.

III: Fundamental and Applied Ecology
Quadrat method for studying vegetation; Measurement of frequency, density, and abundance of plant species.
Analysis of soil pH, moisture content
Estimation of dissolved oxygen and pH in water samples
Biodiversity index calculation (Shannon-Weiner index)
Visit to a forest, grassland, or wetland and preparation of field report
Study of ecological adaptations in hydrophytes and xerophytes.

Reference Books:

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. – Plant Physiology and Development (Oxford University Press)
2. Sadasivam, S. & Manickam, A. – Biochemical Methods (New Age International)
3. Plummer, D.T. – An Introduction to Practical Biochemistry (Tata McGraw-Hill)
4. Sharma, A.K. & Sharma, A. – Chromosome Techniques: Theory and Practice (Butterworth-Heinemann)
5. Singh, R.J. – Plant Cytogenetics (CRC Press)
6. Glick, B.R. & Pasternak, J.J. – Molecular Biotechnology (ASM Press)
7. Odum, E.P. & Barrett, G.W. – Fundamentals of Ecology (Cengage Learning)
8. Kormondy, E.J. – Concepts of Ecology (Pearson)
9. Trivedi, R.K. & Goel, P.K. – Chemical and Biological Methods for Water Pollution Studies (Environmental Publications)
10. Mishra, R. – Ecology Workbook (Oxford & IBH)

SEMESTER II

I. ELECTIVE COURSE-B [ECBOT411B]

MICROBIOLOGY AND PLANT PATHOLOGY-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives: By the end of this course/unit, students will be able to:

1. Understand and identify the general symptoms of plant diseases caused by bacteria, fungi, and viruses.
2. Explain Koch's Postulates and its importance in the identification of causal organisms of plant diseases.
3. Classify plant pathogenic bacteria based on Gram staining, and distinguish between Gram-positive and Gram-negative bacteria.
4. Describe the microbial mechanisms of pathogenicity, including strategies employed by microbes to invade and colonise host tissues.
5. Analyse the mechanical forces used by pathogens to breach plant surfaces and establish infection.
6. Elaborate on the chemical weapons used by plant pathogens, including: Enzymes involved in degrading plant cell walls. Toxins, their types, and role in disrupting host cellular functions.
7. Examine plant defence mechanisms, focusing on:
   - o Structural barriers that prevent pathogen entry.
   - o Chemical defences produced during or after infection.
   - o The role of phenolic compounds in inhibiting pathogen activity.
   - o The production and role of phytoalexins as antimicrobial compounds.

Learning Outcomes: After successful completion of this module, students will be able to:

1. Identify and diagnose plant diseases based on visible symptoms caused by microbial pathogens.
2. Apply Koch's postulates to experimentally determine the causal agents of plant diseases.
3. Differentiate between Gram-positive and Gram-negative bacteria based on their structural and staining characteristics.
4. Demonstrate understanding of how plant pathogens initiate infection and colonise host plants.
5. Assess and explain the mechanical and chemical tools employed by pathogens to overcome plant defences.
6. Interpret the roles of specific enzymes and toxins in the pathogenesis of plant diseases.
7. Evaluate the effectiveness of plant defence mechanisms including structural reinforcements, chemical responses, and biosynthesis of protective compounds like phytoalexins.

Course Contents:

Unit I: Principles of Plant Pathology: 10 Lectures

History and development of plant pathology. Classification of plant diseases. Pathogenesis: infection, colonization, symptom expression. Disease cycle and survival of pathogens. Koch's Postulates and disease diagnosis, modification of Koch's. Postulates, its application and limitations, relationship between pathogens and diseases.
General symptoms of Plant Disease caused by Bacteria, fungi and Virus.
Classification of Gram +ve and gram -ve bacteria.

Unit II: Pathogens and Disease Mechanisms: 22 Lectures

Bacterial, viral, fungal, and mycoplasma plant pathogens. Mechanism of Attack: Pathogens attack on host: Mechanisms of pathogenicity
a) Enzymes: Role of Enzymes in pathogenesis
b) Toxins: Types of toxins and their role in pathogenesis.
c) Effector proteins
d) Mycotoxins, Aflatoxins, major types and their importance
Compatible and incompatible interactions. Molecular basis of plant-pathogen interaction (gene-for-gene theory)

Unit III: Defence Mechanisms: 12 Lectures

Structural or morphological defence mechanism. Biochemical defence mechanism
Phenolic compounds and its role in defence.
Phytoalexins.
Concept of Phytoncides

Unit IV: Microbial Genetics and Applications: 16 Lectures
Horizontal gene transfer: transformation, conjugation, transduction
Plasmids, transposons, and their role in evolution
Basic recombinant DNA techniques: gene cloning, vectors, PCR
Resistance and susceptibility

Reference Books:

1. "General Microbiology" – Roger Y. Stanier, John L. Ingraham, Mark L. Wheelis, Page R.
2. "Microbiology" – Pelczar, Chan, and Krieg
3. "Bergey's Manual of Systematic Bacteriology" – Various Authors
4. "A Textbook of Microbiology" – R.C. Dubey and D.K. Maheshwari
5. "Introduction to Modern Virology" – Dimmock, Easton, and Leppard
6. "Essentials of Virology" – Luria and Darnell
7. "Introductory Mycology" – C.J. Alexopoulos, Charles W. Mims, M. Blackwell
8. "Industrial Microbiology" – L.E. Casida
9. "Biotechnology" – U. Satyanarayan
10. "Plant Pathology" – George N. Agrios (Highly Recommended)
11. "Plant Pathology" – R.S. Mehrotra & Ashok Aggarwa
12. "Plant Diseases" – Singh, R.S.
13. "Introductory Plant Pathology" – K.S. Bilgrami & H.C. Dube
14. "Plant Pathology Techniques and Protocols" – B. Foster
15. "Laboratory Manual of Microbiology and Plant Pathology" – D.K. Maheshwari
16. "Molecular Genetics of Bacteria" by Larry Snyder and Wendy Champness
17. "Microbial Genetics" by S.R. Maloy, J.E. Cronan & D. Freifelder
18. "Genetics" by P.K. Gupta
19. "Principles of Genetics" by Gardner, Simmons & Snustad
20. "A Textbook of Biotechnology" by R.C. Dubey
21. "Biotechnology" by U. Satyanarayana
22. "Recombinant DNA" by Watson et al.
23. Aflatoxins: Biochemistry and Molecular Biology by Mehdi Razzaghi-Abyaneh
24. Fungal Diseases and Mycotoxins in Crops by K.S. Bilgrami, R. Prasad

OR ELECTIVE COURSE-E [ECBOT411E]

PLANT TAXONOMY, ETHNOBOTANY AND MEDICINAL PLANTS-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives:

1. To understand the concept of species and the taxonomic hierarchy from species to higher categories.
2. To study classical systems of classification (Bentham & Hooker, Hutchinson), their basis, merits, and limitations.
3. To explore recent trends in taxonomy including anatomical, cytological, embryological, phytochemical, and molecular approaches.
4. To impart knowledge of the International Code of Nomenclature and rules for effective plant naming and classification.
5. To identify and describe key angiosperm families of regional importance in Jharkhand along with their economic uses.
6. To introduce ethnobotany as a science, emphasizing traditional medicinal practices of ethnic communities.
7. To teach herbarium techniques, including both classical and digital methods of plant documentation.
8. To explore the role of traditional knowledge in plant conservation and sustainable resource use.

Course Learning Outcomes: After completing this course, students will be able to:

1. Critically compare Bentham & Hooker and Hutchinson systems of classification and understand their historical significance.
2. Integrate modern taxonomic tools such as anatomy, embryology, phytochemistry, and cytology into plant identification and classification.
3. Apply the principles and rules of botanical nomenclature (ICN) including typification, priority, and valid publication.
4. Understand the scope of ethnobotany and document traditional plant-based knowledge from tribal and ethnic communities.
5. Prepare and maintain classical and digital herbarium specimens with correct scientific documentation.
6. Recognise and describe conservation methods for ethnobotanically valuable and endangered plant species.

Course Content:

1. The species concept: Taxonomic hierarchy, species, genus, family and other categories principles used in assessing relationship, delimitation of taxa.
2. Outline of classification: Bentham & Hooker and Hutchinson system. Merits and demerits.
3. Recent trends in taxonomy with special reference to: Morphology, Anatomy, Phytochemistry, Cytology and Embryology.
4. Botanical nomenclature: International Code of Nomenclature for algae, fungi and plants; Principles, Rules and Recommendations, Priority, Typification, Rules of effective and valid publications, Retention and choice of names.
5. Taxonomical features and economic importance of the dominant Angiospermic families of Jharkhand: Magnoliaceae, Apocynaceae(including Asclepiadoideae subfamily), Rubiaceae, Verbenaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Bignoniaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Zingiberaceae, Araceae, Cyperaceae and Poaceae.
6. Definition, scope and method of study of ethnobotany.
7. Contribution of ethnic communities on traditional medicinal knowledge.
8. Preparation of herbarium, including-digital herbarium.
9. Methods of conservation of valuable plants.
10. Ethnomedicinal plants used in the following diseases:
    a) Diabetes b) Jaundice c) Malaria d) Skin diseases e) Gynaecological Problems

Reference Books:

1. Lawrence, G.H.M. – Taxonomy of Vascular Plants (Oxford & IBH)
2. Rendle, A.B. – The Classification of Flowering Plants
3. Stace, C.A. – Plant Taxonomy and Biosystematics (Cambridge University Press)
4. Radford, A.E. – Vascular Plant Systematics
5. Jain, S.K. & Rao, R.R. – A Handbook of Field and Herbarium Methods (Today and Tomorrow's Printers)
6. Heywood, V.H. & Moore, D.M. – Current Concepts in Plant Taxonomy
7. Turland, N.J. et al. (editors) – International Code of Nomenclature for Algae, Fungi and Plants (Shenzhen Code) (Koeltz Botanical Books)
8. Jain, S.K. – Manual of Ethnobotany (Scientific Publishers)
9. Sinha, R.K. – Ethnobotany: The Renaissance of Traditional Herbal Medicine
10. Purohit, S.S. & Vyas, S.P. – Medicinal Plant Cultivation: A Scientific Approach (Agrobios)
11. Nadkarni, K.M. – Indian Materia Medica (Popular Prakashan)
12. Bridson, D. & Forman, L. – The Herbarium Handbook (Royal Botanic Gardens, Kew)
13. Chopra, G.L. – Plant Systematics: An Integrated Approach
14. Samant, S.S. et al. – Plant Biodiversity of Western Himalaya: A Source Book of Important Plants (GBPIHED)

II. ELECTIVE COURSE-B [ECBOT412B]

MICROBIOLOGY AND PLANT PATHOLOGY-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives: By the end of this course/module, students will be able to:

1. Understand and explain the characteristic features of plant pathogenic bacteria, including their structure and modes of infection.
2. Describe the general characteristics of plant viruses, including:
   o Classification of plant viruses
   o Structure and chemical composition
   o Mechanisms of viral replication in host cells
3. Understand various modes of transmission of plant viruses (e.g., insect vectors, mechanical, seed-borne).
4. Gain basic knowledge of antigen-antibody interactions and the immune response in the context of plant pathology.
5. Learn the mode of action of antibiotics and their use in controlling microbial pathogens.
6. Understand the principles and methods of plant disease management, including:
   o Cultural practices to prevent disease spread
   o Chemical control through fungicides/bactericides o Quarantine regulations to stop disease introduction o Biological control using antagonistic microbes
7. Identify, describe, and analyse the symptoms, etiology, and control methods of major plant diseases caused by fungi, bacteria, and viruses, including:
   o Fungal diseases like downy mildew, powdery mildew, smuts, rust, wilt, tikka disease, early blight, red rot, etc.
   o Bacterial diseases like bacterial blight, citrus canker, stalk rot, and black rot.
   o Viral diseases like bunchy top of banana, rice tungro, sugarcane mosaic, yellow vein mosaic, etc.

Course Learning Outcomes: After successful completion of this course, students will be able to:

1. Identify and describe the morphological and physiological characteristics of plant pathogenic bacteria.
2. Classify plant viruses and explain their structure, replication, and transmission mechanisms.
3. Illustrate the basic concepts of antigen-antibody interactions and explain the immune responses relevant to plant health.
4. Explain the general action of antibiotics and evaluate their effectiveness in disease management.
5. Compare and contrast various plant disease management strategies, including cultural, chemical, quarantine, and biological methods.
6. Recognise and diagnose symptoms of major plant diseases in economically important crops.
7. Analyse disease etiology and suggest appropriate control measures for:
   o Fungal diseases: e.g., Downy mildew of maize, Loose smut of wheat, Tikka disease of groundnut, etc.
   o Bacterial diseases: e.g., Citrus canker, Tundu disease of wheat, Leaf spot of tomato, Bacterial stalk rot of maize, etc.
   o Viral diseases: e.g., Tobacco mosaic, Rice tungro, Sugarcane mosaic, Leaf curl of papaya, etc.
8. Apply theoretical knowledge to practical field diagnosis and propose effective plant protection practices based on symptoms and pathogen biology.

Course Contents

Unit I: Applied Microbiology and Virology (12 Lectures)

1. Application of microbes in the field of agriculture, biofertilizers, biopesticides, GMOs, and microbial bioremediation, fermented foods and dairy products, industry and bio-waste management, Characteristics features of plant pathogenic bacteria.
2. General characteristics of plant Viruses:
3. a) Classification of plant virus.
4. b) Structure, physical and chemical properties of Plant virus.
5. c) Virus replication.
6. Transmission of plant viruses.
7. Recent trends in viral diagnostics (ELISA, RT-PCR)

Unit II: Immunology and Medical Microbiology (10 Lectures)

1. Antigen and antibody- Innate and acquired immunity, Humoral and cell-mediated immunity, antigen, Antigen: types, determinants (epitopes), haptens, Antibodies, the immune response.
2. Cells and organs of the immune system (T cells, B cells, macrophages, dendritic cells, NK cells)
3. Antibiotics and their general mode of action: an overview.
4. Antibiotic resistance: Intrinsic resistance (natural), Acquired resistance (mutation, gene transfer).

Unit III: Plant Disease Management (10 Lectures)

1. Principles of disease management
2. Chemical control: fungicides (types, mode of action)
3. Biological control: biocontrol agents and PGPRs
4. Cultural and mechanical control, quarantine and legislative measures
5. Integrated Disease Management (IDM) approach, Integrated Pest Management (IPM), Biopesticides: Bacterial, viral and fungal biopesticides and their and applications

Unit IV: Study of Major Plant Diseases (28 Lectures)

Detailed study of Distribution, Symptoms, Etiology, Disease cycle, and Disease Management (Control measures) of following diseases:

1. Downy mildew of Maize
2. Powdery mildew of Pea (Pisusm sativum)
3. Loose smut of Wheat
4. Covered smut / Bunt of Wheat
5. Black stem rust of Wheat
6. Tikka disease of Groundnut
7. Red rot of Sugarcane
8. Early blight of Potato
9. Bacterial blight of Paddy
10. Tundu disease of Wheat
11. AngularLeafspotofCotton
12. CitrusCanker
13. Bacterial stalk rot of Maize
14. Black rot / bacterial wilt of Crucifers
15. Yellow vein mosaic of Bhindi
16. Rice tungro disease
17. Sugarcane mosaic disease
18. Bunchy Top of Banana
19. Little leaf of Brinjal

Reference Books:

1. R.S. Mehrotra & A. Aggarwal – Plant Pathology
2. R.S. Singh – Plant Diseases
3. George N. Agrios – Plant Pathology
4. K.S. Bilgrami & H.C. Dube – A Textbook of Modern Plant Pathology
5. B.N. Pandey – Virology
6. Roger Hull – Plant Virology
7. Dimmock, Easton & Leppard – Introduction to Modern Virology
8. R.S. Mehrotra – Plant Pathology
9. Agrios – Plant Pathology
10. C.K. Kokare – Pharmaceutical Microbiology
11. R.C. Dubey & D.K. Maheshwari – Microbiology
12. Tortora, Funke & Case – Microbiology: An Introduction
13. Prescott's Microbiology – Willey, Sherwood, Woolverton
14. A.H. Patel – Industrial Microbiology
15. R.C. Dubey – Microbial Biotechnology
16. Casida – Industrial Microbiology
17. S.S. Chahal – Principles of Plant Disease Management
18. Rangaswami & Mahadevan – Diseases of Crop Plants in India
19. P. Sudha Gangal - A Textbook of Immunology
20. K. Sambamurthy - Immunology
21. Kenneth Murphy, Casey Weaver - Janeway's Immunobiology
22. Jenni Punt, Sharon Stranford, Patricia Jones, Judith Owen - Kuby Immunology

OR ELECTIVE COURSE-E [ECBOT412E]

PLANT TAXONOMY, ETHNOBOTANY AND MEDICINAL PLANTS-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100 **Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objectives:

1. To introduce various systems of angiosperm classification with an emphasis on modern phylogenetic approaches.
2. To understand the evolutionary trends and origin of angiosperms through both morphological and molecular perspectives.
3. To familiarise students with molecular taxonomy and the use of DNA markers in plant identification and phylogeny.
4. To explore the diversity, nutritional and medicinal value of under-utilized plants used by indigenous communities, especially in Jharkhand.
5. To gain practical insight into phytochemistry, herbal drug standardization, and pharmacognostic profiling.
6. To prepare students for research and development in the field of ethnomedicine, taxonomy, and conservation.

Course Learning Outcomes: After successful completion of the course, students will be able to:

1. Critically compare traditional and modern systems of angiosperm classification, including Cronquist and APG systems.
2. Apply molecular tools like DNA markers in the taxonomy and phylogenetic study of angiosperms.
3. Understand the basics of remote sensing and GIS in plant biodiversity mapping and conservation.
4. Identify major Indian organisations, botanical gardens, herbariums, and national parks involved in plant research and conservation.
5. Explain phytochemical constituents, bioactive compounds, and standardization techniques used in herbal drug development.
6. Conduct field-based and lab-based ethnobotanical studies with respect to traditional plant usage and conservation.

Course Contents:

1. Outline of classification of angiosperms with their merits and demerits:
   (a) Cronquist system of classification
   (b) Angiosperm Phylogeny Group (APG) systems of classifications.
2. Origin and evolution of Angiosperms.
3. Molecular approaches in plant taxonomy: Application of DNA markers in angiosperm taxonomy, molecular phylogeny.
4. Remote sensing – GIS.
5. Ethnic community of the world. Biological conservation of ethnic society of the world.
6. Role of Government and some other organizations involved in the promotion of ethnobotany in India.
7. National Botanical Gardens, National Parks and Herbarium Centers of India.
8. Phytochemistry and standardization of herbal drugs.
9. Study of the following Nutraceutical and Under – utilized plants used by ethnic communities of Jharkhand state:
   Nutritional and medicinal values of-
   Centella asiatica, Moringa oleifera, Eleusine coracana, Madhuca indica, Psidium guajava, Syzygium cumini, Annona squamosa, Carica papaya, Phyllanthus emblica, Boerhavia diffusa, Aegle marmelos, Senna tora, Ficus glabella, Dolichos biflorus, Cucumis sativus.
10. Detailed study of the following **ethnomedicinal plants** used by ethnic communities with **floral formula, floral diagram, mode of drug preparation, dose and bioactive compounds.**
    Andrographis paniculata, Asparagus racemosus, Rauwolfia serpentina, Azadirachta indica, Achyranthes aspera, Catharanthus roseus, Tinospora cordifolia, Mimosa pudica, Acorus calamus, Ocimum sanctum, Curcuma longa, Stevia spp., Gymnema sylvestre, Bacopa monneri, Vitex negundo, Calotropis procera.

Reference Books:

1. Heywood, V.H. – Plant Taxonomy (Edward Arnold)
2. Cronquist, A. – An Integrated System of Classification of Flowering Plants (Columbia University Press)
3. Judd, W.S. et al. – Plant Systematics: A Phylogenetic Approach (Sinauer Associates)
4. Stace, C.A. – Plant Taxonomy and Biosystematics (Cambridge University Press)
5. Henry, R.J. – Practical Applications of Plant Molecular Biology (Chapman & Hall)
6. Harborne, J.B. – Phytochemical Methods (Springer)
7. Mukherjee, P.K. – Quality Control of Herbal Drugs (Business Horizons)
8. Jain, S.K. – Manual of Ethnobotany (Scientific Publishers)
9. Sinha, R.K. – Ethnobotany: The Renaissance of Traditional Herbal Medicine (Indus Publishing)
10. Purohit, S.S. & Vyas, S.P. – Medicinal Plant Cultivation (Agrobios)
11. Nayar, M.P. – Plant Diversity in India (NBT)
12. Lillesand, T.M., Kiefer, R.W. & Chipman, J.W. – Remote Sensing and Image Interpretation (Wiley)
13. Burrough, P.A. & McDonnell, R.A. – Principles of Geographical Information Systems (Oxford University Press)

III. CORE COURSE [CCBOT413]

LABORATORY SAFELY, REGULATIONS AND RESEARCH ETHICS

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 hours)

Course Objective:

1. To provide comprehensive understanding of laboratory safety protocols and risk assessment in biological research.
2. To familiarise students with biosafety levels, hazardous materials handling, and disposal methods.
3. To educate students about national and international guidelines for biological research and ethical conduct.
4. To instill scientific integrity, good laboratory practices (GLP), and responsible authorship in research.
5. To prepare students for safe and ethical handling of biological materials in research and industrial laboratories.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Demonstrate knowledge of laboratory safety protocols and emergency response.
2. Identify and mitigate biological, chemical, and environmental hazards in lab settings.
3. Apply biosafety and containment practices in handling microorganisms and GMOs.
4. Practice scientific integrity and follow ethical guidelines in botanical research.
5. Comply with national and international regulations concerning life science research.

Course Content:

Unit I: Laboratory Safety and Hazard Management (14 Lectures)

Principles of laboratory safety: fire, chemical, electrical, and mechanical safety.
Identification of physical, chemical, and biological hazards.
Safe handling and storage of reagents and lab equipment.
First aid in laboratory and emergency response planning.
Use of personal protective equipment (PPE).
Lab safety signs, labeling, and hazard communication.

Unit II: Biosafety and Containment Practices (12 Lectures)

Introduction to Biosafety Levels (BSL-1 to BSL-4).
Primary and secondary containment, biosafety cabinets, HEPA filters.
Guidelines for handling genetically modified organisms (GMOs).
Safe practices for working with microbes, plants, and recombinant DNA.
Institutional Biosafety Committees (IBSC) and approval protocols. Fieldwork safety in botanical and ecological research.

Unit III: Waste Management and Environmental Safety (10 Lectures)

Classification of biological and chemical waste.
Waste minimisation and segregation protocols.
Treatment and disposal of solid, liquid, and sharps waste.
Autoclaving, incineration, and chemical neutralization.
Environmental regulations and green lab practices.
National and CPCB guidelines for laboratory waste management.

Unit IV: Research Ethics and Scientific Integrity (12 Lectures)

Ethical principles in scientific research: honesty, objectivity, and accountability.
Plagiarism: detection tools, penalties, and prevention.
Fabrication, falsification, and misconduct in science.
Bioethics: Animal and plant research ethics (CPCSEA and NBA guidelines).
Informed consent and benefit sharing in ethnobotanical research.
Authorship ethics, citation practices, and conflict of interest.

Unit V: Regulatory Framework and National/International Guidelines (12 Lectures)

National Guidelines: DBT, DST, ICAR, NBPGR.
Guidelines for biosafety, genetic engineering, and research funding.
International Frameworks: OECD, WHO, Cartagena Protocol, Nagoya Protocol, UNESCO declarations. GLP (Good Laboratory Practices), GMP (Good Manufacturing Practices).
Laboratory accreditation: NABL and ISO standards.
Case studies on ethical violations and biosafety breaches.

Reference Books:

1. NIH Guidelines for Research Involving Recombinant DNA Molecules (2020).
2. Manual on Laboratory Biosafety – WHO (4th Edition, 2020).
3. Guidelines for Safety in Microbiological and Biomedical Laboratories – CDC, USA.
4. Glick, B.R. & Patten, C.L. (2017). Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
5. Krimsky, S. (2000). Science in the Private Interest: Has the Lure of Profits Corrupted Biomedical Research? Rowman & Littlefield.
6. Day, R.A. & Gastel, B. (2011). How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Indian National Science Academy (INSA). (2019). Ethics in Science Education, Research and Governance.
8. Ministry of Environment, Forest and Climate Change (MoEF&CC). National Biodiversity Action Plan, Government of India.

IV. ELECTIVE COURSE-B [EPBOT414B]

PRACTICAL- MICROBIOLOGY AND PLANT PATHOLOGY

Marks: 100 (ESE Pr: 6 Hrs) = 100	**Pass Marks: 45**

(Credits: Theory-04, 120 hours)

Course Objectives: The primary objectives of this course are to:

1. Provide hands-on training in the isolation, staining, and identification of plant pathogenic microorganisms.
2. Develop practical skills in diagnostic microscopy, including ocular micrometry and temporary slide preparation.
3. Familiarise students with Gram staining and its application in bacterial classification.
4. Train students in standard microbiological techniques such as culture handling, spore measurement, and identification of diseases based on symptoms.
5. Enable students to interpret host-pathogen relationships through morphological and symptomatic studies.
6. Introduce the structure, working principles, and use of basic microbiological laboratory equipment.

Course Learning Outcomes: By the end of this practical course, students will be able to:

1. Prepare and interpret stained microscopic slides of infected plant tissues to identify pathogens using morphological features and diagrams.
2. Calibrate the ocular micrometer and accurately measure microbial spores and cells, determining their average size.
3. Differentiate plant pathogens using temporary slide preparations and draw suitable conclusions regarding host-pathogen interactions.
4. Perform Gram staining of bacterial specimens and determine Gram reaction (positive/negative) to assist in classification.
5. Isolate plant pathogenic microbes from infected material using culture plates, and follow sterile techniques.
6. Recognise common plant diseases by observing preserved or fresh specimens and accurately name the causal organisms.
7. Understand and explain the structure and working principle of essential microbiological equipment used in pathogen identification and analysis.

Course Contents:

1. Make suitable stained preparations of material "A". Study the symptoms of the disease and comment upon the host parasite relationship. Identify the pathogen giving suitable diagrams and reasons. Leave your preparation foR examination.

2. Determine the value of one small division of the ocular micrometer in microns. Measure three spores of the given material "B". Find out the average size of the material given.

3. Make suitable stained temporary preparations of materials "C" to exhibit the structure of the pathogen in it. Identify the pathogen giving suitable diagrams and reasons. Leave your preparation for examination.

4. Prepare a slide of bacterial specimen "D" stain it with the Gram stain and state whether it is gram positive or gram negative.

5. Isolate the pathogen from the given material "E" from the culture plate.

6. Describe the structure, make an illustrative diagram of the given apparatus and describe its principle of working and applications.

7. Give the name of the disease and the causal organism of the specimen 1-5.

Reference Books:

1. Laboratory Manual in Plant Pathology – Rangaswami
2. Plant Pathology Techniques and Protocols – B. Foster (Springer)'
3. "Practical Manual of Microbiology" – R.C. Dubey & D.K. Maheshwari
4. "Laboratory Manual of Plant Pathology" – Rangaswami & Mahadevan
5. "Practical Plant Pathology" - K.P. Srivastava
6. "Microbiological Methods" - Collins and Lyne
7. Staining and pathogen study-Aneja, Dubey & Maheshwari, APS Lab Manual
8. Micrometry and spore measurement -Aneja, Collins & Lyne
9. Temporary mounts of pathogens -K.P. Srivastava, T.S. Thind
10. Gram staining, Dubey & Maheshwari, Aneja
11. Isolation from culture plates, -T.S. Thind, APS Lab Manual
12. Apparatus structure and principle, -Aneja, Srivastava
13. Disease specimen identification, -K.P. Srivastava, APS Lab Manual

OR ELECTIVE COURSE-E [EPBOT414E]

PRACTICAL- PLANT TAXONOMY, ETHNOBOTANY AND MEDICINAL PLANTS

Marks: 100 (ESE Pr: 6 Hrs) = 100	**Pass Marks: 45**

(Credits: Theory-04, 120 hours)

Course Objectives

1. To enable students to identify flowering plants using floral characters and taxonomic keys with the aid of floras and herbarium specimens.
2. To train students in the microscopic preparation and analysis of leaf anatomical features, especially stomatal types and indices.
3. To develop competency in preparing identification keys and understanding diagnostic features of plant specimens.
4. To expose students to the microscopic examination of plant tissues using macerated material and anatomical techniques.
5. To enhance student familiarity with medicinal and ethnomedicinal plants, their families, and active principles.
6. To cultivate the ability to correctly identify and classify angiosperms using field and laboratory-based evidence.

Course Learning Outcomes:

Upon successful completion of this course, students will be able to:

1. Use regional and national floras to correctly identify unknown flowering plant specimens up to family and species level.
2. Prepare slides for stomatal observation, calculate stomatal index, and interpret their ecological significance.
3. Construct dichotomous keys for plant identification and Recognise the importance of active compounds in medicinal plants.
4. Identify key cell types (e.g., vessels, fibers, sclereids, tracheids) from macerated plant tissues and describe their functions.
5. Accurately identify and classify herbarium specimens of medicinal and ethnomedicinal value.
6. Recognise and classify angiosperms from their vegetative and reproductive characters (botanical name and family).
7. Understand the medicinal and ethnobotanical significance of commonly used plant species and document their traditional uses.

Course Contents:

1. Work on Specimen A and identify the family and botanical name of the specimen with the help of flora.
2. Prepare a suitable preparation of Specimen B and find out the stomatal index. Draw suitable diagram and comment on your observation.
3. Prepare a key with a suitable diagram for identification of specimens C, D and E. /Comment on active principles of specimens F, G and H.
4. Identify at least two different cell tissues from the macerated material I supplied to you. Comment on your observation. Spotting - Identify herbarium 1-5 (Plants of medicinal value).
5. Identify the angiospermic plants on spots 6-10 (only botanical names and family).
6. Give botanical name, family and uses of Specimens 11-15 (Plants of Ethnomedicinal Values).

Reference Books:

1. Jain, S.K. & Rao, R.R. – A Handbook of Field and Herbarium Methods (Today & Tomorrow's Printers)
2. Nair, N.C. & Henry, A.N. – Flora of Tamil Nadu (Botanical Survey of India)
3. Bentham, G. & Hooker, J.D. – Genera Plantarum
4. Lawrence, G.H.M. – Taxonomy of Vascular Plants (Macmillan)
5. Radford, A.E. – Vascular Plant Systematics (Harper & Row)
6. Jain, S.K. – Manual of Ethnobotany (Scientific Publishers)
7. Purohit, S.S. & Vyas, S.P. – Medicinal Plant Cultivation (Agrobios)
8. Nadkarni, K.M. – Indian Materia Medica (Popular Prakashan)
9. Sharma, P.V. – Dravyaguna Vijnana (Materia Medica and Pharmacology)
10. Esau, K. – Plant Anatomy (Wiley Eastern)
11. Pandey, B.P. – Plant Anatomy (S. Chand & Company)
12. Johansen,D.A.–PlantMicrotechnique(McGraw-Hill)

V. PROJECT [PRBOT415B]

DISSERTATION/PROJECT/TEACHING APTITUDE- MICROBIOLOGY AND PLANT PATHOLOGY

Marks: 100 (ESE Pr: 6 Hrs) = 100	**Pass Marks: 45**

(Credits: Theory-04, 120 hours)

Guidelines to Examiners for End Semester Examination (ESE):

The evaluation of the dissertation will be done in 100 marks (70 marks + 30 marks of the session). The sessional component will be evaluated by the concerned supervisor.

The end term evaluation (70 marks) will be done by a board of examiners. The end term evaluation in 70 marks will include the literary and scientific presentation of the dissertation and the performance in the viva-voce.

The overall project dissertation may be evaluated under the following heads:

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in an Internship programme with a reputed organisation
- Application of Research techniques in Data collection
- Report Presentation
- Presentation style
- Viva-voce

Course Objective:

1. To develop research skills and scientific inquiry through independent investigations on a topic/ problem.

Course Outcomes:

On successful completion of this course, the student should know:
1. About conducting research with approved stages of research methodology in Botany. A dissertation will enable students to further investigate and navigate different aspects and events of life through research.

PROJECT WORK

Each student has to submit **three** copies of hard-bound dissertation work (along with the raw data), duly forwarded by the HOD of the Department concerned. The forwarded copies will be submitted in the Department of Botany, St. Xavier's College, Ranchi, for evaluation (one month before the viva voce examination).

The paper may involve:

(a) Laboratory research/ Field work/ Lab work related to the project.
(b) Survey research, Case Study or any other type of Botanical research
(c) One Large study/ Experiment or several studies/ Experiments, depending on the objectives of the research.
(d) The writing of the dissertation must be within 80 to 100 pages, including references and appendices.
(e) Content must be typed in Font: Times New Roman with Line Spacing: 1.5 and Font size 14 points.

Presentation of project work in the seminar on the assigned topic in the Department of Botany, St. Xavier's College, Ranchi & open viva there on.

Topics: As decided by the Supervisor/Guide

Teaching Aptitude: Only selected candidates, in place of the Dissertation, may be provided duty to teach the assigned topics in selected colleges. The performance may be evaluated based on the organized feedback for the candidate.

OR. PROJECT [PRBOT415E]

DISSERTATION/PROJECT/TEACHING APTITUDE- PLANT TAXONOMY, ETHNOBOTANY AND MEDICINAL PLANTS

Marks: 100 (ESE Pr: 6 Hrs) = 100	**Pass Marks: 45**

(Credits: Theory-04, 120 hours)

Guidelines to Examiners for End Semester Examination (ESE):

The evaluation of the dissertation will be done in 100 marks (70 marks + 30 marks of the session). The sessional component will be evaluated by the concerned supervisor.

The end term evaluation (70 marks) will be done by a board of examiners. The end term evaluation in 70 marks will include the literary and scientific presentation of the dissertation and the performance in the viva-voce.

The overall project dissertation may be evaluated under the following heads:

- Motivation for the choice of topic
- Project dissertation design
- Methodology and Content depth
- Results and Discussion
- Future Scope & References
- Participation in an Internship programme with a reputed organisation
- Application of Research techniques in Data collection
- Report Presentation
- Presentation style
- Viva-voce

Course Objective:

1. To develop research skills and scientific inquiry through independent investigations on a topic/ problem.

Course Outcomes:

On successful completion of this course, the student should know:
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The paper may involve:

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(b) Survey research, Case Study or any other type of Botanical research
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