To,

The Registrar,

Siddharth University Kapilvastu

Siddharth Nagar (U.P.)

Subject: Discussion on approval of unified syllabus of Botany regarding to New Education Policy (NEP)

Respected Sir,

Date: 03/06/2021

With respect to unified syllabus regarding to New Education Policy (NEP), Board of Studies (BOS) meeting organized virtually on the date 31st May and 1st June 2021. Following members participated in discussion.

1. Dr. D.D. Tewari (Convener) Associate Professor, M.I.K. (P.G.) College, Balrampur
2. Dr. R.K. Pandey (Member) Associate Professor, M.I.K. (P.G.) College, Balrampur
3. Dr. S.M. Singh (Member) Assistant Professor, M.I.K. (P.G.) College, Balrampur
4. Dr. Mohd. Akmal (Member) Assistant Professor, M.I.K. (P.G.) College, Balrampur
5. Professor Malvika Srivastava Retd. (External Member) D.D.U. Gorakhpur
6. Professor Kalavati Shukla Retd. (External Member) D.D.U. Gorakhpur

After two days discussion on different aspects of unified syllabus, the committee has amended slightly the syllabus as per need of university.

Therefore, committee has unanimously accepted the unified syllabus. Amended syllabus enclosed as pdf.

With regards,

Dr. D.D. Tewari
( Convener)
SIDDHARTH UNIVERSITY KAPILVASTU,
SIDDHARTH NAGAR U P

PROPOSED STRUCTURE
OF SYLLABUS

BOTANY

(FACULTY OF SCIENCE)

Modified Syllabus to be accepted by Siddarth University as per guidelines of State Higher Education Council

For
Undergraduate Students

From session 2021-22
### Semester-wise Titles of the Papers in B.Sc. (Botany)

<table>
<thead>
<tr>
<th>Year</th>
<th>Sem.</th>
<th>Course Code</th>
<th>Paper Title</th>
<th>Theory/Practical</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRST YEAR</strong></td>
<td>I</td>
<td>B040101T</td>
<td>Microbiology &amp; Plant Pathology</td>
<td>Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040102P</td>
<td>Techniques in Microbiology &amp; Plant Pathology</td>
<td>Practical</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>B040201T</td>
<td>Archegoniates &amp; Plant Architecture</td>
<td>Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040202P</td>
<td>Land Plants Architecture</td>
<td>Practical</td>
<td>2</td>
</tr>
<tr>
<td><strong>SECOND YEAR</strong></td>
<td>III</td>
<td>B040301T</td>
<td>Flowering Plants Identification &amp; Aesthetic Characteristics</td>
<td>Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040302P</td>
<td>Plant Identification technology</td>
<td>Practical</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>B040401T</td>
<td>Economic Botany, Ethnomedicine &amp; Phytochemistry</td>
<td>Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040402P</td>
<td>Commercial Botany &amp; Phytochemical Analysis</td>
<td>Practical</td>
<td>2</td>
</tr>
<tr>
<td><strong>THIRD YEAR</strong></td>
<td>V</td>
<td>B040501T</td>
<td>Plant Physiology, Metabolism &amp; Biochemistry</td>
<td>Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040502T</td>
<td>Molecular Biology &amp; Bioinformatics</td>
<td>Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040503P</td>
<td>Experiments in physiology, Biochemistry &amp; molecular biology</td>
<td>Practical</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>VI</td>
<td>B040504R</td>
<td><em>Project-I</em></td>
<td>Practical</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td>B040601T</td>
<td>Cytogenetics, Plant Breeding &amp; Nanotechnology</td>
<td>Theory</td>
<td>4</td>
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<tr>
<td></td>
<td></td>
<td>B040602P</td>
<td>Cytogenetics, Conservation &amp; Environment Management</td>
<td>Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040603P</td>
<td>Ecology &amp; Environment</td>
<td>Practical</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B040604R</td>
<td><em>Project-II</em></td>
<td>Practical</td>
<td>3</td>
</tr>
</tbody>
</table>

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**SYLLABUS DEVELOPED BY**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name &amp; email</th>
<th>Designation</th>
<th>Department</th>
<th>College/University</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr D D Tewari</td>
<td>Convenor</td>
<td>Botany</td>
<td>MLKPG College Bijnor</td>
</tr>
<tr>
<td>2</td>
<td>Dr. Gopalji Kushwaha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Dr R K Pandey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Dr Md. Akmal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Dr. S M Singh</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Prof. Kalawati Shukla</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Prof. Malviya Srivastava</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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BOTANY-UG-2020
SUBJECT: BOTANY

Subject prerequisites:
1. To study Botany, a student must have had the subject Biology/Biotechnology learnt at 10+2 level.
2. Keen interest in plants and plant-related research. Potential in mathematics, biology and chemistry.
4. Creativity and good comprehension while working on scientific procedures and research.
5. Computer aptitude.

COURSE INTRODUCTION

The new curriculum of B.Sc. in Science (Botany) offer essential knowledge and technical skills to study plants in a holistic manner. Students would be trained in all areas of plant biology using unique combination of core, elective and vocational papers with significant inter-disciplinary components.

Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

B.Sc. Botany programme covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning.

Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. Botany course.

Programme outcomes (POs):

Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery-learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

PO 1 CBCS syllabus with a combination of general and specialized education shall introduce the concepts of breadth and depth in learning.

PO 2 Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to provide sustainable development.

PO 3 Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solution, improve practical skills, enhance communication skill, social interaction, increase awareness in judicious use of plant resources by recognizing the ethical value systems.

PO 4 The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET, UPSC Civil Services Examination, IFS, NSC, FCI, BSI, FRJ etc.

PO 5 Certificate and diploma courses are framed to generate self-entrepreneurship and self-employability, if multiexit option is opted.

PO 6 Lifelong learning be achieved by drawing attention to the vast world of knowledge of plants and their domestication.
Programme specific outcomes (PSOs):
B.Sc. I Year / Certificate course in Microbial Technology & Classical Botany

This Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. It shall maintain a balance between the traditional botany and modern science for shifting it towards the frontier areas of plant sciences with applied approach. This syllabus has been drafted to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects:
1. Diversity of plants and microbes, their habitat, morphology, architecture and reproduction.
2. Plant disease causing microbes, symptoms & control.

Programme specific outcomes (PSOs):
B.Sc. II Year / (Diploma in Plant Identification, Utilization & Ethnomedicine)

This course provides a broad understanding of identifying, growing and using plants. This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. In the long run, will contribute towards building momentum for people’s participation in environmental conservation without compromising on academic rigour and our rich wealth of knowledge inherited over generations.

1. The course will cover conventional topics in Field Botany like Evolutionary History & Diversity of Plants, Complete Morphology, Nomenclature of plants, Systems of Classification, Keys to Important Families of Flowering Plants, Field Data Collection & Herbarium Techniques.
2. The course is designed to become a commercial crop grower, florist, protected cultivator, green belt plant advisor to industries, pharmacologist & taxonomist.

Programme specific outcomes (PSOs):
B.Sc. III Year / Bachelor of Science

The learning outcomes of three years graduation course are aligned with program learning outcomes but these are specific to specific courses offered in a program. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach.

1. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.
2. This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.
3. Understanding of various analytical techniques of plant sciences, use of plants as industrial
resources or as human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.

4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data.

5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustainable development, Inculcation of human values.

6. Strengthen mathematical and computational skills. Enable students to use ICT&AI effectively.

7. Develop good skills in laboratory such as observation and evaluation by the use of modern tools and technology.

| PSO 1 | Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology. The course will make them aware of natural resources and environment and the importance of conserving it. Hands on training in various fields will develop practical skills, handling equipments and laboratory use along with collection and interpretation of biological materials and data. Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematics and biotechnology. |
| PSO 2 | Botanists are able to contribute to all these fields and therefore, are mainly employed with educational institutions, government or public sectors or companies in industries, such as agriculture or forestry, oil, chemical, biotechnology, geological survey, environmental protection, drugs, genetic research, plant resources laboratories, plant health inspection services, lumber and paper, food, fermentation, nursery, fruit and so on. Jobs available as a botanist: Microbiologist, plant pathologist, Taxonomist, Plant Physiologist, Plant Biochemist, Researcher, Mycologist, Ecologist, Weed Scientist, Palaeobotanist, Conservationist, Fruit Grower, Morphologist, Cytologist, Ethnobotanist, Plant geneticists etc. |
| PSO 3 | Inculcate strong fundamentals on modern and classical aspects of Botany. Understand knowledge of Botany is an essential pre-requisite for the pursuit of many applied sciences. It will facilitate students for taking up and shaping a successful career in Botany and allied sciences. |
| PSO 4 | Introduction of research project will inculcate research aptitude and passion for higher education and scientific research. |
# Proposed Year wise Structure of B.Sc. in Botany

## (CORE / ELECTIVE COURSES & PROJECTS)

### Subject: Botany

<table>
<thead>
<tr>
<th>Course/Entry-Exit levels</th>
<th>Year</th>
<th>Sem.</th>
<th>Paper 1</th>
<th>Credits/hrs</th>
<th>Paper 2</th>
<th>Credits/hrs</th>
<th>Paper 3</th>
<th>Credits/hrs</th>
<th>Research Credit</th>
<th>Total Credits/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificate Course in Microbial &amp; Applied Botany</td>
<td>I</td>
<td>I</td>
<td>Microbiology &amp; Plant Pathology</td>
<td>4/60</td>
<td>Techniques in Microbiology &amp; Plant Pathology</td>
<td>2/60</td>
<td>--</td>
<td>Nil</td>
<td>Nil</td>
<td>6/120</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>II</td>
<td>Archegoniates &amp; Plant Architecture</td>
<td>4/60</td>
<td>Land Plants Architecture</td>
<td>2/60</td>
<td>--</td>
<td>Nil</td>
<td>Nil</td>
<td>6/120</td>
</tr>
<tr>
<td>Diploma in Plant Identification &amp; Ethnomedicine</td>
<td>III</td>
<td>III</td>
<td>Flowering Plants Identification &amp; Aesthetic Characteristics</td>
<td>4/60</td>
<td>Plant Identification technology</td>
<td>2/60</td>
<td>--</td>
<td>Nil</td>
<td>Nil</td>
<td>6/120</td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>IV</td>
<td>Economic Botany, Ethnomedicine &amp; Phytochemistry</td>
<td>4/60</td>
<td>Commercial Botany &amp; Phytochemical Analysis</td>
<td>2/60</td>
<td></td>
<td>Nil</td>
<td>Nil</td>
<td>6/120</td>
</tr>
<tr>
<td>Bachelor of Science</td>
<td>V</td>
<td>V</td>
<td>Plant Physiology, Metabolism &amp; Biochemistry</td>
<td>4/60</td>
<td>Molecular Biology &amp; Bioinformatics</td>
<td>4/60</td>
<td>Experiments in physiology, Biochemistry &amp; molecular biology</td>
<td>2/60</td>
<td><em>Project-I</em></td>
<td>3/45</td>
</tr>
</tbody>
</table>

### Comments

Total Credits/Hrs / lectures: (Credits can be earned from On-line Portals of UGC to create Academic Bank and 15% of the topics of each paper can be taught by on-line/ Virtual/ ICT based as per choice of the Institution)

* Suggestive List of Projects mentioned in Detailed Paper Syllabus

Botany Course is One of the Major Subjects for Biology Students and Minor or Elective for students of other faculties

Second Major Subject can be Zoology/ Biotechnology /Microbiology

Third Major Subject can be from Science or Any other faculty of UGC/AICTE – (Arts/ Agriculture/ Education/ Law/ Commerce)

Fourth Subject is Minor or Elective to be selected from any one of other Faculties as per student’s own interest

One Vocational Course has to be opted from the list given in Syllabus as per NSDC guidelines

One Co-curricular Course is compulsory

### Internal Assessment & External Assessment

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
<th>External Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
<td>Viva Voce on Practical</td>
<td>10</td>
</tr>
<tr>
<td>Quiz</td>
<td>5</td>
<td>Report of Botanical Excursion/ Lab Visits/Industrial training</td>
<td>10</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
<td>Table work / Experiments</td>
<td>45</td>
</tr>
<tr>
<td>Assignments (Charts/ Floral/ Rural Service/ Technology Dissemination/ Botanical Excursion/ Lab Visits/Industrial training)</td>
<td>8</td>
<td>Practical Record File</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>25</td>
<td><strong>TOTAL</strong></td>
<td>75</td>
</tr>
</tbody>
</table>

* Botanical Excursion/ Lab Visits/Industrial training is compulsory

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**BOTANY-UG-2020**
DETAIL SYLLABUS FOR
CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL
BOTANY
OR
B.Sc.-I
## Certificate Course in Microbial Technology & Classical Botany / B.Sc.-I

**Programme:** Certificate Course In Microbial Technology & Classical Botany  
**Year:** I  
**Semester:** I/Paper-I  
**Subject:** Botany  
**Course Code:** B040101T  
**Course Title:** Microbiology & Plant Pathology

### Course Outcomes:
- After the completion of the course the students will be able to:
  1. Develop understanding about the classification and diversity of different microbes including viruses, Algae, Fungi & Lichens & their economic importance.
  2. Develop conceptual skill about identifying microbes, pathogens, biofertilizers & lichens.
  3. Gain knowledge about developing commercial enterprise of microbial products.
  4. Learn host-pathogen relationship and disease management.
  5. Learn Presentation skills (oral & writing) in life sciences by usage of computer of computer & multimedia.
  6. Gain Knowledge about uses of microbes in various fields.
  7. Understand the structure and reproduction of certain selected bacteria algae, fungi and lichens.
  8. Gain Knowledge about the economic values of this lower group of plant community.

**Credits:** 4  
**Core Compulsory**  
**Max. Marks:** 25+75  
**Min. Passing Marks:**

**Total No. of Lectures-Tutorials-Practical (in hours per week):** 4-0-0  

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures (60 hrs)</th>
</tr>
</thead>
</table>
| I    | A. Introduction to Indian ancient Vedic and heritage Botany and contribution of Indian Botanists, in context with the holistic development of modern science and technology, has to be taught, practiced and assessed via class interaction/assignments/self study mentioned under Continuous Internal Evaluation (CIE).  
B. Microbial Techniques & Instrumentation  
Microscopy – Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy. Common equipments of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation and fermenters. | 8 |
| II   | Microbial world  
Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram negative bacteria, Structure of a bacteria; Bacterial Growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes; Sporulation and reproduction and recombination in bacteria; Viruses, general characteristics, viral culture, Structure of viruses, Bacteriophages, Structure of T4 & λ-phage; Lytic and lysogenic cycles, viroids, Prions & myco & phytoplasma, Actinomycetes and their economic uses. | 8 |
| III  | Phycology  
Range of thallus organization in Algae, Pigments, Reserve food – Reproduction - Classification (Fritsch, P E) and life cycle of – Scytonema, Nostoc; Chlorella, Volvox, Oedogonium, Chara; Sargassum, Ectocarpus, Botrychiaspermum.  
Economic importance of algae - Role of algae in soil fertility - biofertilizer, Commercial products of algae – biodeath, Agar. | 7 |
| IV   | Mycology  

**BOTANY-UG-2020**
V

Mushroom Cultivation, Lichenology & Mycorrhiza

Mushroom cultivation.

General account of lichens, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

VI

Plant Pathology

Disease concept. Symptoms, Etiology & causal complex, Primary and secondary inoculum, Infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre-penetration, Penetration and Post-penetration), Disease cycle (monoecyclic, polycyclic and polyptic). Defense mechanism with special reference to Phytoalexin, Resistance- Systemic acquired and Induced systemic fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake & oil

VII

Diseases and Control

Symptoms, Causal organism, Disease cycle and Control measures of - Early & Late blight of Potato, Brown spot of rice, Black stem rust of wheat, White rust of Mustard, Red rot of Sugarcane, Wilting of Arhar, Stem gall of Coriander, mosaic diseases on tobacco and cucumber, yellow vein mosaic of b'indii; citrus canker, little leaf of brinjal; damping off of seedlings, root knot disease. Disease management: Quarantine, Chemical, Biological, Integrated pest disease management

VIII

Applied Microbiology

Food fermentations and food produced by microbes, amino acids, Production of antibiotics, enzymes, vitamins, alcoholic beverages, organic acid general principles of antigen, antibody reaction and genetic recombinant vaccines. Mass production of bacterial biofertilizers, blue green algae, Azolla and mycorrhiza. Plant growth promoting rhizobacteria & biostimulants- Trichoderma sp. and Pseudomonas. Single cell proteins, Organic farming inputs, Microbiology of water, Production of biofuels, biodegradation of pollutants and biodeterioration of materials & Cultural Property

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. rbd publisher 2019
2. rbd publisher 2019
3. rbd publisher 2019
4. rbd publisher 2019
5. rbd publisher 2019
6. rbd publisher 2019
7. rbd publisher 2019
8. Microbiology Fundamental And Applications (hindi) (pb)
9. ISBN : 9788188826230 Edition : 03 Year : 2016 Author : Dr. Purohit SS , Dr. Deo PP Publisher : Student Edition Language : Hindi
11. Modern Microbiology (hindi) (hb) ISBN : 9788177543599 Edition : 1 Year : 2018 Author : Dr. Purohit SS , Dr. Singh T Publisher : Agrobios (India)
12. Unit-I A:

i. https://indianculture.gov.in/rarebooks/economic-botany-india
ii. https://www.infinityfoundation.net/publication/335715457_Ancient_Indian_rishi_s_Sages_knowledge_of_botany_and_medical_plants_since_Vedic_period_was_much_older_than_the_period_of_Theophrastus_A_case_study_who_was_the_actual_father_of_botany
iii. https://www.scrbdl.com/presentation/81269920/Botany-Of-Ancient-India
UNIT I B.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS.

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
</tr>
<tr>
<td>Quiz</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/Flora/RuralService/Technology Dissemination//Research Orientation assignment)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.

Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

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CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY & CLASSICAL BOTANY / B.Sc.-I

Programme: Certificate Course In Microbial Technology & Classical Botany

Year: I | Semester: I/Paper-II

Subject: Botany

Course Code: B040102P | Course Title: Techniques in Microbiology & Plant Pathology

Course outcomes: After the completion of the course the students will be able:
1. Understand the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory.
2. Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes.
3. Practical skills in the field and laboratory experiments in Microbiology & Pathology.
4. Learn to identify Algae, Lichens and plant pathogens along with their Symbiotic and Parasitic associations.
5. Can initiate his own Plant & Seed Diagnostic Clinic
6. Can start own enterprise on microbial products

<table>
<thead>
<tr>
<th>Credit 2</th>
<th>Core Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Marks: 25+75</td>
<td>Min. Passing Marks:</td>
</tr>
</tbody>
</table>

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic * (Minimum Any three from each unit depending on facilities)</th>
<th>No. of Lectures (60 hrs)</th>
</tr>
</thead>
</table>

BOTANY-UG-2020
<table>
<thead>
<tr>
<th>I. INSTRUMENTS &amp; TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Laboratory safety and good laboratory practices</td>
</tr>
<tr>
<td>2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter.</td>
</tr>
<tr>
<td>3. Buffer preparation &amp; titration</td>
</tr>
<tr>
<td>4. Cleaning and Sterilization of glasswares</td>
</tr>
<tr>
<td>5. Preparation of media- Nutrient Agar and Broth</td>
</tr>
<tr>
<td>6. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth</td>
</tr>
<tr>
<td>7. Preparation of agar slant, stab, agar plate</td>
</tr>
<tr>
<td>8. Phenol Coefficient method to test the efficacy of disinfectants</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II BACTERIAL IDENTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Isolation of bacteria.</td>
</tr>
<tr>
<td>2. Identification of bacteria.</td>
</tr>
<tr>
<td>3. Staining techniques: Gram's, Negative, Endospore, Capsule and Cell Wall.</td>
</tr>
<tr>
<td>4. Cultural characteristics of bacteria on NA.</td>
</tr>
<tr>
<td>5. Pure culture techniques (Types of streaking).</td>
</tr>
<tr>
<td>6. Biochemical characterization:</td>
</tr>
<tr>
<td>IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>III MYCOLOGICAL STUDY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic.</td>
</tr>
<tr>
<td>Saccharomyces, Pencillium, Peziza, Ustilago, Puccinia, Fusarium, Curvularia, Alternaria.</td>
</tr>
<tr>
<td>3. Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.</td>
</tr>
<tr>
<td>4. Lichens: crustose, foliace and fruticose specimens.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IV PHYSIOLOGY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Type study of algae and Cyanobacteria - Spirulina, Nostoc.</td>
</tr>
<tr>
<td>Chlorophyceae - Chlorella, Volvox, Oedogonium, Cladophora, and Chara.</td>
</tr>
<tr>
<td>Xanthophyceae - Vaucheria, Bacillariophyceae - Pinnularia Phaeophyceae - Sargassum Rhodophyceae - Polysiphonia</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V EXPERIMENTAL PLANT PATHOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preparation of fungal media (PDA) &amp; Sterilization process.</td>
</tr>
<tr>
<td>2. Isolation of pathogen from diseased leaf.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VI PRACTICALS IN APPLIED MICROBIOLOGY-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Isolation of nitrogen fixing bacteria from root nodules of legumes.</td>
</tr>
<tr>
<td>2. Enumeration of rhizosphere to non rhizosphere population of bacteria.</td>
</tr>
<tr>
<td>3. Isolation of antagonistic Pseudomonas from soil.</td>
</tr>
<tr>
<td>4. Microscopic observations of root colonization by VAM fungi.</td>
</tr>
<tr>
<td>5. Isolation of Azospirillum sp. from the roots of grasses.</td>
</tr>
<tr>
<td>6. Isolation of phyllosphere microflora.</td>
</tr>
<tr>
<td>7. Isolation of P solubilizing microorganisms.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VII PRACTICALS IN APPLIED MICROBIOLOGY-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wine production.</td>
</tr>
<tr>
<td>2. Isolation of lactic acid bacteria from curd.</td>
</tr>
<tr>
<td>3. Isolation of lipolytic organisms from butter or cheese.</td>
</tr>
<tr>
<td>4. Immobilized bacterial cells for production of hydrolytic enzymes.</td>
</tr>
<tr>
<td>5. Enzyme production and assay - cellulase, protease and amylace.</td>
</tr>
<tr>
<td>7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria.</td>
</tr>
<tr>
<td>8. Isolation and characterization of acidophiles, alkalophiles and halophilic bacteria.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIII</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cultivation of Spirulina, &amp; Chlorella in lab for biofuel</td>
</tr>
<tr>
<td>2. Visit to NBAIM, Mau, Varamasi(Kashi)/IMT, Chandigarh for viewing Culture Repository.</td>
</tr>
<tr>
<td>3. Visit to biofertilizers and biopesticides unit to understand about the Unit operation</td>
</tr>
</tbody>
</table>
4. Mushroom cultivation for Protein
5. Alcohol production from Sugarcane Juice.

Suggested Readings:

**Course Books published in Hindi may be prescribed by the Universities.**


This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS.

**Suggested Continuous Evaluation Methods:**

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
</tr>
<tr>
<td>Quiz</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Minor field work/excursion/lab visit/technology dissemination etc.</td>
<td>8</td>
</tr>
</tbody>
</table>

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils/Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Microbiology/biomedical Science.
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts
Lab Requisites: Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, Incubator, Oven, laminar flow cabinet, balances, Fermenter, Anaerobic jar and Spectrophotometer.

Suggested equivalent online courses:
https://community.plantae.org/mooc
futurelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science
https://microbiologysociety.org/publication/education-outreach-resources/basic-practical-microbiology-a-manual.html
https://microbiologynline.org/file/7926d7f4bdfca77b7279150968e1375e.pdf
https://allabouthaelgae.com/benefits/
https://repositorio.unmsm.org/xmlui/bitstream/handle/10883/321964331.pdf
https://www.mooc-list.com/tags/microbiology
http://www.agrifis.ir/sites/default/files/A2%20text%20book%20of%20practical%20botany%20%7BAshok%20Bendre%20%7D%20%5BB817%1339239%5D%20%5B281984%29.pdf
https://www.coursera.org/courses?query=plants
http://cygnus.kcl.ac.uk/handle/123456789/53530
https://www.clinicalcentral.com/tag/microbiology
https://www.eds.org/learn/microbiology
https://www.mooc-list.com/tags/microbiology
https://www.udemy.com/topic/microbiology/

Programme /Class: B.Sc.-I / Certificate Course In Microbial Technology & Classical Botany  Year: I  Semester: II  Paper-I

Subject: Botany

Course Code: B040201T  Course Title: Archegoniates and Plant Architecture

Course outcomes:
After the completion of the course the students will be able to:
1. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
2. Understanding of plant evolution and their transition to land habitat.
3. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants
4. Understand the details of external and internal structures of flowering plants.

Credits: 4  Core Compulsory

Max. Marks: 25+75  Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>Lectures (60hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Introduction to Archegoniates &amp; Bryophytes</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Unique features of archegoniates, Bryophytes: General characteristics, adaptations to land habit, Range of thallus organization. Classification (up to family) of Proskauer (1957). morphology, anatomy and reproduction of Riccia, Marchantia, Anticloeris and Sphagnum. (Developmental details not to be included). economic importance of bryophytes.</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Pteridophytes</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>General characteristics, Early land plants (Rhynia). Classification (up to family) by Bierhorst (1971) with examples, morphology, anatomy and reproduction of Lycopodium, Selaginella, Equisetum and Marsilea (Developmental details not to be included). Heterospory and seed habit, stelar evolution, economic importance of Pteridophytes.</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Gymnosperms</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Classification (Pant-1957) and distribution of gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples, structure and reproduction, economic importance. Morphology, anatomy and reproduction of Cycas, Pinus and Ephedra (Developmental details not to be included)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Palaeobotany</td>
<td></td>
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<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>General account of Cycadofilicales, Bennettitales and Cordaitales; Geological time scale; Brief account of process of fossilization &amp; types of fossils and study techniques; Contribution of Birbal Sahni</td>
<td></td>
</tr>
</tbody>
</table>

8
Angiosperm Morphology (Stem, Roots, Leaves & Flowers, Inflorescence)
Morphology and modifications of roots; Stem, leaf and bud. Types of inflorescences: flowers, flower parts, fruits and types of placentation; Definition and types of seeds.


Reproductive Botany
Plant Embryology, Structure of microsporangium, microsporogenesis, Structure of megasporangium and its types, megasporogenesis, Structure and types of female gametophyte, types of pollination, Methods of pollination, Germination of pollen grain, structure of male gametophyte, Fertilization, structure of dicot and monocot embryo, Endosperm, Double fertilization, Apomixis and polylembryony.


Suggested Course Books published in Hindi may be prescribed by the Universities:

7. Vashishtha BR, Sinha AK and Kumar A (2010) Botany for Degree Students – Gymnosperms, S. Chand and

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAM.

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
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<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>Quiz</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/Flora/Rural Service/Technology Dissemination/Research Orientation assignment)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

BOTANY-UG-2020
Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 4 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class , wifi facility

Other Requisites: Videos, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts

Suggested equivalent online courses:
https://ptEROportal.org/portal/index.php
https://www.comifers.org/ez/gymnosperms.php
http://www.mobot.org/MOBOT/research/APweb/
https://milsnarchid.weebly.com/plant-id-for-beginners.html
https://www.botany.org/PlantImages/PlantAnatomy.php
http://webapp1.dlib.indiana.edu/inauthors/view?docId=VAC0868&doc.view=print
https://palyteology.org/
http://www2.estrellamountain.edu/faculty/farhace/biobk/Biobookflowers.html
https://www.sciencelearn.org.nz/resources/100-plant-reproduction
https://palaeobotany.org/

<table>
<thead>
<tr>
<th>Programme/Class: Certificate Course In Microbial Technology &amp; Classical Botany</th>
<th>Year: I</th>
<th>Semester II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject: Botany</td>
<td>Course Code: B040202P</td>
<td>Course Title: Land Plants Architecture</td>
</tr>
<tr>
<td>Course outcomes:</td>
<td></td>
<td>Paper-II (Practical)</td>
</tr>
<tr>
<td>1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to these plants.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values &amp; taxonomy of lower group of plants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Understand the composition, modifications, internal structure &amp; architecture of flowering plants for becoming a Botanist.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Credits: 2 |
Max. Marks: 25+75 |
Core Compulsory |
Min. Passing Marks: |

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Bryophytes: Riccia &amp; Marchantia- morphology of thallus, W.M. rhizoids and scales, V.S. thallus through Gemma cup W.M. gemmae (all temporary slides), V.S. antheridio phore, archegoniophore, L.S. sporophyte (all permanent slides). Pogonatum- morphology, W.M. leaf, permanent slides showing antheridal and archegonial heads, L.S. capsule.</td>
<td>8</td>
</tr>
</tbody>
</table>
| III | Gymnosperms  
| IV | Palaeobotany & Palynology  
1. Morphology of Rhynia and fossils gymnosperms & other groups  
2. Visit to Birbal Sahni Institute of Palaeobotany or virtual conference with their scientists to learn fossilization  
3. Mark and know about Indian geographical sites rich in plant fossils |
| V | Angiosperm Morphology  
1. To study of diversity in leaf shape, size and other foliar features.  
2. To study monopodial and sympodial branching.  
3. Morphology of Fruits  
4. Inflorescence types- study from fresh/ preserved specimens  
5. Flowers- study of different types from fresh/ preserved specimens  
6. Fruits- study from different types from fresh/preserved specimens  
7. Study of ovules (permanent slides/ specimens/ photographs)- types (anatropous, orthotropous, amphirotous and campylotropous)  
8. Modifications in Roots, stems, leaves and inflorescences |
| VI | Plant Anatomy:  
Normal & Anomalous secondary thickening - Bignonia, Dracaena, Boerhavia difusa, Nyctanthes  
Study of primary and secondary growth in root and stem of monocots and dicots by section cutting and permanent slides.  
Study of internal structure of dicot and monocot leaves.  
Study of structure of stemata. |
| VII | Reproductive Botany  
1. Structure of anther, microsporogenesis and pollen grains  
2. Structure of ovule and embryo sac development (through slides).  
3. Study of embryo development in monocots and dicots.  
5. Study of seed germination.  
6. Study of pollen morphology of the following plants – Hibiscus, Vinca, Balsam, Ixora, Centauria, Bougainvillea by microscopic observation.  
7. Calculation of pollen viability percentage using in vitro pollen germination techniques |
| VIII | Commercial Uses and Production Technology  
1. Azolla production  
2. Production technology of Resins  
4. Lab method for qualitative testing/ extraction of Ephedrine, Taxol and Thuja oil |

Suggested Readings:  
*Course Books published in Hindi may be prescribed by the Universities.*

**This course can be opted as an elective by the students of following subjects:**
Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A.

**Suggested Continuous Evaluation Methods:** Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Interaction</td>
<td>6</td>
</tr>
<tr>
<td>Field work/Virtual/E-learning/Participation in group discussions</td>
<td>7</td>
</tr>
<tr>
<td><strong>Industrial or Central laboratory training of two weeks in summer/winter (Compulsory)</strong></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

**Course prerequisites:**

**Qualification:** To study this course, a student must have qualified 10+2 with Biology/NSQF level 3 from Sector Skill Councils/Diploma holder from ITI in (Biology/Agriculture/Forestry).

**Facilities: Smart and Interactive Class**

**Other Requisites:** Microscopes, Stains, Dissection box, Haemocytometer, Specimens, Permanent slides, Autoclave, incubator, Oven, laminar flow cabinet, balance

**Suggested equivalent online courses:**

https://www.easylife.company/topic-botany
http://www3.botany.ubc.ca/bryophyce/index.html
http://ccflora.sri.india.ac.in/bio_courses/bl4apl/practical_3.1.htm
http://www.plantnotes.blogspot.com/p/botany.html
http://www.fso.org/3/a-93236e.pdf
https://jngic.ac.in/library/ngic/ngr.pdf
https://www.agrienter.tamu.edu/banking/nabard_pdf/Azolla%20Cultivation/Model_project_on_Azolla_cultivation.pdf
https://www.fed.us/rrrr/nabr_other/wo_AgricHandbook730/wo_AgricHandbook727_153_175.pdf
Detail Syllabus of
B.Sc.-II Year
or
Diploma in
Plant Identification, Utilization & Ethnomedicine

Diploma in Plant Identification, Utilization & Ethnomedicine

<table>
<thead>
<tr>
<th>Programme /Class: Diploma in Plant Identification, Utilization &amp; Ethnomedicine</th>
<th>Year: II</th>
<th>Semester: III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject: Botany</td>
<td></td>
<td>Paper-1</td>
</tr>
<tr>
<td>Course Code: B040301T</td>
<td>Course Title: Flowering Plants Identification &amp; Aesthetic Characteristics</td>
<td></td>
</tr>
</tbody>
</table>
Course outcomes:
After the completion of the course the students will be able to:
1. To gain an understanding of the history and concepts underlying various approaches to plant taxonomy and classification.
2. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants.
3. To compare the different approaches to classification with regard to the analysis of data.
4. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of the current taxonomy of a major plant family.
5. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.
6. For the entrepreneur career in plants, one can establish a nursery, Start a landscaping business, Set up a farm Or Run a plantation consultancy firm

<table>
<thead>
<tr>
<th>Credits: 4</th>
<th>Core Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Marks: 25-75</td>
<td>Min. Passing Marks:</td>
</tr>
<tr>
<td>Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures (60hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Taxonomic Resources &amp; Nomenclature</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Herbarium- functions &amp; important herbaria, Botanical gardens, Flora, Keys- single access and multi-access. Botanical Nomenclature- Principles and rules of ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid-publication).</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Types of classification &amp; Evidences</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Artificial, natural and phylogenetic. Bentham and Hooker (up to series), Engler and Prantl (upto series) angiosperm phylogeny group (APG III) classification. Taxonomic evidences from palynology, cytology, phytochemistry &amp;Molecular biology data (Protein and Nucleic acid homology).</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Identification of Angiospermic families -I: (Families can be chosen University wise as per local available flora)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham &amp; Hooker’s system) -- Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Acanthaceae, Acelinaceae, Solanaceae</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Identification of Angiospermic families -II: (Families can be chosen University wise as per local available flora)</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham &amp; Hooker’s system)- Amaranthaceae, Euphorbiaceae, Papaveraceae, Scrophulariaceae, Orchidaceae, Liliaceae, Arecaaceae, Poaceae</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Modern trends in Plant taxonomy:</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Phenetics and Cladistics: Brief idea on Phenetics, Numerical taxonomy- methods, Operational Taxonomic Units, Cladistics- construction of dendrogram and primary analysis; Monophyletic, polyphyletic and paraphyletic groups;</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>TOOLS &amp; SOFTWARES IN PLANT IDENTIFICATION-</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>GIS (Mapping of (i) Patterns(ii) Features (iii) Quantities 0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy, DEscRIPTION Language for TAxonomy – DELTA Internet directory for botany</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>Computer Applications</td>
<td></td>
</tr>
<tr>
<td>-----</td>
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</tr>
<tr>
<td></td>
<td>Introduction to Computers – classification, computer generation, low, medium and high level languages, software and hardware, operating systems, compilers and interpreters, personal, mini, main frame and super computers, characteristics and application, computer memory and its types, data representation and storage. Microsoft excel, data entry, graphs, aggregate functions, formulas and functions, number systems, conversion devices, secondary storage media.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIII</th>
<th>Aesthetic Characteristics of Plants:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, climbers and creepers, rockery, Flower beds, Shrubbery, Borders, Water garden). Some Famous gardens of India. Conservatory, green houses, Indoor garden, Roof garden, Topiary, Bonsai</td>
</tr>
</tbody>
</table>

**Suggested Readings:**

1. *A Course Books published in Hindi may be prescribed by the Universities.*


5. [https://www.macee.co.uk/teacher-improvement/ict-mark](https://www.macee.co.uk/teacher-improvement/ict-mark/)


8. [https://www.macee.co.uk/teacher-improvement/ict-mark](https://www.macee.co.uk/teacher-improvement/ict-mark/)


11. [https://www.macee.co.uk/teacher-improvement/ict-mark](https://www.macee.co.uk/teacher-improvement/ict-mark/)


14. [https://www.macee.co.uk/teacher-improvement/ict-mark](https://www.macee.co.uk/teacher-improvement/ict-mark/)


17. [https://www.macee.co.uk/teacher-improvement/ict-mark](https://www.macee.co.uk/teacher-improvement/ict-mark/)


20. [https://www.macee.co.uk/teacher-improvement/ict-mark](https://www.macee.co.uk/teacher-improvement/ict-mark/)

**This course can be opted as an elective by the students of following subjects: Open to all but special for** B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B.Pharm, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS
### Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
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<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
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<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
</tr>
<tr>
<td>Quiz</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/Flora/ Rural Service/ Technology Dissemination/ Research Orientation assignment)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

### Course prerequisites:

**Qualification:** To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

**Facilities:** Smart and Interactive Class

**Other Requisites:** Video collection, Books, CDs, Flora, Herbarium, Access to Online resources, Display Charts

Suggested equivalent online courses:
- [https://www.egybiologylexus.com/topic-botany/](https://www.egybiologylexus.com/topic-botany/)
- [http://egrankosh.ac.jp/handle/123456789/53530](http://egrankosh.ac.jp/handle/123456789/53530)
- [https://www.delta-intkey.com](https://www.delta-intkey.com)
- [www денопотейдемителемноминиес.com/](www денопотейдемителемноминиес.com/)
- [https://plants.usda.gov/classification.html](https://plants.usda.gov/classification.html)
- [https://www.seneahs.org/pages/uploaded_files/Plant%20Classification.pdf](https://www.seneahs.org/pages/uploaded_files/Plant%20Classification.pdf)
- [https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr_5%20S_5%20Nongbr%20III%20Snn%20ppt.pdf](https://www.ladykeanecollege.edu.in/files/userfiles/file/Dr_5%20S_5%20Nongbr%20III%20Snn%20ppt.pdf)
- [https://libguides.rutgers.edu/c.php?g=336990&p=2267037](https://libguides.rutgers.edu/c.php?g=336990&p=2267037)
- [https://www.delta-intkey.com/](https://www.delta-intkey.com/)

### Programme/Class: Diploma in Plant Identification, Utilization & Ethnomedicine

<table>
<thead>
<tr>
<th>Year: II</th>
<th>Semester: III Paper-II (Practical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject: Botany</td>
<td>Course Title: Plant Identification technology</td>
</tr>
</tbody>
</table>

**Course outcomes:**

After the completion of the course the students will be able:

1. To learn how plant specimens are collected, documented, and curated for a permanent record.
2. To observe, record, and employ plant morphological variation and the accompanying descriptive terminology.
3. To gain experience with the various tools and means available to identify plants.
4. To develop observational skills and field experience.
5. To identify a taxonomically diverse array of native plants.
6. To recognize common and major plant families.
7. To understand aesthetic characters of flowering plants by making-landscapes, gardens, bonsai, miniatures.
8. To comprehend the concepts of plant taxonomy and classification of Angiosperms.

**Credits:** 2  
**Core Compulsory**

**Max. Marks:** 25+75  
**Min. Passing Marks:**

**Total No. of Lectures-Tutorials-Practical (in hours per week):** 0-0-2

**Unit**  
*Perform any three experiments from each unit as per facility*  
**No. of Lectures**

BOTANY-UG-2020
<table>
<thead>
<tr>
<th>I</th>
<th>Herbarium: Plant collecting, Preservation and Documentation:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stepwise Practicing Herbarium techniques: a. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument &amp; Collection of any wild 25 plant specimens b. Learn to handle Herbarium making tools c. Pressing and Drying of collected plant specimens d. Special treatments for all varied groups of plants e. Mount on standard herbarium sheets f. Label them using Standard method g. Organize them and give Index Register Number</td>
</tr>
<tr>
<td></td>
<td>(60Hrs)</td>
</tr>
<tr>
<td>II</td>
<td>Taxonomic Identification using plant structure</td>
</tr>
<tr>
<td></td>
<td>a. Classify 25 plants on the basis of Taxonomic description (Plant Morphology, Anatomy, Reproductive parts, Habit, adaptation anomalies) according to Bentham Hooker system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
</tr>
<tr>
<td>III</td>
<td>Identification during excursions</td>
</tr>
<tr>
<td></td>
<td>a. Conducting Spot identification (Binomial, Family) of common wild plants from families included in the theoretical syllabus (list to be provided) and making FIELD NOTE BOOK and filling Sample of a page of field-book, used in Botanical Survey of India</td>
</tr>
<tr>
<td></td>
<td>b. Describe/compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
</tr>
<tr>
<td>IV</td>
<td>COLLECTION, PRESERVATION AND STORAGE OF ALGAE, FUNGI, BRYOPHYTES, PTERIDOPHYTES (Two each)</td>
</tr>
<tr>
<td></td>
<td>(7)</td>
</tr>
<tr>
<td>V</td>
<td>Botanical Nomenclature &amp; reporting Method:</td>
</tr>
<tr>
<td></td>
<td>a. Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI</td>
</tr>
<tr>
<td></td>
<td>b. Author Citation, Effective Publication and Principle of Priority: To show a specimen paper on Basic structure of a taxonomic Research published on a new species in taxonomic journal</td>
</tr>
<tr>
<td></td>
<td>(7)</td>
</tr>
<tr>
<td>VI</td>
<td>COMPUTERS</td>
</tr>
<tr>
<td></td>
<td>1. Learning to use EXCEL Microsoft PowerPoint and Word., WORKING WITH FOLDER AND WINDOWS UTILITY., CREATE AND MANAGE FILES AND FOLDER TREE,</td>
</tr>
<tr>
<td></td>
<td>2. Practice browsing of different sites using search engine. practice and understand different E-Mail services – Outlook, Yahoo mail, rediffmail etc. Practice Creating E-Mail accounts, Sending, Receiving &amp; Storing of mails.</td>
</tr>
<tr>
<td></td>
<td>3. Create and Participate in virtual conferencing in an interactive Zoom Meeting</td>
</tr>
<tr>
<td></td>
<td>(7)</td>
</tr>
<tr>
<td>VII</td>
<td>Computer Application in taxonomy</td>
</tr>
<tr>
<td></td>
<td>1. Use Taxonomic Softwares (Dichotomous Key)</td>
</tr>
<tr>
<td></td>
<td>2. Practicals on Phylogenetic analysis</td>
</tr>
<tr>
<td></td>
<td>3. Make line drawing of Plants for description</td>
</tr>
<tr>
<td></td>
<td>4. Using of plant identification apps on android phones</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
</tr>
<tr>
<td>VIII</td>
<td>1. Create a Bonsai of any plant</td>
</tr>
<tr>
<td></td>
<td>2. Develop a miniature garden</td>
</tr>
<tr>
<td></td>
<td>3. Draw Layouts of various types of gardens</td>
</tr>
<tr>
<td></td>
<td>4. Plant Propagation methods practice</td>
</tr>
<tr>
<td></td>
<td>(8)</td>
</tr>
</tbody>
</table>

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

5. Kumarsen V. Horticulture, Saras Publication

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS.

**Suggested Continuous Evaluation Methods:**
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class interaction</td>
<td>5</td>
</tr>
<tr>
<td>Botanical Excursion- compulsory</td>
<td>12</td>
</tr>
<tr>
<td>Assignment</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

**Course prerequisites:**
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry).
Facilities: Smart and Interactive Class
Other Requisites: 1 Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts
Lab Requisites: Microscopes (Compound, Stereo) Dissection box, stain, Herbarium, Herbarium press, Dryers, Grinder, Reference Flora

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Suggested equivalent online courses:

1. [http://egyankosh.ac.in/bitstream/123456789/13096/1/Limit-5.pdf](http://egyankosh.ac.in/bitstream/123456789/13096/1/Limit-5.pdf)

Any Other:

Botanical Excursions: One teacher along with a batch not more than 7 students be taken for botanical excursion to places of botanical interest, one in each term. If there are female students in a batch of 7 students, one additional lady teacher is permissible for excursion.

Each excursion will not be more than SEVEN days during college working days. T.A. and D.A. for teachers and non-teaching staff participating in excursions should be paid as per rules. Tour report duly certified by tour in charge teacher and Head of the Department should be submitted at the time of practical examination. For every study tour take the prior permission of the head of the department and Principal.

The marks will be counted under internal assessment and external assessment both. In external assessment student will have to present his excursion report along with industrial training/labs visits and BSI or Museum visits. In internal assessment he shall have to label the campus plants with botanical details/develop herbal/floristic garden/conserve plants in botanical garden/contribute specimens via collection.

A project supported along with photographs taken during field study to be submitted giving comprehensive idea about different types of inflorescence, flowers and fruits.

At least three field excursions at hills/Oceans/Deserts including one compulsory excursion to Botanical Garden, FRI/BSI and Central National Herbarium (CNI) Central Research Institutes/Hot Spots.

<table>
<thead>
<tr>
<th>Programme /Class: Diploma in Plant Identification, Utilization &amp; Ethnomedicine</th>
<th>Year: II</th>
<th>Semester: IV Paper-I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject: Botany</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Code: B040401T</td>
<td>Course Title: Economic Botany, Ethnomedicine and Phytochemistry</td>
<td></td>
</tr>
</tbody>
</table>

Course outcomes:

After the completion of the course the students will be able to:

1. Understand about the uses of plants—will know one plant-one employment.
2. Understand phytochemical analysis related to medicinally important plants and economic products produced by the plants.
3. Know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.

<table>
<thead>
<tr>
<th>Credits: 4</th>
<th>Core Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Marks: 25+75</td>
<td>Min. Passing Marks:</td>
</tr>
</tbody>
</table>

Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures (60hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Origin and domestication of cultivated plants</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Centers of diversity of plants, origin of crop plants, Domestication and introduction of crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes, Spices &amp; beverages.</td>
<td></td>
</tr>
</tbody>
</table>
II Botany of oils, Fibers, timber yielding plants & dyes  
Study of the plants with Botanical names, Family, part used, and economic uses yielding Edible & essential oils; Sugar, Fibers, Paper, Furnitures & Masticatories, Rubber, Dyes, Timber, biofuel crops.  

III Commercial production of Flowers, Vegetables, and fruits (To be Chosen area wise)  
Commercial greenhouse cultivation of rose,, Gladiolus, , tomato, bell pepper, strawberry & Exotic leafy vegetables using Hydroponics.  

IV IPR & Traditional Knowledge  

V Ethnobotany  
Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CIMAP and CARI.  
Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.  

VI Medicinal aspects  
Study of common plants used by tribes: Aegle marmelos, Ficus religiosa, Cynodon dactylon, Eclipta alba, Osulus, Ocimum sanctum and Trichopus zeylanicus) Ethnobotanical aspect of conservation and management of plant resources, Preservation of primitive forests in the form of sacred groves of individual species and Botanical uses depicted in our spics.  
Plants in primary health care: common medicinal plants: Tinospora, Acorus, Ocimum, Turmeric and Aloe Indian Pharmacopoeia.  

VII Pharmacognosy  
Preparation of drugs for commercial market - Organoleptic evaluation of drugs - Microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration. Sources of crude drugs - roots, rhizome, bulb, corn, leaves, stems, flowers, fruits and seeds; organoleptic study of Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea and Zingiber officinale.  

VIII Herbal Preparations & Phytochemistry :  
Collection of wild herbs - Capsules - compresses - Elixirs - Glycerrutes - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas, Plant natural products, general detection, extraction and characterization procedures, Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids and Alkaloids Carotenoids and pharmaceutical activities.  

Suggested Readings:  

Course Books published in Hindi may be prescribed by the Universities.  


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This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Archaeology, B.A. Geology, BAMS

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<tr>
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</tr>
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</table>

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils/ Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class

BOTANY-UG-2020
**Suggested equivalent online resources:**
- https://www.pnas.org/content/104/suppl_1/8641
- https://www.journals.uchicago.edu/doi/pdfplus/10.1086/659998
- https://www.brainkart.com/article/Economic-importance-Plants-Food-Oil-FibreTimber-yielding-plant_1095/
- https://www2.palomar.edu/users/warmstrong/encyclops.htm

**Programme:** Diploma in Plant Identification, Utilization & Ethnomedicine  
**Year:** II  
**Semester:** IV  
**Paper-II**

**Subject:** Botany  
**Course Code:** B040402P  
**Course Title:** Commercial Botany & Phytochemical Analysis

**Course outcomes:** After the completion of the course the students will be able to:
1. Know about the commercial products produced from plants.
2. Gain the knowledge about cultivation practices of some economic crops.
3. Understand about the ethnomedical details of plants.
4. Learn about the chemistry of plants & herbal preparations.
5. Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company.

**Credits:** 2  
**Max. Marks:** 25+75  
**Core Compulsory**  
**Min. Passing Marks:**

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**Unit | Topic | No. of Lectures (60hrs)**
---|---|---
1 | **Economic Botany & Microtechniques:**  
Cereals: Wheat (habit sketch, L.S./T.S. of grain, starch grains, micro-chemical tests); rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests)  
Legume: Pea or ground nut (habit, fruit, seed structure, micro-chemical tests)  
Source of sugars and starches: Sugarcane (habit sketch; cane juice micro-chemical tests); potato (habit sketch, tuber morphology, T.S. of tuber to show localization of starch grains, W.M. of starch) grains, micro-chemical tests.  
Tea: tea leaves, tests for tannin  
Mustard-plant specimen, seeds, tests for fat in crushed seeds  
Timbers: section of young stem.  
Jute: specimen, transverse section of stem, tests for lignin on T.S. of stem and study of fiber following maceration technique.  
Study of specimens of economic importance mentioned in Unit I & II | 8

2 | **Commercial Cultivation**  
Field visit to Green houses for understanding Floriculture & vegetables production  
Development of hydroponics nutrient solutions & running models for cultivation of vegetables  
Development of hydroponics nutrient solutions & running models for cultivation of fodder | 8

3 | **Cultivating Medicinal and aromatic plants & Essential oil extraction**  
a. Lemon grass/ Neem/ Zinger/Rose/Mint | 7

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**BUTANY-UG-2020**
<table>
<thead>
<tr>
<th>IV</th>
<th><strong>Documentation</strong> from Traditional Knowledge Digital Library, Mark the Geographic Indications on Map, Understand - Nakshtra Vatika, Navgrah Vatika and develop in your college. To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td><strong>Ethnobotany</strong> Study of common plants used by tribes. <em>Aegle marmelos, Ficus religiosa, Cynodon dactylon.</em> Visit a tribal area and collect information on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethno botanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research Institute / Hospital</td>
</tr>
<tr>
<td>VI</td>
<td><strong>Instrumentation and herbal Preparations</strong> Develop Capsules of herbs, Develop Herbal oils, Develop Poultice/cream Analyse some active ingredients using chromatography / Spectrophotometry</td>
</tr>
<tr>
<td>VIII</td>
<td><strong>Phytochemistry:</strong> Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimensions of Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, tannins &amp; resins. Any 5 herbal preparations.</td>
</tr>
</tbody>
</table>

**Suggested Readings:** *Course Books published in Hindi may be prescribed by the Universities.*

1. Plant Ecology And Economic Botany by Dhankar - Sharma - Trivedi, RBD Publication
2. *Shivakant Ranjan Kumar Bhattacharyya : Thakur Publication*
3. PHARMACOGNOSY...Hindi Edition (Paperback, Hindi, Dr. Aancha Rashi, KHUSHAL JASWANT), RM Publication
12. Khasim S.M Botanical Microtechniques: Principles and Practice-
This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.A. (Curators), B.A. Arch., BAMS

**Suggested Continuous Evaluation Methods:**
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**Course prerequisites:**
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils/ Diploma holder from ITI in (Biology/ Agriculture/ Forestry).

Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Flora, Herbarium, Access to On-line resources, Display Charts
Lab requisites: Repository of economic products, Microscopes/ Botanical /Herbal Garden, TLC, Spectrophotometer.

Suggested equivalent online courses:
http://nepr.niscair.res.in/handle/123456789/45825
https://www.bontoli.com/commercial-farming-agriculture/
DETAIL SYLLABUS
OF
B.Sc.-III YEAR
or
BACHELOR OF SCIENCE
(BOTANY)
## BACHELOR OF SCIENCE (BOTANY)

**Programme/Class:** Bachelor of Science  
**Year:** III  
**Semester:** V  
**Paper-I**  
**Subject:** BOTANY  
**Course Code:** B040501T  
**Course Title:** Plant Physiology, Metabolism & Biochemistry

### Course Outcomes:
After the completion of the course the students will be able to:
1. Understand the role of Physiological and metabolic processes for plant growth and development.
2. Learn the symptoms of Mineral Deficiency in crops and their management.
3. Assimilate Knowledge about Biochemical constitution of plant diversity.
4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants

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</tbody>
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<th>Topic</th>
<th>No. of Lectures(60hrs)</th>
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<tbody>
<tr>
<td>I</td>
<td><strong>Plant water relation, Mineral Nutrition, Transpiration and translocation in phloem Brief Idea of diffusion, osmosis and water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency. Transport of ions across cell membrane, Mechanism and theories of ion uptake and translocation, active and passive transport, girdling experiment; Pressure flow model.</strong></td>
<td>7</td>
</tr>
</tbody>
</table>
| II   | **Carbon Oxidation**  
Glycolysis, fate of pyruvate - aerobic and anaerobic respiration and fermentation, Kreb cycle, regulation of glycolysis, oxidative decarboxylation of pyruvate, oxidative pentose phosphate pathway, mitochondrial electron transport, oxidative phosphorylation, cytochrome resistant transport, factors affecting respiration. | 7                      |
| III  | **Nitrogen Metabolism**  
Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination, importance of nitrogen metabolism. | 8                      |
| IV   | **Lipid Metabolism & Photosynthesis**  
| V    | **Plant Development, Movements, Dormancy & Responses**  
Developmental roles of Phytohormones (auxins, gibberellins, cytokinins, ABA, ethylene) autonomic & paratonic movements, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery, structure and function), Seed physiology & Dormancy, Vernalization. | 8                      |
<table>
<thead>
<tr>
<th>VI</th>
<th>Biomolecules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbohydrates:</strong></td>
<td>Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin, mucilage; storage – starch, inulin).</td>
</tr>
<tr>
<td><strong>Lipids:</strong></td>
<td>Storage lipids: Fatty acids structure and functions, Structural lipids: Phosphoglycerides; Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VII</th>
<th>Proteins:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, Ramachandran plot,tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIII</th>
<th>Nucleic acids:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure of nitrogenous bases; Structure and function of nucleic acids; Nucleic acid denaturation &amp; Re-association; MiRNA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VIII</th>
<th>Enzymes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), enzyme inhibition and factors affecting enzyme activity, Allosteric enzymes &amp; Abzymes.</td>
<td></td>
</tr>
<tr>
<td>Brief idea about phytonutrients, Nutraceuticals, dietary supplements and antioxidants.</td>
<td></td>
</tr>
</tbody>
</table>

Suggested Readings:


This course can be opted as an elective by the students of following subjects: Open to all but special for following: B.Sc. Math, B.Sc. Statistics, B.Sc. Nutrition, B.Sc. Biophysics, B.Sc. Biotech,
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
</tr>
<tr>
<td>Quiz</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Gardening)
Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:
- https://www.wiziq.com/course/3249-plant-physiology-in-10-live-online-classes
- https://onlinecourses.swayam2.ac.in/cec19_bf09/preview

Programme/Class: Bachelor of Science

Year: III | Semester: V

Paper-II

Subject: BOTANY

Course Code: B040502T | Course Title: Molecular Biology & Bioinformatics

Course outcomes:
After the completion of the course the students will be able to:
1. Understand nucleic acids, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
2. Know about Processing and modification of RNA and translation process, function and regulation of expression.
3. Gain working knowledge of the practical and theoretical concepts of bioinformatics

Credits: 4 | CC / Elective

Max. Marks: 25+75 | Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week) 4-0-0

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures(60hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Genetic material Miescher to Watson and Crick- historic perspective, Griffith’s and Avery’s transformation experiments, Hershey-Chase, bacteriophage experiment, DNA structure, types of DNA, types of genetic material. Packaging of DNA. DNA replication (Prokaryotes and eukaryotes): Semi-conservative, conservative and dispersive modes of replication. Models of DNA replication (Prokaryotes and eukaryotes): replicon, Mechanism of replication- Enzymes of replication, DNA damage and repair.</td>
<td>7</td>
</tr>
<tr>
<td>II</td>
<td>Transcription &amp; Regulation of gene expression</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transcription-Types and structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation, (Prokaryotes and eukaryotes), genetic code, Regulation of gene expression in Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes.</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Principles &amp; Techniques of genetic engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r-DNA, c-DNA. Vectors and enzymes of genetic engineering.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blotting techniques: Northern, Southern and Western Blotting. DNA Fingerprinting: Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection.</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Applications of Genetic engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean);</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice);</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improved horticultural varieties (Moondast carnations); Role of transgenics in bioremediation (Superbug); Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products, Biosafety concerns.</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Bioinformatics &amp; its applications</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>Biological databases:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem).</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>Data Generation and Data Retrieval</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webim), Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot), Sequence annotation, Data retrieval systems (SRS, Entrez).</td>
<td></td>
</tr>
<tr>
<td>VIII</td>
<td>Phylogenetic analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Similarity, identity and homology, Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Phylogenetic analysis: Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees.</td>
<td></td>
</tr>
</tbody>
</table>
Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. Dr Pooja Rai, Bhopal
2. Sharma - Trivedi Molecular Biology And Biotechnology (Hindi) by RBD Publisher
5. Bioinformatics Paperback – 1 January 2015 by Dr. Archana Pandey (Author), Santosh Chauh (Editor), & 2 More Hindi AISECT Ltd.
6. BIOTECHNOLOGY AND GENETIC ENGINEERING (Hindi, Hardcover, Dr. Archna Nigam)
This course can be opted as an elective by the students of following subjects:

**Suggested Continuous Evaluation Methods:** Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Evaluation Type</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
</tr>
<tr>
<td>Quiz</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
</tr>
</tbody>
</table>

**Course prerequisites:**

**Qualification:** To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech)

**Facilities:** Smart and Interactive Class

**Other Requisites:** Video collection, Books, CDs, Access to on-line resources, Display Charts

**Suggested equivalent online courses:**
- [https://www.cdx.org/learn/molecular-biology](https://www.cdx.org/learn/molecular-biology)
- [https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering](https://www.vlab.co.in/broad-area-biotechnology-and-biomedical-engineering)
- [https://www.coursera.org/courses?query=genetics](https://www.coursera.org/courses?query=genetics)
- [https://www.coursera.org/courses?query=molecular%20biology](https://www.coursera.org/courses?query=molecular%20biology)
- [https://www.edx.org/learn/genetic-engineering](https://www.edx.org/learn/genetic-engineering)
- [https://www.mooc-list.com/tags/genetic-engineering](https://www.mooc-list.com/tags/genetic-engineering)
- [https://nptel.ac.in/courses/102/103/102103013/](https://nptel.ac.in/courses/102/103/102103013/)

<table>
<thead>
<tr>
<th>Programme/Class: <strong>Bachelor of Science</strong></th>
<th>Year: III</th>
<th>Semester: V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject: <strong>Botany</strong></td>
<td></td>
<td>Paper-III</td>
</tr>
<tr>
<td>Course Code: B040503P</td>
<td></td>
<td>Course Title: <strong>Experiments in physiology, Biochemistry &amp; molecular biology</strong></td>
</tr>
</tbody>
</table>

BOTANY-UG-2020  
Page 40
**Course outcomes:**
After the completion of the course the students will be able to:
1. Know and authentic the physiological processes undergoing in plants along with their metabolism
2. Identify Mineral deficiencies based on visual symptoms
3. Understand and develop skill for conducting molecular experiments for genetic engineering

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic* <em>(Perform any three from each unit based on facility)</em></th>
<th>No. of Lectures(60 hrs)</th>
</tr>
</thead>
</table>
| I    | Plant water relation, Mineral Nutrition and translocation in phloem  
1. Determination of osmotic potential of plant cell sap by plasmolytic method using leaves of Rhoeo / Tradescantia.  
2. Osmosis – by potato osmoscope experiment  
3. Effect of temperature on absorption of water by storage tissue and determination of Q10.  
4. Experiment to demonstrate the transpiration phenomenon with the bell jar method  
5. Experiment for demonstration of Transpiration by Four-Leaf Experiment:  
6. Structure of stomata (dicot & monocot)  
7. Determination of rate of transpiration using cobalt chloride method.  
8. Experiment to measure the rate of transpiration by using Farmer’s Potometer  
9. Experiment to measure the rate of transpiration by using Gannong’s potometer  
10. Effect of Temperature on membrane permeability by colorimetric method.  
11. Study of mineral deficiency symptoms using plant material/photographs. | 8 |
| I    | Nitrogen Metabolism, Photosynthesis & Respiration  
1. A basic idea of chromatography: Principle, paper chromatography and column chromatography; demonstration of column chromatography.  
2. Separation of plastidial pigments by solvent and paper chromatography.  
3. Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method.  
4. Effect of HCO₃ concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting).  
5. Measurement of oxygen uptake by respiring tissue (per g/hr.)  
6. Determination of the RQ of germinating seeds.  
7. Effect of light intensity on oxygen evolution in photosynthesis using Wilmett’s bubble | 8 |
| III  | Plant Development, Movements, Dormancy & Responses  
1. Geotropism and phototropism — Klinostat  
2. Hydrotropism -  
   a. Measurement of growth — Arc and Liver Auxonometer  
3. To study the phenomenon of seed germination (effect of light).  
4. To study the induction of amylase activity in germinating grains.  
5. Test of seed viability by TTC method.  
6. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA bioassay) | 8 |
| IV   | Techniques for biochemical analysis  
1. Weighing and Preparation of solutions -percentage, molar & normal solutions, dilution from stock solution etc.  
2. Separation of amino acids by paper chromatography. | 8 |
3. Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples.
4. Qualitative Analysis of carbohydrates
5. Estimation of reducing sugar by anthrone method
6. Qualitative Analysis of Lipids
7. Qualitative analysis of Amino acids and Proteins
8. Quantitative Analysis of Nucleic Acids
9. Analysis of dietary supplements, nutraceuticals & antioxidants
10. Testing of adulterants in food items.

<table>
<thead>
<tr>
<th>V</th>
<th>Genetic material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Instruments and equipments used in molecular biology.</td>
</tr>
<tr>
<td>2.</td>
<td>Preparation of LB medium and cultivating E.coli on it.</td>
</tr>
<tr>
<td>3.</td>
<td>Isolation of Genomic DNA</td>
</tr>
<tr>
<td>4.</td>
<td>Isolation of DNA from plants</td>
</tr>
<tr>
<td>5.</td>
<td>Examination of the purity of DNA by agarose gel electrophoresis.</td>
</tr>
<tr>
<td>6.</td>
<td>Quantification of DNA by UV-spectrophotometer</td>
</tr>
<tr>
<td>7.</td>
<td>Estimation of DNA by diphenylamine method.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VI</th>
<th>Preparation of models/ charts:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith’s, Hershey &amp; Chase’s and Fraenkel &amp; Comar’s experiments) through photographs</td>
</tr>
<tr>
<td>2.</td>
<td>Numericals based on DNA re-association kinetics (melting profiles and Cott curves)</td>
</tr>
<tr>
<td>3.</td>
<td>Study of DNA replication through photographs: Modes of replication - Rolling circle, Theta and semi-discontinuous; Semiconservative model of replication (Meselson and Stahl’s experiment); Telomerase assisted end-replication of linear DNA</td>
</tr>
<tr>
<td>4.</td>
<td>Study of structures of: tRNA (2D and 3D); prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs</td>
</tr>
<tr>
<td>5.</td>
<td>Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I &amp; group II introns; Ribozymes and Alternative splicing</td>
</tr>
<tr>
<td>6.</td>
<td>Understanding the regulation of lactose (lac) operon (positive &amp; negative regulation) and tryptophan (trp) operon (Repression and De-repression &amp; Attenuation) through photographs.</td>
</tr>
<tr>
<td>7.</td>
<td>Understanding the mechanism of RNAi by photographs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VI</th>
<th>Genetic Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Isolation of protoplasts.</td>
</tr>
<tr>
<td>2.</td>
<td>Construction of restriction map of circular and linear DNA from the data provided.</td>
</tr>
<tr>
<td>3.</td>
<td>Isolation of plasmid DNA</td>
</tr>
<tr>
<td>4.</td>
<td>Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph)</td>
</tr>
<tr>
<td>5.</td>
<td>Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.</td>
</tr>
<tr>
<td>6.</td>
<td>Agarose gel analysis of plasmid DNA</td>
</tr>
<tr>
<td>7.</td>
<td>Restriction digestion of plasmid DNA -Demonstration of PCR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VII</th>
<th>Applications of Genetic engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ELISA Test, 2. Viability tests of cells</td>
</tr>
<tr>
<td>3.</td>
<td>Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment</td>
</tr>
<tr>
<td>4.</td>
<td>Study of steps of genetic engineering for production of Bt cotton, Golden rice, FlavrSavr tomato through photographs.</td>
</tr>
</tbody>
</table>
Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. ... ...


This course can be opted as an elective by the students of following subjects:

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
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<tbody>
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<td>Quiz</td>
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<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Course prerequisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils/ Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Gardening)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to Online resources, Display Charts

Lab requisites: Electrophoresis units, Gelrocker, UV-transilluminator, Vortex Mixer, Shaker, CVT, HiMedia Biotechnology & Molecular biology Kits/Chemicals, Micropipettes, Elisa reader/Microtitre Reader

Suggested equivalent online courses:

https://www.edx.org/learn/molecular-biology
https://krishtosh.sgrauth.ac.in/handle/1/5810039999
https://www.coursera.org/courses?query=genetics
https://www.coursera.org/courses?query=molecular%20biology
https://www.edx.org/learn/genetic-engineering
https://www.moooc-list.com/tags/genetic-engineering

BOTANY-UG-2020
Programme/Class: Bachelor of Science  |  Year: III  |  Semester: V  
Paper: IV  |  Subject: BOTANY  
Course Code: B040504R  |  Course Title: Project in Botany for Pre-graduation

Course outcomes:
- Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
- Project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes.
- It will promote creativity and the spirit of enquiry in learners.
- They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing.
- It will enhance their abilities, enthusiasm, and interest.

Credits: 03  |  Core: Compulsory
Max. Marks: 25+75  |  Min. Passing Marks: ........

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3.

Suggestive List of Projects:
1. Rural Areas: Flora of a city/village, Biodiversity of Village, Soil & seed testing service provision to farmers.
2. Industrial waste management.
4. Plant disease identification in farms, nurseries and orchards.
5. Digital portal for plants: Campus, city or particular area.
6. Rare and endangered plants & their conservation & domestication.
7. Air pollution tolerance index (APTI): Screening of sensitive/tolerant plant species at various locations in particular area.
8. Science Communication by Creating science documentaries of innovators, Internet Science (Social media, Websites, Blogs, Youtube, Podcast etc.)
10. Phytochemistry of medicinal plants & their antimicrobial, nutraceutical and antioxidant properties.
11. Study of pollen grains in different flowers.
12. Study of stomata in different plants.
13. Study of various types of secretory and special tissues in plants.

Refer: libraries, journals, Memoirs, encyclopedias, herbaria, Museums, etc.

This course can be opted as an elective by the students of following subjects: Open to all

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Internal Assessment</th>
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<tbody>
<tr>
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<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>10</td>
</tr>
<tr>
<td>Thesis/dissertation</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/NSQF level 3 from Sector Skill Councils/Diploma holder from ITI in (Biology/Agriculture/Biotech/Forestry/Microbiology/Gardening/biomedical Science.
Facilities: Smart and Interactive Class
Other Requisites: All listed under all papers of the course.

Suggested equivalent online courses:
https://ndl.iitkgp.ac.in/
https://asiafoundation.org/what-we-do/books-for-asia?gclid=CiwKCAjA7939BRBMEiwA-hX5J-Qh8TSvPnvi38veio-L9f5uTyl1a6ol-oALClA9Ebu6pyz858vQZxoC5wkJQAyD_Bwl:
http://www.dli.ernet.in/
http://www.ulib.org/
http://www.tkdl.res.in/
http://www.vigyanprasar.gov.in/digilib
Directory of Open Access Repositories (DOAR)http://www.opendoar.org
Registry of Open Access Repositories (ROAR)http://roar.eprints.org/
http://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf
**Course outcomes:** After the completion of the course the students will be able:
1. Acquire knowledge on ultrastructure of cell.
2. Understand the structure and chemical composition of chromatin and concept of cell division.
3. Interpret the Mendel’s principles, acquire knowledge on cytoplasmic inheritance and sex linked inheritance.
4. Understand the concept of ‘one gene one enzyme hypothesis’ along with molecular mechanism of mutation.
5. Interpret the concept of Lernerism, Neo Lernerism, Darwinism and also understand the concept of natural selection.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures (60hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Cell biology</td>
<td>8</td>
</tr>
<tr>
<td>II</td>
<td>Genetics</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Brief idea about Mendel’s theory of inheritance, Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants.</td>
<td>7</td>
</tr>
<tr>
<td>IV</td>
<td>Plant breeding</td>
<td>8</td>
</tr>
<tr>
<td>VI</td>
<td>Biostatistics:</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Definition, statistical methods, basic principles, variables - measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution-definition only, Central tendency- Arithmetic Mean, Mode and Median; Measurement of dispersion-Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi-square test for goodness of fit: Computer application in biostatistics - MS Excel and SPSS theoretical.</td>
<td>7</td>
</tr>
<tr>
<td>V</td>
<td><strong>Plant tissue culture</strong></td>
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<td></td>
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<tr>
<td></td>
<td>Principles, components and techniques of in vitro plant cultures, totipotency. Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplasts, principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization, selection of hybrid cells, Somaclonal variation. Plant secondary metabolites production, an idea of morphogenesis (growth, polarity, symmetry and correlation).</td>
<td>8</td>
</tr>
</tbody>
</table>
### VII

**Nanotechnology**

Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes, Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes), nanoscale assembly of microorganisms (virus). Nano-particles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials, Biomineralization, Magnetsomes, nano-pesticides, nano-fertilizers, nano-sensors.

### VIII

**Artificial Intelligence in Plant Sciences**


**Introduction to use of Digital technologies – AI, IoT & ICT in Botany**

Educational software, INFLIBNET, NICNET, BRUNET, internet as a knowledge repository, google scholar, science direct, resource management, weather forecasting, IoT Database management, IoT platforms, IoT Graphical user interface, IoT application development for Android Mobile phones, ICT Applications for different crops and horticulture.

### Suggested Readings:

*Course Books published in Hindi may be prescribed by the Universities.*

1. Sharma and Trivedi by RBD Publisher
2. Cell Biology And Genetics (Hindi) 2/e PB....Gupta P K (Hindi) rastogi Publications
7. Genetics and Biotechnology Sunil D Purohit & Getam K Kukda, Apex Publishing House
8. Padap Pratjanan (Hindi) Hardcover – 1 January 2016 by Chandra Prakash Shukl (Author) Pointer Publishers, Jaipur
9. PLANT BREEDING : PRINCIPLE AND METHODS B D SINGH - IN HINDI
34. Veer Balu Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd
36. S S Purohit and S K Mathur; Biotechnology-Fundamentals and Applications- Agrobotanica, India.
42. Alexis and Mathew Leon, Fundamentals of Information Technology Leon Vikas
46. V. Rajanarayan Introduction to Information Technology... Prentice Hall.
47. Ramesh Bangia Learning Computer Fundamentals., Khanna Book Publishers
This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
</tr>
<tr>
<td>Quiz</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Course pre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)

Facilities: Smart and Interactive Class

Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:
- https://www.cytology-lac.org/educational-resources/virtual-slide-library
- https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx
- https://www.moodle-list.com/tags/genetics
- https://www.coursera.org/learn/genetics-evolution

Further Suggestions:

Access to Statistics, Chemistry, Math and Biotechnology resources will be required
Programme/Class: **Bachelor of Science**  
Year: **III**  
Semester: **VI**  
**Subject: Botany**

**Course Code:** B040602T  
**Course Title:** Ecology & Environment

**Course outcomes:**
1. acquaint the students with complex interrelationship between organisms and environment;
2. make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
3. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

<table>
<thead>
<tr>
<th>Credits: 4</th>
<th>Core Compulsory/ Elective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Marks: 25-75</td>
<td>Min. Passing Marks:</td>
</tr>
<tr>
<td><strong>Total No. of Lectures-Tutorials-Practical (in hours per week): 4-0-0</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td><strong>Natural resources &amp; Sustainable utilization</strong>: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water, Wetlands; Threats and management strategies. Ramsar sites. Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.</td>
<td>7</td>
</tr>
</tbody>
</table>
Phytogeography:
Biogeographic regions of India & world, Agroecological & Floristic zones of India. Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants (Age area hypothesis and Continental drift theory). Phytogeographical regions of India, Vegetational types in Uttar Pradesh.

Environmental audit & Sustainability
Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Sustainability indices; Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India’s environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice; Urbanization; Concept and characteristics of smart city; Urban resources and environmental problems; Carrying capacity analysis; Concept of ecological footprints.

Pollution, Waste management and Circular Economy
Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG; Waste Types; collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) - classification, collection and segregation, Incineration, Pyrolysis and gasification, Sanitary landfilling; composting, Biogas production, Circular Economy & sustainability.

Environmental ethics, Carbon Credits & Role of GIS
Carbon credit; concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism. Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.
   XII Apex Publishing House
   Jitendra Kumar Joshi
   SS , Dr. Deo PP , Dr. Agrawal Ashok KPublisher : Agrobios (India)


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This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology
Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

<table>
<thead>
<tr>
<th>Internal Assessment</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
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<td>Quiz</td>
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</tr>
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<td>Seminar</td>
<td>7</td>
</tr>
<tr>
<td>Assignment (Charts/Flora/Rural Service/Technology Dissemination)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/NSQF level 3 from Sector Skill Councils/Diploma holder from ITI in (Biology/Agriculture/Biotech/Forestry/Microbiology/Gardening/biomedical Science).
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:
https://community.plantae.org/tags/mooc
https://www.coursera.org/courses?query=plants
http://egovankosh.ac.in/handle/123456789/53530

Programme/Class: Bachelor of Science
Year: III
Semester: VI
Paper-III

Subject: Botany
Course Code: B040603P
Course Title: Lab on Cytogenetics, Conservation & Environment management

Course outcomes: After the completion of the course the students will be able:
1. To perform all experiments related to the semester i.e. Plant tissue cultured plants, conducting breeding on field, conserving and depolluting the environment.
2. Can be employed in environment impact assessment companies & start his own venture

Credits: 2
Core Compulsory
Max. Marks: 25+75
Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-2

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topic</th>
<th>No. of Lectures(60hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cell biology</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhode/Crillum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Measurement of cell size by the technique of micrometry.</td>
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<tr>
<td></td>
<td>3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains)</td>
<td></td>
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<tr>
<td></td>
<td>4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.</td>
<td></td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td></td>
</tr>
</tbody>
</table>
| II      | **Genetics**  
1. Monohybrid cross (Dominance and incomplete dominance)  
2. Dihybrid cross (Dominance and incomplete dominance)  
3. Gene interactions (All types of gene interactions mentioned in the syllabus)  
   a. Recessive epistasis 9: 3: 1  
   b. Dominant epistasis 12: 3: 1  
   c. Complementary genes 9: 7  
   d. Duplicate genes with cumulative effect 9: 6: 1  
   e. Inhibitory genes 13: 3  
4. Observe the genetic variations among inter and intra specific plants  
5. Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment |
| III     | **Biostatistics**  
1. Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size)  
2. Calculation of correlation coefficient values and finding out the probability  
4. Computer application in biostatistics - MS Excel and SPSS |
| IV      | **Plant tissue culture**  
1. Familiarization of instruments and special equipments used in the plant tissue culture experiments  
2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media  
3. Surface sterilization of plant materials for inoculation (implantation in the medium)  
4. Micropropagation of potato/tomato - Demonstration  
5. Protoplast isolation and culturing - Demonstration |
| V       | **Ecology & environment**  
1. Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites  
2. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).  
3. (b). Study of biotic interactions of: Stem parasite (Cuscuta), Root parasite (Orobanchae) Epiphytes, Predation (Insectivorous plants)  
4. Observation and study of different ecosystems mentioned in the syllabus  
5. Field visit to familiarize students with ecology of different sites |
| VI      | **Soil Formation, Properties & Conservation**  
1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)  
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests  
3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method  
4. Soil Profile study  
5. Soil types of India-Map |
| VII     | **Biodiversity and Phytogeography**  
1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/field visit).  
2. Marking of vegetation types of India, World & Uttar Pradesh on maps  
3. Phytogeographical areas of India |
Pollution & Waste management
1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Estimation of chloride and dissolved oxygen content in water sample.
3. Comparative anatomical studies of leaves from polluted and less polluted areas.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. Microbiological assessment of drinking water using MPN technique - water from well, river, water supply department and packaged drinking water.

Climate Change, Carbon Credits & Role of GIS
1. Conducting Waste Audit of your Institution - Demo
2. Green auditing of the College/University - Demo

Suggested Readings: as in papers above:

Course Books published in Hindi may be prescribed by the Universities.

1. Practical Botany (Part III) Author: Sunil D Purohit, Anamika Singhvi & Kiran Tak 2013 Apex Publishing House, Raj.

http://thecontent.tupsc.gov.in/Home.aspx
http://epathshala.nic.in/ http://epathshala.gov.in/

This course can be opted as an elective by the students of following subjects:
Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

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</tr>
<tr>
<td>Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)</td>
<td>8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>25</td>
</tr>
</tbody>
</table>
**Course pre-requisites:**

**Qualification:** To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)

**Facilities: Smart and Interactive Class**

**Other Requisites:** Video collection, Books, CDs, Access to On-line resources, Display Charts

**Lab requisites:** Biotech instruments, environmental lab instruments.

Suggested equivalent online courses:
- [https://www.cytopathologyiac.org/educational-resources/virtual-slide-library](https://www.cytopathologyiac.org/educational-resources/virtual-slide-library)
- [https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx](https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx)
- [https://www.mooc-list.com/npa70genetics](https://www.mooc-list.com/npa70genetics)
- [https://www.coursera.org/learn/genetics-evolution](https://www.coursera.org/learn/genetics-evolution)

Further Suggestions: Access to Statistics, Chemistry, Math and Biotechnology resources will be required

<table>
<thead>
<tr>
<th>Programme/Class: Bachelor of Science</th>
<th>Year: III</th>
<th>Semester: VI / Project-II/ Paper-IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject: BOTANY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Code: - B0406004R</td>
<td>Course Title: Project in Botany for Graduation</td>
<td></td>
</tr>
</tbody>
</table>

**Course outcomes:**

- After completing this course a student will have:
  - Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
  - Project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes.
  - It will promote creativity and the spirit of enquiry in learners.
  - They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing.
  - It will enhance their abilities, enthusiasm, and interest.

**Credits: 03**

**Core: Compulsory**

**Max. Marks: 25+75**

**Min. Passing Marks: ........**

**Total No. of Lectures-Tutorials-Practical (in hours per week): 0-0-3.**

**SUGGESTIVE LIST OF PROJECTS**

- Prepare beds for growing nursery for herbs, shrubs and trees.
- Develop Green house facility in college and grow plants.
- Develop hydroponics facility in college and grow plants.
- Develop botanical garden in the college with labelling.
- Vertical gardens, roof gardens.
- Culture & art of making bonsai.
- Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing).
- Phytochemical Analysis of Medicinal plants.
- Bio composting and Vermicomposting.
- Performing Aromatherapy by essential Oils.

Refer: libraries, journals, Memoirs, encyclopaedias, herbaria, Museums, etc.
This course can be opted as an elective by the students of following subjects:
This course can be opted as an elective by the students of following subjects: Open to all

Suggested Continuous Evaluation Methods:

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<tbody>
<tr>
<td>Class Interaction</td>
<td>5</td>
</tr>
<tr>
<td>Seminar</td>
<td>10</td>
</tr>
<tr>
<td>Thesis/dissertation</td>
<td>10</td>
</tr>
</tbody>
</table>

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /Biomedical Science.
Facilities: Smart and Interactive Class
Other Requisites: All listed under all papers of the course.

Suggested equivalent online courses:
https://ndl.itikgp.ac.in/
http://hececontent.unisdc.gov.in/Home.aspx
(http://epathshala.nic.in/; http://epathshala.gov.in/)
ntep.itmp.ac.in
https://aist.foundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5j-QhBT5SY/rnrj3bveo-L9f5uTylAk0dEoAllCIa9Ebu6py858vQZsoC5wkQAvtD_BwE
http://www.dli.iert.in; http://www.ulib.org/
Directory of Open Access Repositories (ROAR) http://www.opendoar.org
Registry of Open Access Repositories (ROAR) http://roar.eprints.org/
http://www.issnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf

A) **Cell division and cell cycle** (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

B) **Protein synthesis and processing** (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proofreading, translational inhibitors, Post-translational modification of proteins).

C) **Cell signaling** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

D) **Innate and adaptive immune system** Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity, monoclonal antibodies

E) **Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

F) **Microbial genetics** : Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

G) **Mutation** : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis.