

**SYLLABUS**  
*for*  
**Choice Based Credit System**  
(CBCS)

**On the basis of**  
**Outcome Based Education**  
**(OBE)**

**BOTANY HONOURS**

CC/DSE/GE/AECC(HINDI/ENG/ENVIR SC)/SEC(IRS)



**PATNA WOMEN'S COLLEGE**

Autonomous

PATNA UNIVERSITY

3<sup>rd</sup> Cycle NAAC Accredited at 'A' Grade with CGPA 3.58/4  
*"College with Potential for Excellence" (CPE) Status Accorded by UGC*

## **Vision**

Rooted in the life, vision, and teachings of Jesus Christ and inspired by Mother Veronica, the foundress of the Apostolic Carmel, Patna Women's College strives to become a centre of academic excellence in higher education, social responsibility, and empowerment of women.

## **Mission Statement**

Patna Women's College, the first college for women in Bihar, is committed to the holistic development of women so as to make an effective contribution to the creation of a better society.

### **To this end, we strive**

- To become a center of excellence in higher education for women in an atmosphere of autonomy.
- To excel in teaching-learning, research, and consultancy.
- To provide education that promotes capacity building and holistic development of a person.
- To offer subjects for competency building and motivate/animate a workforce imbued with human values.
- To promote patriotism, communal harmony and cultural integration to maintain a free and peaceful atmosphere on the campus.
- To train the students in creative arts, social service, critical thinking, and leadership in order to make an effective contribution to the creation of a new and value-based society.
- To create women leaders and to make them agents of social change.
- To develop skill oriented and value-based courses, for the all-round development of individuals.
- To promote academic exchange and academia-industry interface.
- To form young women who are 'always wise' and who will dare to 'go ahead and conquer knowledge' through, competence, commitment, delicate conscience, and compassion.

## PROGRAMME: B.SC. BOTANY

### Programme Outcome

**After the completion of B.Sc. Honours Degree Programme, the students will be able to achieve the following outcomes:**

- PO1: Professional knowledge:** Acquire comprehensive knowledge of major concepts, theoretical principles and experimental findings of various subjects in pure sciences.
- PO2: Critical thinking and Cognitive skills:** Convey the intricate science information effectively and efficiently, analyze and solve the problems related to plants, animal sciences without relying on assumptions and guesses.
- PO3: Environment and sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO4: Effective Communication:** Demonstrate familiarity with and will be able to analyze both verbally and in writing issues and forms of contemporary art with a clear understanding of historical precedents.
- PO5: Instruments and Experiments:** Acquire the skills in handling scientific instruments, planning and performing in laboratory experiments and drawing logical inferences from the scientific experiments.
- PO6: Research and Analysis:** Demonstrate analytical skill and proficiency in a range of tools and techniques used in research in science and interdisciplinary programmes.
- PO7: Employability and higher Education:** Show proficiency in professional, employability and develop soft skills required for higher education and placements.
- PO8: Ethics:** Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality in the field of science.

- PO9: Science and Society:** Apply reasoning acquired by the scientific knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional science practice.
- PO10: Interdisciplinary Learning:** Integrate academic curriculum with other co-curricular goals, such as career development, life-long learning, develop interdisciplinary learning and opportunity to extend their knowledge across all disciplines.
- PO11: Nation Building:** Introspect and evolve into dynamic and creative individuals capable of socially productive, constructive actions that positively impact our Nation and the World at large.

### **Programme Specific Outcomes**

**At the completion of the program, students will attain the ability to:**

- PSO1:** Taxonomic studies will help in exploration of flora.
- PSO2:** Microbiology and plant diseases will enable to know about the various microbes and plant diseases, respectively along with their control.
- PSO3:** Laboratory works will provide knowledge of various techniques and scientific equipments efficiently.
- PSO4:** Study of Basic Genetics will have the way of deciphering complex modern Biology.
- PSO5:** Development of awareness about the types of pollution and their control.
- PSO6:** Study of RDT, Molecular Biology, Biotechnology and others will help in developing genetically engineered crops, protecting endangered plants and large-scale production of different vaccines including very recently developed Corona-vaccine too.



## **B.Sc. (Honours) Botany**

**Note: 1 credit = 15 hours**

1. Core Course paper: 6 credits each (4 Theory and 2 Practical)
2. General Elective paper: 6 credits each (4 Theory and 2 Practical)
3. Ability Enhancement Courses: 2 credits each (Theory/ Practical)
4. Discipline Specific Elective paper: 6 credits each (4 Theory and 2 Practical)
5. Dissertation: 6 credits (Project work and Project Report)

### **Core Courses (BOT CC) (6 credits each)**

**Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

#### **Semester I**

1. Microbiology and Phycology
2. Biomolecules and Cell Biology

#### **Semester II**

3. Mycology and Phytopathology
4. Archegoniate

#### **Semester III**

5. Anatomy of Angiosperms
6. Economic Botany
7. Basics of Genetics

#### **Semester IV**

8. Molecular Biology
9. Plant Ecology and Phytogeography
10. Plant Systematics

#### **Semester V**

11. Reproductive Biology of Angiosperms
12. Plant Physiology

#### **Semester VI**

13. Plant Metabolism
14. Recombinant DNA Technology and Plant Biotechnology

## **Generic Elective Papers (BOT GE) (6 credits each)**

**Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

**P.S.:** A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

### **Semester I**

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)

### **Semester II**

2. Plant Ecology and Taxonomy

### **Semester III**

3. Plant Anatomy and Embryology

### **Semester IV**

4. Plant Physiology and Metabolism

## **Ability Enhancement Compulsory Courses (AECC) (2Credits each)**

Ability Enhancement Compulsory Courses (AECC): These courses are based upon the content that leads to knowledge enhancement- (i) English/Hindi communication, (ii) Environmental Science.

### **Semester I**

**AEC 1** English/MIL communication

### **Semester II**

**AEC 2** Environmental Science

## **Skill Enhancement Course (SEC) (2Credits each)**

Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

### **Semester III**

**IRS SEC 1** Inter Religious Studies (Value based)

### **Semester IV**

**BOT SEC 2.** Mushroom Cultivation Technology (Skill based)

## Discipline Specific Elective (BOT DSE) (6 credits each)

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

### Semester V

#### BOT DSE-1

1. Genetics and Plant Breeding or Ethnobotany

#### BOT DSE-2

2. Biostatistics or Bioinformatics

### Semester VI

#### BOT DSE-3

3. Research Methodology or Analytical Techniques in Plant Sciences

#### BOT DSE-4

4. Dissertation or Industrial and Environmental Microbiology

## Botany (Hons.) CBCS Syllabus

| Sem | Core Course<br>(14)<br><u>6 Credits</u><br><u>each</u> | Ability<br>Enhancement<br>Compulsory<br>Course AECC<br>(2)<br><u>2 Credits</u><br><u>each</u> | Skill<br>Enhancement<br>Course SEC (2)<br><u>2 Credits</u><br><u>each</u> | Discipline<br>Specific<br>Elective DSE<br>(4)<br><u>6 Credits</u><br><u>each</u> | Generic<br>Elective<br>GE (4)<br><u>6 Credits</u><br><u>each</u>                       |
|-----|--|---|---|--|--|
| I   | <b>BOT CC101:</b><br>Microbiology and<br>Phycology     | <b>AEC 101:</b><br>English/ MIL<br>Communication  |   |  | <b>BOT GE101:</b><br>Biodiversity<br>(Microbes,<br>Algae, Fungi<br>and<br>Archegoniat) |
|     | <b>BOT CC102:</b><br>Biomolecules<br>and Cell Biology  |   |   |  |  |
| II  | <b>BOT CC203:</b><br>Mycology and<br>Phytopathology    | <b>AEC202:</b><br>Environmental<br>Science  |   |  | <b>BOT GE202:</b><br>Plant<br>Ecology and<br>Taxonomy                                  |
|     | <b>BOT CC204:</b><br>Archegoniate                      |   |   |  |  |

|     |   |  |  |   |  |
|-----|---|--|--|---|--|
| III | <b>BOT CC305:</b><br>Anatomy of Angiosperms                             |  | <b>IRS SEC301:</b><br>Inter-Religious Studies<br>(Value based)         |   | <b>BOT GE303:</b><br>Plant Anatomy and Embryology    |
|     | <b>BOT CC306:</b><br>Economic Botany                                    |  |  |   |  |
|     | <b>BOT CC307:</b><br>Basics of Genetics                                 |  |  |   |  |
| IV  | <b>BOT CC408:</b><br>Molecular Biology                                  |  | <b>BOT SEC402:</b><br>Mushroom Cultivation Technology<br>(Skill based) |   | <b>BOT GE404:</b><br>Plant Physiology and Metabolism |
|     | <b>BOT CC409:</b><br>Plant Ecology and Phytogeography                   |  |  |   |  |
|     | <b>BOT CC410:</b><br>Plant Systematics                                  |  |  |   |  |
| V   | <b>BOT CC511:</b><br>Reproductive Biology of Angiosperms                |  |  | <b>BOT DSE501:</b><br>Genetics and Plant Breeding or Ethnobotany                      |  |
|     | <b>BOT CC512:</b><br>Plant Physiology                                   |  |  | <b>BOT DSE502:</b><br>Biostatistics or Bioinformatics                                 |  |
| VI  | <b>BOT CC613:</b><br>Plant Metabolism                                   |  |  | <b>BOT DSE603:</b><br>Research Methodology or Analytical Techniques in Plant Sciences |  |
|     | <b>BOT CC614:</b><br>Recombinant DNA Technology and Plant Biotechnology |  |  | <b>BOT DSE604:</b><br>Dissertation or Industrial and Environmental Microbiology       |  |

## Course Structure for B.Sc. Botany (Hons.)

| Semester – I   | Semester – II                                       |
|--|---|
| <b>BOT CC101:</b> Microbiology and Phycology                             | <b>BOT CC203:</b> Mycology and Phytopathology       |
| <b>BOT CC102:</b> Biomolecules and Cell Biology                          | <b>BOT CC204:</b> Archegoniate                      |
| Practical based on <b>BOT CC101 &amp; BOT CC102</b>                      | Practical based on <b>BOT CC203 &amp; BOT CC204</b> |
| <b>AEC101:</b> English/ MIL Communication                                | <b>AEC 202:</b> Environmental Science               |
| <b>BOT GE101:</b> Biodiversity (Microbes, Algae, Fungi and Archegoniate) | <b>BOT GE202:</b> Plant Ecology and Taxonomy        |
| Practical based on <b>BOT GE101</b>                                      | Practical based on <b>BOT GE202</b>                 |

| Semester – III   | Semester – IV  |
|--|--|
| <b>BOT CC305:</b> Anatomy of Angiosperm                        | <b>BOT CC408:</b> Molecular Biology                            |
| <b>BOT CC306:</b> Economic Botany                              | <b>BOT CC409:</b> Plant Ecology and Phytogeography             |
| Practical based on <b>BOT CC305, BOT CC306 &amp; BOT CC307</b> | Practical based on <b>BOT CC408, BOT CC409 &amp; BOT CC410</b> |
| <b>IRS SEC 301:</b> Inter-Religious Studies                    | <b>BOT SEC402:</b> Mushroom Cultivation Technology             |
| <b>BOT GE303:</b> Plant Anatomy and Embryology                 | <b>BOT GE404:</b> Plant Physiology and Metabolism              |
| Practical based on <b>BOT GE303</b>                            | Practical based on <b>BOT GE 404</b>                           |

| Semester – V   | Semester – VI   |
|--|---|
| <b>BOT CC511:</b> Reproductive Biology of Angiosperms                            | <b>BOT CC613:</b> Plant Metabolism  |
| <b>BOT CC512:</b> Plant Physiology   | <b>BOT CC614:</b> Recombinant DNA Technology and Plant Biotechnology                                  |
| Practical based on <b>BOT CC511 &amp; BOT CC512</b>                              | Practical based on <b>BOT CC 613 &amp; BOT CC 614</b>   |
| <b>BOT DSE501:</b> Genetics and Plant Breeding<br><b>BOT DSE501:</b> Ethnobotany | <b>BOT DSE603:</b> Research Methodology<br><b>BOT DSE603:</b> Analytical Techniques in Plant Sciences |
| <b>BOT DSE502:</b> Biostatistics<br><b>BOT DSE502:</b> Bioinformatics            | <b>BOT DSE604:</b> Dissertation<br><b>BOT DSE604:</b> Industrial and Environmental Microbiology       |

|   |   |
|---|---|
| Practical based on <b>BOT DSE501 &amp; BOT DSE502</b> | Practical based on <b>BOT DSE603 &amp; Project work</b> |
|---|---|

| <b>BOT Botany</b>                                 |                                  |
|---|----------------------------------|
| CC Core Course                                    | SEC Skill Enhancement Course     |
| GE General Elective                               | DSC Discipline Specific Elective |
| <b>AECC</b> Ability Enhancement Compulsory Course |                                  |

## Details of Credits for Courses under B.Sc. Honours Botany

| Semester | Course | Theory | Practical | Tutorial | Total Credits |
|----------|--------|--------|-----------|----------|---------------|
|----------|--------|--------|-----------|----------|---------------|

### I. Core Course (BOT CC) (14 Papers) – 06 credits each

|            |  |   |   |   |   |
|------------|--|---|---|---|---|
| <b>I</b>   | 1. Microbiology and Phycology                          | 4 | 2 | - | 6 |
|            | 2. Biomolecules and Cell Biology                       | 4 | 2 | - | 6 |
| <b>II</b>  | 3. Mycology and Phytopathology                         | 4 | 2 | - | 6 |
|            | 4. Archegoniate  | 4 | 2 | - | 6 |
| <b>III</b> | 5. Anatomy of Angiosperms                              | 4 | 2 | - | 6 |
|            | 6. Economic Botany                                     | 4 | 2 | - | 6 |
|            | 7. Basics of Genetics                                  | 4 | 2 | - | 6 |
| <b>IV</b>  | 8. Molecular Biology                                   | 4 | 2 | - | 6 |
|            | 9. Plant Ecology and Phytogeography                    | 4 | 2 | - | 6 |
|            | 10. Plant Systematics                                  | 4 | 2 | - | 6 |
| <b>V</b>   | 11. Reproductive Biology of Angiosperms                | 4 | 2 | - | 6 |
|            | 12. Plant Physiology                                   | 4 | 2 | - | 6 |
| <b>VI</b>  | 13. Plant Metabolism                                   | 4 | 2 | - | 6 |
|            | 14. Recombinant DNA Technology and Plant Biotechnology | 4 | 2 | - | 6 |

### II. Elective Course – 06 credits each

|          |  |   |   |   |   |
|----------|--|---|---|---|---|
|          | <b>A. 1. Discipline Specific Elective (BOT DSE) (4 Papers)</b> |   |   |   |   |
| <b>V</b> | 1. Genetics and Plant Breeding                                 | 4 | 2 | - | 6 |
|          | 2. Biostatistics   | 4 | 2 | - | 6 |

|            |   |   |   |   |   |
|------------|---|---|---|---|---|
| <b>VI</b>  | 3. Research Methodology   | 4 | 2 | - | 6 |
|            | 4. Dissertation   | - | 6 | - | 6 |
|            | <b>B. 1. Generic Elective (BOT GE) / Interdisciplinary (4 Papers)</b> |   |   |   |   |
| <b>I</b>   | 1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)             | 4 | 2 | - | 6 |
| <b>II</b>  | 2. Plant Ecology and Taxonomy   | 4 | 2 | - | 6 |
| <b>III</b> | 3. Plant Anatomy and Embryology                                       | 4 | 2 | - | 6 |
| <b>IV</b>  | 4. Plant Physiology and Metabolism                                    | 4 | 2 | - | 6 |

### **III. Ability Enhancement Courses – 02 credits each**

|            |  |   |   |   |            |
|------------|--|---|---|---|------------|
|            | <b>A. Ability Enhancement Compulsory Course (AECC)</b> |   |   |   |            |
| <b>I</b>   | 1. English/Hindi Communication                         | 2 | - | - | 2          |
| <b>II</b>  | 2. Environmental Science                               | 2 | - | - | 2          |
|            | <b>B. Skill Enhancement Course (SEC)</b>               |   |   |   |            |
| <b>III</b> | 1. Inter Religious Studies                             | 2 | - | - | 2          |
| <b>IV</b>  | 2. Mushroom Cultivation Technology                     | 1 | 1 | - | 2          |
|            | <b>TOTAL</b>   |   |   |   | <b>140</b> |

Institute should evolve a system/policy about ECA / General Interest / Hobby / Sports / NCC / NSS / related courses on its own.

\*wherever there is practical there will be no tutorial and vice-versa.

## **Botany (Honours) Details of CBCS Syllabus**

### **Core Courses Papers (CC) (6 credits each)**

**Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

### **SEMESTER – I**

#### **COURSE OUTCOME**

**After the completion of the course, the student will be able to:**

- CO1.** Classify the Plant kingdom
- CO2.** Describe the diversity, structure and importance of viruses and bacteria
- CO3.** Describe the general account of Mycoplasma and diseases caused by them
- CO4.** Explain the thallus organization, economic importance and the life cycle of various algae

| <b>BOT CC101 : Microbiology and Phycology</b><br><b>PWC (Theory: 4 credits + Practical: 2 credit )</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Classification of Plant Kingdoms and their important features (Whittaker, 1969)  | 04                  |
| 2  | Virus- Discovery, General structure, DNA virus (T-phage); replication (Lytic and lysogenic Cycle), RNA virus- TMV; Economic importance of viruses, Corona virus (elementary idea)  | 12                  |
| 3  | Bacteria – Discovery, General characteristics, types-archaebacteria and eubacteria, Reproduction-vegetative, asexual and genetic recombination (conjugation, transformation and transduction); Economic importance of bacteria with reference to their role in agriculture and industry (N <sub>2</sub> fixation, fermentation and medicine)<br>General account of Mycoplasma and diseases caused by them  | 20                  |
| 4  | Algae- General characteristics; Classification; Range of Thallus organization and Reproduction; Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar); Structure, Life history, and affinities of the following genera: <i>Nostoc</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> , <i>Vaucheria</i> , <i>Batrachospermum</i> and <i>Ectocarpus</i> ; Economic Importance of Algae | 24                  |
|  | <b>Practical</b><br>1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle<br>2. Types of Bacteria to be observed from photographs<br>3. Gram staining.  | 30                  |



|  |   |           |
|--|---|-----------|
|  | 4. Phycology: Study of vegetative and reproductive structures of the forms prescribed in the syllabus through temporary preparations and permanent slides |           |
|  | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4<sup>th</sup> edition.
2. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6<sup>th</sup> edition
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8<sup>th</sup> edition.
5. Pelczar, M.J. (2001) Microbiology, 5<sup>th</sup> edition, Tata McGraw-Hill Co, New Delhi.
6. Vashishtha, B.R., Sinha, A.K. Singh, V.P. (2010). Botany for degree students: Algae, S. Chand & Company Ltd. 2<sup>nd</sup> edition
7. Srivastava, H.N. (2005). Algae, Pradeep Publication. 12<sup>th</sup> edition.
8. Dubey R.C., Maheshwari D.K. (2005). A Text Book of Microbiology, S. Chand & Company Ltd. 2<sup>nd</sup> edition.

### COURSE OUTCOME

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

- CO1.** Describe the structure and properties of biomolecules
- CO2.** Explain the classification, properties and functions of enzymes
- CO3.** Describe cell wall, cell membrane and the structure, chemistry and functions of cellular organelles
- CO4.** Explain the eukaryotic cell cycle, mitotic and meiotic cell divisions; and regulation of cell cycle

| <b>BOT CC102 : Biomolecules and Cell Biology</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Biomolecules: Carbohydrates, amino acids, proteins, lipids, nucleotides and nucleic acid   | 20                  |
| 2  | Enzymes: Classification, nomenclature, physico-chemical properties, mechanism of action and regulation   | 14                  |
| 3  | Cell: Cell theory, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory); Cell wall and Cell membrane, structure and function of cell organelles: nucleus (including nucleolus and chromatin), mitochondria, ribosomes, golgi apparatus, endoplasmic reticulum, lysosomes, plastids and vacuoles   | 20                  |
| 4  | Cell division: Mitosis and meiosis; cell cycle and its regulation  | 06                  |
|  | <b>Practical</b><br>1. Estimation of organic acid and fatty acid by titration<br>2. Estimation of protein and sugar by spectrophotometry<br>3. Detection of tannin, alkaloid and flavonoid in the given plant sample<br>4. Separation of amino acids by paper chromatography technique<br>5. Study of cell and its organelles with the help of electron micrographs<br>6. Study of different stages of mitosis and meiosis | 30                  |
|  | <b>TOTAL</b>   | <b>90</b>           |

## **Reading List :**

1. Campbell, MK (2012) Biochemistry, 7<sup>th</sup> ed., Published by Cengage Learning.
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4<sup>th</sup> ed., Published by Churchill Livingstone.
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2<sup>nd</sup> ed., W.H. Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5<sup>th</sup> Edition., W. H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6<sup>th</sup> edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8<sup>th</sup> edition.
8. Cooper, G.M. and Hausman, R. E. (2009) The Cell: A Molecular Approach, 5<sup>th</sup> edition. ASM.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell 7<sup>th</sup> edition. Pearson Benjamin Cummings Publishing, San Francisco.

## **SEMESTER- II**

### **COURSE OUTCOME**

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

- CO1.** Describe the thallus organization, nutrition, economic importance and life cycle of various fungi
- CO2.** Explain the diversity, structure and importance of lichen and mycorrhiza
- CO3.** Describe the terms, scope and importance of plant pathology
- CO4.** Describe the etiology, symptoms and control measures of plant diseases

| <b>BOT CC203 : Mycology and Phytopathology</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Fungi: General characteristics; Thallus organization; Nutrition; Cell wall composition; Reproduction and Classification<br><br>General account of Lichens, types & economic importance; Mycorrhiza- Ectomycorrhiza, Endomycorrhiza and their significance  | 18                  |
| 2  | Structure and life history of the following genera: <i>Synchytrium</i> , <i>Rhizopus</i> , <i>Peziza</i> , <i>Albugo</i> , <i>Alternaria</i> and <i>Puccinia</i>   | 12                  |
| 3  | Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; Host- Pathogen relationships; disease cycle; prevention and control of plant diseases   | 16                  |
| 4  | Etiology, symptoms and control of the following diseases:<br><br>Citrus canker, Little leaf of brinjal, Wart disease of potato, Early and Late blight of potato, Black stem rust of wheat and white rust of crucifers, Red rot of sugarcane.   | 14                  |
|  | <b>Practical :</b><br><br>1. Mycology: Study of vegetative and reproductive structures of <i>Rhizopus</i> and <i>Peziza</i> (ascocarp) through temporary preparations and permanent slides<br><br>2. Lichen: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates (Photographs); Mycorrhizae: ectomycorrhiza and endo mycorrhiza (Photographs)<br><br>3. Phytopathology: Study of Host-parasite relationship of <i>Synchytrium</i> , <i>Albugo</i> , <i>Alternaria</i> | 30                  |

|  |   |           |
|--|---|-----------|
|  | and <i>Puccinia</i> through temporary preparations and permanent slides   |           |
|  | 4. Photographs of fungal spores   |           |
|  | 5. Herbarium specimens/ Photographs of Citrus Canker; TMV, Early blight of potato, Black stem rust of wheat and White rust of crucifers |           |
|  | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Agrios, G.N. (1997). Plant Pathology, 4<sup>th</sup> edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4<sup>th</sup> edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3<sup>rd</sup> edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
6. Vashishtha, B.R. Sinha, A.K. (2005). Botany for degree Students Part II, S. Chand & Company Ltd. 2<sup>nd</sup> edition.
7. Bilgrami, K.S. Dubey, H.C. (2005). A text book of Modern Plant Pathology, Vikas Publishing Home Pvt. Ltd. 2<sup>nd</sup> edition.

### COURSE OUTCOME

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

- CO1.** Explain the morphological diversity and evolution of bryophytes, pteridophytes and gymnosperms
- CO2.** Compare the life cycle of various bryophytes, pteridophytes and gymnosperms
- CO3.** Describe the economic importance of the bryophytes, pteridophytes and gymnosperms
- CO4.** Describe Fossil pteridophytes (*Rhynia* and *Calamites*)

| <b>BOT CC204 : Archegoniate</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|---|--|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1   | Introduction: Distinguishing features of archegoniates; Transition to land habit; Alternation of generations   | 02                  |
| 2   | Bryophytes: General Characteristics, Adaptation to land habit, Classification (up to family); Vegetative reproduction; Range of thallus organization; Structure, life history & affinities of the following genera- <i>Marchantia</i> , <i>Anthoceros</i> , <i>Sphagnum</i> and <i>Funaria</i> ; Ecological and economic importance of bryophytes  | 18                  |
| 3   | Pteridophytes: General characteristics, Classification (up to family), telome theory, stellar evolution, apogamy and apospory, morphology, anatomy and reproduction of <i>Psilotum</i> , <i>Selaginella</i> with special reference to seed habit, <i>Equisetum</i> and <i>Marsilea</i> ; Ecological and economic importance; Fossil Pteridophytes – <i>Rhynia</i> & <i>Calamites</i>   | 20                  |
| 4   | Gymnosperm: General characteristics, classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i> ; Ecological and economic importance   | 20                  |
|   | <b>Practical :</b><br>1. Bryophytes: Study of vegetative and reproductive structures of <i>Marchantia</i> , <i>Anthoceros</i> , <i>Sphagnum</i> and <i>Funaria</i> through temporary preparations and permanent slides<br>2. Pteridophytes: Study of vegetative and reproductive structures of <i>Psilotum</i> , <i>Selaginella</i> , <i>Equisetum</i> and <i>Marsilea</i> through temporary preparations and permanent slides | 30                  |

|  |  |           |
|--|--|-----------|
|  | 3. Gymnosperms: Study of vegetative and reproductive structures of <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i> through temporary preparations and permanent slides |           |
|  | <b>TOTAL</b>   | <b>90</b> |

### **Reading List :**

1. Vander-Poorteri 2009 Introduction to Bryophytes, COP.
2. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta, S. Chand. Delhi, India.
3. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms,, New Age International (P) Ltd Publishers, New Delhi, India.
4. Vashistha, P.C., Sinha, A.K. Kumar, A. (2006). Botany for degree students: Gymnosperm, S. Chand & Company Pvt. Ltd.
5. Srivastava, H.N. (2002). Gymnosperm, Pradeep Publications. 10<sup>th</sup> edition.
6. Rashid A. (1999). An introduction to Pteridophyta Vikas Publishing Home Pvt. Ltd. 2<sup>nd</sup> edition.
7. Puri P. (1996). Bryophyta: Morphology, Growth and Differentiation, Atma Ram and Sons, 2<sup>nd</sup> edition..

## **SEMESTER – III**

### **COURSE OUTCOME**

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

- CO1.** Explain the tissue system in plants and their functions
- CO2.** Understand the normal and anomalous secondary growth in plants and their causes
- CO3.** Learn about the structural adaptations in plants growing in different environmental conditions
- CO4.** Describe the structure and function of periderm

| BOT CC305 : Anatomy of Angiosperms<br>PWC (Theory: 4 credits + Practical: 2 credits ) |  |                      |
|---|--|----------------------|
| Unit  | Topics to be covered   | No. of hours         |
| 1   | Meristem and permanent tissue; Root and shoot meristem, simple and complex tissue<br>Mechanical Tissues – Structure, distribution and function   | 24                   |
| 2   | Normal secondary growth; Anomalous secondary growth in <i>Tinospora</i> , <i>Bignonia</i> , <i>Boerhaavia</i> , and <i>Dracaena</i>  | 16                   |
| 3   | Organization of tissue in relation to environment: Hydrophytes, Xerophytes, Halophytes and Epiphytes   | 16                   |
| 4   | Periderm – Origin, structure and function  | 04                   |
|   | <b>Practical</b><br>1. Study of anatomical details through permanent slides/temporary stain mounts/ Photographs<br>2. Distribution and types of parenchyma, collenchyma and sclerenchyma through permanent slides/temporary stain mounts/ Photographs<br>3. Study of anomalous secondary growth in <i>Tinospora</i> , <i>Bignonia</i> , <i>Boerhaavia</i> , and <i>Dracaena</i> through temporary preparations and permanent slides<br>4. Study of morphological and anatomical adaptations in hydrophytes and xerophytes through specimens and temporary slide preparations | 30<br><br><br><br>10 |
|   | <b>TOTAL</b>   | <b>90</b>            |

1. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.



2. Fahn, A. (1974). Plant Anatomy, Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy, The Benjamin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants, John Wiley & Sons, Inc., Delhi.
5. Vasishtha, P.C. (2004). Plant Anatomy, Pradeep Publication. 17<sup>th</sup> edition.
6. Grewal, R.C. (2011). Plant Anatomy, Campus Book International. 1<sup>st</sup> edition.
7. Singh S.K. Srivastava. S. (2014). Anatomy of anigosperrms, Campus Books International. 1<sup>st</sup> edition.

## **COURSE OUTCOME**

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

**CO1.** Create awareness about plants of economic importance

**CO2.** Know about their distribution patterns

**CO3.** Identify them on the basis of their botanical features

**CO4.** Learn about their cultivation and economic importance

| <b>BOT CC306 : Economic Botany</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Botanical characteristics, cultivation, processing and uses of Cereals, Legumes, Oil and fats                        | 15                  |
| 2  | Botanical characteristics, cultivation, processing and uses of Spices, Fruits and vegetables                         | 15                  |
| 3  | Botanical characteristics, cultivation, processing and uses of Beverages, Narcotics, Timber and Fiber yielding plant | 15                  |

|   |   |           |
|---|---|-----------|
| 4 | Botanical characteristics, cultivation, processing and uses of Medicinal plants, Sugar and starch yielding plants   | 15        |
|   | <b>Practical :</b><br>1. Study of botanical characteristics, cultivation, processing and uses of Cereals, Legumes, Oil & fats, Spices, Fruits and vegetables, Beverages, Narcotics, Timber and Fibre yielding plant, Medicinal plants, Sugar and starch yielding plants | 30        |
|   | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices, Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture, Jones & Bartlett Publishers.
4. Pandey, B.P. (2005). Economic Botany, S. Chand & Company Pvt. Ltd. 6<sup>th</sup> edition.
5. Kochner, S.N. (2016). Economic Botany a Comprehensive Study, Cambridge University Press. 5<sup>th</sup> edition.
6. Sharma, V. K., Shenai, S. K. (2013). Economically Important Medicinal Plants, Campus Book International. 1<sup>st</sup> edition.
7. Arya, P.S. (2000). Spice Crops of India, Kalyani Publishers.

### COURSE OUTCOME

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

**CO1.** Understand Mendelian laws of inheritance and its variations

**CO2.** Comprehend the effect of chromosomal abnormalities leading to genetic disorders

**CO3.** Know the details of mutations and their uses.

**CO4.** Know about the sex determination and sex linked inheritance.

| <b>BOT CC307 : Basics of Genetics</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |   |                     |
|---|---|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1   | Mendelian inheritance: Mendel's experiments and principles of inheritance: back cross and test cross; gene interactions and modified dihybrid ratio-complementary, supplementary, duplicate and epistatic factor and inhibitory genes   | 20                  |
| 2   | Linkage and crossing over: Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Sex determination and sex linked inheritance   | 16                  |
| 3   | Mutations: Types and induction (physical and chemical mutagens); Molecular basis of mutations and their role  | 14                  |
| 4   | Chromosomes: Physical and chemical characteristics, lampbrush chromosomes, B-chromosomes and polytene chromosomes; Chromosomal aberrations: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy, Polyploidy (types and role in evolution) | 10                  |
|   | <b>Practical</b><br>1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis<br>2. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 9:3:4, 12:3:1, 13:3, 15:1)   | 30                  |
|   | <b>TOTAL</b>  | <b>90</b>           |

### Reading List :

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8<sup>th</sup> edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5<sup>th</sup> edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics, Benjamin Cummings, U.S.A. 10<sup>th</sup> edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis, W. H. Freeman and Co., U.S.A. 10<sup>th</sup> edition.
5. Verma, P.S. Agarwal, V.K. (2010). Genetics, S. Chand & Company Pvt. Ltd. 2<sup>nd</sup> edition.
6. Singh, B.D. (2014). Genetics, Kalyani Publishers. 2<sup>nd</sup> edition.
7. Gupta P.K. (2001). Genetics, Rastogi Publication. 3<sup>rd</sup> edition.

## SEMESTER – IV

### COURSE OUTCOME

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

- CO1.** Decipher the structures and chemical properties of DNA and RNA and their role
- CO2.** Gain an understanding of various steps in transcription and translation in prokaryotes and eukaryotes
- CO3.** Know about gene regulation in prokaryotes and eukaryotes
- CO4.** Gain knowledge of modern biology techniques

| <b>BOT CC408 : Molecular Biology</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Nucleic acids, structures of DNA and RNA, forms of DNA, DNA replication and role of DNA polymerases, different forms of RNA and their role, Genetic code | 18                  |

|   |  |           |
|---|--|-----------|
| 2 | Central dogma, Transcription and Translation in prokaryotes and eukaryotes   | 14        |
| 3 | Gene regulation in prokaryotes (Lac operon) and eukaryotes   | 14        |
| 4 | Blotting techniques : northern, southern & western blotting, DNA finger printing, Gel Electrophoresis, Polymerase Chain Reaction.  | 14        |
|   | <b>Practical</b><br>1. DNA isolation from cauliflower head<br>2. DNA estimation by diphenylamine reagent/UV Spectrophotometry<br>3. Study of DNA replication mechanisms through photographs<br>4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs | 30        |
|   | <b>TOTAL</b>   | <b>90</b> |

### Reading List :

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6<sup>th</sup> edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5<sup>th</sup> edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9<sup>th</sup> edition.
4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3<sup>rd</sup> edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis, W. H. Freeman and Co., U.S.A. 10<sup>th</sup> edition.
6. Channarayappa (215). Molecular Biology, Universities Press. 1<sup>st</sup> edition.
7. Karp Gerald (2010). Cell Biology, John Willey and Sons., Inc. 6<sup>th</sup> edition

## **COURSE OUTCOME**

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

- CO1.** Knowledge of plant communities and ecological adaptations in plants
- CO2.** Knowledge about the soils on the basis of physical, chemical and biological components
- CO3.** Know about the types of pollution and their control measures
- CO4.** Knowledge about the conservation of biodiversity, phytogeographical regions of India and non-conventional energy

| <b>BOT CC409 : Plant Ecology and Phytogeography</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|---|--|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1   | Environment, Ecology, Biosphere, Biome, habitat, niche; Adaptation of hydrophytes and xerophytes<br>Biotic interactions: Beneficial and harmful interactions (symbiosis, commensalism, amensalism, herbivory, predation, parasitism)   | 06                  |
| 2   | Population ecology: Characteristics and Regulations<br>Community ecology: Concept of ecological amplitude; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession (Hydrosere and Xerosere)<br>Ecosystem: Structure and function of ecosystem, food chains and webs, Principles and models of energy flow, ecological pyramids | 12                  |
| 3   | Soil: Origin, Formation, Composition (Physical, Chemical and Biological) Soil profile and importance<br>Water: Precipitation types (rain, fog, snow, hail, dew), Soil, water and Water table   | 20                  |

|   |  |           |
|---|--|-----------|
| 4 | <p>Biogeochemical cycles: Gaseous and sedimentary cycles, Hydrological cycle</p> <p>Environmental pollution: Air pollution, water pollution, noise pollution, radioactive pollution and their control measures</p> <p>Phytogeography: Major vegetational belts of India</p>  | 22        |
|   | <p><b>Practical :</b></p> <ol style="list-style-type: none"> <li>1. Determination of pH of various soil and water samples</li> <li>2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid soil tests</li> <li>3 Study of morphological adaptations of hydrophytes and xerophytes (four each)</li> <li>4 Study of biotic interactions of the following: Stem parasite (<i>Cuscuta</i>), Root parasite (<i>Orobanch</i>e) Epiphytes, Predation (Insectivorous plants) through specimens/ photographs</li> <li>5 Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law</li> <li>6 Quantitative analysis of herbaceous vegetation for density and abundance in the college campus</li> <li>7 Field visit</li> </ol> | 30        |
|   | <b>TOTAL</b>   | <b>90</b> |

### Reading List :

1. Odum, E.P. (2005). Fundamentals of ecology, Cengage Learning India Pvt. Ltd., New Delhi. 5<sup>th</sup> edition.

2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation, Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment, Rastogi Publications, Meerut, India. 8<sup>th</sup> edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach, Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology, PHI Learning Pvt. Ltd., Delhi, India. 4<sup>th</sup> edition.
6. Dash, M.C., Dash, S.P. (2009). Fundamentals of Ecology, Tata McGraw Hill. 3<sup>rd</sup> edition.
7. Shukla, R.S., Chandel, P.S. (2010). A text book of Plant Ecology, S. Chand & Company Pvt. Ltd. 2<sup>nd</sup> edition.

### **COURSE OUTCOME**

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

**CO1.** Identify and classify the local flora

**CO2.** Know about the rules of ICBN

**CO3.** Awareness of different systems of Plant Classification

**CO4.** Preparation of herbarium and its importance

| <b>BOT CC410 : Plant Systematics</b>                   |  |                     |
|--|--|---------------------|
| <b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Systematics, Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary) | 30                  |



|   |  |           |
|---|--|-----------|
|   | Botanical nomenclature: Idea about important rules of plant nomenclature with special reference to ICBN  |           |
| 2 | Classification of plants as proposed by Benthem & Hooker and Hutchinson  | 10        |
| 3 | Floral characteristics and economic importance of following families: Ranunculaceae, Asclepiadaceae, Apocynaceae, Amaranthaceae, Euphorbiaceae, Lamiaceae, Cyperaceae and Poaceae  | 10        |
| 4 | Phylogeny of Angiosperms: Terms and concepts primitive and advanced, homology and analogy, origin & evolution of angiosperms, methods of illustrating evolutionary relationship (phylogenetic tree, cladogram)   | 10        |
|   | <b>Practical :</b><br>1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Ranunculaceae- <i>Ranunculus</i> , Lamiaceae- <i>Ocimum sanctum</i> , Apocynaceae- <i>Vinca rosea</i> , Amaranthaceae- <i>Achyranthus aspera</i> , Asclepiadaceae- <i>Calotropis procera</i> <i>gigantica</i><br>2. Preparation of Herbarium sheets (to be submitted in the record book) | 30        |
|   | <b>TOTAL</b>   | <b>90</b> |

### Reading List :

1. Singh, G. (2012). Plant Systematics: Theory and Practice, Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy, Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002).

Plant Systematics-A Phylogenetic Approach, Sinauer Associates Inc., U.S.A. 2<sup>nd</sup> edition.

4. Maheshwari, J.K. (1963). Flora of Delhi, CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of Plant Systematics, Harper and Row, New York.
6. Sharma, O.P. (2016). Plant Taxonomy, McGraw Hill Education Pvt. Ltd. 2<sup>nd</sup> edition.
7. Sambamurthy, A.V.S.S. (2005). Taxonomy of angiosperms, I.K. International Pvt. Ltd. 1<sup>st</sup> edition.

## **SEMESTER – V**

### **COURSE OUTCOME**

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

- CO1.** Know about the reproductive biology of angiosperms
- CO2.** Understand structure and functions of anther wall and pollen wall, pollen biology
- CO3.** Learn detailed study of structure of pistil, megasporangium, double fertilization and endosperm
- CO4.** Comprehend the causes of Polyembryony and apomixes with its classification

| <b>BOT CC511 : Reproductive Biology of Angiosperms<br/>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Anther: Structure and functions of anther wall, microsporogenesis, callose deposition and its significance<br><br>Pollen biology: Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); | 16                  |

|   |   |           |
|---|---|-----------|
|   | Pollen viability, germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia   |           |
| 2 | <p>Ovule: Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female Gametophyte (Types of Embryo sacs) and megagametogenesis (details of <i>Polygonum</i> type); Organization and ultra structure of mature embryo sac</p> <p>Pollination and Fertilization: Pollination types and significance; adaptations; structure of stigma and style; sexual incompatibility; path of pollen tube in pistil; double fertilization</p> <p>Endosperm: Types, development and structure</p> | 28        |
| 3 | Embryo: General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo  | 10        |
| 4 | Apomixis & Polyembryony – Definition, types and applications  | 06        |
|   | <p><b>Practical :</b></p> <ol style="list-style-type: none"> <li>1. Photographs of pollen grains of families: Malvaceae, Liliaceae, Asteraceae, Poaceae</li> <li>2. Study of anther, ovule, double fertilization, endosperm and embryo through photographs / ppt</li> <li>3. Models of the above topics to be submitted by the students</li> </ol>  | 30        |
|   | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5<sup>th</sup> edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.

3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Johri, B.N. Ambegaokar, K.B., Srivastava, P.S. (2015). Comparative Embryology of Angiosperms, Vol. 1 & 2. Springer. 1<sup>st</sup> edition.

## **COURSE OUTCOME**

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

- CO1.** Understand Water relation of plants with respect to various physiological processes
- CO2** Know about the mineral nutrition
- CO3.** Classify aerobic and anaerobic respiration, significance of respiration and Photosynthesis
- CO4.** Understand dormancy and germination in plants; learn about types and roles of phytohormones

| <b>BOT CC512 : Plant Physiology</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits)</b> |   |                     |
|--|---|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1  | Plant water relationship: Imbibition, diffusion and osmosis; Water Potential and its components; Active and passive transport of water and solutes; Ascent of sap; Transpiration and factors affecting transpiration, mechanism of stomatal movement and factors controlling it<br>Transport of organic substances, path of translocation, mechanism of translocation | 22                  |
| 2  | Mineral nutrition: Macro and micronutrients and their role in plant nutrition; nutrient uptake and transport mechanisms. role of carriers   | 08                  |

|   |   |           |
|---|---|-----------|
| 3 | Phytohormones: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Absciscic acid, Ethylene   | 16        |
| 4 | Physiology of flowering: Photoperiodism and vernalization; Plant movements, Plant Growth  | 14        |
|   | <b>Practical :</b><br>1. Determination of the rate of transpiration by using Farmer's Potometer<br>2. Determination of the amount of water absorbed and transpired by a plant, using T/A apparatus<br>3. To compare the rate of imbibition of oily and starchy seeds<br>4. Study of effect of sugar concentrations on leaf cell by plasmolytic method<br><br><b>Demonstration experiments</b><br>1. Bell jar experiment<br>2. Demonstration of osmosis using potato | 30        |
|   | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology, John Wiley and Sons. U. S.A. 4<sup>th</sup> edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development, Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.
4. Jain V. K. (2014). Fundamentals of Plant Physiology, S. Chand & Company Ltd. 16<sup>th</sup> Revised edition
5. Verma V. (2016). Plant Physiology, Athena Academic. 2<sup>nd</sup> edition.
6. Mazumdar, B.C. (2005). Photoperiodism and Vernalization in Plants, Daya Publishing House. 1<sup>st</sup> edition.
7. Mukherji, S., Gosh, A.K. (1996). Plant Physiology, New Central Book Agency (P) Ltd. 1<sup>st</sup> edition.

## SEMESTER – VI

### COURSE OUTCOME

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

- CO1.** Understand the anabolic and catabolic pathways of metabolism
- CO2.** Recognize the importance of Carbon assimilation in photorespiration
- CO3.** Understand ATP-Synthesis in respiration
- CO4.** Interpret the biological nitrogen fixation

| <b>BOT CC613 : Plant Metabolism</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|---|--|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1   | Concept of metabolism, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes)   | 06                  |
| 2   | Photosynthesis; photosynthetic apparatus, pigments, photochemical reactions, electron transport pathways in chloroplast membranes, photophosphorylation, Calvin Cycle, Crassulacean Acid Metabolism, Hatch & Slack pathway, factors affecting photosynthesis | 20                  |
| 3   | Respiration: Glycolysis, TCA Cycle and its regulation, electron transport in Mitochondria, oxidative phosphorylation, Pentose Phosphate Pathway  | 20                  |
| 4   | Biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation   | 14                  |
|   | <b>Practical</b><br>1. Chemical separation of photosynthetic pigments by Paper Chromatographic Technique   | 30                  |

|  |  |           |
|--|--|-----------|
|  | 2. To study the effect of light intensity on the rate of photosynthesis<br>3. To study the effect of carbon dioxide concentration on the rate of photosynthesis<br><br><b>Demonstration experiments</b><br>1. Moll's half leaf experiment<br>2. Demonstration of light-screen experiment |           |
|  | <b>TOTAL</b>   | <b>90</b> |

### **Reading List :**

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology, John Wiley and Sons. U. S.A. 4<sup>th</sup> edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development, Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.
4. Jain V. K. (2014). Fundamentals of Plant Physiology, S. Chand & Company Ltd. 16<sup>th</sup> Revised edition.
5. Verma V. (2016). Plant Physiology, Athena Academic. 2<sup>nd</sup> edition.
6. Harborne, J.B. (1973). Phytochemical Methods, John Wiley & Sons. New York.
7. Pathak, V.N., Khatri, N.K., Pathak, M. (2012). Fundamental of Plant Physiology, Agribios. 5<sup>th</sup> edition.

### **COURSE OUTCOME**

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

- CO1.** Have knowledge about the core enzymes involved in Recombinant DNA Technology
- CO2.** Have knowledge about the different steps of Recombinant DNA Technology
- CO3.** Understand the principle and basic protocols for Plant Tissue Culture and its application
- CO4.** Know about the role of rDNA and Plant Biotechnology as well as biosafety concerns of GMO

| <b>BOT CC614 : Recombinant DNA technology and Plant Biotechnology</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|---|--|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1   | rDNA technology: History; Major enzymes used: Restriction enzymes-types and cleavage pattern; DNA ligase- types and ligation process. Steps of Genetic engineering: Selection of cloning vectors- Plasmids (natural, pBR322), Phages, cosmid.  | 16                  |
| 2   | Passenger DNA: Different strategies used for isolation/synthesis of gene; Construction of genomic and cDNA libraries<br>Construction of rDNA: Different strategies for construction of rDNA.<br>Methods of DNA transfer in suitable host: electroporation, microinjection, particle gun method.<br>Selection strategies: Different methods for selection of clone (antibiotic resistant markers, colony hybridization, immune screening)<br>Expression of foreign gene | 16                  |
| 3   | Plant Tissue Culture: Basic aspect, totipotency, organogenesis, embryogenesis (somatic and zygotic), Role of plant tissue culture in growth, development and differentiation, anther culture and their applications micro-propagation<br>Germplasm conservation, Cryopreservation  | 16                  |
| 4   | Application of Recombinant DNA technology: In medicine (Humulin) and Agriculture (Bt-cotton, FlavrSavr tomato, Golden rice). Biosafety concerns on GMO   | 12                  |
|   | <b>Practical</b><br>1. (a) Preparation of MS medium<br>(b) Demonstration of <i>in vitro</i> sterilization and inoculation methods using leaf and nodal explants of tobacco, <i>Datura</i> , <i>Brassica</i> etc<br>2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs  | 30                  |



|  |   |           |
|--|---|-----------|
|  | 3. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs<br>4. Models on the above mentioned topics to be submitted by the students |           |
|  | <b>TOTAL</b>  | <b>90</b> |

### **Reading List :**

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice, Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA, ASM Press, Washington.
3. Singh, B.D. (2012). Biotechnology : Expanding Horizons, Kalyani Publishers, 4<sup>th</sup> edition.
4. Rana, S.V.S. (2010). Environmental Biotechnology, Rastogi Publication. 1<sup>st</sup> edition.
5. Dubey R.C. (2006). A text book of Biotechnology, S. Chand & Company Pvt. Ltd. 4<sup>th</sup> edition.
6. Trivedi, P.C. (2006). Plant Biotechnology, Perspectives and Prospects, Printer Publisher. 1<sup>st</sup> edition.

## **Generic Elective Papers (GE) (6 credits each)**

**Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

**P.S.:** A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

## **SEMESTER- I**

### **COURSE OUTCOME**

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

- CO1.** Know about viruses and bacteria
- CO2.** Know about different types of algae
- CO3.** Get the knowledge of fungi and its different types
- CO4.** Analyze the anatomy and reproduction of specified bryophytes, pteridophytes and gymnosperms along with their ecological and economical importance

| <b>BOT GE101 : Biodiversity (Microbes, Algae, Fungi and Archegoniate)</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|---|--|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1   | Microbes: Viruses – Discovery, general structure, DNA virus (T-phage); Replication (Lytic and lysogenic cycle); RNA virus (TMV); Economic importance;<br><br>Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and genetic recombination (conjugation, transformation and transduction); Economic importance  | 10                  |
| 2   | Algae: General characteristics; Range of thallus organization and Classification of algae; Morphology and life-cycles of the following: <i>Nostoc</i> , <i>Oedogonium</i> , <i>Ectocarpus</i> , <i>Batrachospermum</i> ; Economic importance of algae  | 12                  |
| 3   | Fungi: General characteristics, range of thallus organization, nutrition, reproduction and classification; Morphology and life cycle of <i>Peziza</i> and <i>Puccinia</i> ; Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance<br><br>Bryophytes: General characteristics, adaptations to land habit, Range of thallus Organization; Classification (up to family), Morphology, anatomy and reproduction of <i>Marchantia</i> , and <i>Sphagnum</i> | 18                  |

|   |  |           |
|---|--|-----------|
| 4 | <p>Pteridophytes: General characteristics, Classification (up to family), Stellar evolution, morphology, anatomy and reproduction of <i>Selaginella</i> with special reference to seed habit, <i>Equisetum</i> and <i>Marsilea</i></p> <p>Fossil Pteridophytes – <i>Rhynia</i></p> <p>Gymnosperm: General characteristics, classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> and <i>Pinus</i>, Economic importance</p> | 20        |
|   | <p><b>Practical :</b></p> <ol style="list-style-type: none"> <li>1. Study of vegetative and reproductive structures of algae, fungi, bryophytes, pteridophytes and gymnosperms specified in the syllabus through temporary preparations and permanent slides</li> <li>2. Models and microphotographs of viruses and bacteria</li> </ol>  | 30        |
|   | <b>TOTAL</b>   | <b>90</b> |

### Reading List :

1. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6<sup>th</sup> edition.
2. Pelczar, M.J. (2001) Microbiology, 5<sup>th</sup> edition, Tata McGraw-Hill Co, New Delhi.
3. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4<sup>th</sup> edition.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4<sup>th</sup> edition.
5. Vander-Poorteri (2009). Introduction to Bryophytes, COP.
6. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms, New Age International (P) Ltd Publishers, New Delhi, India.

## SEMESTER- II

### COURSE OUTCOME

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

- CO1.** Comprehend the basic concepts of plant ecology and taxonomy and botanical nomenclature
- CO2.** Understand the characteristics of different plant communities
- CO3.** Know the structure and functions of eco-system
- CO4.** Be aware about environmental pollution

| <b>BOT GE202 : Plant Ecology and Taxonomy</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |   |                     |
|---|---|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1   | Introduction: Concept of Environment, Ecology, Biosphere, Biome, habitat, niche; Adaptation of hydrophytes and xerophytes<br><br>Environmental pollution: Air pollution, water pollution, noise pollution, radioactive pollution and their control measures                                     | 20                  |
| 2   | Ecosystem: Structure and functions , food chains and webs, ecological pyramids<br><br>Succession: Hydrosere and Xerosere  | 16                  |
| 3   | Introduction to plant taxonomy: Identification, Nomenclature; Taxonomic hierarchy and classification<br><br>Botanical Nomenclature: Principles and rules (ICBN), binomial system  | 14                  |
| 4   | Classification: Types of classification-artificial, natural and phylogenetic; Bentham and Hooker (up to series), Hutchinson system of classification (up to series); A study of the diagnostic features and economic importance of following families: Apocynaceae, Amaranthaceae and Lamiaceae | 10                  |

|  |   |           |
|--|---|-----------|
|  | <b>Practical :</b><br>1. Study of morphological and anatomical adaptations of hydrophytes and xerophytes<br>2. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):<br>Lamiaceae- <i>Ocimum sanctum</i> , Apocynaceae- <i>Vinca rosea</i> , Amaranthaceae- <i>Achyranthus aspera</i><br>3. Preparation of Herbarium sheets (to be submitted in the record book) | 30        |
|  | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5<sup>th</sup> edition.
2. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
4. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
5. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3<sup>rd</sup> edition.
6. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
7. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics- A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2<sup>nd</sup> edition.
8. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.

## SEMESTER – III

### COURSE OUTCOME

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

- CO1.** Understand the fundamental concepts of plant anatomy and embryology
- CO2.** Learn about the structural adaptations in plants growing in different environmental conditions
- CO3.** Know about secondary growth in plants
- CO4.** Gain the knowledge of flower, pollination and fertilization

| <b>BOT GE303 : Plant Anatomy and Embryology</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |   |                     |
|---|---|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1   | Meristem and permanent tissue; Root and shoot meristem, simple and complex tissue   | 10                  |
| 2   | General account of adaptations in xerophytes and hydrophytes (morphological and anatomical)   | 10                  |
| 3   | Normal secondary growth; Anomalous secondary growth in <i>Tinospora</i> , <i>Boerhaavia</i> , and <i>Dracaena</i>   | 10                  |
| 4   | Structure of development of anther and pollen grain; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac<br><br>Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms<br><br>Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship | 30                  |
|   | <b>Practical :</b><br><br>1. Study of anatomical details through permanent slides/temporary stain mounts/ Photographs   | 30                  |

|  |   |           |
|--|---|-----------|
|  | 2. Study of anomalous secondary growth in <i>Tinospora</i> , <i>Bignonia</i> , <i>Boerhaavia</i> , and <i>Dracaena</i> through temporary preparations and permanent slides<br>3. Study of morphological and anatomical adaptations in hydrophytes and xerophytes through specimens and temporary slide preparations<br>4. Photographs of pollen grains<br>5. Study of anther, ovule, double fertilization, endosperm and embryo through photographs |           |
|  | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy, Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy, The Benjamin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants, John Wiley & Sons, Inc., Delhi.
5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
6. Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
7. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
8. Johri, B.M. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

## **SEMESTER – IV**

### **COURSE OUTCOME**

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

- CO1.** Understand Water relation of plants with respect to various physiological processes
- CO2.** Know about the mineral nutrition
- CO3.** Know the details of Respiration of Photosynthesis
- CO4.** Comprehend the Biological nitrogen fixation and its importance

| <b>BOT GE404 : Plant Physiology and Metabolism</b><br><b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Plant-water relations: Transpiration and factors affecting transpiration, mechanism of stomatal movement and factors controlling it<br>Mineral nutrition: Macro and micronutrients and their role in plant nutrition   | 14                  |
| 2  | Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C <sub>3</sub> , C <sub>4</sub> and CAM pathways of carbon fixation; Photorespiration | 14                  |
| 3  | Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway  | 14                  |
| 4  | Nitrogen metabolism: Biological nitrogen fixation;<br>Hormone: A general account;<br>Movements: Phototropic and Geotropic movements  | 18                  |



|  |   |           |
|--|---|-----------|
|  | <b>Practical</b> <ol style="list-style-type: none"> <li>1. Determination of the rate of transpiration by using Farmer's Potometer</li> <li>2. Determination of the amount of water absorbed and transpired by a plant, using T/A apparatus</li> <li>3. Chemical separation of photosynthetic pigments by Paper Chromatographic Technique</li> <li>4. To study the effect of light intensity on the rate of photosynthesis</li> <li>5. To study the effect of carbon dioxide concentration on the rate of photosynthesis</li> </ol> <b>Demonstration experiments</b> <ol style="list-style-type: none"> <li>1. Bell jar experiment</li> <li>2. Demonstration of osmosis using potato</li> <li>3. Moll's half leaf experiment</li> <li>4. Demonstration of light-screen experiment</li> </ol> | 30        |
|  | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology, John Wiley and Sons. U. S.A. 4<sup>th</sup> edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development, Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.
4. Jain V. K. (2014). Fundamentals of Plant Physiology, S. Chand & Company Ltd. 16<sup>th</sup> Revised edition.
5. Verma V. (2016). Plant Physiology, Athena Academic. 2<sup>nd</sup> edition.
6. Harborne, J.B. (1973). Phytochemical Methods, John Wiley & Sons. New York.
7. Pathak, V.N., Khatri, N.K., Pathak, M. (2012). Fundamental of Plant Physiology, Agribios. 5<sup>th</sup> edition.

## **Ability Enhancement Compulsory Courses (AECC)**

### **(2 Credits each)**

Ability Enhancement Compulsory Courses (AECC): These courses are based upon the content that leads to knowledge enhancement-(i) English/Hindi communication, (ii) Environmental Science.

### **SEMESTER- I**

#### **COURSE OUTCOME**

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

- CO1.** Communicate effectively using the techniques in the area of spoken as well as written communication.
- CO2.** Hone their LSRW skills within their communication.
- CO3.** Design and answer job interview questions.
- CO4.** Demonstrate the ability to craft professional messages that are clear yet courteous.

| <b>ENG AEC101 : English Communication</b><br><b>PWC (Theory :2 credits)</b> |   |                     |
|---|---|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| <b>1</b>  | <b>Communication</b><br>(a) Definition of Communication<br>(b) Stages of Communication<br>(c) Barriers of Communication<br>(d) Verbal and Non-verbal Communication<br>(e) Skills of Communication – Listening, Reading, Writing, Speaking | <b>5</b>            |
| <b>2</b>  | <b>Listening Skill</b><br>(a) Meaning and Importance of Listening<br>(b) Principles of Good listening   | <b>5</b>            |
| <b>3</b>  | <b>Writing Skills</b><br>(a) Notice, Agenda, Minutes of the meeting<br>(b) Report writing, Circulars  | <b>15</b>           |

|          |   |           |
|----------|---|-----------|
|          | (c) Writing Resume<br>(d) Building vocabulary   |           |
| <b>4</b> | <b>Speaking Skill</b><br>(a) Interview<br>(b) Meeting<br>(c) Situational Conversation | <b>5</b>  |
|          | <b>TOTAL</b>  | <b>30</b> |

### Reading List :

1. Scot, O.; *Contemporary Business Communication*. Biztantra, New Delhi.
2. Lesikar, R.V. & Flatley, M.E.; *Basic Business Communication Skills for Empowering the Internet Generation*, Tata McGraw Hill Publishing Company Ltd. New Delhi.
3. Ludlow, R. & Panton, F.; *The Essence of Effective Communications*, Prentice Hall Of India Pvt. Ltd., New Delhi.
4. R. C. Bhatia, *Business Communication*, Ane Books Pvt Ltd, New Delhi

## **SEMESTER – I**

### **HINAECC101 – हिन्दी-व्याकरण और सम्प्रेषण**

#### **परिणाम:**

1. विभिन्न प्रतियोगी परीक्षाओं के लिए तैयार करना ।
2. सम्प्रेषण-क्षमता की वृद्धि करना ।
3. कार्यालयी-पत्र लेखन की क्षमता विकसित करना ।
4. हिन्दी के व्याकरणिक एवं सैद्धांतिक स्वरूप की जानकारी हासिल करना ।

| <b>HINAECC101</b> <b>हिन्दी व्याकरण और सम्प्रेषण</b><br><b>PWC</b> <b>(Theory: 2 credits)</b> |  |                     |
|---|--|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| <b>1</b>  | <b>हिन्दी व्याकरण और रचना : संज्ञा, सर्वनाम, विशेषण, क्रिया, अव्यय, उपसर्ग, प्रत्यय, समास, सन्धि, पर्यायवाची शब्द, विलोम</b> | <b>15</b>           |

|   |  |           |
|---|--|-----------|
|   | शब्द, अनेक शब्दों के लिए एक शब्द, मुहावरे एवं लोकोक्तियाँ, पल्लवन, संक्षेपण, शब्द शुद्धि, वाक्य शुद्धि, विविध प्रकार के पत्र-लेखन                            |           |
| 2 | <b>सम्प्रेषण: भाषिक सम्प्रेषण :</b> स्वरूप और सिद्धांत, संप्रेषण की अवधारणा और महत्व, संप्रेषण की प्रक्रिया, संप्रेषण के विभिन्न मॉडल, संप्रेषण की चुनौतियाँ | 05        |
| 3 | <b>सम्प्रेषण के प्रकार :</b> मौखिक और लिखित, वैयक्तिक और सामाजिक, व्यावसायिक, भ्रामक संप्रेषण, संप्रेषण बाधाएँ और रणनीति                                     | 05        |
| 4 | <b>सम्प्रेषण के माध्यम :</b> एकालाप, संवाद, सामूहिक चर्चा, प्रभावी संप्रेषण  | 05        |
|   | <b>TOTAL</b>   | <b>30</b> |

## **SEMESTER- II**

### **COURSE OUTCOME**

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

- CO1.** Understand multidisciplinary nature of environmental studies.
- CO2.** Understand the concept and types of natural resources and environmental pollution.
- CO3.** Evaluate the anomalies created due to haphazard population growth and its impact on environment.
- CO4.** Understand about the organizations, conventions and legislations working on mitigation of environmental issues.

| <b>EVS AEC202 : Environmental Science<br/>PWC (Theory: 2 Credits)</b> |  |                     |
|---|--|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1   | (a) Multidisciplinary Nature of Environmental Studies: Definition, Scope and Importance. | 07                  |

|   |  |    |
|---|--|----|
|   | (b) Concept of Ecosystem: - Components, Elementary Idea of Major Ecosystem:  |    |
| 2 | <p>(a) Natural Resources : Land, Water, Forest And Mineral Resources : Introduction; Earth's Resources and Man; Renewable and Non-Renewable Resources ; Natural Resources and Associated Problems ; Non-Renewable Resources ; Renewable Resources ; Non-Renewable Energy; Renewable Energy, Conservation of Natural Resources</p> <p>(b) Biodiversity and its conservation: Hotspots and threats to Biodiversity : Biodiversity ; Definition ;Keystone Species ; Conservation of Biodiversity ; Methods For The Conservation of Wildlife ; Hot Spots ; Types of Biodiversity ; Genetic, Species and Ecosystem Diversity, Threats to Biodiversity ; Endangered And Endemic Species ; Conservation of Biodiversity: In Situ And Ex-Situ ; Wildlife Sanctuaries and National Parks of India ; The Need for An Integrated Protected Area System (IPAS) ; Beej BachaoAndolan ; List of Biosphere Reserves in India ; Tiger Reserves in India.</p> | 10 |
| 3 | <p>Environmental Pollution:</p> <p>(a) Causes, Effects, and Control Measures; Types and sourcesof Pollution.</p> <p>(i) Air Pollution; Sources of air pollution and its impact on human health.</p> <p>(ii) Water Pollution and contamination: Introduction, Types and sources; Classification of Water Pollutants. Impact on human health</p> <p>(iii) Soil Pollution: Introduction: Contaminants and Degradation; Impact on human health.</p>  | 05 |

|   |  |    |
|---|--|----|
|   | <p>(iv) Noise Pollution: Effects of Noise Pollution on Physical Health; Permitted Noise Levels; Noise-Control Techniques. Impact on human health.</p> <p>(b) Public Awareness about Greenhouse Effects; Acid Rain; Effects; Ozone Layer Depletion, Ganga Action Plan (GAP); Chipko Movement; Chernobyl disaster; Bhopal Gas Tragedy.</p> <p>(c) Environment and Human Health: Outcome of Unhygienic Environmental Conditions</p>   |    |
| 4 | <p>Human Population and Environment and Important Organizations:</p> <p>(a) Population Growth, Variation Among Nations : Global Population Growth ; Population Explosion – Family Welfare Program ; Urban Poverty and The Environment ; Environment and Human Health ; Environmental Health ; Examples of Linkages ; Definition of Health Impact Assessment (HIA) by WHO ; Climate and Health ; Infectious Diseases; Water borne and water related diseases, Mitigation Strategies to control adverse health impact, Role of Information Technology in Environment and Human Health.</p> <p>(b) Important Organizations : IUCN ; WWF ; BNHS ; PETA; Important Dates and Years; Some Important Environmental Conventions ; Atmospheric conventions ; Biodiversity conventions ; Land conventions ; Hazardous wastes ; Some important Acts and Notifications in India ; Environment Action Programme – India (EAP) ; Environment Protection Act ; Penalties ; Air (Prevention and Control of Pollution) Act 1981 ; Penalties ; Water (Prevention and control of Pollution) Act</p> | 08 |

|  |  |           |
|--|--|-----------|
|  | ; Penalties ; Wildlife Protection Act ; Penalties ; Forest Conservation Act ; Penalties ; Issues involved in enforcement of environmental legislation. |           |
|  | <b>TOTAL</b>   | <b>30</b> |

### **Reading List :**

1. Chandna R. C., 2002: Environmental Geography, Kalyani Publications, Ludhiana.
2. UNEP, 2007: Global Environment Outlook: GEO4: Environment For Development, United Nations Environment Programme
3. Odum, E. P. et al, 2005: Fundamentals of Ecology, Cengage Learning India.
4. Singh S., 1997: Environmental Geography, Prayag Pustak Bhawan. Allahabad.
5. Baskar Sushmita and Baskar R. 2007 :Environmental studies for Undergraduate Courses, Unicorn Books, Bangalore

## **Skill Enhancement Course (SEC) (2Credits)**

**Skill Enhancement Courses (SEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

## **SEMESTER – III**

### **COURSE OUTCOME**

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

- CO1.** Develop Inter-religious harmony & better understanding of other religions.
- CO2.** Interpret the different religions of the world.
- CO3.** Identify the common elements that bind different religions together.
- CO4.** Acquaint with the salient features of different religions.

| <b>PHIL SEC301 : Inter-Religious Studies (Value Based)</b><br><b>PWC (Theory :2 credits)</b> |  |                     |
|--|--|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Nature and Need of Inter-Religious study, Scope of Comparative Religion.   | 05                  |
| 2  | Salient Features of Hinduism, Jainism and Buddhism, Salient Features of Christianity, Islam and Sikhism.                   | 10                  |
| 3  | Similarities and Differences among Religions, Conflicting Truth claims of different religions and inter-religious Harmony. | 10                  |
| 4  | Religious Tolerance, Secularism.   | 05                  |
|  | <b>TOTAL</b>   | <b>30</b>           |

### **Reading List :**

1. Chaudhary, C. Neeraj (1979)-"Hinduism",B.I.Publication,New Delhi.
2. Devraj,N.K., (1917)-"Hinduism and Christianity"Asian Publishing House.
3. Gordh, George, -"Christian Faith and its Cultural Exoperssion", Printed in USA.
4. Hick, John, -"Philosophy of Religion", Prentice Hall of India.
5. Hopfe, M.Lewis (1983)- "Religion of the World", Macmillan Publishing Co. Inc, New York
6. Masih,Y. (1990)- "Comparitive study of Relgion",Motilal Banarasidass.
7. Sethi,S. Arijit, Pummer, Reinhard, (1979)-"Comparitive Religion", Vikas Publishing House pvt. ltd, Delhi.
8. Singh, B.N., (1994)-"Vishwa Dharma Darshan ki Samasyain", Ratna Printing Works.
9. Tiwari, Nath Kedar,(1983)-"Comparative Religion", Motilal Banarasidass.
10. Ward, CHS (1998) –"Early Buddhism", Caxton Publication, Delhi.



## SEMESTER – IV

### COURSE OUTCOME

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

- CO1.** Know about various types of mushrooms.
- CO2.** Undertake mushroom cultivating technology
- CO3.** Know about uses of mushroom
- CO4.** Highlight the benefits of mushroom cultivation and its marketing.

| <b>BOT SEC 402 : Mushroom Culture Technology<br/>PWC (Theory + Practical :2 credits)</b> |   |                     |
|--|---|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1  | Introduction, history; Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms; Types of edible mushrooms available in India- <i>Volvariella volvacea</i> , <i>Pleurotus citrinopileatus</i> , <i>Agaricus bisporus</i>  | 05                  |
| 2  | Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, composting technology in mushroom production | 10                  |
| 3  | Storage and nutrition: Short-term storage (Refrigeration – up to 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions; Nutrition - Proteins - amino acids,   | 06                  |

|   |  |           |
|---|--|-----------|
|   | mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins   |           |
| 4 | Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level; Cost benefit ratio - Marketing in India and abroad, Export Value. | 05        |
|   | <b>Practical</b><br>1. Mushroom cultivation  | 04        |
|   | <b>TOTAL</b>   | <b>30</b> |

### Reading List :

1. Pathak V. N., Yadav N. and Gaur M. (2013). Mushroom production and processing technology, Agrobios (India), Jodhpur.
2. Dey S. C. (Reprint 2010). Gardening Series. Mushroom Growing, Agrobios (India).
3. Quaesitor P. (2015). Magic Mushroom Grower's Guide- Simple Steps to Bulk Cultivation, The Psychonautical Society.
4. Anantanarayanan R., Nimmagadda J. (2006). A hand book of Research Process, McMillan Publishers India Ltd. 3<sup>rd</sup> edition.
5. Janarthanan, S., Vincet, S. (2009). Practical Biotechnology, Universities Press Pvt. Ltd. 1<sup>st</sup> edition.

## **Discipline Specific Elective (DSE) (6 credits each)**

**Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

### **SEMESTER – V**

#### **COURSE OUTCOME**

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

- CO1.** Understand the patterns of inheritance in different organisms
- CO2.** Know the basics of linkage of genes, sex determination and quantitative inheritance
- CO3.** Obtain knowledge of methods of crop improvement
- CO4.** Decipher various methods of plant propagation and its importance in human welfare

| <b>BOT DSE501 : Genetics and Plant Breeding</b>        |   |                     |
|--|---|---------------------|
| <b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |   |                     |
| <b>Unit</b>  | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1  | Heredity: Brief life history of Mendel; Terminologies; Laws of Inheritance; Modified Mandelian Ratios: 2:1- lethal Genes; 1:2:1- Co-dominance, incomplete dominance; 9:7, 9:6:1, 9:3:4, 12:3:1, 13:3 and 15:1; Chi Square; Pedigree Analysis; Male sterility; Multiple allelism; Pleiotropism; Chromosome theory of Inheritance, Balance theory<br><br>Quantitative inheritance: Concept, mechanism, examples; Monogenic vs polygenic Inheritance | 22                  |
| 2  | Linkage and Crossing over: Linkage: concept & history; complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three  | 10                  |

|   |  |           |
|---|--|-----------|
|   | factor crosses. Crossing over: concept and significance, cytological proof of crossing over; Sex-determination and Sex-linked Inheritance  |           |
| 3 | <p>(a) Mutations and Chromosomal Aberrations: Types of mutations, effects of physical &amp; chemical mutagens</p> <p>(b) Structural chromosomal changes: Deletions, Duplications, Inversions and Translocations</p> <p>(c) Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy</p>  | 10        |
| 4 | <p>Plant Breeding: Introduction and objectives; Breeding systems: modes of reproduction in crop plants; Important achievements and undesirable consequences of plant breeding</p> <p>Methods of crop improvement: Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations</p> <p>Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement</p> <p>Inbreeding depression and heterosis: History, genetic basis of inbreeding depression and heterosis; Applications</p> | 18        |
|   | <p><b>Practical :</b></p> <ol style="list-style-type: none"> <li>1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis</li> <li>2. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 9:3:4, 12:3:1, 13:3 and 15:1)</li> <li>3. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs</li> <li>4. Hybridization techniques - Emasculation, Bagging (For demonstration only)</li> </ol>   | 30        |
|   | <b>TOTAL</b>   | <b>90</b> |

### **Reading List :**

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics, 8<sup>th</sup> Ed. Wiley - India.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5<sup>th</sup> edition.
3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10<sup>th</sup> Ed., Benjamin Cummings.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis, W. H. Freeman and Co., U.S.A. 10<sup>th</sup> edition.
5. Pierce BA (2011) Genetics: A Conceptual Approach, 4<sup>th</sup> Ed., Macmillan Higher Education Learning.
6. Singh, B.D. (2005). Plant Breeding: Principles and Methods, Kalyani Publishers. 7<sup>th</sup> edition.
7. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding, Oxford - IBH. 2<sup>nd</sup> edition.
8. Acquaah, G. (2007). Principles of Plant Genetics & Breeding, Blackwell Publishing.

## **SEMESTER – V**

### **COURSE OUTCOME**

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

- CO1.** Know the value and usefulness of the natural products and their efficient use by the local communities.
- CO2.** Know about the patterns of cultural evolution with plants.
- CO3.** Know about different methodology used by ethnobotany researchers.
- CO4.** Understand importance of interaction between cultural practices, ecosystems and modern science.

| <b>BOT DSE501 : Ethnobotany</b><br><b>PWC (Theory:4 credits + Practical: 2 credits)</b> |   |                     |
|---|---|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1   | Introduction, Concept, Scope and Objectives; Ethnobotany as an interdisciplinary science. The relevance of Ethnobotany in the present context; Major and minor ethnic groups or Tribes of India, and their life styles.   | 16                  |
| 2   | Methodology of Ethnobotany studies: (a) Field work (b) Herbarium (c) Ancient literature (d) Archaeological findings, (e) Temples and sacred places.   | 14                  |
| 3   | Role of ethnobotany in Modern Medicine: Medico – ethnobotanical source in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) (a) <i>Azadirachta indica</i> (b) <i>Ocimum sanctum</i> (c) <i>Vitex negundo</i> (d) <i>Tribulus terrestris</i> and <i>Cassia auriculata</i> (f) <i>Indigofera tinctoria</i> . Role of Ethnobotany in modern medicine. | 16                  |
| 4   | Ethnobotany and legal aspects: Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional knowledge.  | 14                  |
|   | <b>Practical:</b><br>1. Collection, identification and preparation of herbarium of ethnobotanically important plants with appropriate references.<br>2. Preparation of crude extract of ethnobotanically important plants with appropriate reference.<br>3. Project work – documentation, literature survey, and collection of information on ethnobotanically useful plants from traditional healers.              | 30                  |
|   | <b>TOTAL</b>  | <b>90</b>           |

### Reading List :

1. Balick , M. J .and Cox , P.A. . 1996. Plants and Culture: The Science of Ethnobotany. Scientific American Library.
2. Bera , S , Mukherji, D. and D 'Rozario , A .2004. A handbook of Ethnobotany. Kalyani Publishers.
3. Colton C.M. 1997. Ethnobotany: Principal and Application. John Wiley and Sons.  
Jain, S.K. (ed.). 1989. Method and Approaches in Ethnobotany. Society of Ethnobotanists

### COURSE OUTCOME

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

- CO1.** Comprehend the fundamental concepts related to descriptive and inferential biostatistics
- CO2.** Develop skills in data tabulation, its treatment, analysis, interpretation and graphical representation of data
- CO3.** Analyze the implications of inferential statistics in biology
- CO4.** Develop the competence in hypothesis testing and interpretation

| <b>BOT DSE502 : Biostatistics</b>                      |  |                     |
|--|--|---------------------|
| <b>PWC (Theory: 4 credits + Practical: 2 credits )</b> |  |                     |
| <b>Unit</b>  | <b>Topics to be covered</b>  | <b>No. of hours</b> |
| 1  | Biostatistics: Definition, statistical methods-basic principles Variables -measurements, functions, limitations and uses of statistics<br><br>Collection of data (primary and secondary), types and methods of data collection, merits and demerits; Classification of data, tabulation and presentation, sampling methods | 24                  |
| 2  | Measures of central tendency - mean, median, mode, geometric mean - merits & Demerits;   | 14                  |

|   |  |    |
|---|--|----|
|   | Measures of dispersion - range, standard deviation, mean deviation, quartile deviation –merits and demerits; Co-efficient of variations  |    |
| 3 | Correlation - types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression   | 12 |
| 4 | Statistical inference - hypothesis - simple hypothesis - student 't' test - chi square test  | 10 |
|   | <b>Practical :</b><br>1. Calculation of mean, standard deviation and standard error<br>2. Calculation of correlation coefficient values and finding out the probability<br>3. Calculation of 'F' value and finding out the probability value for the F value | 30 |

### Reading List :

1. Danniel, W.W. (1987). Biostatistics, New York, John Wiley Sons.
2. Selvin, S. (1991). Statistical Analysis of epidemiological data, New York University Press.
3. Campbell, R.C. (1998). Statistics for Biologists, Cambridge University Press.
4. Arora, P.N. Malhan, P.K. (2006). Biostatistics, Himalaya Publishing House. 9<sup>th</sup> edition.
5. Pagano, M. Gauvreau K. (2004). Principles of Biostatistics, Duxbury. 1<sup>st</sup> edition.
6. Bhuyan, K.C. (2017). Advanced Biostatistics, New Central Book Agency (P) Ltd. 1<sup>st</sup> edition.



## **SEMESTER – V**

### **COURSE OUTCOME**

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

- CO1.** Understand the Aim, Scope and Research areas of Bioinformatics.
- CO2.** Know the concept of Biological Database Retrieval System.
- CO3.** Develop an understanding in molecular phylogeny
- CO4.** Understand the ethical aspects Bioinformatics in Drug Discovery

| <b>BOT DSE502 : Bioinformatics</b><br><b>PWC (Theory:4 credits + Practical: 2 credits)</b> |   |                     |
|--|---|---------------------|
| <b>Unit</b>  | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1  | Introduction to Bioinformatics<br>Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.  | 05                  |
| 2  | Databases in Bioinformatics<br>Introduction, Biological Databases, Classification format of Biological Databases, Biological; Database Retrieval System.<br>Biological Sequence Databases<br>National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST) | 20                  |
| 3  | Nucleotide Database, Protein Database, Gene Expression Database.<br>EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Molecular Phylogeny; Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular; Phylogenetic Prediction.  | 20                  |

|   |   |           |
|---|---|-----------|
| 4 | Applications of Bioinformatics; Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement | 15        |
|   | <b>Practical :</b><br>1. Nucleic acid and protein databases.<br>2. Sequence retrieval from databases<br>3. Construction of phylogenetic tree.   | 30        |
|   | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

## SEMESTER – VI

### COURSE OUTCOME

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

- CO1.** Understand the concept of research and different types of research in the context of biology
- CO2.** Develop laboratory experiment related skills
- CO3.** Develop competence on data collection and process of scientific documentation
- CO4.** Understand the ethical aspects of research

**BOT DSE603 : Research Methodology**  
**PWC (Theory:4 credits + Practical: 2 credits)**

| Unit | Topics to be covered   | No. of hours |
|------|--|--------------|
| 1    | Basic concepts of research: Research-definition and types of research (Descriptive vs. analytical; applied vs. fundamental; quantitative vs. qualitative; conceptual vs. empirical); Research methods vs. methodology; Literature-review and its consolidation; Library research; field research; laboratory research; Key biology research areas  | 16           |
| 2    | General laboratory practices: Common calculations in botany laboratories; Understanding the details on the label of reagent bottles; Molarity and normality of common acids and bases; Preparation of solutions; Dilutions; Percentage solutions; Molar, molal and normal solutions; Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling | 16           |
| 3    | Data collection and documentation of observations: Maintaining a laboratory record; Tabulation and generation of graphs; Imaging of tissue specimens and application of scale bars; The art of field photography   | 08           |
| 4    | The art of scientific writing and its presentation: Numbers, units, abbreviations and nomenclature used in scientific writing; Writing references; Powerpoint presentation; Poster presentation; Scientific writing and ethics; Introduction to copyright-academic misconduct/plagiarism   | 20           |
|      | <b>Practical :</b><br>1. Experiments based on chemical calculations  | 30           |

|  |  |           |
|--|--|-----------|
|  | 2. The art of imaging of samples through microphotography and field photography<br>3. Poster presentation on defined topics<br>4. Technical writing on topics assigned |           |
|  | <b>TOTAL</b>   | <b>90</b> |

### **Reading List :**

1. Narayana P. S., Varalakshmi D. and Pullaiah T. (2016). Research Methodology in Plant Sciences, Scientific Publisher.
2. Arumugam N. (2015). Research Methodology, Saras Publication.
3. Napoleon D. (2014). Research Methodology: A Theoretical Approach, Laxmi Publication.
4. Sadasivam, S., Manickam, A. (2011). Biochemical Methods, New Age International Publishers. 3<sup>rd</sup> edition.
5. Raman. A., Mimmagadda J. (2009). A hand book of Research Process, McMillan Publishers India Pvt. Ltd. 1<sup>st</sup> edition.
6. Bhaskar A. (2014). Biochemical Methods : A Practical Approach, Narosa Publishing House. 1<sup>st</sup> edition.

## **SEMESTER – VI**

### **COURSE OUTCOME**

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

- CO1.** Understand the Principles of different microscopic techniques and their uses.
- CO2.** Perform laboratory experiments related to isolation, separation and identification of plant cell components.
- CO3.** Understand spectrophotometry and its applications in biological research.
- CO4.** Develop the skill of separation and characterization of useful phytochemicals.

**BOT DSE603 : Analytical Techniques in Plant Sciences**  
**PWC (Theory:4 credits + Practical: 2 credits)**

| Unit | Topics to be covered   | No. of hours |
|------|--|--------------|
| 1    | Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching. | 16           |
| 2    | Cell fractionation - Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl <sub>2</sub> gradient, analytical centrifugation, ultracentrifugation, marker enzymes.<br><br>Radioisotopes: Use in biological research, autoradiography, pulse chase experiment.  | 12           |
| 3    | Spectrophotometry: Principle and its application in biological research; Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.   | 12           |
| 4    | Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE  | 20           |
|      | <b>Practical:</b><br><br>1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.   | 30           |

|  |   |           |
|--|---|-----------|
|  | 2. To separate nitrogenous bases by paper chromatography.<br>3. To separate chloroplast pigments by column chromatography.<br>4. To estimate protein concentration through Lowry's methods.<br>5. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH). |           |
|  | <b>TOTAL</b>  | <b>90</b> |

### Reading List :

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A. 36.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

## **COURSE OUTCOME**

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

- CO1.** Acquire special/advanced knowledge through a project work with an advisory support by a teacher/faculty member
- CO2.** Apply knowledge involving / analyzing /exploring a real life situation / difficult problem
- CO3.** Practical work in the field and laboratory experiments will enhance skills in handling scientific instruments
- CO4.** Enhance presentation (oral and writing) skills

| <b>BOT DSE604 : Dissertation ( 6 Credits)</b><br><b>PWC</b> |   |                     |
|---|---|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1   | <p>Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester.</p> <p>Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his/her own with an advisory support by a teacher/ faculty member is called dissertation/project.</p> <p>Project work/Dissertation is considered as a special course involving application of knowledge involving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper</p> |                     |
|   | <b>TOTAL</b>  | <b>90</b>           |

## **SEMESTER – VI**

### **BOT DSE604 Industrial and Environmental Microbiology**

**(Theory: 4 Credits, Practical: 2 Credits)**

#### **COURSE OUTCOME**

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

- CO1.** Get equipped with a theoretical and practical understanding of industrial microbiology.
- CO2.** Understand the application of microbiology in manufacture of industrial products.
- CO3.** Understand role of various microbes in agriculture.
- CO4.** Learn the occurrence, abundance and distribution of microorganism in environment and their role.

| <b>BOT DSE604 : Industrial and Environmental Microbiology<br/>PWC (Theory: 4 credits + Practical: 2 credits )</b> |   |                     |
|---|---|---------------------|
| <b>Unit</b>   | <b>Topics to be covered</b>   | <b>No. of hours</b> |
| 1   | Bioreactors/Fermenters and fermentation processes: Solid-state, submerged fermentations; Batch and continuous fermentations; Components of a typical bioreactor; Types of bioreactors-laboratory, pilot scale and production fermenters; Constantly stirred tank fermenter; Downstream processing.        | 16                  |
| 2   | Microbial production of industrial products and enzymes: Microorganisms involved, media, fermentation conditions, and uses; Microbial fermentations for the production of enzyme: amylase or lipase activity, organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin). | 16                  |
| 3   | Microbes in agriculture and remediation of contaminated soil: Biological fixation; Isolation of   | 13                  |



|   |  |           |
|---|--|-----------|
|   | root nodulating bacteria, Mycorrhizae; arbuscular mycorrhizal, Bioremediation of contaminated soils.   |           |
| 4 | Microbial flora of air and water: Distribution of microbes in air; Isolation of microorganisms from soil, air and water. Role of microbes in sewage and domestic waste water treatment systems. Determination of BOD and COD of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.  | 15        |
|   | <b>Practical:</b> <ol style="list-style-type: none"> <li>1. Principles and functioning of instruments in microbiology laboratory</li> <li>2. Hands on sterilization techniques.</li> <li>3. Preparation of culture media.</li> <li>4. Production of enzyme from bacteria/fungi.</li> <li>4. Isolation of microorganism from air.</li> <li>5. Isolation of Rhizobium from leguminous plant</li> </ol> | 30        |
|   | <b>TOTAL</b>   | <b>90</b> |

### Suggested Readings:

1. Pelzar MJ, Chen ECS and Krieg NR. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora GJ, Funke BR and Case CL. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd

## Notes

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