ROYAL GLOBAL UNIVERSITY

GUWAHATI

ROYAL SCHOOL OF LIFE SCIENCES

(RSLSC)

DEPARTMENT OF BOTANY

COURSE: B.Sc. BOTANY

Preamble

Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects learning outcome based curriculum in order to maximize the benefits of the newly designed curriculum. The learning outcome based curriculum in general and in Botany in particular will definitely help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. It is pertinent to mention here that the purpose of education is to develop an integrated personality of the individual and the educational system provides all knowledge and skills to the learner for this.

The template as developed has the provision of ensuring the integrated personality of the students in terms of providing opportunity for exposure to the students towards core courses, discipline specific courses, generic elective courses, ability enhancement courses and skill enhancement courses with special focus on technical, communication and subject specific skills through practical and other innovative transactional modes to develop their employability skills. The template of learning outcome based curriculum has categorically mentioned very well defined expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness and so on along with very specific learning course outcomes at the starting of each course. Therefore, this template on Learning Outcomes based Curriculum Framework (LOCF) for B.Sc. with Botany/ Botany Honors will definitely be a landmark in the field of outcome based curriculum construction.

1. Introduction

This curriculum framework for the bachelor-level program in Botany is developed keeping in view of the student centric learning pedagogy, which is entirely outcome-oriented and curiosity-driven. To avoid rote -learning approach and foster imagination, the curriculum is more leaned towards self-discovery of concepts. The curriculum framework focuses on pragmatist approach whereby practical application of theoretical concepts is taught with substantial coverage of practical and field works. The platform aims at equipping the graduates with necessary skills for botany-related careers, careers with general graduate-level aptitude and for higher education in Botany and allied subjects. Augmented in this framework are graduate attributes including critical thinking, basic psychology, scientific reasoning, moral ethical reasoning and so on, qualification descriptors that are specific outcomes pertinent to the discipline of botany, learning outcomes for the two programmes these frameworks have been developed, learning outcomes for individual courses, pedagogical methods and assessment methods. While designing these frameworks, emphasis is given on the objectively measurable teaching-learning outcomes to ensure employability of the graduates. In line with recent trends in education section, these frameworks foster implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e-learning platforms. In addition, the framework pragmatic to the core; it is designed such a way to enable the learners implementing the concepts to address the real world problems. A major emphasis of these frameworks is that the curriculum focuses on issues pertinent to India and also of the west; for example, biodiversity and conservation of endemic and threatened species that are found in India, Indian climatological variables, Indian biodiversity and so on. Above all, these frameworks are holistic and aim to mould responsible Indian citizen who have adequate skills in reflective thinking, rational skepticism, scientific temper, digital literacy and so on such that they are equipped to fight immediate social issues apropos to Indian milieu, including corruption and inequity.

Aims:

1. To transform curriculum into outcome-oriented scenario
2. To develop the curriculum for fostering discovery-learning
3. To equip the students in solving the practical problems pertinent to India
4. To adopt recent pedagogical trends in education including e-learning, flipped class, hybrid learning and MOOCs
5. To mold responsible citizen for nation-building and transforming the country towards the future

2. **Learning Outcome Based Curriculum *Vis- A -Vis* Objective Based Curriculum**

Curriculum is the heart of any educational system. It can be focused either to achieve the objectives of each course of the programme or on the expected learning outcomes from each course. The objective based curriculum refers to the overall targets to be achieved through curriculum which may be long term or immediate. On the other hand, the learning outcome based curriculum is very specific in nature in terms of changes in the cognitive, affective and psychomotor behavior of the students as a result of their exposure to the curriculum. The outcome based curriculum provides the teacher very specific targets which he can achieve through the selected instructional process as compared to the objective based curriculum which provides general outcomes.

The learning outcome based curriculum has very close relationship with the learning of the students whereas objective based curriculum focusses on only providing knowledge to the students. In other words, higher cognitive skills are developed through learning outcome based curriculum. Hence, it is preferred to develop learning outcome based curriculum which will provide specific directions to the teacher with respect to the transaction process and expected changes in the behavior of the students as well.

a. Nature and extent of the B.Sc Botany Programme

Botany, as traditionally delimited epistemologically, is the broad discipline encompassing various subjects involved with the study of plants. Emphasis has been shifted to modern science at the cost of traditional botany. This shift is discussed at various forums. There is need to balance the traditional botany and upcoming modern computational and applied approach.

In view of above, adequate balance of topics is proposed displaying latest APG IV based phylogenetic systematics of plants covering higher plants, lower plants, aquatic (fresh and marine water) plants, nature/ field study, functional aspects of various cellular processes of plants, molecular genetics and modern tools i.e. tissue culture, genetic engineering and computational studies are required to be introduced at undergraduate level.

This modified syllabus has been drafted to enable the students to equip for national level competitive exams that they may attempt in future. To ensure implementation of a holistic pedagogical model, several allied disciplines are covered/introduced in this framework, including Chemistry, Mathematics and a

number of generic, and ability enhancement electives. In addition, employability of B.Sc. Botany graduate is given due importance such that their core competency in the subject matter, both theoretical and practical, is ensured. To expand the employability of graduates, a number of skill development courses are also introduced in this framework.

b. Aims of Bachelor's degree programme in Botany

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

1. To provide an environment that ensures cognitive development of students in a holistic manner. A dialogue about plants and its significance is fostered in this framework, rather than didactic monologues on mere theoretical aspects
2. To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A botany graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
3. To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.
4. To enable the graduate prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination

3. Program Learning Outcomes

The student graduating with the Degree B.Sc. (Honours) Botany should be able to acquire

• **Core competency:** Students will acquire core competency in the subject Botany, and in allied subject areas.

• The student will be able to identify major groups of plants and compare the characteristics of lower (e.g. algae and fungi) and higher (angiosperms and gymnosperms) plants.

• Students will be able to use the evidence based comparative botany approach to explain the evolution of organism and understand the genetic diversity on the earth.

- The students will be able to explain various plant processes and functions, metabolism, concepts of gene, genome and how organism's function is influenced at the cell, tissue and organ level.

- Students will be able to understand adaptation, development and behavior of different forms of life.

- The understanding of networked life on earth and tracing the energy pyramids through nutrient flow is expected from the students.

- Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Botany.

- **Analytical ability:** The students will be able to demonstarte the knowledge in understanding research and addressing practical problems.

- Application of various scientific methods to address different questions by formulating the hypothesis, data collection and critically analyze the data to decipher the degree to which their scientific work supports their hypothesis.

- **Critical Thinking and problem solving ability:** An increased understanding of fundamental concepts and their applications of scientific principles is expected at the end of this course. Students will become critical thinker and acquire problem solving capabilities.
- **Digitally equipped:** Students will acquire digital skills and integrate the fundamental concepts with modern tools.
- **Ethical and Psychological strengthening:** Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses.
- **Team Player:** Students will learn team workmanship in order to serve efficiently institutions, industry and society.
- **Independent Learner:** Apart from the subject specific skills, generic skills, especially in botany, the program outcome would lead to gain knowledge and skills for further higher studies, competitive examinations and employment. Learning outcomes based curriculum would ensure equal academic standards across the country and broader picture of their competencies. The Bachelor program in Botany and Botany honours may be mono-disciplinary or multidisciplinary.

4. Course Learning Outcomes

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

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B.Sc. BOTANY PROGRAMME STRUCTURE							
1ST SEMESTER							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	BOT142C101	Microbiology and Phycology	4	0	0	4	4
2	BOT142C102	Mycology and Phytopathology	4	0	0	4	4
3	BOT142C103	Biomolecules and Cell Biology	4	0	0	4	4
4	BOT142C114	Practical-I	0	0	12	6	12
Total credit for core papers						**18**	**24**
Ability Enhancement Compulsory Courses (AECC)							
5	CEN982A101	Communicative English - I	1	0	0	1	1
6	BHS982A104	Behavioural Science – I	1	0	0	1	1
Generic Elective							
7	BOT142G101	GE1: Biodiversity of Plants	2	0	2	3	4
8	BOT142G102	GE2: Nursery & Gardening	2	0	2	3	4
TOTAL CREDIT FOR THE SEMESTER			**18**	**0**	**8**	**26**	**36**
2ND SEMESTER							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	BOT142C201	Archegoniatae	4	0	0	4	4

2	BOT142C202	Anatomy of Angiosperms	4	0	0	4	4
3	BOT142C203	Economic Botany	4	0	0	4	4
4	BOT142C214	Practical-II	0	0	12	6	12
Total credit for core papers						**18**	**24**
Ability Enhancement Compulsory Courses (AECC)							
5	CEN982A201	Communicative English - II	1	0	0	1	1
6	BHS982A204	Behavioural Science – II	1	0	0	1	1
Generic Elective							
7	BOT142G201	GE-3: Mushroom Cultivation	2	0	2	3	4
8	BOT142G202	GE-4: Plant Ecology & Economic Botany	2	0	2	3	4
TOTAL CREDIT FOR THE SEMESTER			**18**	**0**	**16**	**26**	**36**
3RD SEMESTER							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	**BOT142C301**	Genetics	4	0	0	4	4
2	**BOT142C302**	Plant Ecology and phytogeography	4	0	0	4	4
3	**BOT144C313**	Practical III	0	0	8	4	8
Total credit for core papers						**12**	**16**
Ability Enhancement Compulsory Courses (AECC)							
4	**CEN982A301**	Communicative English - III	1	0	0	1	1

5	**EVS982A303**	Environmental Science	2	0	0	2	2
Ability Enhancement Elective Courses (AEEC)							
6		AEEC/SEC/-1*	2	0	0	2	2
Generic Elective							
7	BOT142G301	GE-5: Botany in Rural Communities	2	0	2	3	4
8	BOT142G302	GE-6: Nursery & Gardening	2	0	2	3	4
TOTAL CREDIT FOR THE SEMESTER			**17**	**0**	**12**	**23**	**29**
4TH SEMESTER							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	**BOT142C401**	Plant Systematics	5	0	0	5	5
2	**BOT142C402**	Reproductive Biology of Angiosperms	5	0	0	5	5
3	**BOT142C413**	Practical IV	0	0	8	4	8
Total credit for core papers						**14**	**18**
Ability Enhancement Compulsory Courses (AECC)							
4	**CEN982A401**	Communicative English - IV	1	0	0	1	1
Ability Enhancement Elective Courses (AEEC)							
5		AEEC/SEC/-2*	2	0	0	2	2
Generic Elective							
6	BOT142G401	GE-7: Medicinal Botany/ Environmental Biotechnology	2	0	2	3	4

7	BOT142G402	GE-8: Plant Ecology & Economic Botany	2	0	2	3	4
TOTAL CREDIT OF THE SEMESTER			**15**	**2**	**12**	**23**	**29**
5TH SEMESTER							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	BOT142C501	Plant Physiology	5	0	0	5	5
2	BOT142C502	Plant Metabolism	5	0	0	5	5
3	BOT142C513	Practical V	0	0	12	6	12
Total credit for core papers						**16**	**22**
Ability Enhancement Compulsory Courses (AECC)							
5	CEN982A501	Communicative English - V	1	0	0	1	1
Discipline Specific Elective (DSE) (Any One Theory To Be Selected)							
6	BOT142D501	Research Methodology	4	0	0	4	4
7	BOT142D502	Analytical techniques in plant science.	4	0	0	4	4
TOTAL CREDIT OF THE SEMESTER						**21**	**31**
6TH SEMESTER							
Sl.No.	**Subject Code**	**Names of subjects**	**L**	**T**	**P**	**C**	**TCP**
Core Subjects							
1	**BOT142C601**	Plant Biotechnology	6	0	0	6	6
2	**BOT142C602**	Molecular Biology	6	0	0	6	6

3	**BOT142C613**	Practical VI	0	0	12	6	12
Total credit for core papers						**18**	**24**
Ability Enhancement Compulsory Courses (AECC)							
4	**CEN982A501**	Communicative English - VI	1	0	0	1	1
Discipline Specific Elective (DSE) (Any Two Theory Paper Or Project Work To Be Selected)							
5	BOT142D601	Plant diversity and human welfare	4	1	0	5	5
6	BOT142D602	Industrial and environmental microbiology	4	1	0	5	5
	BOT142D603	Dendrology, Arboriculture and Agronomy	4	1	0	5	5
7	BOT142D621	Project work (Major)	0	0	30	10	30
TOTAL CREDIT OF THE SEMESTER						**29**	**55**
TOTAL CREDIT OF THE COURSE [26 (1^{st}) + 26(2^{nd}) + 23(3^{rd}) + 23(4^{th}) + 21 (5^{th}) +29 (6^{th})] = 148							

SCHEME OF EVALUATION

I. Theory Papers (T):

a. Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three)
b. Mid-term examination: 10%
c. Attendance: 5%
d. End term examination: 70%

II. Practical Papers (P):

a. Continuous evaluation: 25% (skill test, lab copy, practical viva, lab involvement/performance) (any five).
b. Attendance: 5%
c. End term examination: 70 %

III. Semester wise distribution of courses and credits:

Semester	No. of Core papers and total credit of core papers	No. of DSE papers and total credit of DSE papers	Project work credit	No. of AECC papers and credit	No. Of AEEC papers and credit	No. Of GE papers and credit	Total credit
1st	4, 18	0	0	2,2	0	2, 6	**26**
2nd	4,18	0	0	2,2	0	2, 6	**26**
3rd	3,12	0	0	2,2	1,2	2, 6	**23**
4th	3,14	0	0	1,1	1,2	2, 6	**23**
5th	3,12	1,6	6	1,1	0	0	**19**
6th	3,18	2, 12	12	1,1	0	0	**31**
Total							**148**

1ST SEMESTER

DETAILED SYLLABUS OF 1ST SEMESTER

Paper I: MICROBIOLOGY AND PHYCOLOGY,

Subject Code: BOT142C101, L-T-P-C: 4-0-0-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To introduce the students to the world of microbes focusing on the diversity of bacteria and viruses. To enable development of the basic concepts of the fundamental biological processes in bacteria and viruses. To provide an understanding of the economic aspects of bacteria. To introduce the range of diversity amongst the algae. To introduce the ecological roles and biotechnological importance of algae.	Lecture Presentation Assignment Individual/group presentation	The course shall enable the students to understand the physical dimensions, forms, functions and habitats of bacteria. The students shall be able to understand the structure of typical viruses, their mode of replication, host ranges of typical plant and animal viruses and pathogenesis of viral diseases. On completion of the course, the students shall become aware of the diversity of algae, the ecological role of algae and the biotechnological application of certain species of the group. The students shall gain hands on experience of bacterial culture in the laboratory.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End-term examination: 70%

Prerequisite: Basic knowledge of biology and chemistry up to class 12

Detailed Syllabus

Modules	Course content	Periods

I	**Introduction to microbial world**: Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).	**16**
II	**Viruses and Bacteria**: Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Bacteria: Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).	**16**
III	**Algae**: Algae: General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry. Economic importance of Algae.	**16**
IV	**Major Groups of Algae:** Cyanophyta and Xanthophyta: Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria.* Chlorophyta and Charophyta: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete, Chara.* Evolutionary significance of *Prochloron.* Phaeophyta and Rhodophyta: Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus, Fucus* and *Polysiphonia.*	**16**
Total		**64**

Text Books:

1. Pelczar, M.J. Microbiology. 2005.Tata McGraw-Hill Co, New Delhi
2. Lee, R.E. Phycology. 2018. Cambridge University Press, Cambridge
3. Wiley, J.M., Sherwood, L.M. and Woolverton C.J., Prescott. Microbiology. 2017. McGraw Hill International.
4. Brown A.E. and Smith H. Benson's Microbiological Applications: Laboratory Manual in General Microbiology.2016. McGraw-Hill Education.

Reference Books:

1. Tortora G.J., Funke B.R., Case C.L., Weber D and Bair W. Microbiology: An Introduction (13th Edition). 2018. Pearson Publisher.
2. Madigan M.T., Martinko J.M., Bender K.S., Buckley D.H., Stahl D.A., Brock T. Brock Biology of Microorganisms (14th Edition). 2014. Pearson Publisher.
3. Harvey R.A. and Cornelissen C.N. Lippincott Illustrated Reviews: Microbiology (Lippincott Illustrated Reviews Series) Third, North American Edition. 2012. LWW; Third, North American edition.

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Paper II: MYCOLOGY AND PHYTOPATHOLOGY

Subject Code: BOT142C102, L-T-P-C=4-0-0-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To introduce the students to the fungal diversity, various modes of fungal nutrition, their detailed taxonomy and life cycles, fungal	Lecture Presentation Assignment Individual/group presentation	The course shall equip the students with the understanding of the wide diversity of fungi, their nutritional and ecological variations and roles.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5%

associations like lichens and mycorrhiza., economic and biotechnological prospects of fungi To introduce various plant pathogens viz. bacterial, viral and fungal.		The learners shall gain an understanding of the symbiotic relation of some fungi. The course shall provide the basic understanding of plant pathology. The students shall be able to grasp the applications of mycology.	End term examination: 70%

Prerequisite: Basic knowledge of biology and chemistry up to class 12

Detailed Syllabus

Modules	Course content	Periods
I	**Introduction to fungi and their groups:** Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification. Chytridiomycetes: General account. Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus*. Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, *Alternaria*, *Neurospora*, and *Peziza*.	**16**
II	**Higher fungi:** Basidiomycota: General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation. **Allied Fungi:** General characterises; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies. Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora*, *Albugo.*	**16**
III	**Mutualism:** Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization. Nature of associations of algal and fungal partners. Reproduction. Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance. **Applied Mycology:** Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations);	**16**

	Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.	
IV	**Phytopathology**: Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology. Host-Pathogen relationships. Disease cycle and environmental relation. Prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.	**16**
Total		**64**

Text Books:

1. Singh R.S. Introduction To Principles Of Plant Pathology. 2018. Oxford Publisher.
2. Sharma P.D. Plant Pathology. 2013. Rastogi Publication, Meerut.
3. Agrios G.N. Plant pathology, (5^{th} edition). Academic Press 2005. San Deigo, London.
4. Alexopoulos and Mims. Introductory Mycology (4^{th} edition). 2007. Wiley India Pvt. Ltd.
5. Mehrotra R.S. Plant Pathology.2017. McGraw Hill Education.

Reference Books:

1. Sinclair W.A. and H.H.Lyon. Diseases of trees and shrubs. 2005. Cornell university press.
2. Webster J and Weber R.W.S. Introduction to fungi. 2007. Cambridge university press.
3. Lucas J.A. Plant Pathology and Plant Pathogens. 2011. John Wiley and Sons Ltd

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Paper III: BIO-MOLECULES AND CELL BIOLOGY,

Subject Code: BOT142C103, L-T-P-C= 4-0-0-4 Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To introduce the biomacromolecules and their specific attributes, explain the laws of thermodynamics in the context of bioenergetics	Lecture Presentation Assignment Individual/group presentation	The course shall equip the students with the understanding of various bonds involved in formation of biomolecules, their types and roles.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three)

in the biological reaction processes, give a comprehensive understanding of the structure, function and the mechanism of functions of enzymes, present cell structure and function in the evolutionary perspective of prokaryotes and eukaryotes.		The learner shall gain an understanding of laws of thermodynamics and enzyme kinetics. The course shall provide basic knowledge on cell and its organelles. The student will gain the basic concept of cell cycle and its regulation.	Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology and chemistry up to class 12

Detailed Syllabus

Modules	Course content	Periods
I	**Bio-molecules:** Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides. Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.	**16**
II	**Bioenergetics and enzymes:** Bioenergenetics: Laws of thermodynamics. Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.	**16**
III	**Cell**: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). Cell wall and plasma membrane: Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes.	**16**
IV	**Cellular organelles, nucleus and cell division**: Cell organelles: Structural organization and function of chloroplast, mitochondria, endoplasmic	**16**

	reticulum, Golgi Apparatus, Lysosomes and peroxisomes, semiautonomous nature of mitochondria and chloroplast. Nucleus: Structure, nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Cell division: Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.	
Total		**64**

Text Books:

1. Cooper G.M. and Hausman R.E. The Cell: A molecular approach.(7th edition). 2015. Oxford University Press.
2. Verma P.S. Cell Biology, Genetics, Molecular Biology.2015. S. Chand & Co Ltd. India.
3. Hardin J and Bertoni G.P. Becker's World of the Cell (9th Edition). 2015. Pearson Publishers.
4. Bruce et al. Molecular Biology of the Cell (7th Edition). 2014. Garland Science.
5. Bruce A. et al. Essential Cell Biology, 4th Edition. 2013. W. W. Norton & Company.

Reference Books:

1. Karp G. Cell Biology (7^{th} edition).2013. Wiley publications.
2. Lodish H, Berk A, Kaiser C.A. Molecular Cell Biology. 2007. W.H.Freeman & Co Ltd.

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Paper IV: PRACTICAL-I

Subject Code: BOT142C114, L-T-P-C=0-0-6-6, Credit Units: 06

STUDENTS SCHEME OF EVALUATION: Practical Only (P)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To introduce the students to the world of microbes by showing them live cultures and photographs of bacteria and viruses. To enable the students to have a hands-on experience	Hands on activity or Laboratory work	The course will help the students to gain practical knowledge of lower plants as well as fungi and other microbes. They will be equipped to identify plant diseases bases on symptoms.	Continuous evaluation: 25% (skill test, lab copy, practical viva, lab involvement/ performance) (any five). Attendance: 5% End term examination: 70 %

of observing algae and fungi under microscope		They will be able to identify cell structures under microscopes.	

Prerequisite: Basic knowledge of biology and chemistry up to class 12

Detailed Syllabus

Modules	Course content	Periods.
I	**Microbiology and Algae:** Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule. Gram staining. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas,* Volvox, *Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia,* temporary preparations and permanent slides (subject to availability, a minimum of 5 genera to be studied).	**12**
II	**Fungi**: Types of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps). Type study of *Saccharomyces, Rhizopus, Aspergillus, Penicillium*, *Neurospora, Peziza, Alternaria, Agaricus, Phythophthora, Albugo, Puccinia* (subject to availability, a minimum of 5 genera to be studied). Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs).	**12**
III	**Phytopathology:** Herbarium specimens/ photographs of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.	**12**
IV	**Biomolecules and cell biology:** Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum*. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf. Study different stages of mitosis and meiosis through photographs and live plant cells and flower buds.	**12**
Total		**48**

Text books:

1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
3. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
4. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3. 2011. S.Chand Publication.

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DETAILED SYLLABUS OF 2ND SEMESTER

Paper I: ARCHEGONIATAE

Subject Code: BOT142C201, L-T-P-C=4-0-0-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To introduce the students to the world of archegoniates and their evolutionary significance. To teach the students the major classes of bryophytes, their detailed taxonomy and their life cycles. To introduce the students to various groups of pteridophytes. To give an idea about the gymnosperms. To give a brief idea on economic importance of all archegoniates.	Lecture Presentation Assignment Individual/group presentation	The course will enable students to know the earlier plants, their vegetative and reproductive structures and their importance. The course shall equip the students with the understanding of evolutionary lines in each group of archegoniates. The learners shall gain an understanding of the various important features of the lower plants like stellar evolution and seed habit in pteridophytes. The student will have a clear concept on ecological importance of the archegoniates.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	**Introduction to archegoniates**: Unifying features of archegoniates. Transition to land habit and its evolutionary significance. Alternation of generations.	**10**
II	**Bryophytes:** Bryophytes: General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Photosynthetic tissues. Type Studies: Classification (up to family), morphology, anatomy and reproduction, evolutionary trends of *Riccia, Marchantia, Anthoceros, Sphagnum and Funaria*. Ecological and economic importance of bryophytes.	**19**

III	**Pteridophytes:** Pteridophytes: General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*). Type Studies: Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum, Marsilea* and *Pteris*. Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution. Ecological and economic importance of pteridophytes.	**19**
IV	**Gymnosperms:** Gymnosperms: General characteristics. Classification (up to family). Morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*. Ecological and economic importance of gymnosperms.	**16**
Total		**64**

Text Books:

1. A.V.S.S. Sambamurty. A Textbook Of Bryophytes, Pteridophytes, Gymnosperms And Paleobotany. 2006. I.K. International Publishing House Pvt. Ltd.
2. C.J. Chamberlain. Gymnosperms: Structure And Evolution. 2009. Andesite Press.
3. W.N. Stewart and G.W. Rothwell. Paleobotany and the evolution of plants. 2010. Cambridge University Press.
4. J. M. Coulter, C.J.Chamberlain. Morphology Of Gymnosperms. 2016. Wentworth Publishers.
5. A. K. Thakur et al. Biodiversity (Microbes, Algae, Fungi & Archegoniates) (3rd Edition).2018. S. Dinesh and Co publisher.
6. G. M. Smith. Cryptogamic botany. 1955. Mcgraw-hill (available online).

Reference Books:

1. R.S. Chopra. Taxonomy of Indian mosses: an introduction. 2009. Publications & Information Directorate, CSIR, New Delhi.
2. A Manual Of Cryptogamic Botany: Adapted To The Requirements Of The Science And Art Department (Classic Reprint). 2018. Charlotte M. W. Ross. Forgotten Books Publisher.

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Paper II: PLANT ANATOMY

Subject Code: BOT142C202, L-T-P-C=4-0-0-4, Credit Units:04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To acquaint the students about the various tissues of the plant. To enable the students to understand the development and functions of various tissue systems inside the plant body. To introduce the concept of secondary growth of plants. To introduce the special types of anatomical adaptations in xerophytes and hydrophytes.	Lecture Presentation Assignment Individual/group presentation	The course will enable students to know about the different tissue systems in angiosperms and how they function. The students will get a concept on different developmental theories of root and shoot development. The students will get a concept on different types of woods developed in plant body. The learners shall gain an idea of dendrochronology and anatomical adaptations.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	**Introduction and organization of plant body:** Applications of plant anatomy in systematics, forensics and pharmacognosy. Internal organization of plant body: The three tissue systems, types of cells and tissues. Tissues: Classification of tissues; Simple and complex tissues. Pits and plasmodesmata; Wall ingrowths and transfer cells. Ergastic substances. Hydathodes, lenticels, cavities, lithocysts and laticifers.	**18**

II	**Meristems, vascular system and structure of root, stem and leaves:** Apical meristems: Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation). Types of vascular bundles. Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Quiescent centre; Root cap. Structure of dicot and monocot root. Endodermis, exodermis and origin of lateral root.	**18**
III	**Secondary growth:** Vascular Cambium and Wood: Structure, function and seasonal activity of cambium. Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma. Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses. Dendrochronology. Development and composition of periderm.	**18**
IV	**Specialised anatomical structures:** Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification).Anatomical adaptations of xerophytes and hydrophytes.	**10**
Total		**64**

Text Book:

1. Evert, R.F.. Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. 2006. John Wiley and Sons, Inc.
2. Annie Ragland. Fundamentals Of Plant Anatomy And Microtechniques. 2016. Saras Publication.
3. Katherine Esau .Anatomy Of Seed Plants. 2006. Wiley Publications.
4. B.P.Pandey. Plant Anatomy. 2001. S.Chand Publication.

Reference Books:

1. Charles B. Beck. An introduction to plant structure and development (plant anatomy for 21st century). (2nd edition). 2010. Cambridge University Press.
2. James D. Mauseth. Plant Anatomy. 2008. The Blackburn Press.
3. William Chase Stevens. Plant Anatomy From The Standpoint Of The Development And Functions Of The Tissues: And Handbook Of Micro-Technic. 2012. Wentworth Press.

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Paper III: ECONOMIC BOTANY

Subject Code: BOT142C203, L-T-P-C= 4-0-0-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To enable the students to have an understanding on how cultivated plants originated and how they are introduced across the world. To impart a brief idea on various methods used for extraction of various plant products like rubber. To introduce the students to various uses of plants in day to day life. To provide an understanding of the economic aspects of various plants.	Lecture Presentation Assignment Individual/group presentation	The course will enable students to understand how plants influence day to day life. The course will help the students to have a brief idea on different types of plants used for economic purposes. The course will help the students to have a brief idea on industrial application of different plant parts for economic purposes.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	**Introduction, origin, cereals and legumes:** Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity. Cereals: Wheat and Rice (origin, morphology, processing & uses). Brief account of millets. Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.	**18**

II	**Sugars, starches, spices and beverages**: Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses. Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper. Beverages: Tea, Coffee (morphology, processing & uses)	**18**
III	**Oils and fats and rubber**: Sources of oils and fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses. Natural Rubber: Para-rubber: tapping, processing and uses.	**14**
IV	**Medicinal, timber and fiber plants**: Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to C*inchona*, *Digitalis*, *Papaver*, *Swvertia*, *Andrographis* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards). Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).	**14**
Total		**64**

Text Book:

1. Kochhar, S.L. *Economic Botany in Tropics*, 2012. MacMillan & Co. New Delhi, India.
2. Kochhar, S.L. Economic Botany:a compresenhive study.2016. Cambridge University Press.
3. R.L. Prasad. Essentials Of Economic Botany. 2016. Medtech.
4. A.V.S.S.Sambamurty And N.S.Subrahmanyam. A Textbook Of Modern Economic Botany. 2008. CBS Publisher.

Reference Books:

1. Harlan, J.R. Crops and Man. 2nd ed. 1992.Madison W D: American Society of Agronomy.
2. Chrispeels, M.J. and Sadava, D.E. Plants, Genes and Agriculture. 1994. Jones & Bartlett Publishers.
3. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

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Paper IV: PRACTICAL-II

Subject Code: BOT142C214, L-T-P-C= 0-0-12-6, Credit Units: 06

STUDENTS SCHEME OF EVALUATION: Practical Only (P)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To impart practical knowledge on various group of archegoniates, have a clear concept on cellular structure of plants by microscopic observation, have a hands on experience on economically important plant parts used and do microchemical tests to observe the molecules present there.	Hands on activity or Laboratory work	The course will help the students to gain practical knowledge of vascular plants. They will be equipped to identify various anatomical structures of plant body. They will be able to identify economic importance of various plants.	Continuous evaluation: 25% (skill test, lab copy, practical viva, lab involvement/ performance) (any five). Attendance: 5% End term examination: 70 %

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	**Bryophytes:** Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides) of ***Riccia, Marchantia***, ***Anthoceros***, ***Sphagnum***, ***Funaria.***	**12**

II	**Pteridophytes and Gymnosperms:** ***Psilotum***- Study of specimen, transverse section of synangium (permanent slide). - Morphology, whole mount of leaf, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide) of ***Selaginella, Equisetum***, ***Pteris***, ***Pinus***, ***Gnetum***.	**12**
III	**Plant anatomy**: Study of anatomical details through permanent slides/temporary stain mounts/ macerations/museum specimens/microphotographs with the help of suitable examples. Apical meristem of root, shoot and vascular cambium. Distribution and types of parenchyma, collenchyma and sclerenchyma. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres. Epidermal system: cell types, stomata types; trichomes: non glandular and glandular. Root: monocot, dicot, Stem: monocot, dicot, lenticels. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy). Adaptive Anatomy: xerophytes, hydrophytes. Secretory tissues: cavities, lithocysts and laticifers.	**12**
IV	**Economic botany : Cereals**: Wheat, Rice **Legumes**: Soybean, Groundnut, **Sources of sugars and starches**: Sugarcane , Potato **Spices:** Black pepper and Clove (habit and sections). **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans). **Sources of oils and fats**: Coconut, Mustard, **Essential oil-yielding plants**: Habit sketch of *Santalum* and *Eucalyptus* (specimens/photographs). **Rubber**: specimen, photograph/model of tapping, samples of rubber products. **Drug-yielding plants**: Specimens of *Digitalis* and *Cannabis.* **Tobacco**: specimen and products of Tobacco. **Woods:** *Tectona*, *Pinus*: Specimen, Section of young stem. **Fiber-yielding plants**: Cotton , Jute	**12**
Total		**48**

1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
3. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
4. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3.2011. S.Chand Publication.

DETAILED SYLLABUS OF 3RD SEMESTER

Paper I: GENETICS

Subject Code: BOT142C301, L-T-P-C= 4-0=0=4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To acquaint the students about the basics of plant genetics and heredity. To introduce the students to various laws of Mendelism. To give a brief idea about the linkage-crossing over. To give an idea about the different types of inheritance. To impart basic knowledge on mutations and chromosomal aberrations.	Lecture Presentation Assignment Individual/group presentation	The course will enable students to understand how plants inherit characters. The students will gather knowledge on different types of inheritance. The students will have a concept on gene structure.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	**Mendelism and Quantitative inheritance:** Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance: Concept, mechanism, examples. Monogenic vs polygenic Inheritance.	**16**

II	**Extrachromosomal Inheritance and Linkage and crossing over:** Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity-Kappa particles in Paramecium. Sex-determination and Sex-linked Inheritance. Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses.Crossing over: concept and significance, cytological proof of crossing over.	**16**
III	**Mutations and Chromosomal Aberrations:** Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy. Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.	**16**
IV	**Fine structure of gene and population and evolutionary genetics:** Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism. Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.	**16**
Total		**64**

Text Book:

1. Gupta P.K. Cytogenetics. 2019. Rastogi Publications, Meerut.
2. Klug, W.S., Cummings .Spencer M.R.C.A, M.A. Palladino. Essentials Of Genetics. 2019. Pearson Education India.
3. Gardner, E.J., Simmons, M.J., Snustad, D.P. VIII ed. Principles of Genetics. 2008. Wiley India.
4. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. 2009. John Wiley and Sons Inc.
5. Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. XI Edition. 2009. Benjamin Cummings.

Reference Books:

1. Ayden Llyod. Essentials of Genetics. 2017. Larsen and Keller Education.
2. James D.Watson. Molecular Biology Of The Gene. 2013. Pearson Education India..
3. Russell P.J. iGenetics A Molecular Approach. 2016. Pearson Education India.

Paper II: PLANT ECOLOGY AND PHYTOGEOGRAPHY

Subject Code: BOT142C302, L-T-P-C=4-0-0-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To acquaint the students about environment and plant interactions. To give a concept on various plant communities and community succession in a particular habitat. To impart the basic concept on biogeography. To introduce traditional knowledge in botany.	Lecture Presentation Assignment Individual/group presentation	The course will enable students to understand how plants interact with their environment. The course will enable the students to have a clear understanding of concepts of phytogeography and endemism. The course will give a brief knowledge on traditional uses of plants.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	**Ecological factors**: Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors. Shelford law of tolerance. Biotic interactions (2 lectures) Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. Adaptation of hydrophytes and xerophytes.	**16**

II	**Plant communities and ecosystem**; Biotic interactions: Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. Ecotone and edge effect. Succession; Processes and types. Ecosystem Structure; energy flow Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous.	**16**
III	**Phytogeography and ecological niche**: Principle biogeographical zones; Endemism. Definition; Characteristics and Dynamics of Population. Ecological Speciation; Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic.	**16**
IV	**Ethnobotany**: Ethnobotany in India: Methods to study ethnobotany. Applications of Ethnobotany: National interacts. Palaeo-ethnobotany. Folk medicines of ethnobotany, ethnomedicine, ethnoecology. Ethnic communities of India. Application of natural products to certain diseases-Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.	**16**
Total		**64**

Text Book:

1. Eugene Odum. Fundamentals Of Ecology. 2005. Cengage
2. Ambasht R.S. Text Book of Plant Ecology. 2008. CBS Publisher.
3. Ashby M. Introduction to Plant Ecology. 1969. McMilla Co, Ltd, New York.(Available in Amazon)
4. Thomas William Woodhead. The Study of Plants: An Introduction To Botany And Plant Ecology. 2018. Wentworth Press. (Forgotten books Publisher)
5. Sharma, P.D. Ecology and Environment. 2017. Rastogi Publications, Meerut.
6. Wilkinson, D.M. Fundamental Processes in Ecology. An Earth System Approach.2006. Oxford.
7. Kumar Umesh. Ecology and Plant Geography. 2018. Amiga Press Inc.
8. Juniper Tony. The Ecology Book: Big ideas simply explained. 2019. Dorling Kindersley Publishing Incorporated.

Reference Books:

1. F. Stuart Chapin, Pamela A. Matson , Peter M. Vitousek , M. C. Chapin. Principles of Terrestrial Ecosystem Ecology. 2011. Springer-Verlag New York Inc.
2. Jessica Gurevitch , Gordon A. Fox. Ecology of Plants. 2006. Oxford University Press Inc
3. Grant V. Diversity in Plant Speciation. 1981. Columbia University Press.

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Paper III: PRACTICAL-III

Subject Code: BOT142C314, L-T-P-C= 0-0-8-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Practical Only (P)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To impart practical knowledge on various principles of genetics, give a idea on different cytological techniques, special chromosomes. To give a brief idea on the ecological processes in the environment.	Hands on activity or Laboratory work	The course will help the students to gain practical knowledge of cell cycle, special chromosomes etc. They will be equipped to understand different ecological processes as well interactions.	Continuous evaluation: 25% (skill test, lab copy, practical viva, lab involvement/ performance) (any five). Attendance: 5% End term examination: 70 %

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	1. Study of cell division – Mitosis in onion root tips (Squash method). 2. Study of cell division – Meiosis in *Rheo discolour* or *Allium Cepa* or any available material/flower buds (Smear method). 3. Cytological technique of making (Mitosis and Meiosis) permanent slides. 4. Observation of polythene and lamp brush chromosomes (Permanent slides). 5. Genetics problems based on theory syllabus – monohybrid, dihybrid, test cross and interaction of factors.	**20**

II	1. Study of ecological adaptations – (morphological and anatomical) Hydrophytes, Xerophytes, Halophytes and Epiphytes (2 each). 2. Analysis of water samples for pH, Chloride, CO2, Dissolved Oxygen and total hardness. 3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed)	**10**
III	1. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 2. Study of biotic interactions of the following: Stem parasite, Root parasite, Epiphytes, Predation (Insectivorous plants)	**10**
IV	1. Trip to nearby forest at least for 3 days to study the vegetation and submit a report. 2. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 3. Visit to a pond / forest to study communities.	**08**
Total		**48**

Text Books:

1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
3. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
4. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3.2011. S.Chand Publication.

DETAILED SYLLABUS OF 4TH SEMESTER

Paper I: PLANT SYSTEMATICS

Subject Code: BOT142C401, L-T-P-C=4-1-0-5, Credit Units: 05

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To introduce the techniques of plant identification. To acquaint the students to various techniques of herbarium making. To introduce the students to various families of angiosperms through study of type specimen. To provide the students with a basic concept on angiosperm evolution.	Lecture Presentation Assignment Individual/group presentation	The course will enable students to understand the classification of plants. The student will have a practical knowledge on the different types of families of angiosperms. The student can understand the evolutionary changes in angiosperms. The students can have hands on experience on how to observe local vegetation and make herbaria from nearby local vegetation.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	**Significance of Plant systematic**: Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys:Single access and Multi-access. Concept of taxa (family, genus, species);	**22**

	Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.	
II	**Systems of classification**: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist. Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series). Brief reference of Angiosperm Phylogeny Group (APG III) classification. Biometrics, numerical taxonomy and cladistics Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).	**18**
III	**Family studies**: Affinities, phylogeny, economic importance and comparative studies of the following families: Magnoliaceae, Fabaceae, Malvaceae, Euphorbiaceae, Solanaceae, Verbenaceae, Lamiaceae, Rubiaceae, Cucurbitaceae, Asteraceae. Arecaceae, Poaceae, Musaceae, Zingiberaceae, Liliaceae, Orchidaceae	**24**
IV	**Phylogeny of Angiosperms**: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and pollinators. Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	**16**
Total		**80**

Text Book:

1. Singh G. Plant Systematics: Theory and Practice. 2012. Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
2. Verma B.K.2011. Taxonomy of Angiosperms.
3. Stussy, T.F. 1990. Plant Taxonomy, Columbia University Press, USA.
4. Dutta S.C. Systematic Botany.2018. New Age International Private Limited.
5. Sharma O.P. Plant taxonomy. 2017. McGraw Hill Education.
6. Baruah A. Plant taxonomy. 2013. EBH Publishers.

7. Ragland A and Kumaresan V. Morphology of Angiosperm, Taxonomy and Economic Botany. 2018. Saras Publication.

Reference Books:

1. Simpson M. Plant sytematics (3rd edition).2019.Academic Press.
2. Mabberly D.J. The plant-book: A portable dictionary of the vascular plants.1997. Cambridge University Press.

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Paper II: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Subject Code: BOT142C402, L-T-P-C= 4-1-0-5, Credit Units: 05

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To acquaint the students about the development of flower. To introduce the students to various stages of development of male and female gametophytes. To introduce the students to various stages of fertilization. To introduce the students to various incompatibilities.	Lecture Presentation Assignment Individual/group presentation	The course will enable students to understand the process of fertilization. The student will get the basic concept of double fertilization and its significance. The students will have an idea on types of ovules and pollen grains belonging to different families of angiosperms. The students will undertand the developmental stages of an embryo and this knowledge can be later on used for plant tissue culture.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods

I	**Reproductive development**: Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects. Anther and pollen biology Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system. Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination. Abnormal features: Pseudomonads, polyads, massulae, pollinia. Scope and process of palynology.	**20**
II	**Ovule Structure, pollination and double fertilization**: Ovule Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase. Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type). Organization and ultrastructure of mature embryo sac. Pollination and fertilization Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil. Double fertilization.	**20**
III	**Self incompatibility**: Self incompatibility Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI). Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination. Intra-ovarian and in vitro pollination. Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization.	**20**
IV	**Embryo, Endosperm and Seed Structure and types:** General pattern of development of dicot and monocot embryo and endosperm. Suspensor: structure and functions; Embryo-endosperm relationship, Nutrition of embryo. Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms. Polyembryony and apomixes: Introduction; Classification; Causes and applications.	**20**
Total		**80**

Text Book:

1. Bhojwani, S.S. and Bhatnagar, S.P. (2014). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. Pollen Biology and Biotechnology. 2003. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Pandey B.P. Embryology of Angiosperm. 2017. Rastogi publication, Meerut.
4. Raghavan, V. Developmental Biology of Flowering plants. 2000. Springer, Netherlands.
5. Raghavan, V. Molecular embryology of flowering plants. 1997. Cambridge, University Press.
6. Johri, B.M. Reproductive biology of Angiosperms. 2012. Springer-Verlag, Netherlands
7. Johri, B.M. Embryology of Angiosperms. 2015. Springer-Verlag, Netherlands.

Reference Book:

1. Went van J.L. Fertilization in Angiosperm plants. 1992. Springer-Verlag, Netherlands. (Research paper)
2. Haig D and Westoby M. Seed size, pollination costs and angiosperm success.1991. Springer-Verlag, Netherlands. (Research Paper).

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Paper III: PRACTICAL-IV

Subject Code: BOT142C414, L-T-P-C= 0-0-8-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Practical Only (P)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To impart practical knowledge on various families of angiosperms. To give a brief idea on the various reproductive structures of angiosperm flowers.	Hands on activity or Laboratory work	The course will help the students to gain on field knowledge of identifying various plants. They will be equipped to understand different reproductive structures and processes of angiosperms.	Continuous evaluation: 25% (skill test, lab copy, practical viva, lab involvement/ performance) (any five). Attendance: 5% End term examination: 70 %

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	Study of vegetative and floral characters of the families studied in the theory and which are locally available (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).	**12**
II	Field visit (local). Mounting of 5 properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book). Preparation of virtual/digital herbarium.	**12**
III	Anther: types and stages of development. Tapetum (amoeboid and glandular); MMC, spore tetrads (slides/photographs, fresh material). Uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test. Germination: Calculation of percentage germination in different media using hanging drop method.	**12**
IV	Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus. Endosperm: types of endosperm with the help of photographs. Embryogenesis: Study of development of dicot embryo through permanent slides; Study of suspensor through photographs.	**12**
Total		**48**

Text Books:

a. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
b. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
c. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.
d. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3.2011. S.Chand Publication

DETAILED SYLLABUS OF 5TH SEMESTER

Paper I: PLANT PHYSIOLOGY

Subject Code: BOT142C501, L-T-P-C=4-0-0-4, Credit Units:04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To acquaint the students with the various physiological processes inside the plant body. To make them understand the important life processes of plants. To help them understand the functions of various hormones as well as pigments present in plants.	Lecture Presentation Assignment Individual/group presentation	The students will have a concept on different physiological processes of plants on completion of this course. They will gain ideas on different factors effecting the physiological process.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course Contents	Periods
I	**Plant-water relations**: Plant-water relations: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement. Symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, anti transpirants, mechanism of stomatal movement.	**16**

II	**Mineral nutrition**: Mineral nutrition: Essential and beneficial elements, macro and micronutrients. Methods of study and use of nutrient solutions, criteria for essentiality. Mineral deficiency symptoms, roles of essential elements, chelating agents. Nutrient Uptake. Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport. Translocation in the phloem :Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship	**16**
III	**Plant growth regulators**: Plant growth regulators (Discovery, chemical nature (basic structure). Bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.	**16**
IV	**Physiology of flowering**; Photoperiodism, flowering stimulus, florigen concept, Vernalization. Seed dormancy. Phytochrome , cryptochromes and phototropins. Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.	**16**
Total		**64**

TEXT BOOKS:

1. Hopkins, W.G. and Huner, A. Introduction to Plant Physiology. 2008. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A. Plant Physiology and Development. 2015. Sinauer Associates Inc. USA. 6th edition.
3. Dennis D. T., Turpin, D. H. LefebvreD. D. and LayzellD. B.(eds)(1997).Plant Metabolism (Second Edition) Longman, Essex, England.
4. Willium G Hopkins, Norman P Hunar. Introduction To Plant Physiology. 2009. Wiley.
5. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Reference Books

6. Buchanan B.B, Gruissem W. and Jones R. L. Biochemistry and Molecular Biology of Plants. 2000. American Society of Plant Physiologists, Maryland,USA.
7. Hopkins, W.G., Huner, N.P. Introduction to Plant Physiology. 2009. John Wiley & Sons, U.S.A. 4th Edition.
8. Bajracharya, D. Experiments in Plant Physiology- A Laboratory Manual. 1999. Narosa Publishing House, New Delhi.

Paper II: PLANT METABOLISM

Subject Code: BOT142C502, L-T-P-C=4-0-0-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
The students will develop the basic concept of metabolic processes in the plant body. The students will have an idea regarding role of enzymes in the metabolism. The students will have a basic idea about different cycles like TCA inside the plant body.	Lecture Presentation Assignment Individual/group presentation	The students will have a concept on different metabolism of plants on completion of this course. They will gain ideas on various metabolic cycles and factors affecting them.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course Contents	Periods

I	**Concept of metabolism**: Introduction, anabolic and catabolic pathways, regulation of metabolism. Role of regulatory enzymes (allosteric ,covalent modulation and Isozymes). Carbon assimilation Historical background, photosynthetic pigments. Role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction. Photorespiration, C4pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction. Carbohydrate metabolism Synthesis and catabolism of sucrose and starch.	**18**
II	**Metabolic pathways**: Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis. Oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle. TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration. ATP-Synthesis Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.	**18**
III	**Metabolic pathways**: Lipid metabolism: Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation. Nitrogen metabolism Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.	**18**
IV	**Signal transduction**: Mechanisms of signal transduction: Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.	**10**
Total		**64**

TEXT BOOKS:

1. Hopkins, W.G. and Huner, A. Introduction to Plant Physiology. 2008. John Wiley and Sons. U.S.A. 4th edition.

2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

3. Harborne, J.B. Phytochemical Methods. 1973. John Wiley & Sons. New York.

4. Kumar H.D. and Singh H.N. Plant metabolism. 1980. MacMillan Education.

5. Sriram G. Plant metabolism- Methods and Protocols. 2014. Springer-Varlegh.

Reference Books

1. Buchanan B.B, Gruissem W. and Jones R. L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland,USA.
2. Ashihara H *et al*. Plant metabolism and biotechnology. 2011. John Wiley and Sons, Ltd.

Paper III: PRACTICAL-V

Subject Code: BOT142C514, L-T-P-C= 0-0-8-4, Credit Units: 04

STUDENTS SCHEME OF EVALUATION: Practical Only (P)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To impart practical knowledge on various physiological and metabolic processes of plants.	Hands on activity or Laboratory work	The course will help the students to gain knowledge on metabolism of plants. They will be equipped to understand different physiological processes of angiosperms through laboratory experiments.	Continuous evaluation: 25% (skill test, lab copy, practical viva, lab involvement/ performance) (any five). Attendance: 5% End term examination: 70 %

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods

I	Determination of osmotic potential of plant cell sap by plasmolytic method. Determination of water potential of given tissue (potato tuber) by weight method. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf. Study the induction of amylase activity in germinating barley grains. Demonstration of suction due to transpiration. Demonstration of fruit ripening/Rooting from cuttings.	**12**
II	Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces). To study the phenomenon of seed germination (effect of light). To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay).	**12**
III	Chemical separation of photosynthetic pigments. Experimental demonstration of Hill's reaction. To study the effect of light intensity on the rate of photosynthesis. Effect of carbon dioxide on the rate of photosynthesis.	**12**
IV	To compare the rate of respiration in different parts of a plant. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination. Demonstration of fluorescence by isolated chlorophyll pigments. Demonstration of absorption spectrum of photosynthetic pigments	**12**
Total		**48**

Text Books:

a. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
b. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
c. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.

d. Pandey.B.P. Modern Practical Botany Vol. 1, 2, 3.2011. S.Chand Publication

DISCIPLINE SPECIFIC PAPERS (ONLY ONE TO BE SELECTED)

PAPER III: RESEARCH METHODOLOGY

SUBJECT CODE: BOT142D501, L-T-P-C= 4-0-4-6, CREDIT UNITS: 06

STUDENTS SCHEME OF EVALUATION: Theory and Practical (TP)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To make students understand the overall process of designing a research study from its inception to its report. To make them understand the way of writing various research article, papers and proposals. To acquaint them with the methods of data collection.	Lecture/ Presentation/ Assignment Individual/group presentation Laboratory work	To know how to identify a research problem Understand importance of educational research Understand basics of research design	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus:

Modules	Course content	Periods
I	**Research fundamentals and terminology**: Foundations of Research: Meaning, Objectives, Motivation, Utility and Understanding the language of research Concept, Construct, Definition, Variable. Concept of hypothesis, theory and scientific law. Difference between hypothesis, theory and scientific law. Formulation of hypothesis.	**16**
II	**Data collection:** Understand concepts of quantitative and qualitative data collection. Types of data and methods and techniques of data collection.	**16**

	Methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/ pilot study). Methods of secondary data collection (internal/ external), schedule method. Use of computers in data collection: Literature survey using web, handling search engines.	
III	**Data analysis:** Methods to analyze data and Elements of analysis in data processing. The different conventions for scholarly/ report writing. Experimental data collection and data processing, Processing operations, problems in processing. Software for data processing.	**16**
IV	**Report writing and presentation**: poster and oral presentations. Types of research reports, guidelines for writing a report, report format, appendices, project proposals. Miscellaneous information. Writing of review of literature.	**16**
Total		**64**

Practical:

1. Assignments on report writing.
2. Assignments on project proposal writing.
3. Assignments on review of literature.

Text Books:

1. C.R.Kothari . Research Methodology: Methods And Techniques. 2019. New Age Publ. Wiley Eastern,
2. P.S.G. Kumar (2004). Research methods and statistical techniques. B.R. publishing Academy, Udaypur.
3. Ranjit kumar. Research methodology: a step by step guide for beginners. 2019. Sage Publication.

Reference Books:

1. Select references from the Internet.
2. Wayne C. Booth *et al*. The craft of research. 2016. University of Chicago Press.

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PAPER IV: ANALYTICAL TECHNIQUES IN PLANT SCIENCE

SUBJECT CODE: BOT142D502, L-T-P-C-4-0-4-6, CREDIT UNITS: 06

STUDENTS SCHEME OF EVALUATION: Theory and Practical (TP)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
Help the students understand the use of major laboratory instruments. Help students understand the different techniques related to research. Acquaint the students about the use of biostatistics.	Lecture Presentation Assignment Individual/group presentation Laboratory work	The student will gain knowledge on new tools and techniques in involved in plant research. The course will make the student learn the different statistical tools in research. The course will help the students to make different types of herbaria.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus:

Modules	Course content	Periods
I	**Microscopy**: Principles of microscopy, different types of microscope. Basic of staining and imaging techniques. Basic microbiological techniques. Principles of spectrophotometry. pH, electrophoresis, AGE, PAGE, SDS-PAGE, centrifugation and chromatography. Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.	**16**
II	**Bioinformatics:** Basic of bioinformatics. Biological database, data search sequencing methods, fundamentals of computer programming, protein structure analysis.	**16**

III	**Biostatistics** : The scope of biostatistics; Exploration and presentation of data: (Scales of measurement, Tables, Graphs, Histograms, Box and Whisker plots, Frequency polygon, Scatter Plots). Measures of central tendency, Statistical software packages and their importance in data analysis	**16**
IV	**Herbarium techniques** - drying, poisoning, pressing, labeling, cataloging and preservation. Microtomy: Principles, sample preparation, block preparation, sectioning, staining and mounting.	**16**
Total		**64**

Practical:

1. Laboratory visit and field report.
2. Application of statistical knowledge to different research problems.

Text Books:

1. Attwood TK and Parry-Smith DJ (2004) Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
2. David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press, New Jersey, USA.

Reference Books:

1. Kulas JT (2008) SPSS Essential: Managing and Analyzing Social Science Data. John Wiley & Sons, New York.
2. Selected references from internet.

DETAILLED SYLLABUS OF 6TH SEMESTER

Paper I: Plant Biotechnology,

Subject Code: BOT142C601, L-T-P-C=4-2-0-6, Credit Units: 06

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To acquaint the students with various fields of biotechnology. To acquaint the students with techniques of plant tissue culture, R-DNA technology, gene cloning etc. To help the students to understand the various applications of plant biotechnology.	Lecture Presentation Assignment Individual/group presentation Laboratory work	The student will gain knowledge on various techniques of biotechnology and prepare for various fields of research. The student will also gain knowledge on applied aspects of biotechnology and can become ready for various biotechnology based companies.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus :

Modules	Course Contents	Periods
I	**Plant Tissue Culture**: Plant Tissue Culture: Historical perspective. Composition of media; Nutrient and hormone requirements (role of vitamins and hormones). Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite	**16**

	production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).	
II	**Recombinant DNA technology**: Restriction Endonucleases (History, Types I-IV, biological role and application). Restriction Mapping (Linear and Circular). Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).	**16**
III	**Gene Cloning and Recombinant DNA**: Bacterial Transformation and selection of recombinant clones. PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR Methods of gene transfer Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).	**16**
IV	**Applications of Biotechnology**: Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean). Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice). Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase). Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.	**16**
Total		**64**

TEXT BOOKS:

1. Bhojwani, S.S. and Razdan, M.K. Plant Tissue Culture: Theory and Practice. 2004. Elsevier Science Amsterdam. The Netherlands.

2. Glick, B.R., Pasternak, J.J. Molecular Biotechnology- Principles and Applications of recombinant DNA. 2003. ASM Press, Washington.

3. Slater A, Scott N and Fowler M. Plant Biotechnology. 2012. Oxford University Press.

4. Malik Z.A. Plant Biotechnology:Principles and applications.2017. Springer.

5. Singh B.D. Plant Biotechnology. 2014. Kalyani Publishers

Reference books:

References will be given based on latest research papers.

PAPER II: MOLECULAR BIOLOGY,

Subject Code: BOT142C602, L-T-P-C= 4-2-0-6, Credit Units: 06

STUDENTS SCHEME OF EVALUATION: Theory Only (T)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To impart knowledge on different types of hereditary material. To impart knowledge on replication of DNA upto molecular level. To give a brief idea on proteins and transcription.	Lecture Presentation Assignment Individual/group presentation Laboratory work	The course will 1. Strengthen the concepts on DNA replication, transcription etc. at molecular level. 2. Help the students to design experiments based on molecular level.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus:

Modules	Course Contents	Periods
I.	**Nucleic acids**: Nucleic acids: Carriers of genetic information Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment. The Structures of DNA and RNA (Genetic Material) DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA.Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses,	**16**

	Eukaryotes.RNA Structure. Organelle DNA -mitochondria and chloroplast DNA. The Nucleosome, Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.	
II	**Replication of DNA:** The replication of DNA Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome. Enzymes involved in DNA replication. Central dogma and genetic code. Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features).	**16**
III	**Transcription** : Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation.Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in E.coli. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.	**16**
IV	**Processing and modification of RNA**: Processing and modification of RNA Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport. Translation Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.	**16**
Total		**64**

TEXT BOOKS

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. Molecular Biology of the Gene. 2007. Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

2. Snustad, D.P. and Simmons, M.J. Principles of Genetics. 2010. John Wiley and Sons Inc., U.S.A. 5th edition.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. Concepts of Genetics. 2009. Benjamin Cummings. U.S.A. 9th edition.

4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. Introduction to Genetic Analysis. 2010. W. H. Freeman and Co., U.S.A. 10th edition.

5. Verma P and Agrwal P.K. Molecular Biology.2010. S.Chand Publication.

Refernce Books:

References will be given based on latest research papers.

Paper III: PRACTICAL-VI

Subject Code: BOT142C614, L-T-P-C= 0-0-12-6, Credit Units: 06

STUDENTS SCHEME OF EVALUATION: Practical Only (P)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
To impart practical knowledge to students on various techniques of DNA isolation, gene transfer etc. To give them the concept of in vitro sterilization, and various types of cultures done now a days for plant propagation.	Hands on activity or Laboratory work	The student will have a hand on knowledge of laboratory techniques required for biotechnology based processes. They will gather latest knowledge on GM crops, DNA replication etc.	Continuous evaluation: 25% (skill test, lab copy, practical viva, lab involvement/ performance) (any five). Attendance: 5% End term examination: 70 %

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus

Modules	Course content	Periods
I	Preparation of LB medium, Preparation of MS medium and raising *E.Coli*., Isolation of genomic DNA from *E.Coli*., DNA isolation from cauliflower head, DNA estimation by diphenylamine reagent/UV Spectrophotometry. (All practicals to be done in laboratory subject to availability and use of educational videos for ready reference). Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication), Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs, Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)	**12**
II	Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura, Brassica* etc. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.	**12**
III	Construction of restriction map of circular and linear DNA from the data provided. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.	**12**
IV	Isolation of protoplasts, Isolation of plasmid DNA. Restriction digestion and gel electrophoresis of plasmid DNA. (All practicals to be done in laboratory subject to availability and use of educational videos for ready reference).	**12**
Total		**48**

Text Books:

a. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
b. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
c. Internet : https://www.biodiversitylibrary.org/item/90703#page/3/mode/1up.

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DISCIPLINE SPECIFIC PAPERS (TWO THEORY PAPERS OR PROJECT WORK TO BE SELECTED)

PAPER III: PLANT DIVERSITY AND HUMAN WELFARE

SUBJECT CODE: BOT142D601, L-T-P-C=4-0-4-6, CREDIT UNITS: 06

STUDENTS SCHEME OF EVALUATION: Theory and Practical (TP)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
The course has been designed to introduce the students to - Various diversity found in plant world. Impart traditional knowledge of plants. Application of plants in human society. .	Lecture Presentation Assignment Individual/group presentation Laboratory work	The student will gain knowledge on plant biodiversity and its scope. The course will make the student learn the management of plant diversity and role of various world organizations in this regard. The course will help the students to have an understanding of ethnobotany.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus:

Modules	Course content	Periods
I	Plant diversity and its scope: Genetic diversity, Species diversity, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity, Uses of plants, Uses of microbes. Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss.	**16**
II	Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information	**16**

	management and communication. Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, In situ and ex situ conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.	
III	Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses.	**16**
IV	Ethnic groups and their life styles. Medico-ethnobotanical resources in India with special reference to NE states. Socio-economy and other aspects of Ethnobotany with reference to: Food, Intoxicants and Beverages, Ropes and Binding Materials, Resins and Oils, Cosmetics, Ornamentals, Fodder, Medicinal and Aromatic properties. Medicinal and Aromatic plants-Abundance, conservation and utilization in respect to N.E. India,	**16**
Total		**64**

Practical (2 hours of practical per week):

1. Preparation of report on traditional plant knowledge.
2. Field visit to nearby areas and compilation of field notes and identification, field notes.
3. Visual and digital records and preparation of herbarium, especially of the following categories (1 each) – oils, medicines, food.

Text Books

1. Cotton C.M. (1997) Ethnobotany – Principles and applications. John Wiley and sons. Chichester. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale Pub. Ltd., London.
2. Jain S.K., (ed.) 1981. Glimpses of Indian Ethnobotany, Oxford and I B.H., New Delhi.
3. Jain S.K., 1995 Manual of Ethnobotany, Scientific Publishers, Jodhpur

Reference Books

1. Martin, G.J. 1996, Ethnobotany, A methods manual, Chapman & Hall, London.
2. Schultes, R.E. 1995. Ethnobotany, Chapman and Hall.

3. Krishnamurthy, K.V. A textbook of Biodiversity. 2004. Science Publishers Inc.,Enfield, New Hampshire, USA.

PAPER IV: INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY

SUBJECT CODE: BOT142D602, L-T-P-C= 4-0-4-6, CREDIT UNITS: 06

STUDENTS SCHEME OF EVALUATION: Theory and Practical (TP)

Course objective	Teaching-Learning Process	Learning Outcomes	Course evaluation
Help the students to understand the application of microbes in human society. Help the students give an idea about various techniques such as fermentation used in industries. Application of microbes in combating pollution.	Lecture Presentation Assignment Individual/group presentation Laboratory work	The student will gain knowledge on application of microbes in various industrial processes. The course will make the student learn the concept of biofuels and biopolymers. The course will help the students to deduce a relationship between renewable sources and microbial metabolism.	Continuous evaluation: 15% (assignment, class test, practical viva, seminar, quiz (any three) Mid-term examination: 10% Attendance: 5% End term examination: 70%

Prerequisite: Basic knowledge of biology of class XII.

Detailed Syllabus:

Modules	Course content	Periods
I	**Bioprocess Technology and Engineering**: Microbial growth kinetics- Batch culture, continuous culture, industrial applications of continuous culture processes, fed-batch culture. The isolation, preservation and improvement of industrially important and useful microorganisms. Industrial fermentation- typical media, media formulation, water, energy and carbon sources, nitrogen sources, minerals, vitamin sources, nutrient recycle, buffers, precursors and metabolic regulators, oxygen requirement.	**16**

II	**Microbial production of metabolites**: Microbial production of Primary and secondary metabolites. Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives. Microbial transformations: steroids and alkaloids production. Large scale production of recombinant molecules interferon, human proteins insulin, somatostatin, vaccines and anticancer agents.	**16**
III	**Biofuels and Biopolymers**; Biofuels (ethanol and methane) from organic residues; fuels from algae. Biopolymers and EPS, Bioplastics, Biosurfactants, effluent treatment, SCP	**16**
IV	**Renewable bioenergy using microorganisms** Methanogenesis, Methane production by anaerobic digestion of waste organic materials. Bioethanol and Biobutanol production by using microorganisms. Biohydrogen Generation, Microbial Fuel. Biodiesel from algae.	**16**
Total		**64**

Practical (2 hours of practical per week):

Seminar presentation based on the syllabus.

Text Books:

1. Casida L.E.J.R.Industrial Microbiology. 2019. New Age International Publishers.
2. Reed. G. Prescott & Dunn's Industrial Microbiology.2004. CBS Publishers.
3. Patel A.H. Industrial Microbiology. 2015. Laxmi Publications.
4. Buckley R.G. Environmental Microbiology.2016. CBS Publishing.
5. Ramesh K.V. Environmental Microbiology. 2019. Mjp Publishers

Reference Books:

Selected research papers from the internet will be given to study.