Kurukshetra University, Kurukshetra

Scheme of Examination and Syllabus
for
B.Sc. (Medical)

Subjects: Botany

under

Choice Based Credit System (CBCS)

Semester 1st to 6th

w.e.f. session 2020-21 in Phased Manner

Programme Outcomes (POs) for UG courses of Faculty of Life Sciences

1. To develop skills in graduate students to be able to acquire theoretical and practical knowledge in fundamentals of biology in respective disciplines of plants, animals, microbes and environment.
2. To inculcate ability to critically evaluate problems and apply lateral thinking and analytical skills for professional development.
3. To create awareness on ethical issues, good laboratory practices and biosafety.
4. To develop ability in youth for understanding basic scientific learning and effective communication skills.
5. To prepare youth for career in teaching, industry, government organizations and self reliant entrepreneurship.
6. To make students aware of natural resources and environment and its sustainable utilization.
7. To provide learning experience in students that instills deep interest in biological science for the benefit of society.

Programme Specific Outcomes (PSOs) for Botany subject of B.Sc. Medical

1. The students will be able to identify the various plants and compare the diagnostic characteristics of lower and higher groups of plants. This comparative approach will help the students to explain the evolution and degree of genetic diversity in plants.
2. The students will be able to explain the various biological processes in plants and how they are sustained and regulated at the cellular and molecular levels. Students will also be able to understand the ecology, development, and behavior of different forms of life.
3. The students will be able to describe and demonstrate the different experimental techniques and methods in various fields of plant sciences.
4. The students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses. Students will also learn team workmanship in order to serve the institutions, industry, and society efficiently.
5. The students will possess minimum standards of communication skills expected from a Botany graduate in the country. They will also become acritical thinker and acquire problem-solving capabilities.
6. This programme will help the students in finding career opportunities in higher education in the field of plant sciences and other entrepreneurship programmes.

Scheme of examination for B.Sc. Medical (General), Subject: Botany

Sem.	Type of paper/ Course	Paper code	Nomenclature of paper	Credits	Int. marks	Ext. marks	Total	Exam Duration (Hours)	Contact Hours per week
I	Core Course **Botany-I**	BOT-101	Biodiversity –I (Microbes, Algae, Fungi)	3	15	60	75	3	3
		BOT -102	Biodiversity-II (Archegoniate)	3	15	60	75	3	3
		BOT -103	Biodiversity –I (Microbes, Algae, Fungi) & Biodiversity-II (Archegoniate)- Practical	2	10	40	50	4	4
II	Core Course **Botany–II**	BOT -201	Plant Ecology	3	15	60	75	3	3
		BOT -202	Plant Taxonomy	3	15	60	75	3	3
		BOT -203	Plant Ecology & Plant Taxonomy - Practical	2	10	40	50	4	4
III	Core Course **Botany-III**	BOT -301	Plant Anatomy	3	15	60	75	3	3
		BOT -302	Plant Embryology	3	15	60	75	3	3
		BOT -303	Plant anatomy & Plant Embryology Practical	2	10	40	50	4	4
IV	Core Course **Botany-IV**	BOT -401	Plant Physiology	3	15	60	75	3	3
		BOT -402	Plant Metabolism	3	15	60	75	3	3
		BOT -403	Plant Physiology & Plant Metabolism- Practical	2	10	40	50	4	4
V	Discipline Specific Elective * **Botany- I**	**Option-I**							
		BOT-501	Economic Botany	2	10	40	50	3	2
		BOT-502	Plant Biotechnology	2	10	40	50	3	2
		BOT-503	Practical BOT-501 & BOT-502 **(Option- I)**	2	10	40	50	4	4
		Option-II							
		BOT-501	Cell Biology	2	10	40	50	3	2
		BOT-502	Molecular Biology	2	10	40	50	3	2

		BOT 503	Practical BOT-501 & BOT-502 **(Option- II)**	2	10	40	50	4	4
VI	Discipline Specific Elective***** **Botany- II**	**Option-I**							
		BOT-601	Genetics	2	10	40	50	3	2
		BOT-602	Plant Breeding	2	10	40	50	3	2
		BOT-603	Practical BOT-601 & BOT-602 (**Option- I)**	2	10	40	50	4	4
		Option-II							
		BOT-601	Research Methodology- I	2	10	40	50	3	2
		BOT-602	Research Methodology- II	2	10	40	50	3	2
		BOT-603	Practical BOT- 601& BOT-602 **(Option- II)**	2	10	40	50	4	4
Sem. IV-VI	Skill Enhance-ment Course-III****Botany**	BOT-S1 BOT-S2 BOT-S3 BOT-S4 BOT-S5	Nursery and Gardening / Bio-fertilizers / Intellectual Property Rights / Floriculture / Organic Farming	2	10	40	50	3	2

*Students have to opt one option/stream of DSE Botany either (I) or (II)
Formula for 20 per cent Internal Assessment (10 Percent on the basis of two hand written assignments, 5 percent on the basis of one class test and 5 percent on the basis of attendance of the student).
**SEC can be opted in any of the three semesters (IV-VI) as per feasibility and time table of College/Institution

Nomenclature of Papers- B.Sc. Medical (General), Subject: Botany

Semester	Type of paper/ Course	Paper code	Nomenclature of paper
I	Core Course **Botany-I**	BOT-101	Biodiversity - I (Microbes, Algae, Fungi)
		BOT -102	Biodiversity- II (Archegoniate)
		BOT -103	Biodiversity- I(Microbes, Algae, Fungi) & Biodiversity- II (Archegoniate)- Practical
II	Core Course **Botany–II**	BOT -201	Plant Ecology
		BOT -202	Plant Taxonomy
		BOT -203	Plant Ecology & Plant Taxonomy- Practical
III	Core Course **Botany-III**	BOT -301	Plant Anatomy
		BOT -302	Plant Embryology
		BOT -303	Plant Anatomy & Plant Embryology Practical
IV	Core Course **Botany-IV**	BOT -401	Plant Physiology
		BOT -402	Plant Metabolism
		BOT -403	Plant Physiology & Plant Metabolism- Practical
V	Discipline Specific Elective **Botany- I**	**Option-I**	
		BOT-501	Economic Botany
		BOT-502	Plant Biotechnology
		BOT-503 **(Option-I)**	Practical BOT-501 & BOT-502 **based on option- I**
		Option-II	
		BOT-501	Cell Biology
		BOT-502	Molecular Biology
		BOT 503 **(Option-II)**	Practical BOT-501 & BOT-502 **based on option- II**
VI	Discipline Specific Elective **Botany- II**	**Option-I**	
		BOT-601	Genetics
		BOT-602	Plant Breeding
		BOT-603 **(Option-I)**	Practical BOT-601 & BOT-602 **based on option- I**
		Option-II	
		BOT-601	Research Methodology- I
		BOT-602	Research Methodology- II
		BOT-603 **(Option-II)**	BOT-601 & BOT-602 **based on option- II**
Semester IV-VI	Skill Enhance-ment Course-III **Botany**	BOT- S1 BOT- S2 BOT- S3 BOT- S4 BOT- S5	Nursery and Gardening/ Bio-fertilizers/ Intellectual Property Rights/ Floriculture/ Organic Farming

SEMESTER-I
PAPER CODE: BOT- 101
BIODIVERSITY –I (MICROBES, ALGAE, FUNGI)

Internal Assessment: 15 Marks **External Marks: 60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type).Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: The objective of the course is to introduce students to the world of primary diversity of living systems.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 understand the general characters, economic importance and life-cycles of various groups of general microbes, algae and fungi.

CO2 learners will also be able to explain their impact on environment, human welfare androle in industries.

CO3 understanding the evolutionary significance of these organisms, in terms of phylogenetic implications on thallophyta.

Table -1: CO-PO matrix for the course Botany -101 (Biodiversity 1-Microbes, Algae, Fungi)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 101.1	3	---------	---------	2	2	1	2
BOT 101.2	2	---------	---------	2	2	3	3
BOT 101.3	2	---------	---------	1	2	1	1
Average	2.33	----------	---------	1.66	2.00	1.66	2.00

Table -1: CO-PSO matrix for the course Botany -101(Biodiversity 1-Microbes, Algae, Fungi)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 101.1	3	2	1	--------	2	3
BOT 101.2	1	3	3	--------	2	3
BOT 101.3	3	3	1	--------	--------	3
Average	2.33	2.66	1.66	------	1.33	3.00

UNIT-I

Bacteria: Structure, nutrition, reproduction and economic importance;

General account of cyanobacteria (with reference to *Nostoc*).

Algae: General characters, classificationupto classes (Lee 1980) and economic importance; Important features and life-history (excluding development) of *Volvox,* (Chlorophyceae), *Chara*(Charophyceae) *Vaucheria* (Xanthophyceae), *Ectocarpus* (Phaeophyceae) and *Polysiphonia* (Rhodophyceae).

UNIT-II

Viruses: General account of Viruses including structure of TMV and Bacteriophages.

Fungi: General characters, classification upto classes (Ainsworth 1971) and economic importance; important features and life-history of *Phytophthora* (Mastigomycotina), *Mucor* (Zygomycotina), *Penicillium* (Ascomycotina), *Puccinia* (Basidiomycotina), *Colletotrichum* (Deuteromycotina); General account of Lichens.

SUGGESTED READINGS

- Ahluwalia, A.S. (Ed.). Phycology: Principles, Processes and Applications. Daya Publishing House, New Delhi. 2003.
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
- Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA.8th edition.
- Dube, H.C. 1990. An Introduction to Fungi, Vikas Publishing House Pvt. Ltd., Delhi.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
- Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge.4th edition.
- Mehrotra,R.S.&Aneja,K.R.1990:AnintroductionofMycology,NewAgeInternationalPress,N.Delhi
- Mehrotra,R.S. and Aggarwal,Ashok (2013) Fundamentals of Plant Pathology, Tata McGraw-Hill Publishing company Ltd,New Delhi
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005).Biology. Tata McGraw Hill, Delhi.
- Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Sharma, O.P. 1992. Text Book of Thallophytes, McGraw Hill Publishing Co.
- Sharma, P.D. 1991. The Fungi. Rastogi& Co., Meerut.

- Smith, G.M. 1971. Cryptogamic Botany.Vol. I. Algae & Fungi. Tata McGraw Hill Publishing Co., New Delhi.
- Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
- Wiley J. M., Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

SEMESTER-I
PAPER CODE: BOT - 102
BIODIVERSITY-II (ARCHEGONIATE)

Internal Assessment: 15 Marks **External Marks: 60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type).Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: The objective of the course is to introduce students to the world of diversity exhibited by lower plants.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 understand the general characters, economic importance and life-cycles of various groups of Bryophytes and Pteridophytes.

CO2 explain their role in environment, human welfare and industrial applications.

CO3 understanding the evolutionary significance of these plants.

Table -2: CO-PO matrix for the course Botany -102(Biodiversity-II Archegoniate)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 102.1	3	---------	---------	1	2	2	1
BOT 102.2	2	---------	---------	3	1	1	1
BOT 102.3	1	---------	---------	-------	1	1	1
Average	2.00	------	-------	1.33	1.33	1.33	1.00

Table -2: CO-PSO matrix for the course Botany -102(Biodiversity-II Archegoniate)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 102.1	2	1	--------	-------	2	3
BOT 102.2	2	1	2	-------	2	3
BOT 102.3	2	2	1	1	2	2
Average	2.00	1.33	1.00	0.33	2.00	2.66

UNIT-I

Bryophyta: General characters, classification upto classes (Smith, 1935), alternation of generations, structure and reproduction (excluding development) of *Marchantia* (Hepaticopsida), *Anthoceros* (Anthocerotopsida), *Funaria* (Bryopsida).

Pteridophyta: General characters, classification upto classes (Proskauer1957), alternation of generations, structure and reproduction (excluding development) of *Rhynia* (Psilopsida)

UNIT-II

Pteridophyta: Structure and reproduction (excluding development) of *Selaginella* (Lycopsida), *Equisetum* (Sphenopsida) and *Pteris* (Pteropsida).

Gymnosperms-General characteristics, classification up to family (Smith 1955), morphology, anatomy and reproduction of *Cycas,Pinus and Ephedra* (developmental details not to be included); Ecological and economic importance.

SUGGESTED READINGS

- Bhatnagar, S.P. &Moitra, A. (1996).Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA.8th edition.
- Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
- Puri, P., 1980, Bryophyta, Atma Ram & Sons, Delhi.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. 2005.Biology. Tata McGraw Hill, Delhi.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., 2005. Biology. Tata McGraw Hill, Delhi, India.
- Sharma, O.P. 1990. Text Book of Pteridophyta, McMillan India Ltd.
- Sharma, O.P. 1992. Text Book of Thallophytes, McGraw Hill Publishing Co.
- Smith, G.M. 1971. Cryptogamic Botany, Vol.II, Bryophytes & Pteridophytes. Tata McGraw Hill Publishing Co., New Delhi.
- Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
- Vanderpoorten, A. &Goffinet, B. (2009) Introduction to Bryophytes.Cambridge University Press.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India

SEMESTER-I

PAPER CODE: BOT- 103
BIODIVERSITY–I (MICROBES, ALGAE, FUNGI) & BIODIVERSITY-II (ARCHEGONIATES)-PRACTICAL

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**

Credits: 2 **Time: 4 Hours**

1. Identify, classify and write short morphological notes giving well labeled relevant diagrams on the given specimens A, B, C, D& E (one each from Algae, Fungi, Bryophytes, Pteridophytes & Gymnosperms). 15

2. Identify, giving two important characters of identification, the spots 1, 2, 3, 4& 5 (one slide or material each from Algae, Fungi, Bryophytes Pteridophytes& Gymnosperms). 10

3. Write short note on given chart/Photograph/Specimen 6 & 7 (one from Viruses/Bacteria & one from Cyanobacteria/ Lichen) 3

4. Note-book 4

5. Collection and collection report. 4

6. Viva-voce. 4

List of Practicals

- **Viruses**: EMs/Models of viruses: T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycles.
- **Bacteria**: Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; BinaryFission; Conjugation; Structure of root nodule.
- **Cynobacteria&Algae**: Study of vegetative and reproductive structures of *Nostoc*, *Volvox*, *Chara*, *Vaucheria*, *Ectocarpus* and *Polysiphonia* through temporarypreparations and permanent slides.
- **Fungi**: Study of vegetative & reproductive structures of *Phytophthora*, *Mucor*, *Puccinia*, *Penicillium*&*Colletotrichum*: Asexual and sexual stagesthrough temporarypreparations and permanent slides.
- **Lichens**: Study of growth forms of lichens (crustose, foliose and fruticose)
- ***Marchantia***- Morphology of thallus, W.M. rhizoids and scales, V.S. thallus with gemma cup,W.M. gemmae, V.S. antheridiophore, archegoniophore, L.S. sporophyte (temporary/permanent slides).
- ***Anthoceros***- Morphology of thallus, W.M. rhizoids, V.S. thallus, VS Antheridia and Archegonia, L.S. sporophyte (temporary/permanent slides).

- ***Funaria***- Morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores, slides showing antheridial and archegonial heads, L.S. capsule (temporary /permanent slides).
- ***Selaginella***- Morphology, W.M. leaf with ligule, T.S. stem, W.M. strobilus, W.M. microsporophylland megasporophyll, L.S. strobilus (temporary/ permanent slide).
- ***Equisetum***- Morphology, T.S. internode, L.S. strobilus, T.S. strobilus, W.M.sporangiophore, W.M. spores (wet and dry)(temporary slides); T.S. rhizome (permanent slide).
- ***Pteris***- Morphology, T.S. rachis, V.S. sporophyll, W.M. sporangium, W.M. spores, T.S. rhizome, W.M. prothallus with sex organs and young sporophyte (temporary/permanent slide).
- ***Cycas***- Morphology (coralloid roots, bulbil, leaf, megasporophyll), T.S. coralloid root, T.S. rachis, V.S. leaflet, V.S. microsporophyll, W.M. micropsores, L.S. ovule, T.S. root (temporary/ permanent slide).
- ***Pinus***- Morphology (long and dwarf shoots, W.M. dwarf shoot, male cones and female cones), W.M. dwarfshoot, T.S. needle, T.S. stem, L.S./T.S. male cone, W.M. microsporophyll, W.M. microspores (temporary slides), L.S. female cone (temporary/ permanent slide).
- ***Ephedra***- Morphology, T.S. internode, L.S./T.S. male and female strobilii, W.M. spores (wet and dry),T.S. rhizome (temporary/permanent slide).
- **Excursion Report**: Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to archegoniates.

SEMESTER-II
PAPER CODE: BOT- 201
PLANT ECOLOGY

Internal Assessment: 15 Marks **External Marks: 60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type).Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: The objective of the course is to explain the impact of ecological implications on environment protection and human welfare.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 explain the concept of ecology and the influence of different environmental factors: climatic,

CO2 physiographic and edaphic factors on plant life system.

CO3 comprehend the concept of phytogeographic zonation of India, biodiversity and its conservation.

Table -3: CO-PO matrix for the course Botany -201(Plant Ecology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 201.1	3	1	2	------	2	3	3
BOT 201.2	3	1	1	1	3	3	2
BOT 201.3	3	1	2	-----	2	2	3
Average	3.00	1.00	1.66	0.33	2.33	2.66	2.66

Table -3: CO-PSO matrix for the course Botany -201(Plant Ecology)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 201.1	___	1	-----	1	1	1
BOT 201.2	2	____	1	1	1	1
BOT 201.3	3	1	___	3	1	2
Average	1.66	0.66	0.33	1.66	1.00	1.33

UNIT-I

Introduction to Ecology: Definition; scope and importance; levels of organization.

Environment: Introduction; environmental factors- climatic (water, humidity, wind, light, temperature), edaphic factors (soil profile, physico-chemical properties), topographic and biotic factors (species interaction). Adaptations of plants to water stress and salinity (morphological and anatomical features of hydrophytes, xerophytes and halophytes).

Population Ecology: Basic concept; characteristics; biotic potential, growth curves; ecotypes and ecads.

Community Ecology: Concepts; characteristics (qualitative and quantitative-analytical and synthetic); methods of analysis; ecological succession.

UNIT-II

Ecosystem: Structure (components) and functions (trophic levels, food chains, food webs, ecological pyramids and energy flow)

Biogeochemical Cycles: Carbon and Nitrogen; Hydrological (water) cycle.

Phyto-geography: Phyto-geographical regions of India; vegetation types of India (forests).

Environmental Pollution: Sources, types and control of air and water pollution.

Global Change: Greenhouse effect and greenhouse gases; impacts of global warming; carbon trading.

Suggested Readings

- Botkin, D.B. and E.A. Keller, 2004. Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
- Kormondy, E.J. 1996: Concepts of Ecology, Prantice-Hall of India Pvt. Ltd., New Delhi.
- Mackenzie, A. et al. 1999: Instant Notes in Ecology, Viva Books Pvt. Ltd., New Delhi.
- Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
- Sharma, P.D., 2010 Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
- Smith, R.L. 1996, Ecology and Field Biology, Harper Collins, New York.

SEMESTER-II

PAPER: BOT- 202
PLANT TAXONOMY

Internal Assessment: 15 Marks **External Marks:60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: The objective of the course is to make the students aware of various components and concepts of plant taxonomy.

Learning Outcomes: Upon completion, the students will be able to comprehend

CO1 the botanical description of plants;

CO2 discuss the essentials of plant taxonomy and taxonomic hierarchy;

CO3 the classification system of Bentham and Hooker;

CO4 explain the concepts of numerical taxonomy and cladistics.

Table -4: CO-PO matrix for the course Botany -202(Plant Taxonomy)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 202.1	3	2	1	2	2	1	2
BOT 202.2	3	2	1	2	2	1	1
BOT 202.3	3	3	------	1	1	1	2
Average	3.00	2.33	0.66	1.66	1.66	1.00	1.66

Table -4: CO-PSO matrix for the course Botany -202(Plant Taxonomy)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 202.1	3	___	1	____	1	2
BOT 202.2	3	1	____	1	2	2
BOT 202.3	3	2	------	-------	2	2
Average	3.00	1.00	0.33	0.33	1.66	2.00

UNIT-I

Taxonomy and systematics, fundamental components of taxonomy (identification, classification, description, nomenclature and phylogeny).

Role of chemotaxonomy, cytotaxonomy and taximetrics in relation to taxonomy.

Botanical nomenclature, principles and rules, principle of priority.Type concept, author citation, taxonomic ranks.

Keys to identification of plants.

Herbarium: General introduction and importance of herbaria. Botanical gardens and their importance.

Documentation of Floristic Diversity: Brief idea about floras, monograph and journals.

Flower and types of inflorescence.

UNIT-II

Types of classification: Artificial, natural and phylogenetic.

Bentham and Hooker system of classification (upto series), Angiosperm Phylogeny Group (APG)-general introduction.

Diversity of Flowering Plants: Diagnostic features and economic importance of the following families: Ranunculaceae, Brassicaceae, Malvaceae, Euphorbiaceae, Rutaceae, Leguminosae, Apiaceae, Apocynaceae, Lamiaceae, Solanaceae, Asteraceae, Liliaceae and Poaceae.

Suggested Readings

- B.P. Pandey. 2001. A Textbook of Botany: Angiosperms - Taxonomy, Anatomy, Embryology and Economic Botany. S Chand and Co Delhi
- Chopra, GL. 1984. Angiosperms: Systematic & Life-Cycle. Pradeep Publications
- Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperm Taxonomy, Oliver and Boyd,London.
- Gifford, E.M. and Foster, A.S. 1988. Morphology and Evolution of Vascular Plants, W.H. Freeman &Company, New York.
- Heywood, V.H. and Moore, D.M. (Eds.) 1984.Current Concepts in Plant Taxonomy. Academic Press,London.
- Jeifrey, C. 1982. An introduction to Plant Taxonomy. Cambridge University Press, Cambridge,London.
- Jones, S.B., Jr. Luchsinger, A.E. 1986. Plant Systematics (2nd edition).McGraw Hill Book Co.
- Radford, A.E. 1986. Fundamentals of Plant Systematics.Harper and Row, New York.
- Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
- Singh and Jain, 2015. Taxonomy of Angiosperms 10 Edition. Rastogi Publication Meerut.
- Singh, G. 2017. Plant Systematics Theory And Practice 3rd Edition, Oxford & IBH Publishing
- Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd edition). Edward Arnold, London.

SEMESTER-II
PAPER CODE: BOT- 203
PLANT ECOLOGY AND PLANT TAXONOMY- PRACTICAL

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**

Credits: 2 **Time: 4 Hours**

1. Ecological experiment A & B (as per the list)	8
2. Write Ecological notes on the specimens C and D	6
3. Describe/compare the given flowers A and B in semi-technical language giving V.S. of flowers, T.S. of ovaries, Floral Diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.	10
4. Identify spots 1 and 2 from the point of view of morphology of the plant part given.	4
5. Note-book	4
6. Collection and Collection Report.	4
7. Viva-voce.	4

List of Practicals

1. Study of instruments used to measure microclimatic variables: Soil thermometer,maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gaugeand lux meter.

2. Determination of pH, and analysis of two soil samples for carbonates, chlorides and sulphatesby rapid field test.

3. Comparison of bulk density, porosity and rate of infiltration of water in soil of threehabitats.

4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).

(b)Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite(*Orobanche*), Epiphytes(Orchid) and Predation (Insectivorous plants) using museum specimens/ live plants.

5. Determination of minimal quadrat size for the study of herbaceous vegetation in thecollege campus or nearby fields by species area curve method (species to be listed).

6. Quantitative analysis of herbaceous vegetation in the college campus or nearby fields for frequency andcomparison with Raunkiaer's frequency distribution law.

7. Study of vegetative and floral characters of the one or two member of each family/sub-family mentioned in theory syllabus (Description, V.S.flower, section of ovary, floral diagram/s, floral formula/e and systematic positionaccording to Bentham & Hooker's system of classification).

8. Excursion Report: Report on excursion tours with photographs, collection, preservation and preparation of herbarium sheets and specimens related to Angiosperms.Mounting of a collected, properly dried and pressed specimen of minimum 20 wild plants with herbarium label.

SEMESTER- III
PAPER CODE: BOT- 301
PLANT ANATOMY

Internal Assessment: 15 Marks **External Marks: 60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: The objective of this course is to familiarize the students with internal organization of plants, which plays important roles in plant sciences.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 identify, describe and differentiate plant cells, cell organelles and their functions;

CO2 apply plant anatomical features for correct identification and its role in taxonomy;

CO3 analyze and comprehend wood structure.

Table -5: CO-PO matrix for the course Botany -301(Plant Anatomy)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 301.1	3	----	-----	2	1	-----	2
BOT 301.2	3	2	-----	2	1	------	2
BOT 301.3	2	3	1	1	2	1	2
Average	2.66	1.66	0.33	1.66	1.33	0.33	2.00

Table -5: CO-PSO matrix for the course Botany -301(Plant Anatomy)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 301.1	2	2	2	-------	2	2
BOT 301.2	2	2	------	-------	2	1
BOT 301.3	2	---------	2	-------	2	3
Average	2.00	1.33	1.33	--------	2.00	2.00

UNIT-I

Diversity in plant forms: Annuals, biennials and perennials.

Tissues: Meristematic and permanent (simple and complex).

Leaf: Types of leaves (simple and compound); phyllotaxy.

Epidermis: Uniseriate and multiseriate, epidermal appendages and their morphological types.

Anatomy of typical monocot and dicot leaf and cell inclusions in leaves;

Leaf abscission.

Stomatal apparatus and their morphological types.

UNIT-II

Shoot system: Shoot apical meristem and its histological organizations (monocot and dicot stem); **Cambium:** Structure and functions; secondary growth in dicot stem; characteristics of growth rings; sap wood and heart wood, periderm.

Anomalous secondary growth (*Achyranthes*&*Boerhaavia*)

Root system: Root apical meristem; histological organization of monocot and dicot roots.

Secondary growth in dicot root.

Structural modifications in roots: Storage (*Beta*), respiratory (*Rhizophora*), epihytic (*Vanda*).

Anatomical aspects of adaptations in xerophytes, hydrophytes, halophytes.

Suggested Readings

- Bryan G. Bowes 1999. A Colour Atlas of Plant Structure. Manson Publishing
- Cutter, E.G. 1969. Plant Anatomy Part-I, Cells and Tissues, Edward Arnold, London.
- Cutter, E.G. 1971. Plant Anatomy:Experiment and Interpretation. Part-II Organs, Edward Arnold London.
- Esau, K. 1977. Anatomy of Seed Plants, 2nd Edition. John Wiley & Sons, New York.
- Fahn, A. 1974. Plant Anatomy, 2nd Edition. Pergamon Press, Oxford.
- Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation; Principles and Practices. 3rdEdition.Prentice Hall of India Pvt. Ltd. New Delhi.
- King. J. 1997. Reaching for the Sun: How Plants Work. Cambridge University Press, Cambridge,U.K.
- Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/Cummings Publishing Company Inc.,Menlo Park, California, USA.
- Pandey, B.P 2012. Plant Anatomy. S. Chand & Co. Publisher
- Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants.5th edition.W.R.Freeman and Co., Worth Publishers, New York.
- Sharma MK. Plant Structure (An Introduction To Plant Anatomy) JBC Press
- William C. Dickison 2015. Integrative Plant Anatomy. Academic Press

SEMESTER- III

PAPER CODE: BOT- 302
PLANT EMBRYOLOGY

Internal Assessment: 15 Marks **External Marks: 60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: Embryological studies play important role in plant breeding and crop improvements, this course is designed to make them aware of some important aspects of embryology.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1: explain the developmental patterns of both vegetative and reproductive organs of plants;

CO2: apply knowledge about embryological characters in explaining plant reproductivebiology.

Table -6: CO-PO matrix for the course Botany -302 (Plant Embryology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 302.1	3	1	-----	1	1	------	2
BOT 302.2	3	2	1	2	1	------	2
Average	3.00	1.50	0.50	1.50	1.00	------	2.00

Table -6: CO-PSO matrix for the course Botany -302 (Plant Embryology)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 302.1	3	2	3	-----	2	2
BOT 302.2	2	1	2	1	2	2
Average	2.50	1.50	2.50	0.50	2.00	2.00

UNIT-I

Flower-a modified shoot; functions of various floral parts.

Microsporangium, its wall and dehiscence mechanism.Microsporogenesis, pollen grains and its structure (pollen wall).

Pollination (types and agencies); pollen germination (microgametogenesis).

Pollen-pistil interaction; self-incompatibility.

Male gametophyte.

Structure of megasporangium (ovule), its curvatures.

Megasporogenesis and megagametogenesis.

UNIT-II

Female gametophyte (monosporic, bisporic and tetrasporic)- organization and ultrastructure of mature embryo sac.

Double fertilization.

Endosperm types and their biological importance.

Embryogenesis in dicot and monocot;

Polyembryony and apomixis.

Structure of dicot and monocot seed.

Fruit types; dispersal mechanisms in fruits and seeds.

Suggested Readings

- B.M. Johri Editor (1984) Embryology of Angiosperms Springer Verlag
- Bhojwani, S.S. &Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
- Fageri, K. and Van der Pijl1979.The Principles of Pollination Ecology.Pergamon Press, Oxford.
- Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation; Principles and Practices. 3rdEdition.Prentice Hall of India Pvt. Ltd. New Delhi.
- King. J. 1997. Reaching for the Sun: How Plants Work. Cambridge University Press, Cambridge,U.K.
- P. Maheshwari (1950) An Introduction to the Embryology of Angiosperms McGraw Hill
- Proctor, M. and Yeo, P. 1973. The Pollination of Flowers.William Collins Sons, London.
- Raven, P.H. Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants.5th edition.W.R.Freeman and Co., Worth Publishers, New York.
- Thomas, P. 2000. Trees: Their Natural History. Cambridge University Press, Cambridge.

SEMESTER- III
PAPER CODE: BOT- 303
PLANT ANATOMY AND PLANT EMBRYOLOGY- PRACTICAL

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**

Credits: 2 **Time- 4 Hrs.**

1. Cut Transverse Section and prepare a double-stained permanent mount of the given material A and B (from angiosperms). Identify giving reasons and show it to the examiner. 14
2. Identify, giving the important characters of identification, the spots 1, 2, 3 and 4 (one material/photograph/ slide from embryology of angiosperms). 16
3. Dissect out the globular/heart-shaped embryo from the given material. 5
7. Note-book and Collection permanent prepared slides 10
8. Viva-voce 5

List of Practicals

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (Permanent slides preparation).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (Permanent slides preparation).
5. Leaf: Dicot and Monocot leaf (Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory)(Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous (Permanent Slides).
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril,caruncle)(Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.

SEMESTER IV
PAPER CODE: BOT- 401
PLANT PHYSIOLOGY

Internal Assessment: 15 Marks **External Marks: 60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: This course will make students aware of very important aspects of plant growth, and will also enhance their understanding of their cultivation requirements.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 explain plant water relations and elucidate mineral nutrients that plants require, how they are obtained, metabolized and transported.

CO2 describe physiological details of photosynthesis and respiration in plants.

CO3 describe enzymes, hormones, environmental responses and nitrogen metabolism required for plant growth and development.

Table -7: CO-PO matrix for the course Botany -401(Plant Physiology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 401.1	3	3	1	2	2	------	3
BOT 401.2	3	3	1	1	1	1	2
BOT 401.3	3	1	1	1	2	1	2
Average	3.00	2.33	1.00	1.33	1.66	0.66	2.33

Table -7: CO-PSO matrix for the course Botany -401(Plant Physiology)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 401.1	2	2	3	1	3	2
BOT 401.2	2	2	3	1	3	2
BOT 401.3	1	3	2	1	1	2
Average	1.66	2.33	2.66	1.00	2.33	2.00

UNIT-I

Plant-water Relations: Importance of water to plant life; physical properties of water; Imbibition, Diffusion, Osmosis and Plasmolysis; absorption and transport of water; transpiration-types, physiology of stomata, factors affecting transpiration, importance of transpiration.

Mineral Nutrition: Essential macro and micro elements; criteria of essentiality of elements; Role of essential elements; mineral uptake; deficiency symptoms.

Transport of Organic Substances: Mechanism of phloem transport; source-sink relationship; factors affecting translocation

UNIT-II

Seed dormancy; Plant movements; Concept of photoperiodism; Physiology of flowering; Florigen concept; Physiology of senescence; Fruit ripening.

Growth and Development: Definitions; phases of growth and development.

Plant Hormones: Auxins, Gibberellins, Cytokinins, Abscissic acid and Ethylene, history of their discovery, mechanism of action.

Photo-morphogenesis:phytochromes and their discovery, physiological role and mechanism of action.

Suggested Readings

- Dennis,D.T., Turpin, D.H., Lefebvre,D.D. and Layzell (eds.). 1997: Plant Metabolism (2nd Edition), Longman, Essex, England.
- Galston, A.W. 1989: Life Processes in Plants, Scientific American Library, Springer-Verlag, NewYork, USA.
- Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology.John Wiley and Sons.U.S.A.4th edition.
- Hopkins, W.G., 1995: Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
- Mohr, H. and Schopfer, P. 1995: Plant Physiology. Springer-Verlag, Berlin Germany.
- Pandey, S.N &Sinha BK. 2018. Plant Physiology 4/Ed .Vikas Publishing House Pvt Ltd
- Salisbury, F.B. and Ross, C.W. 1986: Plant Physiology. CBS Publishers and Distributors, New Delhi.
- Taiz, L. and Zeiger, E. 2003: Plant Physiology. Panima Publishing Corporation, New Delhi.
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- Verma, V. 2015. Plant Physiology 2nd Ed. Athena Academic

SEMESTER- IV
PAPER CODE: BOT- 402
PLANT METABOLISM

Internal Assessment: 15 Marks **External Marks: 60** **Maximum Total Marks: 75**

Credits: 3 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (12 marks each).

Objectives: Objectives: This course will make students aware of very important life processes of plants which are very vital for all the ecosystems.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 Explain the most important metabolic processes of this planet, i.e. photosynthesis and respiration;

CO2 understand the basics of enzymology and metabolism of nitrogen and lipid.

Table -8: CO-PO matrix for the course Botany -402(Plant Metabolism)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 402.1	3	2	1	1	2	1	2
BOT 402.2	3	3	2	3	2	----	3
Average	3.00	2.50	1.50	2.00	2.00	0.50	1.50

Table -8: CO-PSO matrix for the course Botany -402(Plant Metabolism)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 402.1	1	3	3	1	2	2
BOT 402.2	------	-------	2	1	3	2
Average	0.50	1.50	2.50	1.00	2.50	2.00

UNIT-I

Photosynthesis: Significance; historical aspects; photosynthetic pigments; action spectra and enhancement effects; concept of two photosystems; Z-scheme; photo-phosphorylation; Calvin cycle; C4 pathway; CAM plants; photorespiration.

Respiration: ATP–the biological energy currency; aerobic and anaerobic respiration; Krebs cycle; electron transport mechanism (chemi-osmotic theory); redox -potential; oxidative phosphorylation; pentose phosphate pathway.

UNIT-II

Nitrogen metabolism: Biology of nitrogen fixation; importance of nitrate reductase and its regulation; ammonium assimilation.

Lipid metabolism: Structure and functions of lipids; fatty acid biosynthesis; B-oxidation; saturated and unsaturated fatty acids; storage and mobilization of fatty acids

Basics of Enzymology: Discovery and nomenclature; characteristics of enzymes; concept of holoenzyme, apoenzyme, coenzyme and co-factors; regulation of enzyme activity; mechanism of action.

Suggested Readings:

- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology.John Wiley and Sons.U.S.A.4th edition.
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. (2015). Plant Physiology and Development.Sinauer Associates Inc. USA.6th edition.
- Harborne, J.B. (1973). Phytochemical Methods.John Wiley & Sons. New York.
- Dennis,D.T., Turpin, D.H., Lefebvre,D.D. and Layzell (eds.). 1997: Plant Metabolism (2nd Edition), Longman, Essex, England.
- Galston, A.W. 1989: Life Processes in Plants, Scientific American Library, Springer-Verlag, NewYork, USA.
- Hopkins, W.G., 1995: Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
- Mohr, H. and Schopfer, P. 1995: Plant Physiology. Springer-Verlag, Berlin Germany.
- Salisbury, F.B. and Ross, C.W. 1986: Plant Physiology. CBS Publishers and Distributors, New Delhi.
- Taiz, L. and Zeiger, E. 2003: Plant Physiology. Panima Publishing Corporation, New Delhi.

SEMESTER-IV
PAPER CODE: BOT- 403
Plant Physiology and Plant Metabolism- Practical

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**
Credits: 2 **Time: 4 Hours**

1. Devise experiments A and B to demonstrate the physiological process (as per the list). Perform it and show it to the examiners. 14

2. Comment on the physiologicalexperiment C and D (Specimen/ set-up / Model / Chart). 8
3. Test for carbohydrates / Proteins / Fats / Peroxidase activity. 6
4. Note Book and Report 8
5. Viva-voce. 4

List of Practicals

- Demonstration of imbibition by plaster of Paris method.
- Demonstration of Osmosis by potato osmoscope method.
- To study the Osmotic pressure of onion scale/ Rhoeo leaf peel by plasmolytic method.
- Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte. Demonstration of transpiration by Ganong's/ Farmer's potometer.
- To separate of photosynthetic pigments by thin layer/paper chromatography.
- Demonstration of Ascent of sap/Transpiration pull
- To study the rate of photosynthesis under varying CO2 concentration using Wilmott's bubbler.
- To study the effect of light intensity on oxygen evolution during photosynthesis
- UsingWilmott's bubbler.
- Demonstration of aerobic respiration.
- Demonstration of anaerobic respiration.
- To study the evolution of heat during respiration
- Demonstration of manometric determination of R. Q.
- Demonstration of phototropism, geotropism and hydrotropism.
- Determination of peroxidase activity.
- Simple tests for the detection of carbohydrates(monosaccharides,disaccharides and starch); Proteins and Fats.
- Preparation of report on use of plant hormones in vegetative reproduction, seed germination etc.

SEMESTER- V

DISCIPLINE SPECIFIC ELECTIVE- I

PAPER CODE: BOT- 501 (Option-I)

ECONOMIC BOTANY

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To highlight the role and significance of cultivated plants.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 enumerate various services and benefits provided by the plants like food, medicines, timber etc.;

CO2 know the practical methods to cultivate and harvest various important plants and their parts.

Table -9: CO-PO matrix for the course Botany -501(Economic Botany)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 501.1	3	2	3	2	3	2	3
BOT 501.2	3	1	2	2	3	3	3
Average	3.00	1.50	2.50	2.00	3.00	2.50	3.00

Table -9: CO-PSO matrix for the course Botany -501(Economic Botany)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 501.1	3	2	1	2	1	3
BOT 501.2	3	1	2	2	1	3
Average	3.00	1.50	1.50	2.00	1.00	3.00

UNIT-I

Origin, distribution, botanical description, brief idea of cultivation and uses of the following:

Food plants: Cereals (Rice, Wheat and Maize).

Pulses: Gram, Arhar and Pea.

Vegetables: Potato, Tomato and Onion.

Fibers: Cotton, Jute and Flax.

Oils: Groundnut, Mustard and Coconut.

UNIT-II

Morphology of plant part used, brief idea of cultivation and uses of the following:

Spices: Coriander, *Ferula*, Ginger, Turmeric, Cloves.

Medicinal Plants:*Cinchona*, *Rauwolfia*, *Atropa*, Opium, *Cannabis*, Neem, *Withania*

Botanical description and processing of:

Beverages: Tea and Coffee; **Rubber:***Hevea*; **Sugar:** Sugarcane.

General account and sources of timber.

Energy plantations and bio-fuels.

Suggested Readings:

- Kocchar, S.L. 1998: Economic Botany in Tropics, 2nd edition, MacMillan India Ltd., New Delhi.
- Kocchar, S.L. 2016. Economic Botany: A Comprehensive Study, 5 Ed, Cambridge India.
- Sambammurthy, A.V.S.S. And Subramanyam, N.S. 1989: A Textbook of Economic Botany, Wiley Eastern Ltd., New Delhi.
- Sharma, O.P. 1996: Hills Economic Botany (Late Dr. A.F. Hill adapted by O.P. Sharma), Tata McGraw Hill Co. Ltd., New Delhi.
- Simpson, B.B. and Conner-Ogorzaly, M. 1986: Economic Botany- Plants in our World, McGraw Hill,New York.

SEMESTER- V

DISCIPLINE SPECIFIC ELECTIVE-I

PAPER CODE: BOT- 502 (Option-I)

PLANT BIOTECHNOLOGY

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To study material, methods and applications of plant biotechnology.

Learning Outcomes: After completion of the course the learners will be able to:

CO1 understand the concepts and fundamentals of plant biotechnology.

CO2 develop their competency on different types of plant tissue culture methods

CO3 examine gene cloning and evaluate different methods of gene transfer

CO4 critically analyze the major concerns and applications of transgenic technology

Table -10: CO-PO matrix for the course Botany -502(Plant Biotechnology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 502.1	3	2	3	1	3	2	2
BOT 502.2	3	1	3	2	2	1	1
BOT 502.3	3	2	3	2	2	-----	1
BOT 502.4	3	2	3	1	2	------	1
Average	3.00	1.75	3.00	1.50	2.25	0.75	1.25

Table -10: CO-PSO matrix for the course Botany -502(Plant Biotechnology)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 502.1	1	3	3	1	1	1
BOT 502.2	1	3	3	2	1	3
BOT 502.3	---------	3	3	2	1	2
BOT 502.4	1	2	2	2	2	2
Average	0.75	2.75	2.75	1.75	1.25	2.00

Unit I

Historical perspective of plant tissue culture; Composition of media; Nutrient and hormone requirements; Totipotency; Organogenesis; Embryogenesis; Protoplast culture; Plant tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production; Cryopreservation. Restriction Endonucleases- types and role. Brief idea about cloning vectors- Ti plasmid, BAC, Lambda phage, M13phagemid, cosmid, shuttle vector; eukaryotic vectors (YAC).

Recombinant DNA, bacterial transformation and selection of recombinant clones, PCR mediated gene cloning; Genomic and cDNA libraries

UNIT II

Methods of gene transfer- Agrobacteriummediated, electroporation, microinjection,microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP). Applications of biotechnology-pest resistant (Bt-cotton); herbicide resistant plants (Round-Upready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines;

Industrial enzymes (aspergillase, protease, lipase); Biosafety concerns.

Suggested Readings

- BD Singh. Biotechnology. Kalyani Publications
- Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam.The Netherlands.
- Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
- Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
- Trehan, K. 1990. Biotechnology, New Age Int. Pvt. Ltrd. New Delhi India.

SEMESTER-V
DISCIPLINE SPECIFIC ELECTIVE-I
PAPER CODE –BOT- 503 (Option-I)
ECONOMIC BOTANY AND PLANT BIOTECHNOLOGY- PRACTICAL

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**

Credits: 2 **Time: 4 Hours**

1. Identify and Classify spots 1, 2, 3, and 4 from the point of view of economic importance and morphology of the plant part used.	14
2. Perform the Applied Botany experiment (as per the list).	8
3. Comment on the specimen A and B (Chart/ Model /Photograph from Biotechnology)	6
4. Note Book, Collection and field report.	8
5. Viva-voce.	4

List of Practicals

- Study of economically important plants : Wheat, Rice, Gram, Pea, Arhar, Soybean, Black pepper, Ginger, Clove, Turmeric, Tea, Coffee, Cocoa, Cotton, Jute, Coir, Groundnut, Coconut and Mustard
- Collection and preparation of report on various crops and economically important plants being cultivated/wildly available in your area.
- Brief introduction to the components and working of the instruments- oven, autoclave, incubator, centrifuge, laminar air flow and spectrophotometer)Familiarization with basic equipments in tissue culture
- Preparation of MS medium.
- To prepare the slants and petri plates for plant tissue culture.
- 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.
- 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, FlavrSavr tomato through photographs.
- Isolation and quantification of genomic DNA from bacteria (E. coli) or Plants
- Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
- To separate proteins using PAGE.

SEMESTER- V

DISCIPLINE SPECIFIC ELECTIVE-I

PAPER CODE: BOT- 501 (Option-II)

CELL BIOLOGY

Internal Assessment: 10 Marks **External Marks: 40 Maximum Total Marks: 50**

Credits: 2 **Time: 4 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To familiarize with structure and components of cell

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 explain the chemical composition and structure of cell wall and cell membrane

CO2 compare the structure and functions of organelles of a plant cell.

CO3 describe the structure and organization of a chromosome

Table -11: CO-PO matrix for the course Botany -503(Cell Biology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 503.1	3	___	_____	1	1	___	___
BOT 503.2	3	1	___	1	1	___	1
BOT 503.3	3	1	1	1	1	___	1
Average	3.00	0.66	0.33	1.00	1.00		0.66

Table -11: CO-PSO matrix for the course Botany -503(Cell Biology)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 503.1	3	2	2	1	2	2
BOT 503.2	2	3	2	1	2	2
BOT 503.3	2	3	2	1	2	2
Average	2.33	2.66	2.00	1.00	2.00	2.00

UNIT-I

Cell as a unit of Life; The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components

The Cell Envelopes: Structure and functions of Cell Wall and Plasma Membrane.

Ultrastructure and function of nucleus, Nuclear Envelope- structure of nuclear pore complex

Ultrastructure and function of following cell organelles: Golgi Apparatus, Endoplasmic Reticulum, Chloroplast,Mitochondria, Lysosomes, Peroxisomes and Vacuoles.

UNIT-II

Cell Division: Mitosis and Meiosis.

Chromosome: Morphology, organization, ultrastructure of Centromere and Telomere; Chromosomalalterations- deletions, duplications, translocations, inversions; Variations in chromosome number- aneuploidy, polyploidy; sex chromosomes and sex determination.

SUGGESTED READINGS

- Alberts, B.Bray, D.Lewis, J., Raff, M.., Roberts, K. and Watson J.D. 1999. Molecular Biology of Cell. Garland Publishing Co., Inc., New York, USA.
- Atherly, A.G. Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics, Saunders College Publising, Fort Worth, USA.
- Gupta, P.K. 1999. A text book of Cell and MolelcularBiology.Rastogi Publications, Meerut, India.
- Kleinsmith, L. J and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd edition) Harper Collins College Publishers, New York, USA.
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimoe, D. and Darnell, J. 2000. Molecular, Cell Biology, W.H. Freeman and Co., New York., USA.
- Russel, P.J. 1998. Genetics, The Benjamin/Cummings Publishing Co. Inc., USA.
- Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics. John Wiley and Sons, Inc. USA.

SEMESTER- V

DISCIPLINE SPECIFIC ELECTIVE-I

PAPER CODE: BOT- 502 (Option-II)

MOLECULAR BIOLOGY

Internal Assessment: 10 Marks **External Marks: 40 Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To understand structure and function of genetic material.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 analyze the structures and chemical properties of DNA and RNA

CO2 gain an understanding of various steps of transcription, translation, protein modifications and gene regulation.

Table -12: CO-PO matrix for the course Botany -504(Molecular Biology)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 504.1	3	3	2	2	1	1	2
BOT 504.2	3	3	2	1	3	1	1
Average	3.00	3.00	2.00	1.50	2.00	1.00	1.50

Table -12: CO-PSO matrix for the course Botany -504(Molecular Biology)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 504.1	3	3	2	1	2	2
BOT 504.2	2	3	2	1	2	3
Average	2.50	3.00	2.00	1.00	2.00	2.50

Unit I

Genetic material DNA: Miescher to Watson and Crick- historic perspective,

Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment.

DNA structure, types of DNA, types of genetic material.

DNA Replication: Prokaryotes and eukaryotes; bidirectional replication, semi–conservative, semi discontinuous RNA priming, Ø (theta) mode of replication, replication of linear, dsDNA, replicating the 5′end of linear chromosome including replication enzymes.

Unit II

Transcription: Prokaryotes and Eukaryotes.

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types;

Translation: Prokaryotes and eukaryotes, genetic code.

Regulation of gene Expression in Prokaryotes: Lac operon and Tryptophan operon; regulation of gene expression in Eukaryotes.

Suggested Readings

- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of theCell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th Ed. Sinauer Associates, Inc. • Publishers Sunderland, Massachusetts U.S.A.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8thedition. Lippincott Williams and Wilkins, Philadelphia
- Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley &Sons.Inc.
- Lewin, B. 2018. Genes XII,Osford University Press, Oxford, UK

SEMESTER-V
DISCIPLINE SPECIFIC ELECTIVE-I
PAPER CODE: BOT- 503 (Option-II)
CELL BIOLOGY AND MOLECULAR BIOLOGY- PRACTICAL

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**

Credits: 2 **Time: 3 Hours**

1. Prepare the root smear and find out two different stages of Mitosis. Identify and show it to the examiners. Also give characters of identification. 8
2. Identify the two stages of Meiosis from given permanent slide and write notes on it 4
3. Identify and comment on the specimen A, B, C and D (Chart/ Model /Photograph from Cell organelles, other molecular biology phenomenon) 16
4. Note Book, and Model on any DNA/Molecular Biology Phenomenon. 8
5. Viva-voce. 4

List of Practicals

- To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
- Study of the photomicrographs of cell organelles
- To study the structure of plant cell through temporary mounts.
- Study of mitosis and meiosis (temporary mounts and permanent slides).
- Demonstration of dialysis of starch and simple sugar.
- Study of plasmolysis and deplasmolysis on Rhoeo leaf.
- Measure the cell size (either length or breadth/diameter) by micrometry.
- Study the structure of nuclear pore complex by photograph.
- Study of special chromosomes (polytene&lampbrush) either by slides or photographs.
- Study DNA packaging by micrographs.
- Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

SEMESTER VI

DISCIPLINE SPECIFIC ELECTIVE-II

PAPER CODE: BOT- 601 (Option-I)

GENETICS

Internal Assessment: 10 Marks **External Marks: 40 Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To enhance knowledge of the concept of Heredity, structure and functioning of Gene and chromosome

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 have the conceptual understanding of the laws of inheritance and gene interaction.

CO2 comprehend the chromosomal abnormalities that lead to genetic disorders.

CO3 analyze the effect of mutations on gene functions and dosage.

Table -13: CO-PO matrix for the course Botany -601(Genetics)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 601.1	3	2	1	1	1	___	1
BOT 601.2	3	3	3	1	2	____	2
BOT 601.3	3	3	3	1	2	_____	2
Average	3.00	2.66	2.33	1.00	1.68	-------	1.68

Table -13: CO-PSO matrix for the course Botany -601(Genetics)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 601.1	3	1	--------	1	1	1
BOT 601.2	1	2	3	2	2	2
BOT 601.3	1	3	3	2	2	2
Average	1.66	2.00	2.00	1.66	1.66	1.66

Unit I

Heredity: Brief life history of Mendel; Terminologies; Laws of Inheritance.

Modified Mandelian Ratios: Lethal Genes; Co-dominance, incompletedominance; Gene interaction (9:7; 9:4:3; 13:3; 12:3:1, 15:1); Chi Square test; Pedigree Analysis.

Cytoplasmic Inheritance: Kappa particles in Paramecium, leafvariegation in *Mirabilis jalapa*

Male sterility; Multipleallelism;Pleiotropism;

Chromosome theory of Inheritance.Sex-determination and Sex-linked Inheritance.

Unit II

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.

Mutations and Chromosomal Aberrations; Types of mutations, effects of physical & chemical mutagens.

Numerical chromosomalchanges: Euploidy, Polyploidy and Aneuploidy.

Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

Suggested Readings

- Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley India.
- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
- Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
- Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
- Singh, BD. Genetics. Kalyani Publishers Delhi
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.

SEMESTER- VI

DISCIPLINE SPECIFIC ELECTIVE-II

PAPER CODE: BOT- 602 (Option-I)

PLANT BREEDING

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To enhance the skill in the field of crop improvement.

Learning Outcomes: After completion of the course the learners will be able to:

CO1 develop conceptual understanding of plant genetic resources and plant breeding,

CO2 know the various methods of plant propagation.

CO3 explain the monogenic and polygenic inheritance

CO4 understand the various methods used in crop improvement.

Table -14: CO-PO matrix for the course Botany -602(Plant Breeding)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 602.1	3	3	2	1	3	2	2
BOT 602.2	3	2	1	1	3	2	1
BOT 602.3	3	1	2	1	1	___	1
BOT 602.4	3	3	2	1	2	2	2
Average	3.00	2.25	1.75	1.00	2.25	1.50	1.50

Table -14: CO-PSO matrix for the course Botany -602(Plant Breeding)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 602.1	3	1	2	2	2	3
BOT 602.2	1	1	3	1	2	2
BOT 602.3	1	1	3	1	3	2
BOT 602.4	1	1	3	1	2	3
Average	1.50	1.00	2.75	1.25	2.25	2.50

Unit- I

Introduction and objectives of Plant Breeding: Breeding systems; modes of reproduction in crop plants; Important achievements and undesirable consequences of plant breeding.

Methods of crop improvement: Introduction;Centers of origin and domestication of crop plants; plant genetic resources;Acclimatization.

Selection methods: For self-pollinated, cross pollinated and vegetativelypropagated plants; **Hybridization:** For self, cross and vegetatively propagated plants–Procedure, advantages and limitations.

Unit II

Quantitative inheritance: Concept, mechanism, examples.Monogenic vs polygenic Inheritance.

Inbreeding depression and heterosis: History, genetic basis of inbreeding depression and heterosis; applications; Crop improvement and breeding.

Role of mutations, polyploidy, distant hybridization and role of biotechnology incropimprovement.

Suggested Readings

- Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.
- Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
- Poehlman JM and Sleper DA (1995) Breeding Field Crops, AVI. Publ., U.S.A.
- Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

SEMESTER-VI

DISCIPLINE SPECIFIC ELECTIVE-II

PAPER CODE: BOT- 603 (Option-I)

GENETICS AND PLANT BREEDING- PRACTICAL

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**

Credits: 2 **Time: 4 Hours**

1. Numerical regarding Genetics (Mendelian Inheritance or Gene Interaction) as per syllabus.	10
2.Identify and comment on the specimen A, B, C and D (Chart/ Model /Photograph)	12
3. Preparation of Idiogram from a given karyotype photograph	6
4. Note Book and Chart/Model/Report on any Genetics/Plant Breeding Phenomenon.	8
5. Viva-voce.	4

List of Practicals

- Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
- Chromosome mapping using point test cross data.
- Pedigree analysis for dominant and recessive autosomal and sex linked traits.
- Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3,15:1, 12:3:1, 9:3:4).
- Photographs/Permanent Slides showing Translocation Ring, Laggards and InversionBridge.
- Hybridization techniques - Emasculation, Bagging & Cross Pollination(For demonstration only).
- Induction of polyploidy conditions in plants (For demonstration only).

SEMESTER- VI

DISCIPLINE SPECIFIC ELECTIVE-II

PAPER CODE: BOT- 601 (Option-II)

RESEARCH METHODOLOGY-I

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To understand some basic concepts of research and its methodologies.

Learning Outcomes: After completion of the course the learners will be able to:

CO1 select and define appropriate research problem and its parameters

CO2 prepare and undertake a project

CO3 organize and conduct research (advanced project) in a more appropriate manner

Table -15: CO-PO matrix for the course Botany -603(Research Methodology-I)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 603.1	2	3	___	1	____	____	1
BOT 603.2	1	3	___	1	___	____	1
BOT 603.3	1	3	3	2	2	____	2
Average	1.33	3.00	1.00	1.33	0.66		1.33

Table -15: CO-PSO matrix for the course Botany -603(Research Methodology-I)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 603.1	---------	2	3	3	3	2
BOT 603.2	---------	2	3	3	3	3
BOT 603.3	1	3	3	2	3	2
Average	0.33	2.33	3.00	2.66	3.00	2.33

Unit I

Basic concepts of Research**:** Research-definition and types of research (Descriptive versus analytical; applied versus fundamental;quantitative versus qualitative; conceptual versusemperical). Research methods versus methodology.

Literature-review and its consolidation; Library research; field research; laboratory research.

General laboratory practices- Common calculations in botany laboratories.Understanding the details on the label ofreagent bottles.Molarity and normality of common acids and bases.

Unit II

Preparation of solutions.Dilutions.Percentage solutions.Molar, molal and normal solutions.Technique of handlingmicropipettes; Knowledge about common toxic chemicals and safety measures in theirhandling.

Data collection and documentation of observations.Maintaining a laboratory record; Tabulation and generation of graphs.

Imaging oftissuespecimens and application of scale bars. The art of field photography.

Suggested Readings

- Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

SEMESTER- VI

DISCIPLINE SPECIFIC ELECTIVE-II

PAPER CODE: BOT- 602 (Option-II)

RESEARCH METHODOLOGY- II

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: Tounderstand some basic concepts of research and its methodologies.

Learning Outcomes: After completion of the course the learners will be able to:

CO1 select and define appropriate research problem in biological sciences.

CO2 understand basic techniques used in biological research.

CO3 learn various micro techniques in plant sciences.

Table -16: CO-PO matrix for the course Botany -604(Research Methodology-II)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT 604.1	1	3	___	1	___	____	2
BOT 604.2	2	3	2	2	2	____	2
BOT 604.3	2	3	1	1	2	____	2
Average	1.66	3.00	1.00	1.33	1.33		2.00

Table -16: CO-PSO matrix for the course Botany -604(Research Methodology-II)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT 604.1	-------	2	3	2	3	3
BOT 604.2	-------	2	3	2	3	2
BOT 604.3	--------	2	3	1	3	1
Average	--------	2.00	3.00	1.66	3.00	2.00

Unit I

Overview of Biological Problems: History; Key biology research areas,

Model organisms in biology (A brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics,Proteomics-Transcriptional regulatory network.

Methods to study plant cell/tissue structure: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning.

Tissue preparation: Living versus fixed, physical versus chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plasticinfiltration; Preparation of thin and ultrathin sections.

Unit II

Plant microtechniques:Staining procedures, classification and chemistry of stains. Staining equipment.Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP andother tags).Cytogenetic techniques with squashed plant materials.

The art of scientific writing and its presentation**,** Numbers, units, abbreviations and nomenclature used in scientific writing.

Writingreferences.Powerpoint presentations.Poster presentations.

Scientific writing and ethics,Introduction to copyright-academic misconduct/plagiarism.

Suggested Readings

- Dawson, C. (2002). Practical research methods.UBS Publishers, New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writingfor agricultural research scientists – a training reference manual. West Africa RiceDevelopment Association, Hong Kong.

SEMESTER-VI

DISCIPLINE SPECIFIC ELECTIVE-II

PAPER CODE: BOT-603 (Option-II)

RESEARCH METHODOLOGY-I AND RESEARCH METHODOLOGY-II : PRACTICAL

Maximum Marks: 50 **External marks: 40** **Internal Assessment: 10**

Credits: 2 **Time: 4 Hours**

1. Prepare whole mount of given material. 6
2. Calculate amount of salt ($CaNO_3$, KNO_3, $MgSO_4$, K_2SO_4, $ZnSO_4$, $FeCl_3$ etc.) in gms need to prepare molar, molal and normal solutions (any 2 salts) 10
3. Explain picture of given symbols on reagent bottle(3 symbols) 6
4. Prepare a bar graph from given data 6
5. Note Book and technical writing of at least 5000 words on any defined topic 8
6. Viva-voce. 4

List of Practicals

- Calculation for making molar, molal and normal solution for common salts ($CaNO_3$, KNO_3, $MgSO_4$, K_2SO_4, $ZnSO_4$, $FeCl_3$etc) used in biological experiments.
- Study of symbols and signs printed on common reagents used in biological experiments
- Study of making simple graphs from given data
- Preparation of Whole mount squash preparation of biological samples
- Fixation of onion root tips in fixative for mitosis studies
- To study methods of staining for studying Anatomy, chromosomal studies
- Preparation of Poster presentation on defined topics.
- Technical writing on topics assigned.

SEMESTER IV-VI
SKILL ENHANCEMENT COURSE-III
PAPER CODE: BOT- S1
NURSERY AND GARDENING

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**
Credit:2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To sharpen the skills of learners about this self-employing discipline.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 practically execute basic skills of gardening and landscaping;

CO2 apply the knowledge gained in raising small scale nursery or kitchen gardens.

Table -17: CO-PO matrix for the course Botany –SEC 01 (Nursery and Gardening)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT SEC-1.1	3	2	1	1	2	3	2
BOT SEC-1.2	2	1	-------	2	2	2	2
Average	2.50	1.50	0.50	1.50	2.00	2.50	2.00

Table -17: CO-PSO matrix for the course Botany –SEC 01 (Nursery and Gardening)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT SEC-1.1	3	2	3	--------	1	3
BOT SEC-1.2	1	2	2	--------	1	3
Average	2.00	2.00	2.50	-------	1.00	3.00

Unit I

Nursery: Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities – planting, direct seeding and transplants.

Seed: Structure and types -Seed dormancy; causes and methods of breaking dormancy

Seed storage: Seed banks, factors affecting seed viability, genetic erosion.

Seed production technology: Seed testing and certification.

Gardening operations: Soil laying, manuring, watering, management of pests and diseases and harvesting, sowing/raising of seeds and seedlings, transplanting of seedlings.

Unit II

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings.

Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design

Computer applications in landscaping.

Cultivation of different vegetables: Cabbage, Brinjal, Lady's finger, Onion, Tomatoes and carrots

Cultivation of different flowers: Marigold, *Lilium*, Rose, *Gerbera*, *Gladiolus*, *Chrysanthemum* and Carnation

Storage and marketing procedures.

Suggested Readings

- Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
- Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
- Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
- Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.
- Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
- Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
- Singh B, Singh N. and Kumar K. 2015. Common Garden Plants. Unique Publications,Panipat

SEMESTER IV-VI

SKILL ENHANCEMENT COURSE-III

PAPER CODE: BOT- S2

BIO-FERTILIZERS

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To familiarize the students about important aspects of sustainable bio-fertilizers.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 elucidate different types of fertilizers using biological organisms;

CO2 apply the knowledge gained in utilization of bio-fertilizers in organic farming.

CO3 isolate, identify and mass multiply the microbes used as bio-fertilisers.

Table -18: CO-PO matrix for the course Botany –SEC 02 (Bio-Fertilizers)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT SEC-2.1	3	2	1	2	2	3	1
BOT SEC-2.2	3	1	----------	2	1	2	1
Average	3.00	1.50	0.50	2.00	1.50	2.50	1.00

Table -18: CO-PSO matrix for the course Botany –SEC 02 (Bio-Fertilizers)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT SEC-2.1	1	1	2	-------	1	2
BOT SEC-2.2	--------	2	3	--------	---------	3
Average	0.50	1.50	2.50	---------	0.50	2.50

Unit I

General account about the microbes used as bio-fertilizers:

Rhizobium-isolation,identification, mass multiplication and carrier based inoculants, Actinorrhizal symbiosis.

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.

Azotobacter: classification, characteristics-crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogenfixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

Unit II

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence anddistribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation andinoculum production of VAM, and its influence on growth and yield of crop plants.

Organic farming: Green manuring and organic fertilizers.

Recycling of biodegradable municipal, agricultural and Industrial wastes- bio-compost making methods. Types and method of vermicomposting – field application.

Antagonistic bacteria and fungi- role in agriculture

Suggested Readings

- Dubey, R.C., 2005 A Text book of Biotechnology S. Chand & Co, New Delhi.
- Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
- John JothiPrakash, E. 2004. Outlines of Plant Biotechnology.EmkayPublication, New Delhi.
- Sathe, T.V. 2004. Vermiculture and Organic Farming. Daya publishers.
- SubhaRao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
- Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

SEMESTER IV-VI

SKILL ENHANCEMENT COURSE-III
PAPER CODE: BOT- S3

INTELLECTUAL PROPERTY RIGHTS

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To make aware students about legal aspects of Intellectual property.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 understand the concept of IPR and differentiate between various agreements of IPR.

CO2 compare copyrights, patents and geographical Indicators.

CO3 examine various legal issues related to IPR.

Table -19: CO-PO matrix for the course Botany –SEC 03 (Intellectual Property Rights)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT SEC-3.1	2	2	3	2	1	------	2
BOT SEC-3.2	2	2	3	1	1	---------	1
BOT SEC-3.3	1	2	3	1	1	1	-------
Average	1.66	2.00	3.00	1.33	1.00	0.33	1.00

Table -19: CO-PSO matrix for the course Botany –SEC 03 (Intellectual Property Rights)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT SEC-3.1	1	1	--------	3	2	1
BOT SEC-3.2	1	1	--------	3	3	2
BOT SEC-3.3	1	1	---------	3	2	1
Average	1.00	1.00	----------	3.00	2.33	1.33

Unit I

Introduction to intellectual property rights (IPR): Concept and kinds, economic importance.

IPR in India and world: Genesis and scope, some important examples.

IPR and WTO (TRIPS, WIPO).

Patents: Objectives, rights, patent act 1970 and its amendments. Procedure of obtaining patents, working of patents, infringement.

Copyrights: Introduction, works protected under copyright law, rights, transfer of copyright, infringement.

Trademarks: Objectives, types, rights, protection of goodwill, infringement, passing off, defenses, domain name.

Geographical indications: Objectives, justification, international position, multilateral treaties, national level, Indian position.

Protection of traditional knowledge: Objective, concept of traditional knowledge, holders, issues concerning, Bio-prospectingand Bio-piracy, alternative ways, protectability, needfor a *Sui-Generis* regime, Traditional knowledge on the international arena, at WTO, at National level, traditional knowledge digital library.

Unit II

Industrial designs: Objectives, rights, assignments, infringements, defences of design infringement

Protection of plant varieties: Objectives, justification, international position, plant varieties protection in India. Rights of farmers, breeders and researchers.

National gene bank, benefitsharing.

Protection of plant varieties and farmers' rights act, 2001.

Information technology related intellectual property rights- Computer software and intellectual property, database and data protection, protection of semi-conductor chips, domain name protection

Biotechnology and Intellectual Property Rights- Patenting biotech inventions: objective, applications, concept of novelty, Concept ofinventive step, Microorganisms,

Moral issues in patenting biotechnological inventions.

Suggested Readings:

- Arthur Raphael Miller, MichealH.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
- JayashreeWatal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.
- Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
- N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
- P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).

SEMESTER IV-VI

SKILL ENHANCEMENT COURSE-III

PAPER CODE: BOT- S4
FLORICULTURE

Internal Assessment: 10 Marks **External Marks: 40** **Total Marks: 50**

Credits: 2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two from each unit. Question no.1 is compulsory (Short answer type). Nine questions are to be set spread over entire syllabus. All questions carry equal marks (8 each).

Objectives: To sharpen the skills of learners about this self-employing discipline.

Learning Outcome: After completion of the course, the learner will be able to:

CO1 practically execute basic skills of designing of gardens and landscaping.

CO2 apply the knowledge gained for commercial floriculture.

Table -20: CO-PO matrix for the course Botany –SEC 04 (Floriculture)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT SEC-4.1	3	2	1	1	3	3	3
BOT SEC-4.2	3	2	1	2	2	3	2
Average	3.00	2.00	1.00	1.50	2.50	3.00	2.50

Table -20: CO-PSO matrix for the course Botany –SEC 04 (Floriculture)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT SEC-4.1	2	2	2	---------	2	3
BOT SEC-4.2	2	2	1	------	3	3
Average	2.00	2.00	1.50	------	2.5	3.00

Unit I

Introduction: History, importance and scope of floriculture and landscape gardening.

Nursery management and routine garden operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit II

Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (garden wall, fencing, steps, hedge, edging, lawn, flower beds, shrubbery, borders, water garden. Some famous gardens of India.

Landscaping ofplaces of public importance: Landscaping highways and educational institutions.

Commercial floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life.

Cultivation of Important cut flowers- Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium).

Diseases and Pests of Ornamental Plants.

Suggested Readings

- Allan M. Armitage and Judy M. Laushman. 2008. Speciality Cut Flowers: The Production of Annuals, Perennials, Bulbs and Woody Plants for Fresh and Dried Cut Flowers. Timber Press; REV
- Christopher Brickell. Royla Horticulture Society. Encyclopedia of Plants and Flowers (Rhs).
- D. Ravinath. 2007. Floriculture: A Viable Business. Excel Books.
- D.G. Hessayon. 2005. The House Plant Expert. Expert; 2nd edition.
- Desh Raj 2019. Floriculture At A Glance. KALYANI PUBLISHER, Delhi
- Floriculture, Vols. I and II Aavishkar Pub., Second Revised and Enlarged Edition, 798.
- Griner, C. 2020. Floriculture Deigning And Merchandising (4th Edition) CENGAGE LEARNING.
- J.S. Arora.2007. Introductory ornamental horticulture. Kalyani Publications.
- John M. Dole and Harold F. Wilkins. 2004. Floriculture: Principles and Secies : Prentice Hall; 2 edition (2nd Edition)
- Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
- S. Prasad, U. Kumar. 2010. A Handbook of Floriculture). Agrobios (India)
- S.K. Bhattacharjee and LakshmanChandran De. 2010. Advanced Commercial.
- Sathyanarayana,E.2019.A competitive book on Floriculture and Landscaping. Jain Brothers.
- Singh B, Singh N. and Kumar K. 2015. Common Garden Plants. Unique Publications, Panipat

SEMESTER IV-VI

SKILL ENHANCEMENTCOURSE- III

PAPER CODE: BOT- S5

ORGANIC FARMING

Internal Assessment: 10 Marks **External Marks: 40** **Maximum Total Marks: 50**

Credits:2 **Time: 3 Hours**

Note: Attempt five questions in all, selecting two questions from each unit. Question No. 1 is compulsory (short answer type). Nine questions are to be set spread over the entire syllabus. All questions carry equal marks (8 marks each).

Objectives: To familiarize the students about important aspects & benefits of Organic Farming.

Learning Outcomes: After completion of the course, the learners will be able to:

CO1 differentiate the different types of farming system and their important features.

CO2 apply the knowledge gained in carrying out organic farming practices.

Table -21: CO-PO matrix for the course Botany –SEC 05 (Organic Farming)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
BOT SEC-5.1	3	1	1	1	2	3	2
BOT SEC-5.2	3	2	1	1	1	3	3
Average	3.00	1.50	1.00	1.00	1.50	3.0	2.50

Table -21: CO-PSO matrix for the course Botany –SEC 05 (Organic Farming)

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BOT SEC-5.1	1	1	3	---------	2	3
BOT SEC-5.2	1	2	3	----------	3	3
Average	1.00	1.50	3.00	--------	2.50	3.00

Unit I

Basics of organic farming – Concept and components of organic farming, aims and objectives; Need of organic farming; Historical development of organic farming in India; Status of organic farming in India; Advantages and disadvantages of organic farming

Organic farming process- Concept of farming system, Developing organic farms, Important steps & methods; Pure organic farming and integrated farming system (combination of organic and inorganic),

Plant nutrients: Essential plant nutrients, their role in plant growth and development, Nutrient uptake and utilization by plant.

Nutrient management in organic farming: Balanced nutrients supply for organic farming system using nutrients from organic sources. Preparation, nutrient content and methods of use of following- FYM/Rural compost, mulching, city compost, oil cakes, animal wastes, vermicomposts, vermiwash, jeevamrit, beejamrit, green manures, biofertilizers.

Unit II

Bio fertilizers and their method of use – Nitrogenous, Phosphatic, Potassic, availability of nutrients from above sources.

Recycling of organic matter in organic agriculture - Transformation of organic substances in soil

Disease and pest management in organic farming- Integrated pest & disease managements; Organic pesticides, bio-pesticides; Inorganic pesticides, disadvantages of their use; Seed, seedling and soil treatment measures; Feasibility of complete dependence on organic sources. Weed management in organic farming

Use of Neem and other plant products in organic farming; Organic agri-horticulture in urban &semi urban areas.

Certification, Standardization, Marketing - Quality control and certification procedures of organic products.Organic standards In India. Govt. schemes related to organic farming in India. Potential demand and Marketing of organic products.Organic farming and food security in India.

Suggested Readings

1. P K Shetty Claude Alvares Ashok Kumar Yadav (Eds), 2014. Organic Farming And Sustainability. National Institute of Advanced Studies Bangalore, India.

2. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya Publishers.

3. SubhaRao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.

4. Vayas,S.C, Vayas, S. And Modi, H.A. 1998 Bio-Fertilizers And Organic Farming AktaPrakashan, Nadiad.

5. Narayanan S., 2005. Organic Farming in India: Relevance, Problems and Constraints. National Bank for Agriculture and Rural Development, 2005

6. Krishan Chandra, 2005. Organic Manures. Regional Centre of Organic Farming, Banglaore-24

7. Mohan S. etal Pest and Disease Management: Organic Ecosystem. TNAU Publication

8. S.R. Reddy, 2017. Principles of Organic Farming.Kalyani Publishers New Delhi

9. S.R. Reddy, 2017, Farming System and Sustainable Agriculture. Kalyani Publishers New Delhi

10. MamtaBansal . 2017. Basics of Organic Farming, CBS PUBLICATION.

11. K. Annadurai, SP. Palaniappan, 2018. Organic Farming: Theory And Practice. Scientific Publishers (India)

CO-PO-PSO mapping matrix for all the courses of B.Sc. Medical

Course code	PO 1	PO 2	PO3	PO 4	PO 5	PO6	PO 7	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO 6
B 101	2.33	------	------	1.66	2.00	1.66	2.00	2.33	2.66	1.66	------	1.33	3.00
B 102	2.00	------	-------	1.33	1.33	1.33	1.00	2.00	1.33	1.00	0.33	2.00	2.66
B 201	3.00	1.00	1.66	0.33	2.33	2.66	2.66	1.66	0.66	0.33	1.66	1.00	1.33
B 202	3.00	2.33	0.66	1.66	1.66	1.00	1.66	3.00	1.00	0.33	0.33	1.66	2.00
B 301	2.66	1.66	0.33	1.66	1.33	0.33	2.00	2.00	1.33	1.33	--------	2.00	2.00
B 302	3.00	1.50	0.50	1.50	1.00	------	2.00	2.50	1.50	2.50	0.50	2.00	2.00
B 401	3.00	2.33	1.00	1.33	1.66	0.66	2.33	1.66	2.33	2.66	1.00	2.33	2.00
B 402	3.00	2.50	1.50	2.00	2.00	0.50	1.50	0.50	1.50	2.50	1.00	2.50	2.00
B 501	3.00	1.50	2.50	2.00	3.00	2.50	3.00	3.00	1.50	1.50	2.00	1.00	3.00
B 502	3.00	1.75	3.00	1.50	2.25	0.75	1.25	0.75	2.75	2.75	1.75	1.25	2.00
B 503	3.00	0.66	0.33	1.00	1.00		0.66	2.33	2.66	2.00	1.00	2.00	2.00
B 504	3.00	3.00	2.00	1.50	2.00	1.00	1.50	2.50	3.00	2.00	1.00	2.00	2.50
B 601	3.00	2.66	2.33	1.00	1.68	-------	1.68	1.66	2.00	2.00	1.66	1.66	1.66
B 602	3.00	2.25	1.75	1.00	2.25	1.50	1.50	1.50	1.00	2.75	1.25	2.25	2.50
B 603	1.33	3.00	1.00	1.33	0.66		1.33	0.33	2.33	3.00	2.66	3.00	2.33
B 604	1.66	3.00	1.00	1.33	1.33		2.00	----	2.00	3.00	1.66	3.00	2.00
SEC 01	2.50	1.50	0.50	1.50	2.00	2.50	2.00	2.00	2.00	2.50	-------	1.00	3.00
SEC 02	3.00	1.50	0.50	2.00	1.50	2.50	1.00	0.50	1.50	2.50	-----	0.50	2.50
SEC 03	1.66	2.00	3.00	1.33	1.00	0.33	1.00	1.00	1.00	----	3.00	2.33	1.33
SEC 04	3.00	2.00	1.00	1.50	2.50	3.00	2.50	2.00	2.00	1.50	------	2.5	3.00
SEC 05	3.00	1.50	1.00	1.00	1.50	3.0	2.50	1.00	1.50	3.00	--------	2.50	3.00

KURUKSHETRA UNIVERSITY KURUKSHETRA

BOTANY DEPARTMENT

M.Sc. BOTANY Scheme of Examination (CBCS) w.e.f. 2020-21in Phased Manner

Semester I

Paper code	Title of paper	Type of paper	Hours /week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-101	Algae & Fungi	Core	4	4	80 + 20	100	3 hrs
BOT-102	Bryophytes & Pteridophytes	Core	4	4	80 + 20	100	3 hrs
BOT-103	Cytogenetics & plant breeding	Core	4	4	80 + 20	100	3hrs
BOT-104	Ecology	Core	4	4	80 + 20	100	3 hrs
BOT-105	Practical based on 101 + 102	Core	8	4	80 + 20	100	6 hrs
BOT-106	Practical based on 103 + 104	Core	8	4	80 + 20	100	6 hrs
Total				24		600	

Semester-II

Paper code	Title of paper	Type of paper	Hours/ week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-201	Microbiology and Biostatistics	Core	4	4	80 + 20	100	3 hrs
BOT-202	Natural Resources & Biodiversity	Core	4	4	80 + 20	100	3 hrs
BOT-203	Gymnosperms & Ethnobotany	Core	4	4	80 + 20	100	3 hrs
BOT-204	Molecular genetics	Core	4	4	80 + 20	100	3 hrs
BOT-205	Seminar	Core	1	1	25	25	1 hr
BOT-206	*Plants for human welfare	Open Elective	2	2	40 + 10	50	3 hrs
BOT-207	Practical based on 201 + 202	Core	8	4	80 + 20	100	6 hrs
BOT-208	Practical based on 203 + 204	Core	8	4	80 + 20	100	6 hrs
Total				27		675	

Semester III

Paper code	Title of paper	Type of paper	Hours/ week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-301	Plant physiology & Plant biochemistry	Core	4	4	80 + 20	100	3 hrs
BOT-302	Plant Taxonomy & Economic botany	Core	4	4	80 + 20	100	3 hrs
BOT-303	Plant Biotechnology & Genetic engineering	Core	4	4	80 + 20	100	3 hrs
BOT-304	a) Advanced Phycology-I (elective) b) Applied Mycology (elective) c) Restoration Ecology (elective) d) Advanced Plant Physiology (elective) e) Biophysical & biochemical techniques (elective)	Elective	4	4	80 + 20	100	3 hrs
BOT-305	Seminar	Core	1	1	25	25	1 hr
BOT-306	*Biodiversity and its conservation	Open Elective	2	2	40 + 10	50	3 hrs
BOT-307	Practical based on 301	Core	6	3	60 + 15	75	6 hrs
BOT-308	Practical based on 302 + 303	Core	6	3	60 + 15	75	6 hrs
BOT-309	Practical based on 304	Core	4	2	40 + 10	50	6 hrs
Total				27		675	

Semester IV

Paper code	Title of paper	Type of paper	Hours/ week	Credits	Marks + Internal Assessment	Total	Duration of Exam
BOT-401	Physiology of Plant growth & development	Core	4	4	80 + 20	100	3 hrs
BOT-402	Biology of Reproduction and Anatomy	Core	4	4	80 + 20	100	3 hrs
BOT-403	Plant Tissue Culture	Core	4	4	80 + 20	100	3 hrs
BOT-404	a) Advanced Phycology-II (elective) b) Principles of Plant Pathology (elective) c) Conservation Biology (elective) d)Plant Growth Regulators (elective) } e) Genomics (elective)	Elective	4	4	80 + 20	100	3 hrs
BOT-405	Practical based on 401	Core	6	3	60 + 15	75	6 hrs
BOT-406	Practical based on 402 + 403	Core	6	3	60 + 15	75	6 hrs
BOT-407	Practical based on 404	Core	4	2	40 + 10	50	6 hrs
BOT-408	**Project Work/Field Training Report	Core	4	4	100	100	
Total				28		700	

*** Students can choose two open elective courses from the courses available in any department of Kurukshetra University Kurukshetra/Mooc courses available on Swayam portal- Two credits each**

****Candidates shall be allotted to teachers at the beginning of II semester to facilitate the students to carry project work during semester break in house or in other institutes. Project report would be prepared and submitted under guidance of the concerned teacher.**

Total Credits = 106 **Total Marks = 2650**

Programme Outcomes for PG courses of Faculty of Life Sciences:

1. To acquaint students with recent knowledge and techniques in basic and applied biological sciences.
2. To develop understanding of organismal, cellular, biochemical and environmental basis of life
3. To provide insight into ethical implications of biological research for environmental protection and good laboratory practices and biosafety.
4. To develop problem solving innovative thinking with robust communication and writing skills in youth with reference to biological, environmental and nutritional sciences.
5. To understand the applications of biotic material in health, medicine and food security for human well being and sustainable development.
6. To impart practical and project based vocational training for preparing youth for a career in research and entrepreneurship in fields of life sciences for self reliance.

Program Specific Outcomes (PSOs):

1. Biodiversity of lower and higher plants along with their taxonomic status. The students will have in-depth knowledge about physiology and metabolism of plants.
2. Students will be able to gain in-depth knowledge regarding ethnobotany, conservation status and strategies of economically important plants.
3. This program aims to critically engage students with concepts of ecological principles, biodiversity, population, community, ecosystem structure and function, importance of environment and the problems related with it at local and global level.
4. The students will have strong base knowledge of physiological, cellular and molecular aspects of plants biology. It will help them venture into advanced research areas.
5. This program will help students to be aware of good laboratory practices in microbial technology and plant biotechnology.

SEMESTER – I

Paper – BOT-101 Algae & Fungi Credit -4 MM-80+20 T: 3hrs

Objectives: To educate and train the students for professional and research career in the field of Algology & Mycology.

Outcomes:

CO1 The students will be inspired to become aware and comprehend the broader aspects of Algology.
CO2 The learning outcome will be aimed towards advanced academic education to broaden the knowledge its Biodiversity, Ecological significance and Economic importance of algae.
CO3 The students will be inspired to become well versed with the fungal world in terms of recent researches.
CO4 Economic importance of Fungi with regards to its deleterious and beneficial aspects. Modern economic importance of Lichens. Working knowledge of biological laboratories and research centres in India.

CO-PO MAPPING MATRIX FOR PAPER BOT-101 (Algae & Fungi):

No.	PO1	PO2	PO3	PO 4	PO5	PO6
CO 1	2	1	2	2	2	3
CO 2	2	2	2	2	1	2
CO 3	2	1	2	2	1	1
CO 4	2	2	1	2	1	1
Average	2	1.5	1.75	2	1.25	1.75

CO-PSO MAPPING MATRIX FOR PAPER BOT-101 (Algae & Fungi):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	1	2
CO2	2	2	1	2	1
CO3	1	1	2	1	2
CO4	2	2	2	2	2
Average	1.75	1.5	1.75	1.5	1.75

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Criteria for algal classification (pigments, reserve food, flagella etc.) and their taxonomic importance.
2. Comparative account of important systems of classification and recent trends.
3. Thallus organization in algae and evolutionary trends.
4. Economic importance of algae as food, feed, uses in industries etc and algal biofertilizers.

Unit-II

5. Biodiversity of algae in different habitats (terrestrial, freshwater and marine).
6. Ecological diversity of algae in unusual habitats (thermal, psychrophilic, subaerial, symbioticetc.).
7. Dynamics and consequences of algal blooms and red tides (Freshwater and Marine). Algae as major components of phytoplankton.
8. Morphological features and life cycle patterns of major divisions with suitable examples (Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, and Rhodophyta).

Unit- III

9. General characters of fungi: Thallus organization, nutrition and reproduction.
10. Classification of fungi by Ainsworth & Bisby (1983), Alexopoulus et. Al (1996).- phylogeny of fungi- characters used in classification.
11. General account of Myxomycota, mastigomycota, Zygomycota, Ascomycota, Basidiomycota and Mitosporic gungi. Different kinds of spores and their dispersal.
12. Concept of Homothallism, Heterothallism, alternation of generations and parasexualuality.

Unit – IV

13. Economic importance of fungi in nutrient cycling, decomposition, humus formation, decay and deterioration of wood & timber.
14. Causal organisms, sysptoms and management of : late and early blight of potato, downy mildew of grapes, green ear disease of Bazra (Sorghum), apple scab, karnal bunt of wheat, rust of wheat, tikka disease of ground nut
15. Lichens: structure, reproduction and economic importance

Suggested Readings:

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications.* Daya Publishing House, New Delhi. 2003.
2. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
3. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.
4. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publihers.
5. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.
6. Gupta, R.K. & Pandey, V.D. (2007): Advaces in Applied Phycology, Daya Publishing House, Daryaganj, New Delhi.
7. Hoek, C. Van Den, Mann, D.G. & Jahns, H.M. (1995): Algae: An Introduction to Phycology, Cambridge University Press, U.K.
8. Kaushik, B.D. (1987): Laboratory methods for Blue-green Algae, Associated Publishing Co., New Delhi.
9. Morris, I. (1980): The Physiological Ecology of Phytoplankton (studies in Ecology, Vol.7), Blackwell Scientific Publ., USA.
10. Prescott, L.M., Harley, J.P. & Klein, D.A. (1996): Microbiology, 3rd edition, Wm. C. Brown Publishers, USA.
11. Singh, B.D. (1998): Biotechnology, Kalyani Publishers, New Delhi.
12. Singh, R.P. (1990): Introductory Biotechnology, Central Book Depot, Allahabad, India.
13. Sze, P. (1993): A. Biology of the Algae, Wm. C. Brown Publishers, U.K.
14. Venkataraman, G.S. ((1969): The Cultivation of Algae, IARI, New Delhi.
15. Alexopoulos, C.J. Mins, C.W. & Blackwell, M. 1995: Introductory Mycology, John Willy and Sons. Inc.
16. Bilgrami, K.S. & Dubey H.C. (1986): A text book of Modern Plant Pathology, Vikas, Publ Ltd., N.Delhi.
17. Bilgrami, K.SA. & Verma R.N. (1981): Physiology of fungi, Vikas Publ. Ltd., New Delhi.
18. Biswas, S.P. & Biswas, A. 1984: An Introduction to Viruses, Vani Education Books, New Delhi.
19. Butler, E.J. & Jones, S.G. (1978): Plant Pathology, Periodical Expert Book Agency, New Delhi.

20. Clifton, A. 1958: Introduction to the Bacteria. McGraw Hill Books Co. New York.
21. Mehrotra, R.S. & Aneja, K.R. 1990: An introduction of Mycology, New Age International Press, N.Delhi.
22. Moore-landeckar, E.J. (1972): Fundamentals of the fungi, Prentice Hall, Eaglewood, U.K.
23. Mundukar, B.B. (1967): Fungi & Plant Diseases, Mac million Co. Ltd., USA.
24. Webster, J. 1985: Introduction of Fungi. Cambridge University, Press.

Paper – BOT-102 – BRYOPHYTES & PTERIDOPHYTES Credit -4 MM-80+20 T: 3hrs

Objectives: The course has been conceived to equip students with the knowledge of characteristics, structure and development of gametophyte and sporophyte in bryophytes & pteridophytes.

Outcomes:

CO1 Classify and distinguish bryophytes and pteridophytes from other groups of plants.
CO2 Learn about the origin and evolution of sporophyte, heterospory, origin of seed habit , evolutionary trends in stele and spore producing organs.
CO3 Describe the ecological, economic significance of bryophytes and pteridophytes,
CO4 Appreciate role of these group of plants in understanding basic concepts of morphogenesis, apogamy, apospory and regulation of development *in vitro*.

CO-PO MAPPING MATRIX FOR PAPER BOT-102 (BRYOPHYTES & PTERIDOPHYTES):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	2	2
CO2	2	2	2	2	1	2
CO3	2	2	2	2	2.5	2
CO4	2	2	2	2	2	2
Average	2	2	2	2	1.875	2

CO-PSO MAPPING MATRIX FOR PAPER BOT-102 (BRYOPHYTES & PTERIDOPHYTES):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2.5	2.5	2	2.5	2.5
CO2	2	2	2.5	2	2.5
CO3	2	2.5	2.5	2	2
CO4	2	2	2	3	3
Average	2.125	2.25	2.25	2.375	2.5

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. General characteristics features of Bryophytes. Classification of Bryophytes upto classes, General account of structure and development of gametophyte, sporophyte of Marchantiales, Jungermanniales and Anthcerotales.
2. General account of structure and development of gametophyte and sporophyte of Sphagnales, Funariales and Polytrichales.

Unit -II

3. Regulation of protonemal differentiation and bud formation.
4. Biology of reproduction- *In Vitro* regulation of gametangia formation: effect of physical and chemical factors, Cytology of Bryophytes, Apogamy and Apospory.

5. Ecological importance of bryophytes: Bryophytes as indicators of pollution and minerals; role of Bryophytes in succession

Unit-III

6. General characteristics of Pteridophytes and their classification
7. Comparative morphology and reproduction of the following:
   Psilophytales (Rhynia, Zosterophyllum), Psilotales (Psilotum), Lycopodiales (Lycopodium, Selaginella), Lepidodendrales (Lepidodendron),
   Sphenophyllales (Equisetum)

Unit- IV

8. Comparative morphology and reproduction of the following :
   Ophioglossales (Ophioglossum, Botrychium), Marattiales (Marattia, Angiopteris), Osmundales, Filicales (Pteris, Dryopteris),Marsileales and Salviniales
9. Economic and Ecological significance of Pteridophyte in succession.

Suggested Readings:

1. Parihar, N.S. 1965. An Introduction to Embryophyta Vol. I. Bryohpyta, Central Book Depot, Allahabad, India.
2. Schofield, W.B. 1985. Introduction to Bryology, Macmillan, New York.
3. Chopra, R.N. and Kumra, P.K. 1988. Biology of Bryophytes. Wiley Eastern Ltd., New Delhi.
4. Chopra, R.N. & Bhatla, S.C. 1990. Bryophyte Development: Physiology and Biochemistry.CRC Press, Boca Raton, USA.
5. Rashid, A. 1998. An Introduction to Bryophyta. Vikas Publishing House Pvt. Ltd. New Delhi.
6. Watson, E.V. 1967. The Structure and Life of Bryophytes. B.I. Publications, New Delhi.
7. Glime, J.M and Saxena D. 1991. Uses of Bryophytes. Today and Tomorrow's Printers and Publishers, New Delhi.
8. Richardson, D.H.S. 1981. The Biology of Mosses. Blackwell Scientific Publications, Oxford, London.
9. Parihar, N.S. 1977. The Biology and Morphology of Pteridophytes. Central Book Depot. Allahabad.
10. Rashid, A. 1976. An Introduction to Pteridophyta (Diversity and Differentiation). Vikas Publishing House Pvt. Ltd., New Delhi.
11. Sporne, K.R. 1985 (reprint) The Morphology of Pteridophytes. B.I. Publications Pvt. Ltd., Delhi.

Paper – BOT-103 - CYTOGENETICS AND PLANT BREEDING Credit -4 MM-80+20 T: 3hrs

Objective: The purpose of this paper is to acquaint the students about structure and functions of a chromosome in detail. The course also explains the chromosomal variations and their effects on biological system. Further, it aims to draw attention to methods used for crop improvement.

Outcomes:
CO1 The students get acquainted about the different cytogenetic and molecular techniques used for genome analysis.
CO2 This course will enable the students to use linkage and recombination frequencies in gene mapping.
CO3 The students get familiarised about role of chromosomes in sex determination and generation of variations.
CO4 The students will know about the methods that can be used to create the desired genotype/phenotype.

CO-PO MAPPING MATRIX FOR PAPER BOT-103 (CYTOGENETICS AND PLANT BREEDING):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	3	3
CO2	3	3	1	2	2	3
CO3	3	3	1	2	3	3
CO4	3	2	2	2	3	3
Average	3	2.75	1.25	2	2.75	3

CO-PSO MAPPING MATRIX FOR PAPER BOT-103 (CYTOGENETICS AND PLANT BREEDING):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	1
CO2	2	2	1	2	1
CO3	2	1	3	3	1
CO4	3	3	1	3	1
Average	2.5	1.5	1.75	2.75	1

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Chromatin structure and organization: Chromosome structure and DNA packaging; euchromatin and heterochromatin.
2. Organization of plastid and mitochondrial genomes.
3. Special Chromosomes: Structure, occurrence and behaviour of polytene, lampbrush, B and sex chromosomes.
4. Karyotype: Karyotype analysis and its evolution; FISH, GISH and flow cytometery.

Unit-II

5. Cell cycle: Cell cycle phases, checkpoints and regulation.

6. Chromosome banding techniques and their applications.
7. Linkage and crossing over: Molecular mechanism of crossing over and role of different enzymes; linkage groups.
8. Chromosome mapping- Two point and three point test crosses.

Unit-III

9. Sex determination: Chromosomal and gene determining sex in plants, animals, *Drosophila* and humans; Gene dosage compensation.
10. Structural alterations in chromosomes – Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes.
11. Variation in chromosome number: Haploids, aneuploids and euploids- origin, production, effects and uses; polyploidy and crop improvement.

Unit-IV

12. Principles of plant breeding: Principles and objectives; methods of breeding self and cross pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding.
13. Asexual breeding systems: Methods of breeding of vegetatively propagated crops; Non-conventional methods; gene variability.
14. Male sterility: Concept; classification; genetic control; inheritance pattern and breeding utility.

Suggested Readings:

1. Alberts B, Johnson A, Lewis J. Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5th Ed.). Garland Publishing Inc., New York.
2. Gustafron JP (2002) Genomes, Kluwer Academic Plenum Publishers, New York, USA.
3. Karp G (1999) Cell and Molecular Biology, John Wiley and Sons, USA.
4. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
5. Lewin B (2010) Gene X, Jones and Barlett Publishers.
6. Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008) Molecular Cell Biology (6th Ed), W.H. Freeman and Company, New York, USA.
7. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
8. Poehlman JM and Sleper DA (1995) Breeding Field Crops, AVI. Publ., U.S.A.
9. Russell PJ (2006) Genetics (5th Ed.), Addison Wesley Longman, California, USA.
10. Snustad P and Simmons MJ (2011) Principles of Genetics. (6th Ed.), John Wiley, New York.
11. Weaver RF (2005) Molecular Biology, McGraw Hill International Edition.
12. Watson, JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6th Ed.), CSHLP, New York.

Paper – BOT-104 – ECOLOGY Credit -4 MM- 80+20 T: 3hrs

Objectives: Critically engage with concepts of Ecological principles and importance of environment and the problems related with it at global and local level.

Outcomes:
CO1 Students will be able to understand about limiting factors controlling distribution and growth of organisms.
CO2 Students will be able to develop insights about the concepts of populations, community and ecosystems and can use in management of natural resources for sustainable development.
CO3 Students will be able to comprehend interactions among components of ecosystems for better stability.
CO4 By understanding the concept of ecological principles and environmental issues, the students will be able to develop attitude, value system and ethics towards environmental related issues.

CO-PO MAPPING MATRIX FOR PAPER BOT-104 (ECOLOGY):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	1	1	1	1
CO2	2	3	3	1	2	2
CO3	3	2	3	2	2	1
CO4	3	3	2	2	3	2
Average	2.5	2.75	2.25	1.5	1.5	1.5

CO-PSO MAPPING MATRIX FOR PAPER BOT-104 (ECOLOGY):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	3	1	1
CO2	2	3	3	2	1
CO3	1	3	3	2	1
CO4	2	3	3	2	2
Average	1.5	3	3	1.75	1.25

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. The Environment: Physical environment, biotic environment, biotic and abiotic interactions; Tolerance range and limiting factors, ecotypes
2. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
3. Population ecology: Concept, characteristics, population growth and regulation, species interactions—mutualism, competition, allelopathy, predation, parasitism, Life-history strategies and r-and K selection, concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations

Unit-II

4. Community structure and organization; Nature of communities, community structure and its attributes; species diversity, Edges and ecotones, vegetation characteristics (analytical and synthetic characters, methods of analysis.
5. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit-III

6. Ecosystem organization: structure and functions; primary production (global pattern and controlling factors); energy dynamics—trophic levels, energy flow pathways and ecological efficiencies.
7. Decomposition (mechanism, substrate quality and climatic factors); global biogeochemical cycles of C, N, P, & S, ecosystem stability (resistance and resilience).

Unit-IV

8. Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India, speciation and extinction, endemism.
9. Global atmosphere changes: Environmental pollution, global environmental change and its consequences (CO2 fertilization, global warming sea level rise and UV radiation).

Suggested Readings :

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Miller (Jr.) and G. Tyler (1994) : Living in the Environment. Wadsworth Publishing Company, Belmont, California.
3. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.
4. Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.
5. Ramakrishnan, P.S. 2000. Ecology and Sustainable Development. National Book Trust, India
6. Robert Ricklefs (2001). The Ecology of Nature. Fifth Edition. W.H. Freeman and Company.
7. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
8. Smith, R.L. (1996), Ecology and Field Biology, Harper Collins, New York.
9. Steffen, W., A. Sanderson, P. D. Tyson, J. Jager, P. M. Matson, B. Moore, III, F. Oldfield, K. Richardson, H. J. Schnellnhuber, B. L. Turner, II, and R. J. Wasson. 2004. Global change and the Earth system: a Planet under Pressure. Springer-Verlag, New York, New York, USAReference books.
10. Townsend, C.R., Begon, M. And Harper, J.L. 2003. Essentials of Ecology. Second Edition. Blackwell Publishing, Oxford.

Paper – BOT-201 – Microbiology and Biostatistics Credit -4 MM- 80+20 T: 3hrs

Objectives: The Course has been conceived to equip the students with the knowledge of various microbial pathogens and their effect on human affairs. In addition, the course also deals with growth, collection and maintenance of microbes, their interactions and control different therapeutic methods.

Outcomes:

CO1 To acquaint the students with the knowledge of various microbes (viruses, bacteriophages, and Cyanobacteria their impacts Biological Importance.
CO2 The Course has been conceived to equip the students with the knowledge of various laboratory conditions for their culture and maintenance of microorganisms in terms of their control through physical and chemical methods.
CO3 It is aimed to impart knowledge about microbial interactions in the wider context of Environmental Microbiology biological laboratories and research centres in India.
CO4 Working knowledge of biostatistics and there importance in the plant sciences while discussing the results & findings in terms of correlations, regressions and other details.

CO-PO MAPPING MATRIX FOR PAPER BOT-201 (Microbiology and Biostatistics):

	PO 1	PO 2	PO3	PO 4	PO5	PO6
CO1	2	1	1	2	2	2
CO2	1	2	1	2	2	2
CO3	2	2	1	1	1	1
CO4	1	1	2	2	2	1
Average	1.5	1.5	1.25	1.75	1.75	1.5

CO-PSO MAPPING MATRIX FOR PAPER BOT-201 (Microbiology and Biostatistics):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	1	1	1
CO2	1	1	2	2	1
CO3	2	1	1	2	1
CO4	1	2	1	2	2
Average	1.25	1.5	1.25	1.75	1.25

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Structure & replication of viruses and bacteriophage; transmission & control of viruses; Isolation & purification of Plant Viruses.
   Diseases caused by Viruses**:** TMV, Tristeza of citrus
2. Cyanobacteria: Salient features and Biological Importance.

Unit-II

3. Growth, culture and maintenance of microorganisms
   Microbial growth and measurement, environmental factors influencing growth.

4. Control of micro organisms: Physical methods(High temperature, dry hot or hot air sterilization, moist air sterilization, low temperature, filtration, lycophilisation, Radiation), Chemical methods (Disinfectants and antiseptics)

Unit-III

5. Microbial interaction: Functions of symbiotic relationships, types of symbiosis, commensalism, synergism, mutualism-(Lichens, Bacterial endosymbionts of protozoa, Nitrogen fixing symbiosis,mycorrhizae), parasitism.
6. Environmental Microbiology**:** Microbiology of fresh, marine and extreme environment, Biofilms, Bioremediation of polluted environment, Bioleaching.

Unit-IV

7. Biostatistics: Brief description and tabulation of data and its graphical representation.
8. Measures of central tendency and dispersion.
9. Mean, mode, median, range standard deviation, variance idea of two types of errors and level of significance, tests of significance (F & t test); chi-square test.
10. Simple Linear Regression and Correlation.

Suggested Readings:

1. Gupta R & Mukherji K G (2001). Microbial technology, APH Publ. co., New Delhi.
2. Pelezar, MJ, Chaing, ECS & Krieg, NR (1993). Microbiology, Tata McGrawHill Publ. New Delhi.
3. Prescott, LM., Harley, JP & Klein, DA (1996). Microbiology Wm. C. Brown Publ. USA.
4. Ronald, M Atlas (1995). Principles of microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.
5. Singh R.P. (1990): Introductory Biotechnology, Central Book Depot, Allahabad, India.
6. Sumbali, G. 2005: The Fungi, Narosa Publ. House, New Delhi.
7. Statistics for Biologists (1974) Campbell R.C. Cambridge University Press, Cambridge.
8. Statistics in Biology, Vol. 1 (1967) Bliss, C.I.K, McGraw Hill, New York

Paper-BOT-202: Natural Resources and Biodiversity Credit -4 MM-80+20 T: 3hrs

Objectives: This course aims to develop knowledge regarding natural resources and their utilization. This also aims to critically engage students with biodiversity-its status, monitoring and conservation.

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

CO1 Resources and their sustainable uses.
CO2 Environmental issues at global and local level.
CO3 Ecosystem Restoration
CO4 Conservation status and strategies, sustainable indicators

CO-PO MAPPING MATRIX FOR PAPER BOT-202 (Natural Resources and Biodiversity):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	1.5	3	2
CO2	3	2	2	1.5	2	3
CO3	2	2	3	1	3	2
CO4	2	2	3	1	2	3
Average	2.25	2	2.75	1.25	2.5	2.5

CO-PSO MAPPING MATRIX FOR PAPER BOT-202 (Natural Resources and Biodiversity):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	3	1	1.5
CO2	2	3	3	2	1
CO3	1	3	3	2	2
CO4	2	3	3	1	1.5
Average	1.5	3	3	1.5	1.5

Note:-

1. Nine questions will be set in all.
2. Question No. 1, which will be objective/short –answer type covering the entire syllabus, will be compulsory. The remaining eight questions will be set section-wise with two questions from each unit I, II, III & IV. The candidates will be required to attempt Q. No. 1 and four more selecting one question from each section.

Unit-I

1) Resources: Types, Renewable and non-renewable resources; resources degradation and conservation.
2) Land resources: Land degradation and desertification; management of waste lands in India.
3) Water resources: Pools of water and Hydrological cycles, surface water and ground water; water-use and management.
4) Environmental pollution of air, water and soil-types, sources and effects.

Unit-II

5) Forest resources: Forests and their importance, Non timber forest produce, forest resources of India and forest management.
6) Types of energy resources, renewable sources of energy-wine energy, wave energy, Energy from biomass, bioconversion technologies, energy plantation and petrocrops.
7) Ecosystem restoration and Environment impact assessment- Brief account.

Unit- III

8) Principals of resources conservation and conservation strategies.
9) Biological diversity: importance, concept and levels biodiversity, threats to biodiversity-habitat loss and fragmentation, exotic species, pollution, species extinctions; IUCN categories of threat.
10) Distribution and global patterns of biodiversity.
11) Terrestrial and marine hotspots of biodiversity; Hotspots of biodiversity in India.

Unit- IV

12) *In situ* conservation of biodiversity: Protected area in India wildlife sanctuaries, national parks, biosphere reserves.
13) Conservation of biodiversity of wetlands, mangroves and coral reefs.
14) *Ex situ* biodiversity conservation: principles and practices, field gene banks, seed banks and cryopreservation.
15) Sustainable development: concept, principles and strategies; sustainability indicators.

Suggested Readings:

1. Ball, J.B. 2001. Global forest resources: history and dynamics. In: *Forest Handbook Volume* 1, Evans, J. (ed.) Blackwell Science, Oxford.
2. Chape, S., Fish, L. Fox, P. and Spalding, M. 2003. United Nations list of protected areas. UCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge.
3. Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk by. The Hague.
4. Heywood, V.(Ed.) (1995) Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge.
5. Huston, M.A. 1994. *Biological Diversity*: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
6. Owen, O.S., Chiras, D.D. and Reganold, J.P. 1998. Natural Resource Conservation: Management for Sustainable Future. Seventh Edition. Prentice Hall. Upper Sadle River, New Jersey.
7. Raven, P.H. and Berg, L.R. 2005. Environment , 5th Edition, John Wiley & Sons Inc., New York.
8. Singh, J.S. and Singh, S.P. 1992. *Forests of Himalaya, Structure, Functioning and Impact of Man.* Gyanodaya Prakashan, Nainital, India.

9. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.

Paper – BOT-203 – Gymnosperms &Ethnobotany Credit -4 MM- 80+20 T: 3hrs

Objective: This course is intended to provide the basic understanding of morphology and reproduction in pteridophytes and gymnosperms. It also describes the modern methods of propagation of gymnosperms.

Outcomes:

CO1 Classify and distinguish gymnosperms from other groups of plants.
CO2 Trace evolutionary trends in development of male and female gametophytes
CO3 Learn about economic importance of gymnosperms and modern methods of their propagation.
CO4 Explain the ethnobotany, its history, significance , methods and techniques used in ethnobotanical study and research.

CO-PO MAPPING MATRIX FOR PAPER BOT- 203 (Gymnosperms &Ethnobotany):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	2	2	1
CO2	2	2	1	1	1	1
CO3	3	2	1	2	3	2
CO4	2	2	1	1	3	2
Average	2.25	2	1	1.5	2.25	1.25

CO-PSO MAPPING MATRIX FOR PAPER BOT-203 (Gymnosperms & Ethnobotany):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	1
CO2	3	3	2	1	1
CO3	2	2	1	1	1
CO4	3	2	2	1	1
Average	2.75	2.5	1.75	1	1

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Classification of gymnosperms and their distribution in India.
2. Brief account of the following families:
   Lyginopteridaceae, Medullosaceae, Glossopteridaceae, Caytoniaceae.

Unit – II

3. General account of the following orders:
   Cycadeoidales(Cycadeoidea), Pentoxylales, Cordiatales
4. Comparative account of Structure and reproduction in the following orders:
   Cycadales (Cycas), Ginkgoales (Ginkgo).

Unit- III

5. Coniferales (Pinus, Cedrus), Ephedrales (Ephedra), Welwitschiales, Gnetales
6. Economic importance of gymnosperms, Role of Gymnosperms in Biodiversity.
7. Modern methods of propagation of gymnosperms: somatic embryogenesis, haploids and protoplast culture

Unit-IV

8. Ethnobotany: History and importance of ethnobotany, ethnomedicobotany, ethnozoology, ethnoveterinary, ethnomusicology and ethnoagriculture

9 Wild edible plants used as emergency food by triblals in India, methods and techniques in ethnobotanical study and research.

10. Traditional plants: Cereals, pulses, vegetables, spices and mushrooms, wild edible fruits and seeds. Plants in folk songs and proverbs. Sacred grooves, Impact of moderenization.

Suggested Readings:

1. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New Delhi.
2. Sporne, K.R. 1965. The Morphology of Gymnosperms. B.I. Publications Pvt. Ltd., New Delhi.
3. Bierhorst, D. W. 1971. Morphology of Vascular Plants. Macmillan. New York.
4 . Cotton, C.M. 1996. Ethnobotany- Principles and Appliations, Centruy School Book by service Film setting Ltd.
5. Dahlgren. R.H., Clifford, T and P.F Yeo 1985.The families of the monocotyledons; structure, Evolution and Taxonomy. SpingeVerag, NY.
6. Gary J, Martin, 2004. Ethnobotany- A Methods Manual, Chapman and Hall. U.K.
7. Jain S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.
8. Jain S.K. 1987. A manual of ethnobotany. Scientific publisher Jodhpur.
9. Jain S.K. and Mundgal, 1999. Handbook of ethnobotany, London.
10. Pursrglove, J.W. 1972. Tropical Crops-Monocotyledons and Dicotyledons of ethnobotany, ethnomedicine, ethnoecology, ethnic communities.
11. Rao, P.C. 2006. Medicinal plants: Ethanobotanical Approach, Agribios, India.
12. Trivedi, P.C. 2006. Medicinal plants: Ethanobotanical Approach, Agribios, India.
13. Yoganarasimhan, S.N. Medicinal Plants of India-Vol-I- Karnataka, Interline Publishing Pvt. Ltd.

Paper – BOT-204 – MOLECULAR GENETICS Credit -4 MM- 80+20 T: 3hrs

Objective: This course is intended to provide the basic understanding of biological processes such as DNA replication, transposition and mutations. A key thrust of this paper is towards the molecular mechanisms involved in the control of gene expression and regulation.

Outcome:
CO1 The students will have enhanced understanding of genome structure, evolution and its replication.
CO2 This course will impart the knowledge of basics of mutations and their importance; DNA repair mechanisms.
CO3 The students will learn about the methods of genetic recombination in bacteria
CO4 The students will gain insight into the principle mechanisms of genome expression and its regulation.

CO-PO MAPPING MATRIX FOR PAPER BOT- 204 (MOLECULAR GENETICS):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	2	3
CO2	2	3	3	2	3	2
CO3	2	1	1	2	3	1
CO4	3	3	2	1	3	1
Average	2.5	2.5	1.75	1.75	2.75	1.75

CO-PSO MAPPING MATRIX FOR PAPER BOT-204 (MOLECULAR GENETICS):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	1
CO2	2	2	2	3	2
CO3	1	2	2	1	1
CO4	1	2	1	3	2
Average	1.75	2	2	2.5	1.5

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

UNIT-I

1. Eukaryotic genome: Different forms of DNA, C- value paradox, unique and repetitive DNA, gene families, hybridization kinetics and split genes.
2. Transposable elements: Mechanisms of transposition; transposons in bacteria, maize, *Drosophila* and yeast.
3. DNA Replication: Semi-conservative, bidirectional, replication origins, replication machinery.

UNIT-II

4. Mutations: types, isolation of mutants, molecular basis of mutations.
5. DNA damage and repair: Causes of DNA damage; Photoreactivation, excision, mismatch, post replication and error prone repair systems.
6. Fine structure of gene: *cis-trans* test, rII locus, fine structure analysis of eukaryotes.
7. Bacterial genetics: conjugation, transduction and transformation.

UNIT- III

8. Transcription: Initiation, elongation and termination in prokaryotes and eukaryotes, RNA polymerases.
9. RNA Processing: Processing of mRNA, rRNA and tRNA.
10. Genetic code: Deciphering the genetic code, characteristics.
11. Translation: Initiation, elongation and termination in prokaryotes and eukaryotes.

UNIT-IV

12. Regulation of gene expression in prokaryotes: Operon concept, lac operon regulation by positive and negative mechanism, trp operon, regulation by negative and attenuation.
13. Regulation of gene expression in eukaryotes:
    a) Transcriptional level – Regulatory sequences, nucleosome positioning, chromatin remodelling, histone modifications.
    b) Post-transcriptional level – RNA splicing, RNA stability.
    c) Translational level and post-translational level.

Suggested Readings:

1. Alberts B, Johnson A, Lewis J. Raff M, Roberts K and Walter P (2008) Molecular Biology of the Cell (5th Ed.). Garland Publishing Inc., New York.
2. Brown TA (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
3. Burns GW and Bottino PJ (1989) The Science of Genetics, Macmillan Publishing Co. New York.
4. Clark D (2005) Molecular abiology, Understanding the Genetic Revolution. Elsevier Inc. C. California.
5. Gustafron JP (2002) Genomes.Kluwer Academic Plenum Publishers, New York, USA.
6. Hartl DL (1999) Genetics Principles and analysis. (4th Ed.) Jones and Bartle, Boston.
7. Henry RJ (1997) Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK.
8. Klug WS and Cunning MR (1996) Essentials of Genetics. Prentice Hall London.
9. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
10. Lewin B (2005) Genes VIII. Oxford University Press, New York.
11. Lodish H, Berk A, Kaiser, CA, Krieger M, Scott MP Bretscher A Ploegh H and Matsudaira P (2008) Molecular Cell Biology (6th Ed), W.H. Freeman and Company, New York, USA.
12. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
13. Russell PJ (2006) Genetics (6th Ed.), Addison Wesley Longman, California, USA.
14 Snustad P and Simmons MJ (2011), Principles of Genetics. (6th Ed.), John Wiley, New York.
15. Swanson CP, Mertz T and Young WJ (1981) Cytogenetics- The Chromosome in Division, Inheritance and Evolution (2nd Ed.), Englewood Cliffs, Prentice Hall, New Jersey.
16. Weaver RF and Hedrick PW (1997). Genetics (3rd Ed.) WMC Brown, Chicago.
17. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene (6th Ed.), CSHLP, New York.

OPEN ELECTIVE

PAPER – BOT-206 – PLANTS FOR HUMAN WELFARE CREDIT -2 MM- 40+10 T: 3hrs

Objective: This course is intended to provide the basic understanding the origin, morphology, cultivation of major crops. It also deals with the traditional knowledge and utility of some common spices, condiments, medicinal plants and horticulture crops.

Outcomes:

CO1 Explain the origin of agriculture and centres of origin of various crops
CO2 Identify the plant sources of foods, modern and traditional medicines, spices, oil, fibres, dyes, gum and timbers.
CO3 Learn about plant sources of psychoactive compounds, ornamental plants and identification of common food adulterants

CO-PO MAPPING MATRIX FOR PAPER BOT- 206 (PLANTS FOR HUMAN WELFARE):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1.5	2	3	1.5
CO2	3	3	3	2	3	3
CO3	3	2	3	2	3	3
Average	3	2.66	2.5	2	3	2.5

CO-PSO MAPPING MATRIX FOR PAPER BOT-206 (PLANTS FOR HUMAN WELFARE):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2
CO2	3	3	2.5	2.5	3
CO3	3	3	3	2.5	3
Average	3	3	2.5	2.33	2.66

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Plants and Civilization: Origin of agriculture
Origin crop plants: Idea about centre of origin of common crop plants
Minor Cereals, Major cereals Pseudocereals and pulses
Spices and condiments (Saffron, Clove, Cardamom, Ginger, Turmeric, Cinnamon, Capsicums, Asafetida, Coriander, Fennel, Fenugreek**)**

Unit –II

Medicinal plants: Importance of medicinal plants – role in human health care

Traditional knowledge and utility of some common medicinal plants-*Sarpgandha, Isabgol,Vasaka, Neem, Bhiringraj, Amla, Harrad, Bahera, Arjun ,Punarnava , Brahmi, Kasondi, Ghritkumari, Quinine and Eucalyptus*

Psychoactive plants – general account and classification

Unit –III

Nutritive and medicinal value of some fruits and vegetables (Guava, Sapota, Orange, Mango, Banana, Lemon, Pomegranate, Moringa, Cabbage)
Beverages (Coffee, Tea, Chocolate, Cola)
Common ornamental plants
Common food adultrants

Unit-IV

Common timber yielding plants and minor forest products
General account of Fibers, dyes, tannins, gums and resins
Insecticides from plants Pyrethrum and Rotenone

Suggested Readings:

Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd.,Delhi
Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA
Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.

SEMESTER – III

Paper – BOT-301-Plant Physiology and Plant Biochemistry Credit -4 MM-80+20 T: 3 hrs

Objective: The course would deal with the study of plant physiology especially the water transport, absorption, mineral nutrition, photosynthesis, respiration and nitrogen metabolism.

Outcome:

CO1 The students will be able to understand the physiology and basic metabolism of plants.
CO2 The students will be learning about the concepts of water potential, transpiration and mechanisms of water absorption in plants.
CO3 During the course students will gain in depth knowledge about mineral nutrition, photosynthesis and respiration in plants.
CO4 The students will be able to increase the understanding about enzymes, lipid metabolism and nitrogen metabolism.

CO-PO MAPPING MATRIX FOR PAPER BOT- 301 (Plant Physiology and Plant Biochemistry):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	2	2
CO2	3	3	1	1	1	1
CO3	3	3	1	2	2	1
CO4	3	3	1	2	3	1
Average	3	3	1	1.5	2	1.25

CO-PSO MAPPING MATRIX FOR PAPER BOT-301 (Plant Physiology and Plant Biochemistry):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	3	2
CO2	3	1	1	3	2
CO3	3	1	2	3	2
CO4	3	1	1	3	2
Average	3	1	1.25	3	2

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Water: Passive and active absorption of water.
Plant water relations: Concept and components of water potential, soil water relationship, transpiration and factors governing transpiration, antitranspirants.

Unit-II

Mineral Nutrition: Role and mode of action of micro and macro-nutrients.
Photosynthesis: Photo-oxidation of water, cyclic and non-cyclic photophosphorylation, photorespiration and its significance. The sequence of reactions in photosynthesis, the path of carbon assimilation (C3 and C4 cycles, CAM pathway).

Unit-III

Respiration: Glycolysis, Krebs cycle, electron transport chain and ATP synthesis, pentose phosphate pathway, glyoxylate cycle.

Nitrogen Metabolism: Biochemistry of nitrogen fixation, nitrogenase, nitrogen fixation in legumes, nitrate assimilation, ammonium assimilation, biosynthesis of amino acids.

Unit-IV

Lipid Metabolism:

Fatty acid biosynthesis, Alpha and beta oxidation and conservation into carbohydrates.

Enzymes: Structure, properties and functions of enzymes, factors affecting rates of enzymatic reactions, isozymes, allosteric enzymes.

Suggested Readings:

Bonner, J. And Varner, J.E. (1976). Plant Biochemistry, IIIrd Edition, Academic Press, New York and London.

Buchanan, B.B., Gruissem, W. And Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.

Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.

Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.

Hopkins, W.G. (1995) Introduction to Plant Physiology, John Wiley and Sons.

Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.

Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East-West Press Pvt Ltd. New Delhi.

Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana, India (Indian edition).

Lehninger, A.L, Nelson, D.L. and Co MM 1993Principles of Biochemistry Second edition, CBS Publishers.

Moore, Thomas. C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi..

Noggle, G.R. and Fritz, G.J. (1983). Introductory Plant Physiology, Prentice-Hall of India Pvt. Ltd., New Delhi, Second edition Seventh reprint, 1993.

Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition, Wadsworth Publishing Co. Belmont, California, USA.

Singhal, G.S. Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (editors) (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.

Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.

Taiz, L and Zeiger, E. (1998). Plant Physiology. Second edition. Sinauer Associates, Inc., Publishers, Massachusetts, USA

Trehan, K. (1990). Biochemistry. Second edition, Wiley-Eastern Ltd., New Delhi.

Trivedi, P.C. (2006). Plant Molecular Physiology: Current Scenario and Future Projections. Aavishkar Publishers, Distributors, Jaipur.

Weil, J.H. (1990). General Biochemistry. Sixth edition. Wiley-Eastern, New Age International Publishers, New Delhi.

Wilkins, M.B. (1987). Advanced Plant Physiology, ELBS, Longman, England. Zubay, Geoffrey. (1989). Biochemistry. Mc.Millan Publishing Co. New York.

Paper – BOT-302- Plant Taxonomy and Economic Botany Credit -4 MM-80+20 T: 3hrs

Objective: The course would deal with the study of the basic concepts of plant taxonomy and botanical nomenclature. The course is also designed to know about the origin of agriculture and economic importance of major crop plants.

Outcomes:

CO1 Understand the significance, basic concepts, tools of plant taxonomy
CO2 Learn about the different systems of classification of angiosperms and relevance of plant taxonomy to other branches.
CO3 Acquire knowledge about the plant sources of foods, modern and traditional medicines, spices, oil, fibres, dyes, gum and timbers.

CO-PO MAPPING MATRIX FOR PAPER BOT- 302 (Plant Taxonomy and Economic Botany):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2.5	2	3	3
CO2	3	2	2	2	2	3
CO3	3	3	3	2	3	3
Average	3	2.66	2.5	2	2.66	3

CO-PSO MAPPING MATRIX FOR PAPER BOT-302 (Plant Taxonomy and Economic Botany):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3
CO2	3	2.5	2	2	3
CO3	3	3	3	2.5	3
Average	3	2.8	2.6	2.1	3

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

The Species concept, Taxonomic hierarchy, Species, Genus and Family
Taxonomic evidence: Morphology, anatomy, palynology.
Taxonomic Tools: Herbarium and Floras.
Botanical Gardens and herbaria in India; Botanical Survey of India its organization and role.

Unit-II

Salient Features of the International Code of Nomenclature (ICN).
Systems of angiosperm classifications of Benthom and Hooker, Engler and Prantl, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne,
Relative merits and demerits of these systems.

Unit-III

Origin of agriculture: World centers of primary diversity of domesticated plants.

Origin, botany, cultivation and uses of cereals (wheat, rice), Sugarcane, Potato
Oil yielding plants (groundnut, mustard, sunflower)

Unit-IV

Botany, origin, uses of important fibres (Cotton, Jute),
General account of important spices (Ginger, Turmeric, Cinnamon, Clove, Cardamom, Chilies, Pepper, Fennel, Coriander, Cumin, Asafetida, Nutmeg, Mace, and Saffron),
General account of important medicinal plants (Aconite, Cinchona, Belladonna, Digitalis, Glycyrrhiza, Rauvolfia, Papaver, Vasaka, Aloe and Ginseng). A brief account of major Indian Medicinal plants(Amla, Neem, Arjun, Harad, Bahera, Isabgol, Ashwagandha, Bhringraj and Senna)
General account of important timber, dye, gums and tannin yielding plants

Suggested Readings:

Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row Publishers Inc.
Lawrence, G.H.M. 1951. Taxonomy of vascular plants. The Macmillan C., New York.
Davis, P.H. and Heywood, V.H. 1965. Principles of Angiosperm Taxonomy. D Van Nostrand Co. , New York.
Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford IBH Pub. Co., New Delhi.
Kochar, S.L. 1981. Economic Botany in the Tropics. Macmillan India Ltd., Delhi.
Hill, A.F. 1952. Economic Botany (2nd Ed.) McGraw Hill, New York.
Cobley, L.S. and Steele, W.M. 1976. An Introduction to the Botany of Tropical Crops (2nd Ed.) Longmans, London.
Simmonds, N.W. 1976. Evolution of Crop Plants Longman, London, New York.
SambaMurthy, AVS and Subrahmanyam, N.S. 1989. A Text Book of Economic Botany. Wiley Eastern Ltd.,Delhi
Judd, W.S.; Campbell. C.S., Kellogg, E.A. and Stevens, P.F. 1999. Plant Systematics A Phylogenetic Approach. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, U.S.A.
Schery, R.W. 1972. Plants for Man. Prentice Hall. Englewood Cliffs, N.J. USA
Simpson B. B. M. C. Ogorzaly 2001. Economic botany: plants of our world, 3rd ed. McGraw-Hill, New York, New York, USA.
Hancock. J. F. 2004. Plant evolution and the origin of crop species. 2nd edition. CABI Publishing, Cambridge, MA USA.
Radford, A. E., W. C. Dickison, J. R. Massey, C. R. Bell. 1976. Vascular Plant Systematics Harper and Row, New York.

Paper-BOT-303 Plant Biotechnology and Genetic Engineering Credit -4 MM-80+20 T: 3hrs

Objective: This course is intended to provide knowledge about Recombinant DNA Technology, DNA cloning, gene amplification, genetic transformation methods and transgenic plants.

Outcome:
CO1 The students will have better understanding of various tools and techniques of genetic engineering.
CO2 During the course students will gain in depth knowledge about different methods for genetic transformation of plants.
CO3 The students will acquire understanding of production of transgenic plants for biotic and abiotic stress resistance, male sterility and edible vaccines.
CO4 During the course students will gain in depth knowledge about gene cloning methods, PCR and fermentation technology.

CO-PO MAPPING MATRIX FOR PAPER BOT- 303 (Biotechnology and Genetic Engineering):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	3	3
CO2	3	2	2	1	3	2
CO3	3	1	2	2	3	1
CO4	3	1	1	1	2	2
Average	3	1.5	1.75	1.25	2.5	2

CO-PSO MAPPING MATRIX FOR PAPER BOT-303 (Biotechnology and Genetic Engineering):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	3	3
CO2	3	1	1	3	3
CO3	3	1	1	3	2
CO4	3	2	1	3	2
Average	3	1.25	1	3	2.5

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Techniques used in DNA Technology: Gel Electrophoresis, PFGE, Southern and Western blotting, Dot blots, Chemical synthesis of genes, DNA chip technology.
Isolation of genes, Sequencing of genes: Maxam & Gilbert's method, Sanger's method and next-generation sequencing technologies,
Brief account of proteomics and genomics.

Unit-II

DNA cloning methods, using vectors (Plasmids, phages, cosmids, phagemids, transposons, artificial chromosomes, BAC, YAC, MAC), cloning in bacteria and eukaryotes, genomic and C-DNA Libraries.

Gene amplification by PCR: different types, DNA finger printing, molecular probes: General features and applications.

Unit-III

Gene transfer methods in plants: plasmid mediated, electroporation, cation precipitation, liposomes, microinjection and particles gun technology, expression of transgenes.

Transgenic plants: production of transgenic plants with respect to insect resistance, herbicide resistance, resistance against biotic and abiotic factors, transgenics for male sterility and edible vaccines

Unit-IV

Yeast and algal biomass as source of single cell protein, oils and vitamins, microbial fermentation technology in food industry.

Plant and microbial biopesticides, bioremediation and phytoremediation.

Suggested readings

Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-44- Transgenenic Trees, Springer Pub., New York, USA

Bajaj, Y.P.S. 2000. Biotechnology in Agriculture and Forestry-46-Transgenic Trees, Springer Pub., New York, USA

Brown, T.A. 1999 Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore

Dawson, M.T. Powell, R, and L. Gannon, F.1996. Gene Technology, BIOS Sci. Pub. Ltd., Oxford, UK.

Erlich, H.A.(Ed.) 1989, PCR Technology – Principles and applications for DNA Amplification, Stockton Press, New York, USA

Glazer, A.N. and Nikaido, H. 1995. Microbial Biotechnology, W.H. Freeman & Company, New York, USA

Glover, D.M. and Hames, B.D.(Eds.) 1995. DNA Clonning 1 – A Practical Approach, OIRL Press, Oxford, UK

Gupta, P.K. 1996. Elements of Biotechnology, Rastogi & Co., Pub., New Pub., Meerut, India.

Hammond, J., McGarvey, P. And Yusibov, V. (Eds.) 1999. Plant Biotechnology – New Products and Applications, Springer Pub., New York, USA.

Henry, R.J. 1998. Practical Applications of Plant Molecular Biology, Chapman & Hall, London, UK

Keller, G.H. and Manak, M.M. 1993. DNA Probes, Mac Millan Pub. Ltd. UK.

Lea, P. And Leegood, R.C. 1999. Plant Biotechnology and Molecular Biology (2nd Ed.) John Wiley & Sons, Ltd., England.

Lewin, B. 2005. Genes VIII,Osford University Press, Oxford, UK

Lindsey, K. And Jones, M.G.K. 1990. Plant Biotechnology in Agriculture, Prentice Hall Int. Pub., London, UK

Malaacinski, G.M. and Freifilder, D. 1998. Essentials of Molecular Biology 3rd Ed.), Jones & Bartlett Pub., London, UK

Miesfield, R.L. 1999. Applied Molecular Genetics, Wiely Liss, New York, USA.

Nicklin,J., Graeme-Cook, K.Paget, T. And Killington, R. 1999. Instant Notes in Mircobiology, VIVA Books Pvt. Ltd., New Delhi, India

Purohit, S.S., Kothari, P.R. and Mathur, S.K. 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. Bikaner, India.

Rehm;, H.I. and Reed, S.G. (Eds.) 1995. Fundamentals of Genetic Engineering, Pallicut, London, UK.

Scragg, A. 1999. Environmental Biotechnology, Pearson Education Ltd., England, UK

Shantharam, S. And Montogomery, J.F. 1999. Biotechnology, Biosafety and Biodiversity. Oxford & IBH Pub. Pvt. Ltd., New Delhi, India.

Sheehan, D. (Ed.) 1997. Bioremediation Protocols, Humana Press, Totowa, USA

Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Ed.) John Wiley & Sons. Inc., New York, USA

Trehan, K. 1990. Biotechnology, New Age Int. Pvt. Ltrd. New Delhi India.

Twyman, R.M. 1999. Advanced Molecular Biology, VIVA Books Pvt. Ltd., New Delhi, India.

Paper – BOT-304(a) ADVANCED PHYCOLOGY-I (ELECTIVE) Credit -4 MM-80+20 T: 3hrs

Objectives: To acquaint the PG students with importance of Phycology (Algology) towards its contribution to the famous ***'Green Revolution'*** of the nation, thereby making India self-reliant in food grain production.

Outcome:

CO1 To acquaint the PG students with importance of Phycology (Algology) towards its contribution to the famous ***'Green Revolution'*** of the nation, thereby making India self-reliant in food grain production.

CO2 To come out with the trained professionals having the knowledge of nutritional requirements of algae for their mass/ large scale cultivation with particular reference to ecological biodiversity of algae & algal bio-fertilizers in Haryana.

CO3 The Course has been conceived to equip the students with the knowledge of various laboratory conditions for their culture and maintenance of algae in terms of their control in water supplies, on ancient monuments and Paddy field algal flora as the **N_2-economy builders** of the nation.

CO4 The Course has been conceived to equip the students with the knowledge of various physiological and biochemical aspects on algal flora exposed to pesticides, toxicants and heavy metals to comprehend the mechanisms of adaptation against them in terms of their uptake kinetics.

CO-PO MAPPING MATRIX FOR PAPER BOT- 304 (a) (ADVANCED PHYCOLOGY):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	2	1
CO2	1	2	1	2	1	2
CO3	2	1	2	1	1	1
CO4	2	2	1	2	1	2
Average	1.75	1.5	1.5	1.75	1.5	1.5

CO-PSO MAPPING MATRIX FOR PAPER BOT-304 (a) (ADVANCED PHYCOLOGY):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	1	2	1	1
CO2	1	2	2	1	2
CO3	1	1	1	2	1
CO4	2	1	2	1	1
Average	1.5	1.25	1.75	1.25	1.25

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1) Limits to algal growth in natural waters.

2) Dynamics and consequences of freshwater marine & algal blooms; Causative factors for eutrophication and its impact.

3) A brief account of phycological researches in India.

Unit-II

4) Mineral nutrition in algae with emphasis on Calcium, Magnesium, Sodium, Iron, Molybdenum, & Silica.

5) Synchronous & continuous cultures and their uses; Physiology of nutrient regulated algal growth.

6) A brief account of culture techniques, media for algal growth and measurement techniques.

Unit-III

7) Algae in water supplies, on ancient monuments and bio-fouling of ships.

8) Ecological biodiversity of algae in unusual habitats with suitable examples.

9) Paddy field algal flora as N_2-economy builders of the nation.

Unit-IV

10) Physiological and biochemical aspects on algal flora exposed to heavy metals.

11) Kinetics of heavy metal uptake and its bioaccumulation.

12) Mechanisms of adaptation against tolerance to toxicants, pesticides and salt.

Suggested Readings:

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications*. Daya Publishing House, New Delhi. 2003.

2. Becker, E.W. (1994): Microalgae – Biotechnology & Microbiology, Cambridge University Press, Cambridge, U.K.

3. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.

4. Dubey, R.C. (2006): Introduction to Biotechnology, Delhi Book Trust, New Delhi.

5. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.

6. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publihers.

7. Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.

8. Graham, L.E. & Wilcox, L.W. (1999): Algae, Benjamin Cummings, USA.

9. Gupta, R.K. & Pandey, V.D. (2007): Advaces in Applied Phycology, Daya Publishing

Paper – BOT-304(b) APPLIED MYCOLOGY (ELECTIVE) Credit -4 MM-80+20 T: 3hrs

Objectives: The course has been envisaged to make the students aware about the role of fungi in Industry, as biofertilizer, as biocontrol agents, and biodeteriorating agents. Besides this, the course will be helpful in acquainting the students with the various techniques of culturing and isolation of fungi from various sources, culture media and preservation of fungi**.**

Outcomes:

CO1 Production of Valuable microbial products.
CO2 Role of Fungi as biofertilisers and biocontrol agents.
CO3 Techniques used for maintenance of fungal cultures.
CO4 Commercial production of mushrooms.

CO-PO MAPPING MATRIX FOR PAPER BOT-304 (b) (APPLIED MYCOLOGY):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	3	3
CO2	2	1	3	2	2	3
CO3	1	1	1	1	3	1
CO4	2	2	1	1	2	3
Average	2	1.25	2	1.5	2.5	2.5

CO-PSO MAPPING MATRIX FOR PAPER BOT-304 (b) (APPLIED MYCOLOGY):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	1	3	3
CO2	2	2	2	2	3
CO3	2	1	1	3	3
CO4	3	2	2	2	2
Average	2	1.5	1.5	2.5	2.75

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Primary metabolites production by fungi: industrial alcohol, organic acid, beer.
Secondary metabolites production by fungi: Antibiotics, steroid transformation,. Enzymes, amino acids, growth regulators, vitamins

Unit-II

Fungi as biofertilizers : Endomycorrhizae and ectomycorrhizae.
Fungi as biocontrol of plant pathogens and weeds.
Biodeterioration of materials: Paper, painted surface, wood.

Unit-III

Food processing by fungi: Bread, cheese, oriental food and baker's yeast.
Fungal sources of health food: Single cell protein, edible mushrooms.
Spoilage of food and fungal toxicity.

Unit-IV

Culturing and preservation of fungi: isolation of fungi, culturing of fungi, establishing a pure culture, aseptic technique, maintenance of culture collection, culture collection and identification centres.
Common culture media and sterilization techniques.

Suggested Readings:

Alexopoulos, C.J. Mins, C.W. & Blackwell, M. (1995): Introductory Mycology, John Willy and Sons. Inc.

Bilgrami, K.SA. & Verma R.N. (1981): Physiology of fungi, Vikas Publ. Ltd., New Delhi.

Biswas, S.P. & Biswas, A. (1984): An Introduction to Viruses, Vani Education Books, New Delhi.

Butler, E.J. & Jones, S.G. (1976): Plant Pathology, Periodical Expert Book Agency, New Delhi.

Clifton, A. (1958): Introduction to the Bacteria. McGraw Hill Books Co. New York.

Dubey, R.C. (2005): A Text Book of Biotechnology, S Chand & Co. Ltd., New Delhi.

Bilgrami, K.S. & Dubey H.C. (1986): A text book of Modern Plant Pathology, Vikas, Publ. Ltd., N.Delhi.

Gupta, R. & Mukerji, K.G. (2001): Microbial Technology, APH Publ. Co., New Delhi.

Mehrotra, R.S. & Aneja, K.R. (1990): An introduction of Mycology, New Age International Press, N. Delhi.

Michael J. Pelezar, E.C.S. Chaing & N.R. Krieg, 1993: Microbiology. Tata McGraw Hill Publ. N. Delhi.

Mundukur, B.B. (1967): Fungi & Plant Diseases, Pochillion Co. Ltd., USA.

Prescott, L.M., Harley, J.P. & Klein, D.A. (1996): Microbiology, 3rd edition, Wm. C. Brown Publ., USA.

Ronald M. Atlas (1995): Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.

Moore-landeckar, E.J. (1972): Fundamentals of the fungi, Prentice Hall, Eaglewood, U.K.

Sumbali, G. (2005): The Fungi, Narosa Publ. House, New Delhi.

Paper – BOT-304(c) – RESTORATION ECOLOGY (ELECTIVE) Credit-4 MM-80+20
T: 3 hrs

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Objectives: To develop the abilities of students to critically engage with concepts and theory in Restoration ecology from interdisciplinary perspectives and at an advanced level.

Outcomes: Student will be able to embrace the implications of the basic principles of restoration ecology for the future of restoration of degraded ecosystems and their management.

CO-PO MAPPING MATRIX FOR PAPER BOT-304 (c) (RESTORATION ECOLOGY):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	1	1
CO2	3	2	3	2	2	2
CO3	3	2	2	3	2	2
CO4	3	3	2	3	3	2
Average	3	2.25	2.5	2.5	2	1.75

CO-PSO MAPPING MATRIX FOR PAPER BOT-304 (c) (RESTORATION ECOLOGY):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	1	1
CO2	2	3	3	2	1
CO3	2	3	3	1	2
CO4	2	3	3	2	3
Average	2	3	3	1.5	1.75

Unit-I

1) Restoration-Terms and definitions, Importance of ecological restoration: strategies of Restoration-Natural recovery, active restoration, rehabilitation.
2) Restoration plan and rehabilitation measures.
3) Natural and anthropogenic disturbances: Characteristics and sources, effects on structural and functioning of terrestrial and aquatic ecosystems.

Unit-II

4) Rehabilitation of salt affected soils.
5) Prevention and mitigation of invasive species; Habitant fragmentation.
6) Ecosystem stability: Structural and functional stability.
7) Climate change mitigation and Biological carbon sequestration.

Unit-III

8) Sustainable forestry management and agroforestry.
9) Biotechnological Tools of Restoration.
10) Environmental impact and risk assessment.

Unit-IV

11) Degradation and Restoration of forest and grassland ecosystems.
12) Degradation and restoration of aquatic resources: River corridors, wetlands and lakes. Adaptive restoration of wetlands; Waste water recycling and waste management.
13) Reclamation of mining sites, Bioremediation and Phytoremediation.

Suggested Readings :

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Carson, Rachel . 1962. Silent spring. Boston, Houghton Mifflin
3. Manahan, S.E. 2000. Environmental Chemistry. Seventh Edition. Lewis Publishers, New York
4. Mitsch, W.J. and Jorgensen, S.E. (eds.) 1989. Ecological Engineering: An Introduction to Ecotechnology. John Wiley and Sons, New York.
5. Morgan, R.K. Environmental Impact Assessment; A methodological Perspective. Kluwer Academic Publishers, London.
6. Pierzynski, G.M., Sims, J.T. and Vance, G.F. 2000. Soils and Environmental Quality. Second Edition. CRC press, New York.
7. Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
8. Bradshaw, A.D. and Chadwick, M.J. (1980). The Restoration of Land Ecology and Reclamation f Derelict and Degraded Land Blackwell Scientific Publication, Oxford, England. 9. Pace, M.L. and Groffman, P.M. (Eds.) (1998). Success, limitations and Frontiers in Ecosystem Science, Springer Verlag, New York.
10. Packard, S. And Mutel C.F. eds. (1997). The Tall Grass Restoration Handbook, Island Press, Washington, DC.
11. Petts, G. And Calow P. Larsen, P. (1996). River Restoration a Blackwell Science, Oxford, England.
12. Urbanska, K.M. Webb, N.R. and Edwards, P.J. (1998). Restoration Ecology and Sustainable Development. (Cambridge University Press, Cambridge).
13. USEPA (2000). Principles for the Ecological Restoration of Aquatic Resources. EPA 841-F-00-003. Office of Water (4501F), United States Environmental Protection Agency, Washington, DC. 4pp.

Paper – BOT-304(d) – ADVANCED PLANT PHYSIOLOGY (ELECTIVE) Credit-4 MM-80+20 T: 3hrs

Objective: The course would deal with advances in plant physiology especially photosynthesis, respiration and responses of the plants to abiotic stresses.

Outcomes:

CO1 The students will be able to understand the physiological and biochemical basis of drought stress and its manifestation in plant productivity.

CO2 The students will be well acquainted with the mechanisms of salt and temperature stresses.

CO3 The learners will acquire the indepth knowledge of process of photosynthesis and the translocations of photosynthates from source to sinks.

CO4 The students will enhance their knowledge regarding mechanism of respiratory cycle in plants and the methods of estimation of respiration.

CO-PO MAPPING MATRIX FOR PAPER BOT-304 (d) (ADVANCED PLANT PHYSIOLOGY):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	2	3	1
CO2	1	2	2	2	3	1
CO3	1	2	2	1	2	1
CO4	1	1	2	1	2	1
Average	1	1.75	2	1.5	2.5	1

CO-PSO MAPPING MATRIX FOR PAPER BOT-304 (d) (ADVANCED PLANT PHYSIOLOGY):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	3	2
CO2	3	1	1	3	2
CO3	2	2	1	2	2
CO4	3	2	2	3	1
Average	2.75	1.5	1.25	2.75	1.75

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Water stress:

Drought, its definition and quantification, water deficit and plant growth, physiological and biochemical functions, responses injury affected by drought, Adaptive strategies for drought resistance.

Osmotic adjustment, osmoprotectants.

Water logging/ oxygen deficiency and its effects on plant growth.

Unit-II

Salt and temperature stress:

Salt stress; Saline and alkaline soils, salt stress injury, mechanism of salt stress and halophytes.

Temperature stress; high temperature stress, heat shock proteins, chilling and frost injury and mechanism of tolerance.

Unit-III

Photosynthesis:
The four major complexes of thylakoids.
The path of carbon in photosynthesis (C3, C4 and CAM plants)
Rubisco, structure and its association with the mechanism of carboxylation and oxygenation of RUBP.
Effect of environmental factors on photosynthetic rates. Translocation of photosynthates and its importance in sink growth.

Unit-IV

Respiration:
Cyanide insensitive respiration: Mechanism and significance.
Comparison between normal electron transport chain and alternate oxidase pathway of respiration.
Glycolic acid metabolism and photorespiration.
Glyoxylate cycle.
Respiration in intact plants and tissues.

Suggested Readings:

Bonner, J. And Varner, J.E. (1976) Plant Biochemistry, Academic Press, New York and London (Third Edition).
Buchanan, B.B., Gruissem, w. And Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
Cooper, T.G. (1977). Electrophoresis. In : The Tools of Biochemistry. John Wiley and Sons., New York.
Dey, P.M. and Harborne, J.B. (1997), First Indian edition, 2000). Plant Biochemistry. Academic Press, Harcourt Asia Pvt. Ltd.
Noggle, G.r. and Fritz, G.J. (1983). Introductory Plant Physiology. Prentice-Hall of India Pvt. Ltd., New Delhi, 2nd edition (Seventh reprint, 1992).
Salisbury, F.B. and Ross, G.W. (1992). Plant Physiology. Fourth Edition, Wadsworth Publishing Co. Belmont, California, USA.
Sawhney, S.K. and Singh, Randhir. (2000). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi.
Solmos, T. (1977). Cyanide resistant respiration in higher plants. In : Ann. Rev. Pl. Physiol. 28: 279-297.

Paper – BOT-304(e) – Biophysical and Biochemical Techniques (ELECTIVE) Credit -4
MM-80 +20 T: 3hrs

Objective: This paper aims to provide an introduction to various tools and techniques used to gain insight into cell structure and biological processes. The focus is on studying the techniques used for isolation, purification and characterization of biomolecules.

Outcomes:
CO1 This course will provide the students in-depth knowledge of microscopic technology.
CO2 The students will understand the various methods used in separation, purification and quantification of biomolecules.
CO3 It will provide the students a basic understanding of the techniques used for the identification of various macromolecules.
CO4 The students will know about the tools used for tracing the metabolic pathways.

CO-PO MAPPING MATRIX FOR PAPER BOT-304(e) (Biophysical and Biochemical Techniques):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	3
CO2	3	3	3	2	3	3
CO3	3	3	2	2	3	3
CO4	3	3	3	2	3	3
Average	3	3	2.5	2	3	3

CO-PSO MAPPING MATRIX FOR PAPER BOT-304 (e) (Biophysical and Biochemical Techniques):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	3	1
CO2	2	3	3	3	1
CO3	3	3	3	3	2
CO4	1	2	2	3	2
Average	2	1.5	2	3	1.5

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. **Microscopic techniques**: Introduction; Light microscope; Phase contrast microscope; Fluorescent microscope; Electron microscope (EM) – SEM, TEM and STEHM; Scanning probe microscopes- scanning 4284itrogeni microscope and atomic force microscope; Different fixation and staining techniques.
2. **Centrifugation**: Principles of sedimentation; Types, care and safety aspects of centrifuges; Differential centrifugation; Density gradient centrifugation and their applications.

Unit-II

3. **Chromatographic techniques**: Theory of chromatography; Types of chromatography- Paper chromatography, Thin layer chromatography, Adsorption chromatography, Partition chromatography, Affinity chromatography, Ion exchange chromatography, HPLC and Size-exclusion chromatography.
4. **Spectrophotometery**: Colorimetery; UV and Visible spectrophotometery.

Unit-III

5. **Electrophoresis**: Principle; Agarose gel electrophoresis; Polyacrylamide gel electrophoresis; 2-Dimensional gel electrophoresis; Capillary electrophoresis; Microchip electrophoresis and Isoelectric focusing.
6. **Mass spectrometry:** Introduction; Theory; Mass spectrometer; Ionization of molecules; Mass analysers- MALDI; Detectors and Applications.

Unit-IV

7. **Immunotechniques**: Antibody generation; Detection of molecules using ELISA, RIA, Immunoprecipitation and Immunofluorescence microscopy; Detection of molecules in living cells.
8. **Radioisotope techniques**: Radioactive isotopes; Nature of radioactivity; Detection and measurement of different types of radioisotopes normally used in biology; Incorporation of radioisotopes in biological tissues and cells; Molecular imaging of radioactive material; Disposable of radioactive wastes and safety guidelines.

Suggested Readings:

1. Hegyi G, Kardos J, Kovacs M, Csizmadia AM, Nyitray L, Pal G, Radnai L, Remenyi A Venekei I (2013) Introduction to Practical Biochemistry, Eotvos Lorand University, Hungary.
2. Plummer DT (1990) An Introduction to Practical Biochemistry, Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.
3. Prescott L and Harley J Klein D (2005) Microbiology (6^{th} Ed) Mc Graw-Hill.
4. Ranade R and Deshmukh S (2013) Handbook of Techniques in Biotechnology, Studium Press (India) Pvt. Ltd. New Delhi.
5. Sawhney SK and *Singh R (2000)* Introductory *Practical Biochemistry (Ed.),* Narosa Publishing House Pvt. Ltd., New Delhi.
6. Wilson K and Walker J (2010) Principles and Techniques of Biochemistry and Molecular Biology (7^{th} Ed.), Cambridge University Press, New Delhi.

OPEN ELECTIVE

Paper – BOT-306 – Biodiversity and its conservation Credit -2 MM-40+10 T: 3hrs

Objectives: This paper is meant for students to gain in-depth knowledge of different levels, threats and distribution of Biodiversity and focus on the different approaches for biodiversity conservation.

Outcomes:

CO1 Define and appreciate the value of biodiversity
CO2 Learn about the distribution patterns and threats to biodiversity
CO3 Acquire knowledge about hotspots of biodiversity
CO4 Learn about the various methods to conserve biodiversity

CO to PO MAPPING MATRIX OF PAPER BOT -306 (Biodiversity and its conservation):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
Average	3	3	3	2	2.66	3

CO-PSO MAPPING MATRIX FOR PAPER BOT-306 (Biodiversity and its conservation):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3
CO2	3	3	3	1.5	3
CO3	3	3	3	1	3
CO4	3	3	3	2	3
Average	3	3	3	1.6	3

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. Biodiversity: importance, levels of biodiversity- species, genetic and ecosystem diversity, threats to biodiversity- habitat loss and fragmentation, exotic species, pollution, overexploitation, IUCN categories of threat
2. Distribution and global patterns of biodiversity
3. Biodiversity and ecosystem services
4. Terrestrial and marine hotspots of biodiversity; hotspots of biodiversity in India.

Unit-II

5. Principles and importance of conservation biology; In- situ conservation of biodiversity- Sanctuaries, national parks, biosphere reserves.
6. Ex-situ conservation of biodiversity: Principles and practices, field gene banks, seed banks and cryopreservation
7. Approaches for biodiversity conservation: tropical forests, wetlands and aquatic ecosystems
8. Major approaches to Management, Indian case studies on conservation/management strategy (Project tiger, biosphere reserves)

Suggested Readings :

Chape, S., Fish, L., Fox, P. and Spalding, M. 2003. United Nations list of protected areas. IUCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge

Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk bv. The Hague.

Heywood, V.(Ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.

Hunter (Jr.) M.L. (1996); Fundamentals of Conservation Biology, Blackwell Science. Meffe G.K. and C. Ronals Corroll (1994) Principles of Conservation Biology, Sinaur Associates, Inc., Sunderland. Massachusetts.

Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.

Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.

Soule, M.E. (ed.) (1986) : Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.

SEMESTER – IV

Paper – BOT-401 PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT Credit-4
MM- 80+20 T: 3hrs

Objective: The course would deal with different aspects of plant growth and development especially germination and dormancy of seeds, plant growth regulators, senescence and abscission, photomorphogenesis and response of plant to different abiotic stresses.

Outcomes:
CO1 The students will be able to understand the basic concepts of plant growth and development.
CO2 The students will be learning about abiotic stress tolerance/adaptive physiological changes affecting plant productivity.
CO3 During the course students will gain in depth knowledge about various plant growth regulators and their role in physiology of growth and development.
CO4 Students will be acquainted with the knowledge of physiology of flowering and sensory biology.

CO-PO MAPPING MATRIX FOR PAPER BOT- 401 (PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	2	2
CO2	1	2	1	1	3	2
CO3	2	2	1	1	3	2
CO4	1	1	1	1	2	2
Average	1.25	1.75	1	1	2.5	2

CO-PSO MAPPING MATRIX FOR PAPER BOT-401 (PHYSIOLOGY OF PLANT GROWTH AND DEVELOPMENT):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	1	3	1
CO2	3	2	2	3	1
CO3	3	2	1	3	3
CO4	2	1	1	3	1
Average	2.75	1.5	1.25	3	1.5

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Plant Growth: Growth concepts, Growth curves, Growth analysis.
Germination and Dormancy of seeds ; factors affecting dormancy and its regulation by plant growth regulators and environmental factors.
Stress Physiology: Response of plants to abiotic stresses: abiotic stress affecting plant productivity. Basic principles of crop improvement programme under stress.

Unit-II

Plant Growth Regulators: Discovery, biosynthetic pathways, transport, influence on plant growth and mechanism of action of: Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid.

Unit-III

Senescence and Abscission:

Physiological and biochemical changes associated with senescence and abcission .

Tropism: Phototropism, nature of receptors, role of hormones, Geotropism and nastism.

Unit-IV

Sensory Photobiology:

Phytochromes: mechanism of phytochrome action, photomorphogenesis and cryptochromes .

The Flowering Process:

Photoperiodism and its significance, importance of dark periods, role of vernalization.

Nature and events during flowering, florigen concept, chemical control of flowering.

Suggested Readings:

Audus, L.J. (1972). Plant Growth Substances. Vol.I Chemistry and Physiology. Leonard Hill, London.

Bonner, J. And Varner, J.E. (1976). Plant Biochemistry,IIIrd Edition, Academic Press, New York and London.

Buchanan, B.B., Gruissem, W. And Jones, R.L. (2000). Biochemstry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Davies, Peter J. (1995). Plant Hormones: Physiology, Biochemistry and Molecular Biology. 2nd Edition. Kluwer Academic Publishers, The Netherlands.

Dey, P.M. and Harborne, J.B. (1997), First Indian Edition, Plant Biochemistry. Academic Press, Harcourt Asia Pvt.Ltd.

Garrett, R.H. and Grisham, C.M. (1999). Biochemistry. Second edition. Saunders College Publishing, Philadelphia.

Hopkins, W.G. 1995 Introduction to Plant Physiology, John Wiley and Sons.

Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.

Kumar, H.D. and Singh, H.N. (1993). Plant Metabolism. Second edition, Affiliated East- West Press Pvt Ltd. New Delhi.

Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana, India

Lehninger, A.L, Nelson, D.L. and Co MM 1993 Principles of Biochemistry Second edition, CBS Publishers.

Moore, Thomas. C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi..

Noggle, G.R. and Fritz, G.J. (1983). Introductory Plant Physiology, Prentice-Hall of India Pvt. Ltd., New Delhi, Second edition Seventh reprint, 1993.

Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition, Wadsworth Publishing Co. Belmont, California, USA.

Singhal, G.S. Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (editors) (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.

Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.

Taiz, L and Zeiger, E. (1998). Plant Physiology. Second edition. Sinauer Associates, Inc., Publishers, Massachusetts, USA

Trehan, K. (1990). Biochemistry. Second edition, Wiley-Eastern Ltd., New Delhi.

Trivedi, P.C. (2005). Applied Botany. Aavishkar Publishers, Distributors, Jaipur.

Trivedi, P.C. (2006). Plant Molecular Physiology: Current Scenario and Future Projections. Aavishkar Publishers, Distributors, Jaipur.

Weil, J.H. (1990). General Biochemistry. Sixth edition. Wiley-Eastern, New Age International Publishers, New Delhi.

Wilkins, M.B. (1987). Advanced Plant Physiology, ELBS, Longman, England.

Zubay, Geoffrey. (1989). Biochemistry. Mc.Millan Publishing Co. New York.

Paper – BOT-402 Biology of Reproduction and Anatomy Credit -4 MM-80+20 T: 3hrs

Objective: The course would deal with history of Embryology. It also describe the technique and applications of *in vitro* culture of reproductive organs.

Outcomes:
CO1 Describe the structure and development of reproductive structures and the process of reproduction in angiosperms
CO2 Acquire knowledge about *in vitro* culturing techniques and their applications in human welfare.
CO3 Learn about the role of anatomy in taxonomy and anomalous secondary structures in plants

CO-PO MAPPING MATRIX FOR PAPER BOT- 402 (Biology of Reproduction and Anatomy):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	3
CO2	3	3	3	2	3	3
CO3	3	3	3	2	3	3
Average	3	3	3	2	2.66	3

CO-PSO MAPPING MATRIX FOR PAPER BOT-402 (Biology of Reproduction and Anatomy):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	1.5	3	3
CO2	3	2	2	3	3
CO3	3	3	2	2	3
Average	2.6	2.3	1.8	2.6	3

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit I
History of plant embryology
Male gametophyte: structure of anther, microsporogenesis, role of tapetum,
Pollen development, male sterility;
Pollen germination, pollen tube growth and guidance; pollen allergy

Unit II
Female gametophyte; ovule development, megasporogenesis;
Organization of the embryosac, structure of the embryo sac cells.
Pollination, Pollination mechanisms and vectors,

Unit III
Pollen pistil interaction and fertilization; structure of pistils; pollen-stigma interaction, sporophytic and gametophytic incompatibility, double fertilization
Endosperm development, polyembryony; apomixis
Experimental Embryology: in vitro fertilization Anther, Pollen and embryo culture,

Unit IV
Anatomy in relation to taxonomy.

Anomalous secondary Structure: Anomalous secondary growth, anomalous position of cambium, abnormal behaviour of normal cambium, accessory cambium formation and its activity, extrastelar cambium, Interxylary and intraxylary phloe, presence of medullary bundles, cortical bundles, presence of exclusive phloem and xylem bundles, secondary growth in monocots.

Suggested Readings:

Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.

Shivanna, K.R. and Johri, B.M. 1985. The Angiopsrem Pollen: Structure and Function. Wiley Eastern Ltd., New Delhi.

Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge Univ. Press, Cambridge.

Johri, B.M. (ed.) Embryology of Angiosperms. Springer-Verlag, Heidelberg, Berlin,

Esau, K. 1965. Plant Anatomy. John Wiley & Sons New York.

Fahn, A. 1967.Plant Anatomy. Pergamon Press, London, New York.

Eames , A.J. and MacDaniels, L.H. 1947. An Introduction to the Plant Anatomy (2nd Ed.), McGraw Book Comp., New York.

Eames, A. J. 1961. Morphology of Angiosperms. McGraw Hill Book Company, New York

Paper – BOT-403 Plant Tissue Culture Credit -4 MM-80+20 T: 3hrs

Objective: This course seeks to impart detailed knowledge of micropropagation, somatic embryogenesis, haploid production, somatic hybridization, cryopreservation and secondary metabolite production.

Outcomes:
CO1 This course will impart knowledge to students for non-conventional multiplication of plants.
CO2 Students will learn about regeneration of complete plants from plant organs/cell other than seeds.
CO3 Students will be able to apply knowledge regarding in vitro techniques in Agriculture and forestry.
CO4 Students will attain practical knowledge of preparing artificial seeds.

CO-PO MAPPING MATRIX FOR PAPER BOT-403 (Plant Tissue Culture):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	3	2
CO2	2	2	2	1	2	2
CO3	3	2	2	1	3	2
CO4	3	2	1	1	2	3
Average	2.75	1.75	1.75	1	2.5	2.25

CO-PSO MAPPING MATRIX FOR PAPER BOT-403 (Plant Tissue Culture):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	1	1
CO2	2	3	1	1	1
CO3	3	3	2	2	1
CO4	3	3	2	2	1
Average	2.75	3	1.75	1.5	1

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit I

1. History of Plant Tissue Culture, Basic concept, principles and scope of plant cell and tissue culture, concepts of cellular differentiation; Totipotency; basic techniques of plant tissue culture; callus formation, organogenesis and embryogenesis.
2. Protoplast isolation, fusion and culture, somatic hybridization, hybrid selection and regeneration. Cybrids and their application.

Unit-II

3. *In vitro* haploid production and its significance, Anther/Pollen culture and ovary culture; Embryo and ovule culture Production of triploids through endosperm culture.
4. Micropropagation: meristem culture and virus-free plants; Cryopreservation of plant cell and tissue cultures and establishment of gene banks.

Unit-III

5. Somaclonal variations and isolation of useful mutants; mechanisms and applications in genotype improvement.
6. Role of plant cell cultures in Bioreactor types and application in cell culture and secondary metabolite production.

Unit-IV

7. Somatic embryogenesis, production of synthetic seeds, importance, limitation and their utilization.
8. Application of tissue culture in forestry and agriculture; status of tissue and cell culture technology in India edible vaccines, and their prospects

Suggested Readings

1. Ammirato, P.V., D.A. Evans, N.D. Sharp and Y.P.S. Bajaj (1990). Hand Book of Plant Cell Culture, Vols. 1-5. McGraw Hill Publishing Company, New York.
2. Bhojwani, S.S. and Razadan, M.K. 1996. Plant Tissue Culture: Theory and Practice (A revised Edition), Elsevier Science Pub., New York, USA
3. Collins, H.A. and Edwards, S. 1998, Plant Cell Culture, Bios Scientific Pub., Oxford, U.K.
4. Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs, CRC Press, Boca Raton, Florida, U.S.A.
5. Razadan, M.K. 1993. An introduction to Plant Culture. Oxford & IBH Pub., Co., New Delhi, India

Paper – BOT-404(a) ADVANCED PHYCOLOGY-II (ELECTIVE) Credit -4 MM-80+20 T: 3hrs

Objectives: To impart knowledge about the wider perspectives of the ***'Nitrogen economy builders of the nation'*** in the context of fast changing industrializing Haryana as well as which has been traditionally an agricultural economy.

Outcome:

CO1 Student will be able to understand the fundamental principles and philosophy of restoration ecology.

CO2 Students will be able to understand the significance of disturbances affecting structure and functions of different types of ecosystems.

CO3 Students will develop insights into degradation of ecosystems (terrestrial and aquatic) and their restoration by application of ecological principles.

CO4 This course emphasizes critical analysis of restoration approaches used in case studies.

CO-PO MAPPING MATRIX FOR PAPER BOT-404 (a) (ADVANCED PHYCOLOGY-II):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	2	1
CO2	1	2	1	2	1	2
CO3	1	2	1	1	2	1
CO4	2	2	2	2	1	1
Average	1.5	1.75	1.5	1.5	1.5	1.25

CO-PSO MAPPING MATRIX FOR PAPER BOT-404 (a) (ADVANCED PHYCOLOGY-II):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	1	1	1
CO2	2	1	1	1	1
CO3	2	1	2	2	1
CO4	1	2	1	2	1
Average	1.5	1.5	1.25	1.5	1

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1) Photosynthesis and Chromatic adaptations in algae: pigments, photosynthetic membrane organization, oxygenic & anoxygenic photosynthesis.
2) Relationship of CO_2-assimilation with nitrogen assimilation: source of energy & reductants.
3. Nutrient uptake kinetics in algae.

Unit-II

4) Importance of N_2-fixing genera in Indian paddy fields for the improvement of soil fertility.
5) Heterocyst, its differentiation and role in N2-fixation.
6) Mechanism N_2-fixing fixation: nitrogenise and its *in vivo* activity.
7) Uptake kinetics of nitrogenous compounds, their transport and assimilation.

Unit-III

8) Algal immobilization: methods and applications.
9) Technologies for the reclamation, restoration & maintenance of ***usar*** soils and its fertility.
10) Restoration of degraded ecosystems through algae. Importance of algal flora for the treatment of wastewaters (activated sludge system) for the production of useful biomass & energy-rich fuel.

Unit-IV

11) Concept of algalization and biofertilizers.
12) Strain improvement for the production of nitrogenous compounds. Biological & technical aspects of outdoor mass culture of algae.
13) A brief account of commercial potentials of algae, algal products & their uses.

Suggested Readings:

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications.* Daya Publishing House, New Delhi. 2003.
2. Becker, E.W. (1994): Microalgae – Biotechnology & Microbiology, Cambridge University Press, Cambridge, U.K.
3. Carr, N.G. & Whitton , B.A. (1982): The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
4. Dubey, R.C. (2006): Introduction to Biotechnology, Delhi Book Trust, New Delhi.
5. Dubey, R.C. (2014): Advanced Biotechnology, S Chand & Cmpany Pvt. Ltd., New Delhi.
6. Fatma, T. (2005): Cyanobacterial and Algal Metabolism and Environmental Biotechnology, Narosa Publihers.
7.Fay, P & C van Baalen (1987): The cyanobacteria, Elsevier Science Publishers, B.V. Amsterdam, Netherlands.
8.Graham, L.E. & Wilcox, L.W. (1999): Algae, Benjamin Cummings, USA.

Paper – BOT-404(b) PRINCIPLES OF PLANT PATHOLOGY (ELECTIVE) Credit -4 MM-80+20 T: 3hrs

Objectives: The course has been conceived to equip the students with mechanism of infection of fungi, various defence mechanism employed by the plants to protect themselves against plant pathogens. Besides, the course deals with epidemiology, role of environmental factors for disease development, disease forecasting, applications of biotechnology in plant pathology and methods adopted for disease management.

Outcomes:
CO1: Various mechanisms involved during pathogenesis.
CO2: Plant disease epidemiology, forecasting and management
CO3: Applications of biotechnology in plant pathology
CO4: Host-pathogen interactions and mycotoxins

CO-PO MAPPING MATRIX FOR PAPER BOT-404(b) (PRINCIPLES OF PLANT PATHOLOGY):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	3	2
CO2	3	2	2	1	3	2
CO3	3	2	2	2	3	2
CO4	2	2	2	1	2	3
Average	2.5	2	2	1.25	2.75	2.10

CO-PSO MAPPING MATRIX FOR PAPER BOT-404(b) (PRINCIPLES OF PLANT PATHOLOGY):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	1	1	3
CO2	2	2	1	2	3
CO3	2	1	2	2	3
CO4	2	1	1	3	3
Average	1.75	1.50	1.25	2.25	3

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

How pathogens attack plants : chemical weapons of pathogens (enzymes and toxins)
How plants defend themselves against pathogens: structural defense and biochemical defense.

Unit-II

Plant disease epidemiology and plant disease forecasting: Importance of disease forecasting services, methods used in plant disease forecasting.
Management of plant pathogens: cultural, chemical and biological methods.

Unit-III

Applications of biotechnology in Plant Pathology: The use of tissue culture techniques (callus culture, apical meristem culture and protoplast fusion), Recombinant DNA technology, use of monoclonal antibodies in plant pathology.
Effect of environmental factors on disease development.

Unit-IV

Mycotoxin producing fungi during storage and major mycotoxins produced by them.
Host-pathogen interaction of population level: transmission and spread of plant pathogens.

Suggested Readings:

Agrios, G.N. (2005): Plant Pathology, Acad. Press, Inc. California.
Alexopoulos, C.J. Mins, C.W. & Blackwell, M. (1995): Introductory Mycology, John Willy and Sons. Inc.
Biswas, S.P. & Biswas, A. (1984): An Introduction to Viruses, Vani Education Books, New Delhi.
Clifton, A. (1958): Introduction to the Bacteria. McGraw Hill Books Co. New York.
Mehrotra, R.S. & Aneja, K.R. (1990): An introduction of Mycology, New Age International Press, New Delhi.
Mehrotra, R.S. and Ashok Aggarwal (2003): Plant Pathology, Tata Mc Graw Hill Publ. Ltd., New Delhi.
Michael J. Pelezar, E.C.S. Shan & N.R. Krieg (1993): Microbiology. Tata Mc Graw Hill Publ. New Delhi.
Ronald M. Atlas (1995): Principles of Microbiology. Mosby-Year Book, Inc. St. Louis, Missouri, USA.
Singh, R.S. (1990): Plant Disease, 6th Edition, Oxford, IBH Publ., New Delhi.
Sumbali, G. (2005): The Fungi, Narosa Publ. House, New Delhi.
Webster, J. (1985): Introduction of Fungi. Cambridge University, Press.

Paper – BOT-404(c) CONSERVATION BIOLOGY (ELECTIVE) Credit-4 MM-80+20 T: 3hrs

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Objectives: The student will be able to appreciate the value of Biodiversity and focus on the relationship between living organisms and the terrestrial, freshwater and marine environments, coupled with the interactions that results from natural and anthropogenic processes.

Outcomes:

CO1 Students will become aware and understand the concept and significance of different conventions and Protected Area Networks in relation to conservation of Biodiversity.

CO2 Students will be able to develop own conservation values and ethics and appreciate the importance of biodiversity services.

CO3 Student will be able to develop the skills necessary to work efficiently in areas like conservation, EIA, environment management and monitoring.

CO4 After completion of the course, the student be able to formulate one's own scientific and realistic approach towards Conservation Biology.

CO-PO MAPPING MATRIX FOR PAPER BOT-404(c) (CONSERVATION BIOLOGY):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	2	1
CO2	2	2	2	1	2	2
CO3	2	2	3	2	2	3
CO4	2	2	2	2	2	3
Average	2	2	2.25	1.5	2	2.25

CO-PSO MAPPING MATRIX FOR PAPER BOT-404(c) (CONSERVATION BIOLOGY):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	2
CO2	3	3	3	2	1
CO3	3	3	3	2	1
CO4	2	2	2	2	2
Average	2.75	2.75	2.75	1.75	1.5

Unit-1

1) Principles, characteristics and importance of conservation biology
2) Conservation values and ethics, Role of species in conservation

Unit-II

3) Global biodiversity I: Patterns and Processes
4) Global biodiversity II: Losses, Pattern of species vulnerability, Habitat fragmentation and degradation, Synergistic interactions
5) Biodiversity and ecosystem services

Unit-III

6) Biodiversity of wetlands, mangroves and coral reefs- A general account
7) Biosphere reserves and RAMSAR sites in India, The Design of Conservation Reserves
8) Major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere Reserves)

Unit-IV

9) Importance of genetic resources and conservation of crop genetic resources
10) International and National efforts to conserve biodiversity: Convention on biological diversity, CITES, Ramsar convention; National Biodiversity strategy
11) Role of remote sensing and GIS and biodiversity conservation

Suggested Readings :

Chape, S., Fish, L., Fox, P. And Spalding, M. 2003. United Nations list of protected areas. IUCN/UNEP/World Conservation Monitoring Centre, Gland, Switzerland/Cambridge

Gopal, B. (ed.) 1987. Ecology and Management of Aquatic Vegetation of the Indian Subcontinent. W. Junk bv. The Hague.

Heywood, V.(Ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.

Hunter (Jr.) M.L. (1996); Fundamentals of Conservation Biology, Blackwell Science. Meffe G.K. and C. Ronals Corroll (1994) Principles of Conservation Biology, Sinaur Associates, Inc., Sunderland. Massachusetts.

Huston, M.A. 1994. Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.

Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.

Singh,J.S., Singh,S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.

Soule, M.E. (ed.) (1986) : Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.

Turner, M.G., Gadner,R.H. and O,Neill, R.V. 2001. Landscape Ecology: In theory and Practice, Pattern and Processes. Spinger Verlag, New York.

Paper – BOT-404(d) PLANT GROWTH REGULATORS (ELECTIVE) Credit -4 MM-80+20 T: 3hrs

Objective: The course would deal with the study of regulation of different growth regulators to fruit and seed physiology. The advances in senescence, abscission and mechanism of action of various phytohormones will also be studied.

Outcomes: The students will be well acquainted with:
CO1 Biosynthesis, regulation and mechanism of actions of various plant growth regulators.
CO2 The metabolism of seed viability and dormancy and their control.
CO3 Metabolic changes associated with the senescence and abscission and their hormonal control.
CO4 Physiological and biochemical changes of fruit ripening and post harvest storage of fruits.

CO-PO MAPPING MATRIX FOR PAPER BOT-404 (d) (PLANT GROWTH REGULATORS):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	2	2	2
CO2	2	1	1	2	2	2
CO3	1	2	2	1	2	1
CO4	1	2	2	2	2	1
Average	1.5	1.5	1.5	1.75	2	1.5

CO-PSO MAPPING MATRIX FOR PAPER BOT-404 (d) (PLANT GROWTH REGULATORS):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	2
CO2	2	1	1	2	1
CO3	3	2	2	3	2
CO4	2	1	2	2	1
Average	2.5	1.5	1.5	2.5	1.5

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

Phytohormones
Recent advances in the biosynthesis and regulation of cytokinins and ethylene
Current scenario in the mechanism of action of gibberellins, abscisic acid, salicylic acid, jasmonic acid and brassinosteroids.

Unit-II

Seed Physiology
Seed viability and seed dormancy
Metabolism of germinating seeds.
Environmental and hormonal control of seed dormancy and germination.

Unit-III

Senescence and Abscission Role of plant growth regulators
Process of induction
Metabolic changes. Fruit Physiology

Unit-IV

Climacteric and non-climacteric fruits, fruit ripening.
Post-harvest storage of fruits – quality maintenance, physiological and biochemical studies under different kinds of storage conditions.

Suggested Readings:

Krishnamoorthy, H.N. (1993). Physiology of Plant Growth and Development. Atma Ram and Sons, Delhi.
Khan, A.A (1977). The Physiology and Biochemistry of Seed Dormancy and germination. North-Holland Publishing Co., Amsterdam, New Oxford.
Moore. T.C. (1989). Biochemistry and Physiology of Plant Hormones. Second edition (Reprint 1994), Narosa Publishing House, New Delhi.
Saymour, G.B., Taylor, J.E. and Tucker, G.A. (1993). Biochemistry of Fruit Ripening. Chapman and Hall, London.
Stahl, E. (1965). Thin Layer Chromatography, a laboratory handbook. Academic Press, London.
Taiz, L. And Zeiger, E. (1998). Plant Physiology. Second edition, Sinauer Associates, Inc., Publishers, Massachusetts, USA.
Wilkins, M.B. (1987). Advanced Plant Physiology. ELBS-Longman, England.
Srivastava, L.M. (2006). Plant Growth and Development : Hormones and Environment. Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
Trivedi, P.C. (2005). Applied Botany. Aavishkar Publishers, Distributors, Jaipur.

Paper – BOT-404(e) GENOMICS (ELECTIVE) Credit -4 MM-80+20 T: 3hrs

Objective: This course seeks to impart detailed knowledge of basic methods involved in genome studies, their organization and function.

Outcomes:
CO1 The students get acquainted about the basic principles of DNA sequencing and evolution of DNA sequencing techniques.
CO2 Help the students to understand methods/techniques employed in proteome and genome analysis.
CO3 This course will enable the students to learn about the various databases utilize for the storage and analysis of proteome/genome information.
CO4 The students will learn about the various computational tools used for analysis of genome sequence data.

CO-PO MAPPING MATRIX FOR PAPER BOT-404 (e) (GENOMICS):

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	3	2
CO2	3	3	2	1	3	3
CO3	3	2	2	1	2	2
CO4	3	3	1	1	3	2
Average	3	2.75	1.75	1	2.75	2.25

CO-PSO MAPPING MATRIX FOR PAPER BOT-404 (e) (GENOMICS):

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	1
CO2	3	3	3	3	2
CO3	3	3	2	3	1
CO4	2	2	2	3	1
Average	2.75	2.75	2.25	3	1.25

Note: Nine questions will be set in all. Question No.1 will be compulsory covering the entire syllabus. The remaining eight questions will be set with two questions from each Unit. The candidate will be required to attempt one question from each unit. All questions will be of equal marks.

Unit-I

1. **Genome**: Completely sequenced prokaryotic (T_4, and λ phages; *E. coli*) and eukaryotic genomes (*Saccharomyces cerevisiae, Caenorhabditis elegans, Drosophila melanogaster, Arabidopsis thaliana, Oryza sativa, Mus musculus* and *Homo sapiens*); Mitochondrial and Chloroplast genomes.
2. **Mapping of Genome**: Genetic mapping- using DNA markers and Linkage analysis; Physical mapping- restriction mapping, Fluorescent *in-situ* hybridization and Sequence Tagged Sites (STSs) mapping.

Unit-II

3. **Genome sequencing**: Chain termination and chemical degradation methods; Next generation sequencing (NGS)- Pyrosequencing, SOLiD sequencing, Bridge amplification sequencing, Assembly of a contiguous DNA sequence- shotgun and clone contig methods, Human Genome Project.

4. **Understanding a Genome Sequence**: Gene location using 1.) ORF scanning, Automatic annotation, Homology searches and comparative genomics. 2.) Experimental techniques- northern hybridization, cDNA sequencing and RACE.

Unit-III

5. **Identification of a Gene Function**: Using computer analysis; Experimental analysis- gene inactivation and overexpression; Directed mutagenePsis; Reporter genes and Immunocytochemistry.
6. **Analysis of the Transcriptome**: Expressed Sequence Tags (ESTs); Serial analysis of gene expression (SAGE); Differential Display (DD); Representational Difference Analysis (RDA) and DNA Microarrays.
7. **Proteome Analysis:** Using 2-D; Protein identification; Protein-DNA and Protein- Protein interactions and Biochips.

Unit-IV

8. **Biological Databases**: Introduction; Primary and Specialized Databases; Database Scheme; Database Annotation; Retrieval System; Nucleotide Databases; Protein Databases; Genomic Databases and Resources; Gene Databases and Resources; Transcriptome Databases; Mutation Databases; Mitochondrial Databases and Resources.
9. **Computational Methods for Analysis of Genome Sequence Data**: Introduction; Dot-Plot Matrix; Sequence pairwise alignment; Database searching; Multiple alignment; Alignment profiles to recognize distantly related protein or protein modules; Methods for sequence assembly; Linguistic analysis of biosequences; Prediction of RNA secondary structures; Protein sequence analysis; Evolutionary and phylogenetic analysis.

Suggested Readings:

1. Birren B, Green ED, Klapholz S, Myers RM and Roskams J (1997) Genome Analysis, CSHL Press.
2. Brown TA (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
3. Brown TA (2002) Genomes 2, Wiley-Liss, New York
4. Brown TA (2007) Genomes 3, Garland Science Publishing New York, London.
5. Chawla HS (2009) Introduction to Plant Biotechnology (3rd Ed.). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Dale JW, Schantz MV and Plant N (2012) From Genes to Genomes (3rd Ed.), John Wiley and Sons, Ltd. UK.
7. Dawson, MT, Powell R and L Gannon F (1996) Gene Technology, BIOS Sci. Pub. Ltd., Oxford, UK. DNA Amplification, Stockton Press, New York, USA.
8. Glick B and Pasternak JJ (2003), Molecular Biotechnology (3rd Ed), ASM Press, Washington.
9. Hartl DL and Ruvolo M (2011) Genetics- Analysis of Genes and Genomes (8th Ed.), Jones and Bartlett Publishers, Inc., USA.
10. Hunt SP and Livesey FJ (2000) Functional Genomics, Oxford University Press, New York. London.
11. Lewin B (2005) Genes VIII, Oxford University Press, Oxford, UK
12. Li WH (1997) Molecular Evolution, Sinauer Associates, Inc., USA.
13. Saccone C and Pesole G (2003), Handbook of Comparative Genomics, John Wiley and Sons, Inc., Hoboken, New Jersey.
14. Sambamurty AVSS (2007) Molecular Genetics, Narosa Publishing House Pvt. Ltd., New Delhi.
15. Singer M and Berg P (1991) Genes and Genomes: A Changing Perspective; University Science Books, CA, USA.

CO-PO-PSO MAPPING MATRIX FOR ALL THE COURSES OF BOTANY:

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5
BOT-101	2	1.5	1.75	2	1.25	1.75	1.75	1.5	1.75	1.5	1.75
BOT-102	2	2	2	2	1.875	2	2.125	2.25	2.25	2.375	2.5
BOT-103	3	2.75	1.25	2	2.75	3	2.5	1.5	1.75	2.75	1
BOT-104	2.5	2.75	2.25	1.5	1.5	1.5	1.5	3	3	1.75	1.25
BOT-201	1.5	1.5	1.25	1.75	1.75	1.5	1.25	1.5	1.25	1.75	1.25
BOT-202	2.25	2	2.75	1.25	2.5	2.5	1.5	3	3	1.5	1.5
BOT-203	2.25	2	1	1.5	2.25	1.25	2.75	2.5	1.75	1	1
BOT-204	2.5	2.5	1.75	1.75	2.75	1.75	1.75	2	2	2.5	1.5
BOT-206	3	2.66	2.5	2	3	2.5	3	3	2.5	2.33	2.66
BOT-301	3	3	1	1.5	2	1.25	3	1	1.25	3	2
BOT-302	3	2.66	2.5	2	2.66	3	3	2.8	2.6	2.1	3
BOT-303	3	1.5	1.75	1.25	2.5	2	3	1.25	1	3	2.5
BOT-304 (a)	1.75	1.5	1.5	1.75	1.5	1.5	1.5	1.25	1.75	1.25	1.25
BOT-304 (b)	2	1.25	2	1.5	2.5	2.5	2	1.5	1.5	2.5	2.75
BOT-304 (c)	3	2.25	2.5	2.5	2	1.75	2	3	3	1.5	1.75
BOT-304 (d)	1	1.75	2	1.5	2.5	1	2.75	1.5	1.25	2.75	1.75
BOT-304 (e)	3	3	2.5	2	3	3	2	1.5	2	3	1.5
BOT-306	3	3	3	2	2.66	3	3	3	3	1.6	3
BOT-401	1.25	1.75	1	1	2.5	2	2.75	1.5	1.25	3	1.5
BOT-402	3	3	3	2	2.66	3	2.6	2.3	1.8	2.6	3
BOT-403	2.75	1.75	1.75	1	2.5	2.25	2.75	3	1.75	1.5	1
BOT-404 (a)	1.5	1.75	1.5	1.5	1.5	1.25	1.5	1.5	1.25	1.5	1
BOT-404 (b)	2.5	2	2	1.25	2.75	2.10	1.75	1.50	1.25	2.25	3

BOT-404 (c)	2	2	2.25	1.5	2	2.25	2.75	2.75	2.75	1.75	1.5
BOT-404 (d)	1.5	1.5	1.5	1.75	2	1.5	2.5	1.5	1.5	2.5	1.5
BOT-404 (e)	3	2.75	1.75	1	2.75	2.25	2.75	2.75	2.25	3	1.25

Discrepancy, if any noted by stakeholders may please be brought to the notice of Department of Botany for necessary action.

KURUKSHETRA UNIVERSITY
DEPARTMENT OF BOTANY

P.G. DIPLOMA IN FLORICULTURE (ANNUAL SYSTEM)

Learning Outcome: The diploma holders of floriculture will be capable to combat the challenges in the field of growing the ornamental plants, selecting the genotypes of improved characters and their propagation/management under controlled environmental conditions. Students will also be well versed in post-harvest management, marketing and value addition of commercial ornamental plants.

SCHEME OF EXAMINATION w.e.f. session 2020-21 under CBS

Code	Nomenclature	Duration	Max.Marks+I.S	Credit	Hrs/Week
Theory Papers					
PGDF-101	Essentials of Floriculture	3 Hrs.	80 + 20	4	4
PGDF-102	Improvement of Ornamental Plants	3 Hrs.	80 + 20	4	4
PGDF-103	Seed Production and Micro-Propagation	3 Hrs.	80 + 20	4	4
PGDF-104	Agro technology and Marketing	3 Hrs.	80 + 20	4	4
Practical Papers					
PGDF-105	Based on Paper PGDF-101 & 102	4 Hrs.	80 + 20	4	4
PGDF-106	Based on Paper PGDF-103 & 104	4 Hrs.	80 + 20	4	4
PGDF-107	Project work		25	1	
		Total	**625**	**25 Credit**	

SYLLABUS

PGDF-101 Essentials of Floriculture **IA: 20**
Max. Marks: 80 (Theory),
Duration: 3 hours Credit-4

Learning Outcome:

CO1 Students will be able to identify the different plant varieties and their nutritional/soil type requirement as well as their management in nurseries and green houses.
CO2 Learners will be capable to measure soil fertility and apply soil fertility management for improvement of soil structure and its richness.
CO3 Students will learn about various tools and ornamental exhibits used in floriculture.
CO4 Students will be trained in environment control and management strategies of floriculture.

Note: Nine question will be set in all. Question No. 1 will be compulsory and short answer type covering the entire syllabus. Remaining eight questions will be set unit-wise and four questions from each unit. The candidates will be required to attempt Question no. 1 and four more selecting two questions from each unit. All questions carry equal marks.

UNIT-1

1. History and scope of Floriculture
2. Layout structure and management of nursery.
3. Green House Plants.
4. Types and varieties of Dahlia, Chrysanthemum, Gladiolus and Bougainvillea.
5. Cultivation of cacti, succulents, orchids, and water plants.
6. Prolonging the vase life of flowers.

UNIT-2

1. Importance and types of house plants.
2. Effects of factors light, temperature, mineral nutrients, fertilizers, integrated nutrient use.
3. Soil formation, soil structure, soil characteristics and soil fertility assessment.
4. Plant care, training, diseases, pests, control measures.
5. Mycorrhiza and soil fertility management.
6. Methods of growing indoor plants, containers for house plants, dish garden, terrarium, hanging basket.
7. Managing Plant environment-green house, green house covering material, environmental controls, mist chambers.
8. Media and soil mixtures for growing plants.

Suggested Readings:

1. S.K. Bhattacharjee and Lakshman Chandran De. 2010. Advanced Commercial. Floriculture, Vols. I and II Aavishkar Pub., Second Revised and Enlarged Edition, 798.
2. D. Ravinath. 2007. Floriculture: A Viable Business. Excel Books
3. S.Prasad, U. Kumar. 2010. A Handbook of Floriculture). Agrobios (India)
4. John M. Dole and Harold F. Wilkins. 2004. Floriculture: Principles and Secies : Prentice Hall; 2 edition (2nd Edition)
5. Paul V. Nelson (Author). 2002. Greenhouse Operation and Management. Prentice Hall; 6 edition (6th Edition)

PGDF-102 Improvement of Ornamental Plants **IA: 20**
Max. Marks: 80 (Theory),
Duration: 3 hours Credit-4

Learning Outcome:

CO1 Students will be able to understand the concepts of genetic variations and mechanisms for improvement and domestication of ornamental plants.
CO2 Learners will be cognizant about the various methods for the vegetative propagation of commercial ornamental plants
CO3 Students will strengthen skills in improving various ornamental plants of commercial importance.
CO4 Students will be able to handle some of the practical skills of plant multiplication.

Note: Nine question will be set in all. Question No. 1 will be compulsory and short answer type covering the entire syllabus. Remaining eight questions will be set unit-wise and four questions from each unit. The candidates will be required to attempt Question no. 1 and four more selecting two questions from each unit. All questions carry equal marks.

UNIT-1

1. History and overview.
2. Role of Introduction and selection for domestication.
3. Variation and genetic mechanism associated with flower characters like double ness and color in important annuals, bulbs and shrubs.
4. Vegetative propagation: Principles and practices of clone selection.
5. Techniques of cutting, budding, grafting and layering
6. Propagation by specialized stems and roots.

UNIT-2

1. General account of improvement of Roses, Chrysanthemum, Dahlia, Gladiolus, Lilies, Marigold, Zinnia, Carnation, Bougainvillea, Hibiscus rosa sinensis**.**

Suggested Readings:

1. J.S. Arora.2007, introductory ornamental horticulture. Kalyani Publications.
2. Allan M. Armitage and Judy M. Laushman. 2008 Speciality Cut Flowers: The Production of Annuals, Perennials, Bulbs and Woody Plants for Fresh and Dried Cut Flowers. Timber Press; REV
3. Gwen Kelaidis and Saxon Holt. 2008. Hardy Succulents: Tough Plants for Every Climate. Storey Publishing, LLC.
4. Christopher Brickell. Royla Horticulture Society. Encyclopedia of Plants and Flowers (Rhs).
5. D.G. Hessayon. 2005. The House Plant Expert. Expert; 2nd edition.

PGDF-103 Seed production and Micro propagation IA: 20

Max. Marks: 80 (Theory),
Duration: 3 hours Credit-4

Learning Outcome:

CO1 Students will be able to understand about the various methods of seed production, handling, testing and their storage.
CO2 Students will learn the different methods of tissue culture that can be used in propagation of ornamental plants.
CO3 Students will acquire knowledge regarding non-conventional multiplication of ornamental plants.
CO4 Students will be learning preparation of artificial seeds and their application.

Note: Nine question will be set in all. Question No. 1 will be compulsory and short answer type covering the entire syllabus. Remaining eight questions will be set unit-wise and four questions from each unit. The candidates will be required to attempt Question no. 1 and four more selecting two questions from each unit. All questions carry equal marks.

UNIT-1

1. Seed development, structure and stages of seed development.
2. Apomixis and Polyembryony: a general account.
3. Seed production systems
4. Techniques for seed production and handling

5. Seed testing and seed storage
6. Seedling production system
7. Field seedlings, field nurseries

UNIT-II

1. Principles of tissue culture and microprapogations
2. Types of tissue culture systems.
3. Media preparation, sterilization, types of media, methods and applications
4. Protoplast and cell suspension cultures
5. Synthetic seeds
6. Microprapogation of orchids and Carnation.
7. Clonal selection of microprapogated plant

Suggested Readings:

1. Introductory ornamental Horticulture 2007. J.S. Arora, Kalyani Publishers.
2. Advances in ornamental Horticulture, S.K. Bhattacharjee. 2006, Pointer Publishers.
3. Post Harvest Technology of flowers and ornamental plants. S.K. Bhattacharjee 2005, Pointer Publishers.
4. Advanced Commercial Floriculture, S.K. Bhattacharjee 2010. Aaviskar Publishers.
5. Ornamental Horticulture by Vishnu Swarup, Mac Milan Publishers.
6. Plant Propagation by M.K. Sadhu 1989. New Age International Publishers.
7. Propagation of tropical and sub-tropical horticulture crops. Bose, T.K., Mitra, S.K. and Sadhu, M.K. Noya Prakash Publisher.

PGDF-104 Agro technology and Marketing **IA: 20**

Max. Marks: 80 (Theory),
Duration: 3 hours Credit-4

Learning Outcome:

CO1 Students will fathom techniques of harvesting, post-harvest management, packaging and marketing of commercial ornamental plants.
CO2 Students will be acquainted about different value added products, ways of value addition and challenges in value addition industry.
CO3 Students will strengthen their knowledge regarding cut flower business.
CO4 Learners will acquire knowledge regarding marketing and plant quarantine issues.

Note: Nine question will be set in all. Question No. 1 will be compulsory and short answer type covering the entire syllabus. Remaining eight questions will be set unit-wise and four

questions from each unit. The candidates will be required to attempt Question no. 1 and four more selecting two questions from each unit. All questions carry equal marks.

UNIT-1

1. Scope and importance of commercial floriculture in India
2. Production techniques- both conventional and modern for ornamental plants like Roses, Chrysanthemum, Gladiolus, Tuberose and Gerbera for domesticated and expert markets.
3. Hybrid seed production, Post harvest technology of cut flowers in respect of commercial flower crop production of dry flowers.

UNIT- II

1. Indian floriculture industry: An overview
2. Strategies for marketing of floriculture products, IPR and quarantine laws
3. Cut flowers as specialty crops, cut flower industries
4. Trading flowers and potted plants
5. Value addition in floriculture: cosmetics and perfume industry and outdoor designing.
6. Cutting, grading, packaging and marketing of cut flower crops (Aster, Carnation, Chrysanthemum, Gladiolus, Narcissus, Orchids and Antirrhinum) for national and International market.

Suggested Readings:

1. Introductory ornamental Horticulture 2007. J.S. Arora, Kalyani Publishers.
2. Advances in ornamental Horticulture, S.K. Bhattacharjee. 2006, Pointer Publishers.
3. Post Harvest Technology of flowers and ornamental plants. S.K. Bhattacharjee 2005, Pointer Publishers.
4. Advanced Commercial Floriculture, S.K. Bhattacharjee 2010. Aaviskar Publishers.
5. Ornamental Horticulture by Vishnu Swarup, Mac Milan Publishers.
6. Plant Propagation by M.K. Sadhu 1989. New Age International Publishers.
7. Propagation of tropical and sub-tropical horticulture crops. Bose, T.K., Mitra, S.K. and Sadhu, M.K. Noya Prakash Publisher.