NEW

M.Sc

Maa Shakumbhari University, Saharanpur

Syllabus of M.Sc. Botany
(Specialization: Ethnobotany and Ethnopharmacology)

(As per the Guidelines of U.P. Government according to National Education Policy (NEP) - 2020 w.e.f. Session 2024- 2025)

Campus

Members from the Board of Studies (BoS):

S.No.	Name	Signature
1.	**Prof. Garima Jain,** Dean, Faculty of Science, MSU, Saharanpur	
2.	**Prof. Sanjeev Kumar**, Department of Botany, D.A.V. (P.G.) College, Muzaffarnagar **(Convener)**	
3.	**Prof. Ritu Agarwal**, Department of Botany, M.S. College, Saharanpur **(Member)**	
4.	**Dr. Yogendra Kumar**, Department of Botany, Govt. Degree College Nanauta, Saharanpur **(Member)**	
5.	**Dr. Rakesh Kumar**, Department of Botany, VSP Govt. (P.G.) College, Kairana, Shamli **(Member)**	
6.	**Prof. Rup Narayan,** Department of Botany, CCSU, Meerut **(External Expert)**	Online
7.	**Prof. Alok Srivastava,** Department of Plant Science, MJPRU, Bareilly **(External Expert)**	Online

Subject Prerequisites: Students must have passes Bachelor of Science in Botany (or Botany as one of the subjects)/Plant Sciences/Biosciences/Life Sciences from any recognized University equivalent with 55% aggregate.

Course Structure: The courses will be based on Choice Based Credit System (CBCS) structure developed by the University. There will be four compulsory or elective core courses of Botany in each semester. Apart from these, one minor elective course of other faculty is to be chosen by a student in the first year of M.Sc. (Botany). In each semester, there will be one research project of 04 credits.

Programme (M. Sc.) Objectives:

This programme has been designed to train and enable students to understand the relationship between science and society as well as logical, scientific and ethical issues related to science. In addition to this, the students will be able to think critically for the formulation of hypotheses and experimental designing based on the scientific method, which will make the students readily employable in various streams of teaching, research, civil services and in industries.

Programme Specific Outcomes (PSOs): After completing M.Sc. (with Botany), the following will be the PSOs

PSO-1: It is expected that after successfully completing M.Sc. Botany, students will develop deeper theoretical & Practical knowledge of principles and practices of ethanobotany and ethanoparmoacology including the identification, classification, and uses of medicinal plants, Plant taxonomy, Anatomy, Mycology, Microbiology, Physiology, Biochemistry, Cell biology, Genetics, Molecular biology, Pharmacognosy, Environmental issues etc., making them capable of understanding the societal, environmental issues, demands and their solutions.

PSO-2: This program has a strong theoretical basis that will help students in evolutionary relationship of lower and higher plants by using the key characters which is expected from a student of Botany to support the other branches of knowledge related to plants.

PSO-3: Many of the courses in the programme have been carefully designed that will help the students for qualifying competitive exams like IAS, IFS, CSIR NET, SET, TGT, PGT and to write research proposals for grants.

PSO-4: Continuous internal assessment provides ample opportunity to the students for improvement after every evaluation. Seminar and field visits system grooms the personality of the students and enables them to present oneself with confidence, develop a reasonably well compiled content and discuss. Assignments enable the students to compile the solutions of the given problems with optimal discussion.

PSO-5: In each semester of the programme, each student is given research project of their own choice to allow students to understand various steps of solving a research problem. Thus, this programme will help to develop research aptitude at PG level with identification of gaps in knowledge and relevance of their solutions for the society.

PSO-6: The student completing the course will be capable of executing research projects

Examination Pattern

Internal Examination- 25 Marks (Only in Theory Papers)

1. One written Test of 10 Marks +5 Marks Quiz).
2. 5 Marks for Class Seminar and 5 Marks of Assignment

External Examination: Written Examination of 75 Marks of 3 Hours Duration.

External Examination Pattern

Section A: Attempt all 10 questions. Each question carries 2 Marks.
Section B: Attempt any Five out of eight. Each question carries 5 Marks.
Section C: Attempt any Three out of Five questions. Each question carries 10 Marks.

LIST OF PAPERS IN ALL FOUR SEMESTERS

Year	Semester	Course Code	Course Title	Core Compulsory / Elective/ Value Added	Theory/ Practical/ Project	Credits	Internal Marks	External Marks (Min Marks)	Total Mark	Minimum Marks (Int+Ext)	Teaching Hours
Year-4 as per NEP-2020/ Year-I	Semester- VII as per NEP-2020/ Semester-I		Diversity of Algae & Bryophytes	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Diversity of Pteridophytes and Gymnosperms	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Morphology and Taxonomy of Angiosperms	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Biology and diversity of Bacteria, Viruses and Fungi	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Practical Lab (Based on the contents of Theory Courses)	Core Compulsory	Practical	4			100	40	60
	Semester- VIII as per NEP-2020/ Semester-II		Genetics, Cell and Molecular Biology	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Pharmacognosy and Phytochemistry	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Ecology, Phytogeography and Forest Botany	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Anatomy and Embryology of Angiosperms	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Practical Lab (Based on the contents of Theory Courses)	Core Compulsory	Practical	4			100	40	60

Year-5 as per NEP-2020/ Year-II	Semester- IX as per NEP-2020/ Semester-III		Ethnobotany, Ethno pharmacology and Indigenous traditional knowledge	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Herbal Products and Herbal Technology	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Any One of the following: (i) Stress Physiology	Elective	Theory	4	25	75(25)	100	40	60
			(ii) Genetic Engineering		Theory	4	25	75(25)	100	40	60
			(iii) Biotechnology and Plant Tissue Culture		Theory	4	25	75(25)	100	40	60
			(iv) Plant Physiology and Biochemistry		Theory	4	25	75(25)	100	40	60
			Practical Lab (based on the contents of Theory Courses)	Core Compulsory	Practical	4			100	40	60
			Research Project-I	Core Compulsory	Project	4			100	40	60
	Semester- X as per NEP-2020/ Semester-IV		Phytopharmaceutical Drug Development, IPR and Patents	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Phyto-techniques and Biostatistics	Core Compulsory	Theory	4	25	75(25)	100	40	60
			Any One of the following: (i) Bio entrepreneurship and Innovation	Elective	Theory	4	25	75(25)	100	40	60
			(ii) Elementary Knowledge of Computes and Bioinformatics		Theory	4	25	75(25)	100	40	60
			(iii) Economic Botany and Food Security		Theory	4	25	75(25)	100	40	60
			(iv) Biodiversity conservation and Plant resources		Theory	4	25	75(25)	100	40	60
			Practical Lab (Based on the contents of Theory Courses)	Core Compulsory	Practical	4			100	40	60
			Research Project-II	Core Compulsory	Project	4			100	40	60

The types of paper, number of papers, credit for each semester and research project semester wise, as per guidelines of UP state govt. letter no. 401/sattar-3-2022, dated February 09,2022, as a part of NEP-2020 implementation in U.P. universities, have been prepared as above.

The maximum and minimum marks for each Theory paper, Practical papers (internal & external) and projects have been

finalized according to the letter number-1032/sattar-3-2022-8(35)/2020, dated 9 February, 2022. The basic structure of the programme related to types of paper, number of papers, credit etc. have been finalized according to the letter of government dated July 13, 2021.

Core Compulsory Courses: These are main (major) courses of the subject which every student has to study who has taken admission in PG (First and Second Year).

Core Elective Courses: These are full major courses of the subject/programme.

There courses will select by the students in 1/2/3/4 (or 7/8/9/10 in case of integrated PG) Semesters. The Botany department of university/colleges will run these courses in their department/colleges according to their resources/ specialization of teacher and students may opt them according to their choice.

Minor Electives: Some of the above courses, or any other such course developed by BoS, can be taken as Minor electives by the students of other Faculty, for multi-disciplinarily.

Value added course: Some of the above courses, or any other such course developed by BoS, can be taken as Value Added course (Minimum 2 Credits/ 30 Hours) by the students of other Faculty/ Subject, for value addition, besides the courses which are not part of the curriculum/mark sheet of the Botany students are opted by the students of the Botany can be treated as an add-on to the basic requirement for compilation of a degree programme.

Marks Distribution and Teaching hours The marks distribution for each core and elective will be as Maximum marks: 100 (Internal assessment 25 marks + External Assessment 75 marks). Teaching hours for each of the course will be 60 hours. Examination of each paper shall be of 3 Hours (Theory) and 4 Hours (Practical) The distribution of Internal Marks will be as follows

External practical examination the distribution of marks will be as follow	**Marks**
External Assessment	
Viva Voce on Practical's	15
Report of Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models with reports	15
Table work / Experiments	60
Practical Record File	10
Total	**100**

Research Project:

The candidate will submit a research projectin M.Sc. IInd year (IIIrd and IVth Semester) which will be evaluated by an external examiner & internal supervisor along with a presentation and viva-voce examination.

In each semester, each student will work 4 hour/ week/ semester for 4 credits. In this way a project work will be of 4 credits (i.e., 8 credits for two years).

Research project may be interdisciplinary/ multidisciplinary. It may be an industrial training/ internship/ survey work. Research project will be done under the guidance of the faculty member (s) preferably having Ph.D degree. For this a co- supervisor may be chosen from a university, college, industry, research institute etc.

The research project will be of 100 marks. If any student publishes a research paper from his/her research project in a UGC care listed/ Scopus indexed or Thomson Reuters, then he/she will get 25 extra marks (although maximum marks will not exceed more 100). The marks obtained in research project will be coded in grades and they will be counted in the calculation of CGPA.

Credits: MSc Programme will be run semester wise and choice-based credit system. MSc Ist year or B.Sc. 4th year will be of 40 credits whereas MSc 2nd year will be of 40 credits.

Semester Ist and IInd will be of 20 credits each (4 theory+1 practical, each paper/ practical will be of 4 credits) and Semester IIIrd and IVth will also be of 20 credits each (3 theory+1 practical+1 project, each paper/ practical/ project will be of 4 credits). A project work will be of 4 credits (i.e. 8 credits for two years). In other words, it will be of 4 credits/semester i.e. a total of 8 credits.
Thus M.Sc Programme will be of 80 credits (40+40).

DETAILED SYLLABUS

Programme/Class: M.Sc.	**Year:** First	**Semester:** First
Subject: Botany		
Course Code:	**Course Title: Diversity of Algae & Bryophytes**	

Objectives: To study structure, reproduction, phylogeny and inter-relationships of Algae, Bryophyta.

Course Outcomes:

1. Students will have clear idea of the characteristics of the lower plant groups (Algae and Bryophytes).
2. Concepts in the evolution of plants and application will be clear to students.

Credits: 4	**Core:** Compulsory
Max. Marks:	**Minimum Passing Marks:**

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers, research developments, opportunities, institutions and journals.	8
II	Classification and salient features of different classes of Algae. Algal pigments, food reserves, flagellation and their importance in classification. Thallus organization, reproduction and life cycle patterns. Economic importance of algae as food, feed, source of chemicals and drugs, Algal biofertilizers, uses in industry and Algal blooms.	12
III	Comparative study of classes of Chlorophyceae, Xanthophyceae and Bacillariophyceae, with reference to: a. Range of structure of plant body including ultrastructure. b. Methods of reproduction. c. Variation in life cycles.	12
IV	Comparative study of Phaeophyceae and Rhodophyceae with reference to: a. Range of structure of plant body. b. Range of mode of reproduction. C. Variation in life cycles.	12
V	Classification of Bryophytes and their distribution in India. Range of thallus structure (plant body) and anatomy in Bryophytes (with suitable examples) A general account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales.	8
VI	Evolutionary tendencies in sporophytes of Bryophytes (Progressive sterilization of sporogenous tissue) Reproduction, life history, Inter-relationship, affinities of various groups of Bryophytes. Ecology and economic importance of Bryophytes.	8

Suggested Readings:

1. Bold, H.C. and Wynne, M. J. (1985). Introduction to the algae; Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey. 16
2. Cavers, F. (1976). The inter relationships of the bryophyte. S.R. Technic, Ashok Rajpath, Patna.
3. Chapman, V.J. and Chapman D.J. (1975). The algae. 2nd Edition, Mac. Millan Publ. Inc. New York.
4. Chopra, R. N., and Kumar, P. K. (1988). Biology of Bryophytes. John Wiley and Sons, New York (NY).
5. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi.
6. Hoek, C. van den, Mann, D. G. and Jahns, H. M. (1995). Algae: An introduction to Phycology. Cambridge University Press, UK.
7. Kashyap, S. R. (1929). Liverworts of the Western Himalayas and the Punjab Plain. Part1, Chronica Botanica, New Delhi.
8. Kashyap, S. R. (1932). Liverworts of the western Himalayas and the panjab plain (illustrated). Part 2, the Chronica Botanica, New Delhi.
9. Parihar, N. S. (1980). Bryophytes: An introduction to Embryophyta.VolI,Bryophyta, Central Book Depot.
10. Puri, P. (1981). Bryophytes: Morphology, Growth and Differentiation. Atmaram and Sons, New Delhi.
11. Prescott, G. W. (1969). The algae: A review. Nelson, London.
12. Round, F.E. (1981). The Ecology of Algae. Cambridge University Press, Cambridge.

Programme/Class: M.Sc.	Year: First	Semester: First
Subject: Botany		
Course Code:	Course Title: Diversity of Pteridophytes and Gymnosperms	

Objectives: To study phylogeny and inter-relationships of Pteridophytes and Gymnosperms

Course Outcomes: 1. Students will have clear idea of the characteristics of the lower plant groups.
2. Concepts in the evolution, morphology, reproduction & application of plants will be clear to students.

Credits: 4	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers, research developments, opportunities, institutions and journals.	12
II	Classification of Pteridophytes; specific characters of important classes. a. Psilopsida: Psilophytales and Psilotales. b. Lycopsida: Protolepidodendrales, Lepidodendrales, Lepidospermales and Isoetales. c. Sphenopsida: Hyeniales, Sphenophyllales and Calamitales. d. Pteropsida: Coenopteridales, Ophioglossales, Marattiales, Osmundales, Filicales, Marsileales, Salviniales and Indian Fossils.	12
III	Telome concept. Stelar system and evolutionary tendencies. Heterospory and evolution of seed habit. Apogamy, apospory, parthenogenesis. Soral evolution in Pteridophytes. Alternation of generations.	8
IV	Classification and distribution of gymnosperms with special reference to India Study of morphology, structure and life history as illustrated by the following: Pteridospermales, Bennettitales, Cycadales, Pentoxylales, Cordaitales, Ginkgoales, Coniferales, Taxales, Ephedrales, Welwitschiales and Gnetales.	12
V	Evolution and Economic importance of Gymnosperms. Geological Eras and distribution of plants in geological time scale. Types of Fossils, Process of fossilization and fossil preservation methods. Techniques of study of fossils. Distribution of fossils in India	16

Suggested Readings:

1. Agashe, S. N. (1995). Paleobotany. Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
2. Arnold, A. C. (2005). An Introduction to Paleobotany. Agrobios (India), Jodhpur.
3. Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International, New Delhi.
4. Biswas, C. and Johri, B. M. (1997). Gymnosperms. 4 Narosa Publishers, NewDelhi.
5. Parihar, N.S. (1976). Biology and morphology of the Pteidophytes. Central Book Depot.
6. Rashid, A. (1999). An Introduction to Pteridophyta. Vikas Publishing House Pvt. Ltd., New Delhi.
7. Ramanujan, C.K.G. (1970). Indian Gymnosperms in time and space. Today &Tomorrow 's Printers & Publishers.
8. Sporne, K.R. (1965). Morphology of Gymnosperms. Hutchinson University Library.
9. Sporne, K.R. (1986). The morphology of Pteridophytes. Hutchinson University Press, London.

Programme/Class: M.Sc.	Year: First	Semester: First
Subject: Botany		
Course Code:	Course Title: Morphology and Taxonomy of Angiosperms	

Course Objectives: To acquaint the students about the morphology and taxonomy of angiosperms

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

- Understand the distinctive features of different angiosperms plants.
- Learn about various approaches to classify the angiosperms.
- Learn the practical applications, techniques to preserve the plants.

Credits: 4	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Morphology: Morphology of flower, Stamen and Carpel, Floral characteristics, structure of the pistil, pollen stigma interactions, Plant adaptation–physiological and their morphological nature (xerophyte, hydrophyte and halophyte).	12
II	Contribution of Plant Taxonomist, Phylogeny, and research developments, opportunities, institutions and journals. e-Herbarium, Plant identifications through internet applications.	12
III	Need for scientific names, development of botanical code, contents of botanical code, Ranks and endings provided by the ICN, Typification (Holotype, Isotype, Paratype, Syntype, Lectotype, Neotype), Author citation, Publication of Names, Principle of Priority, PhyloCode. Outline of classification of Angiosperms as proposed by Bentham and Hooker. APG classification system: Basal living angiosperm, Monocots and Eudicots. Phylogenetic relationships of major angiosperm clades.	12
IV	Special features of important families: Monocots (Commelinaceae, Cyperaceae, Poaceae, Orchidaceae), Eudicots (Magnoliaceae, Ranunculaceae, Papaveraceae, Brassicaceae, Malvaceae, Oxalidaceae, Rutaceae, Fabaceae, Rosaceae, Lythraceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Convolvulaceae, Solanaceae, Acanthaceae, Scrophulariaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Cannabaceae, Moraceae).	12
V	Herbarium preparation and use, Virtual Herbarium, Roles of a Botanical Garden, Floras, Journals, Taxonomic Keys, DNA Barcoding. Chemotaxonomy, Embryology and Palynology Sieve-tube plastids in relation to taxonomy. Possible ancestors of Angiosperms.	12

Suggested Readings:

1. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition. 29
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi. 5. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York

Programme/Class: M.Sc.	Year: First	Semester: First
Subject: Botany		
Course Code: :	Course Title: Biology and Diversity of Bacteria, Viruses and Fungi	

Course Objectives: The objective of this course is to make students aware about microbial world and its diversity along with their skill enhancement in microbial application for human welfare and development.

Course Outcomes: By the end of the course, the students should be able to:

1. Address the concepts of microbes and their diversity.
2. Evaluate methods for isolation, purification and cultivation of microorganisms from different sources.
3. Understand classification and growth patterns of bacterial cell.
4. Differentiate between virus, viroids, virusoids and prions.

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

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

Unit	Topics	No. of Lectures
I	General account of Archaeobacteria, Eubacteria and Cyanobacteria, Characters, Ultrastructure, nutrition genetic recombination (Transformation, Transduction, Conjugation), and economic importance.	12
II	Introduction and general characteristics of Viruses, Classification of plant viruses. Isolation, purification and characterization of viruses. Replication, transmission of viruses, economic importance, Virus-induced cell transformation, Cyanobacteria, Viroids, Prions.	12
III	Mycoplasma like organism and their role in carrying plant disease, Fungal and Bacterial ,viral disease in plants and humans	8
IV	General characters of fungi, cell structure and nutrition. Range of Thallus organization in fungi. Unique aspects of (i) fungal cells, (ii) molecular biology of fungi Types of reproduction in fungi. Nutrition and growth in Fungi including factors affecting fungal growth. Differentiation in fungi: control of i) Dimorphism. ii) conidiation. iii) mating (with the help of Sex hormones). Heterothallism, Heterokaryosis, parasexuality and physiological specialization in Fungi.	
V	A general account and affinities of the following groups with special reference to systematic position, structure and reproduction of organisms mentioned hereunder: I. The Fungi belonging to kingdom Protozoa: a. Myxomycota (myxomycetes): Stemonites, Ceratiomyxa, b. Plasmodiophoromycota (Plasmodiophorales) Plasmodiophora. II. The Fungi belonging to Kingdom Chromista: a. Oomycota: Saprolegnia, Phythium, Phytopthora, Albugo, III. The Kingdom Fungi: a. Chytridiomycota: Synchytrium, b. Blastocladiomycota: Allomyces, Coelomomyces c. Zygomycota: Saksanaea, Pilobolus, Entomophthora d. Ascomycota : Taphrina, Phyllactinia, Erysiphae, Neurospora, Peziza Basidiomycota: Puccinia, Uromyces, Hemiliea, Melampsora, Tilletia, Ustilago Anamorphic fungi (Deuteromycotina): With reference to their telomorph, also wherever possible; Cercospora, Helminthosporium, Curvularia, Alternaria, Fusarium, Colletotrichum,	12

	Aspergillus, Penicillium.	
VI	Fungal interactions: I. Role of antibiotics, hyphal interference, II. Mycoparasitism	8

Suggested Readings:

1. Salyers, A. A., Whitt, D. D. (2000). Microbiology: Diversity and the Environment. 1st Edition.
2. Pommerville, J. C. (2018). Fundamentals of Microbiology. 11th Edition.
3. Pelczar (Jr.), M. J., Chan, E.C.S. and Krieg, N. R. (2016). Microbiology. 5th Edition.
4. Tortora, F. (2017). Microbiology an introduction. 12th edition.
5. Willey, J., Sandman, K., Wood, D. (2020). Prescott's Microbiology. 11th Edition.

Programme/Class: M.Sc.	Year: First	Semester: Second
Subject: Botany		
Course Code: :	Course Title: Genetics, Cell and Molecular Biology	

Course Objectives: The paper will deal with Mendelian and non-Mendelian inheritance

Course Outcome:

1. This course will provide an understanding of - inheritance of qualitative and quantitative traits.
2. The course will provide an understanding of – fine structure of genes and biochemical genetics
3. The students will be able to learn about – mutations and extra chromosomal inheritance

Credits: 4	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Mendel's Laws of inheritance and modified ratios. Allelic and non-allelic interaction of genes. Multiple alleles: alleles, coat color in rodents, blood groups in Humans, self-incompatibility.	8
II	Linkage and crossing over: chromosome mapping, linkage groups, mechanism of chromosome pairing and synaptonemal complex. Sex determination in man, Drosophila and plants.	8
III	Biochemical genetics, concept of gene. Structural changes in chromosomes: Deficiency, duplication (meiotic pairing & phenotypic effects), Inversions, translocations, (meiotic pairing, Chromosome disjunction), multiple translocations. Numerical changes in chromosomes and Haploidy: a) Euploidy/Polyploidy: Classification, production, role in evolution, utility in crop improvement. b) Aneuploidy: Trisomics, tetrasomics, monosomy, multisomy- Meiotic behaviors, breeding behavior.	12
IV	Mutation: Types of mutations, spontaneous and induced mutations, Physical and chemical mutagens, gene mutations, induction and detection of mutation, mutation by transposons. Concept of gene: gene structure and expression; gene fine structure, cis-trans test, introns.	12
V	The Dynamic cell: Structural organization of plant cell, specialized plant cell. Cell envelopes: Ultra-structure, chemical foundation and functions of cell wall, Biological membranes with special emphasis on plasma membrane and tonoplast membrane	12
VI	The Dynamic cell: Structural organization of plant cell, specialized plant cell. Cell envelopes: Ultra-structure, chemical foundation and functions of cell wall, Biological membranes with special emphasis on plasma membrane and tonoplast membrane.	12
VII	Plant Cell inclusions, their structure and function; Mitochondria and Chloroplast. Nucleus & Nucleolus: Structure, nuclear pores, nucleosome concept. Chromatin Organization: Chromosome structure and composition, Centromere, Telomere, Euchromatin and Heterochromatin, Karyotypes, Polytene, Lamp brush chromosomes and Sex chromosomes.	6

VIII	Ribosomes, Dictyosomes, Lysosomes, ER, Microbodies and Plasmodesmata. Cell cycle & Apoptosis: Biochemical and genetic mechanism– a) Mitosis b) Meiosis and its significance	7
IX	Nucleic Acids: Nature, Structure, types of DNA (A, B, Z-DNA) and RNA, (t-RNA, micro-RNA) difference between DNA & RNA; DNA replication (Origin and fork) and its biosynthesis, extra chromosomal replications, DNA damage and repair, transposons and mechanisms of transposition. Genetic Code: Discovery, Properties and cracking of genetic code.	12
X	Protein Synthesis: Basics, mechanism of protein synthesis in prokaryotes and eukaryotes, transcription, RNA processing, reverse transcription, translation and regulation of protein synthesis in prokaryotes (Structural, regulatory genes and operon model). Control of gene expression at transcription and translation level: Regulation of gene expression in phages, viruses, prokaryotes and eukaryotes, role of chromatin in regulating gene expression and gene silencing.	17

Suggested Readings:

1. Gupta P K (2009). Genetics, 4/e. Rastogi Publications, Meerut.
2. Gupta P K (2007). Genetics: Classical to modern. Rastogi Publications, Meerut.
3. Griffith et *al* (2008). An introduction to Genetic Analysis. Freeman & Co.
4. Hartl DL and Jones EW (1997). Genetics: Principles and Analysis 4th Ed. Jones & Bartlett Publishers, Inc
5. Hartwell L *et al* (2000). Genetics: From genes to genomics. McGraw Hill, New Delhi.
6. Lewin B. (2007). Genes IX. Wiley Eastern Ltd., New Delhi.
7. Pierce, B. (2005). Genetics: A conceptual Approach 2nd Ed. WH Freeman
8. Snustad D P , Simmons NJ and Jenkins JB (2003). Principles of Genetics. John Wiely & Sons, New York.
9. Strickberger, N.W. (1985). Genetics 3rd Ed. Macmillan Co. New York.
10. Alberts, B., et. al. (1983). Molecular Biology of The Cell. W. W. Norton & co., 1464pp, Sixth edition, United states.
11. Coopet, G. (2000). The Cell, A molecular approach. Second edition.
12. Lodish, H., et. al. (2021). Molecular Cell Biology. Ninth edition.
13. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
14. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering. 2nd Edition, CAB International, U.K.
15. Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th ed.). W.H. Freeman & Co., New York.
16. Taiz, L. and Zeiger, E. (2010). Plant Physiology. 5th Edition. Sinauer Associates, USA.

Programme/Class: M.Sc.	Year: First	Semester: Second
Subject: Botany		
Course Code:	Course Title: Pharmacognosy and Phytochemistry	

Course Objectives: To study the fundamentals of Pharmacognosy like scope, classification of crude drugs, their identification and evaluation, phytochemicals present in them and their medicinal properties.

Course Outcomes: : Upon completion of the course, the student shall be able

1. to know the techniques in the cultivation and production of crude drugs
2. to know the crude drugs, their uses and chemical nature
3. know the evaluation techniques for the herbal drugs
4. to carry out the microscopic and morphological evaluation of crude drug

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

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

Unit	Topics	No. of Lectures
I	Definition, history, scope and development of Pharmacognosy. Phytochemical and Pharmacological literature review of Azadirahcta indica, Asparagus Ocimum sanctum, Shankapushpi etc	12
II	Types of Plant drugs from vegetative parts and their Pharmacognostic study a) Root drugs; Glycyrrhiza and Asparagus, Coleus, Withania, Catharanthus b) Rhizome drugs, Zingiber c) Leaf drugs, Andrographis, Clitoria d) Bark drugs: Terminalia arjuna, Holorrhena	16
III	Types of Plant drugs from Reproductive parts and their Pharmacognostic study a) Flower drugs: Crocus, Carthamus, Spilanthes b) Seed drugs: Piper longum, Mucuna c) Fruit drugs: Carum cuminum, Emblica, Cassia.	16
IV	Evaluation of the drugs; Organoleptic, Microscopic, Physical, Chemical and Biological methods of evaluation A brief account of various drug constituents: Carbohydrates, Cardiac glycosides, alkaloids, flavinoids, Tannins volatile oils, resins quinines and steroids with particular reference to Acacia gum, Phyllanthus, Coleus, Asparagus, Rauvolfia	16
V	Elementary idea of secondary metabolites like alkaloids, lignin and phenolics (terpenes, phenols) with emphasis on flavonoids.	

Suggested Readings:

1. Evans, W. C. (2009). Trease and Evans Pharmacognosy. 16th edition, W.B. Sounders & Co., London.
2. Ali, M. (2020). Pharmacognosy and Phytochemistry, CBS Publishers & Distribution, New Delhi.
3. Kolkata, C. K., Gokhlae, P. (2007). Text book of Pharmacognosy. 37th Edition, Nirali Prakashan, New Delhi.
4. Choudhary, R. D. (1996). Herbal drug industry. Ist Edn, Eastern Publisher, New Delhi.
5. Ansari, S. H. (2007). Essentials of Pharmacognosy. IInd Edition, Birla publications, New Delhi.
6. Pande, H. (2015). Herbal Cosmetics. Asia Pacific Business press, Inc, New Delhi.
7. Kalia, A. N. (2005). Textbook of Industrial Pharmacognosy. CBS Publishers, New Delhi.
8. Endress, R. (1994). Plant cell Biotechnology, Springer -Verlag, Berlin.
9. Bobbers, J., Marilyn K. S., VE Tylor. (1996). Pharmacognosy& Pharmaco biotechnology

Programme/Class: M.Sc.	Year: First	Semester: Second
Subject: Botany		
Course Code: :	Course Title: Ecology, Phytogeography and Forest Botany	

Course Objectives: To provide the students the ability to understand the environment and distribution of plants.

Course Outcomes: On successful completion of this course the students will be able to

- Understand the concepts of ecology.
- Know about the environment and learn the way to conserve the environment.

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

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

Unit	Topics	No. of Lectures
I	Ecological factors (light, air, water, topographic, edaphic, biotic), climate change. Ecological concepts of species: Genecology and Ecological niche. Population Ecology: Basic concepts, characteristics of population and population structure. Community Ecology: Composition, characters, structure, origin and development of community: methods of study of structure of community.	12
II	Ecological succession: Process concept and trends. Climax. (Xerosere, hydrosere) Ecosystem Ecology: Structure and functions, with example of a natural and artificial ecosystem, Energy flow in ecosystem. Production Ecology: Measurement methods and productivity in different ecosystems.	12
III	Preliminary Knowledge of I.B.P. (International Biological Programme), M.A.B (Man and Biosphere Programme). Pollution: Kinds of pollution (Air, Water, Soil and Noise) and greenhouse gases, Ozone hole, and global warming.	8
IV	Forests- definition, study of various forests of the world and India. Forest products – Major and minor Influence of forest on environment. Consequence of deforestation and industrialization. Sustainable use of bioresources, Chipko movement, Van Mahotsav, Afforestation, reforestation.	10
V	Principles of phytogeography, vegetation types and Phytogeographical regions of India. Age and area hypothesis, continental drift, endemism, Hot spots, Plant exploration. Invasion and introduction.	8

Suggested Readings:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Ambast, R.S. & Ambast N.K. (2022). A Textbook of Plant Ecology. CBS Publisher & Distributors Pvt Ltd. 16th Ed.
4. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
5. Pratima Kapur and S. R. Govil (2004). Experimental Plant Ecology. CBS Publishers & Distributors Pvt Ltd, India.
6. Govil S. R. & Tripathi, B. D. (2001). Water Pollution: An Experimental Approach. CBS Publishers & Distributors Pvt Ltd, India
7. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
8. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
9. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.

Programme/Class: M.Sc.	Year: First	Semester: Second
Subject: Botany		
Course Code: :	Course Title: Anatomy and Embryology of Angiosperms	

Course Objectives: To study the external and internal structures of root stem and leaf.

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

- Understand the morphology of plants.
- Understand the basic concepts of anatomy of plants.

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

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

Unit	Topics	No. of Lectures
I	Recent Research developments, Opportunities, Institutions and journals. Shoot development: organization of shoot apical meristem (SAM), Cytological and molecular analysis, Leaf (Marginal meristem). Root development: organization of root apical meristem (RAM), Cell fates and lineage differentiation of vascular tissue, regulation of root growth. Epidermal structures, ontogeny and classification of stomata, trichomes and secretory glands Phloem: Structure and development of sieve elements, P- Proteins Xylem: Structure and development of tracheary elements Vascular cambium: normal and abnormal functioning Nodal Anatomy: evolution of nodal vasculature	12
II	Plant Tissues: Classification; Simple and complex tissues; cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.	8
III	Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Leaf: Structure of dicot and monocot leaf, Kranz anatomy. Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent center; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.	8
IV	Vascular Cambium: Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; dendrochronology. Periderm: Development and composition of periderm, rhytidome and lenticels.	12
V	Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and non-glandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes. Secretory System: Hydathodes, cavities, lithocysts and laticifers.	8
VI	Stamen and Carpel evolution. Microsporogenesis and Megasporogenesis. Embryo sac and its types. Pollination and Fertilization. Embryo and Endosperm development. Placentation and its types. Types of fruits. Seed germination. Dormancy.	12

Suggested Readings:

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

Programme/Class: M.Sc.	Year: Second	Semester: Third
Subject: Botany		
Course Code:	Course Title: Ethnobotany, Ethnopharmacology and Indigenous Traditional Knowledge	

Course Objectives:

To appreciate the need to conserve floristic and cultural diversity of the region.

Course Outcomes: On successful completion of this course the students will be able to

Learn and understand the need for development of new drugs for safe and more rationale use of herbal preparations.

Develop laboratory skill in testing of herbal drugs and new commercial products.

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

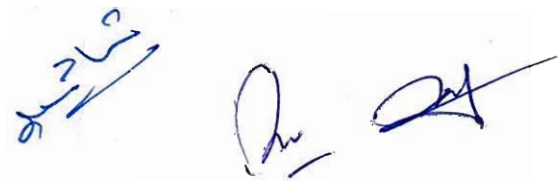
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Ethanobotany:** Introduction, relevance, scope and status. Classification, International, National and Regional Contributions (J.W. Harshberger, R.E. Schultes, E.K. Janakiammal, S.K. Jain, K.S. Manilal, V.V Sivarajan & P. Pushpangadan). Centres of Ethno botanical studies in India, AICRPE-All India Coordinated Research Project on Ethno biology, FRLHT- Foundation for the Revitalization of Local Health Traditions. Contributions of AICRPE and FRLHT to ethno biology of India. Study in brief about Tribal/Folk communities of any State focusing on Anthropology, Customs and Beliefs & Archaeological Ethnobotany. (Koraga, Kurichiya, Adiyan, Paniya, Cholanaikan, Kadar, Kurumba, Kuruman, Kani, Ulladan). Role of ethnomedicine and its scope in modern times. Role of Ethnobotany in conservation and sustainable development.	12
II	Methods and techniques used in Ethnobotany-Field level activities for data collection-Approach, Documentation(Audio, Video recording, Photographs, Interview – Methods, Questionnaire, and Data sheet), Consent forms, Forest productivity check by analysing the log books of Forest, EDC, VSS etc), Authentication of plant species (Field Book, Herbarium) Field and Lab Procedures, Preparation of Data Sheet and Data Base. Peoples biodiversity Register (PBR). Impact of Ethnobotany in herbal-medicine industry, land-use development, agriculture, forestry, betterment of rural livelihoods and education. Plant used in ethno medicine- e.g.: *Trichopus zeylanicus, Ocimum sanctum, Aegle marmelos, Janakia arayalpatra, Phyllanthus niruri, Cissampelos pareira.* Preparation and their uses.	12
III	**Ethanopharmacology:** Introduction, scope and relevance. Brief account of Phytochemistry, pharmacodynamics and pharmacokinetics. Difference between herbal/botanicals and pharmaceutical medicine. Classification and sources of crude drugs. Quality, safety and efficacy of herbal medicines/ neutraceuticals. Role of ethnopharmacology in drug development.	12
IV	Biological screening of herbal drugs- introduction and need for phytopharmacological screening. *In vitro* Screening methods used for herbal drugs: Antimicrobial screening of herbal drugs. Screening for anticancer activity, Screening for antioxidant activity, Screening for antiurolythetic activity. *In vivo* Screening methods used for herbal drugs: Screening for anti-inflammation and analgesic activity, Screening for antiulcer activity, Screening for antidiuretic activity, Screening for liver related disorders. Database on pharmaceutical uses of plants.	12

V	**Indigenous /Traditional Knowledge:** Plants used by ethnic groups as food, medicines (Ethnomedicine), beverages, fodder, fibre, resins, oils, fragrances and other uses. NWFP (Non Wood Forest Produces), animal products, minerals, artefacts, and rituals, used by Tribal and Folk Communities. Traditional/indigenous knowledge and its importance. Ethnobotany and Ethnopharmacology as a tool to protect interests of ethnic groups and rural development.	**12**

Suggested Readings:

1. Traditional plant medicines as sources of new drugs. P J Houghton in Pharmacognosy Trease and Evan's.16 Ed .2009
2. Cunningham, A. B. (2001). Applied Ethnobotany. Earthscan publishers Ltd. London & Sterling, VA, USA Cotton, C.M. (1996).
3. Ethnobotany-Principles and application. John Wiley& Sons Ltd., West Sussex, England
4. In vivo and in vitro assays Glimpses of ethnopharmacology 1994 Eds. P Pushpangadan ,V George and U.Nyman
5. Faulks, P.J. (1958). An introduction to Ethnobotany, Moredale Publ. London
6. Jain, S. K. (1981). Glimpses of Indian Ethnobotany. Oxford & IBH publishing Co. Pvt. Ltd., New Delhi
7. Jain, S. K. (1989). Methods and approaches in Ethnobotany. Society of Ethnobotanists, Lucknow
8. Jain, S. K. (1995). A manual of Ethnobotany. Scientific Publishers, Jodhpur
9. Jain, S. K., Mudgal, V., Banerjee, D. K., Guha, A., Pal, D. C. and Das, D. (1984). Bibliography of Ethnobotany. Botanical Survey of India, Howrah
10. Jain S.K.(1997). Contribution to Indian Ethnobotany, Sci. Publ. Jodhpur
11. Jose Boban K. (1998). Tribal Ethnomedicine: Continuity and change. APH publishing corporation 5, Ansari Road, Darya Ganj, New Delhi
12. Phytochemical Methods. Harborne JB. 1984 .Chapman and Hall , London
13. Mathur, P. R. G. (1977). Tribal situation in Kerala. Kerala Historical Society, Trivandrum
14. Shashi, S. S.(1995). Tribes of Kerala (Encyclopedia of Indian tribes Series-8). Ammol Publication Pvt. Ltd. Ansari Road, Daryagang, New Delhi
15. Snehalatha and Jain, S. K. (1998). Historical Archive in Ethnobotany. Institute of Ethnobotany, NBRI, Lucknow
16. Medical Pharmacology, Padmaja Udaykumar. Sixth Edition, CBS Publishers & Distributors Pvt Ltd.



Programme/Class: M.Sc.	Year: Second	Semester: Third
Subject: Botany		
Course Code: :	Course Title: Herbal Products and Herbal Technology	

Objective: Objective: This course aims to educate student on branches of Herbal Technology such as medicinal plants, natural dyes, biopesticides, biofertilizers and biofuels.

Learning Outcome:

1. The students will get knowledge of herbal technology and nutraceutical therapy.
2. Develop knowledge on the use of herbal technology in cosmetics and laws pertaining to herbal technology.

Credits: 4	Core: Compulsory
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Introduction and scope of Herbal Technology -Plants for Human welfare. Utilization of Different categories of Plants: Medicinal plants, Natural Dyes, Biopesticides, Biofertilizers and Biofuel.	8
II	Herbal Drug Technology. Herbs as raw materials, Herbal-Drug and Herb-Food Interactions General introduction to interaction and classification. Action and side effects of active principles of Selected Herbs: eg. Curcumin, Pepper, Garlic, Ginseng , Artimisinin, Taxol, Camptothecin.	12
III	Herbal Plant extraction and Formulation - single plant and poly herbal formulations. Quality control. Herbal Cosmetics: Biological membranes, Inter facial Phenomena: Liquid-Liquid interface, , Liquid- Solid interface, detergency and water repellence.	10
IV	Plants of Indian Traditional Medicine, Reverse Pharmacology, Activity Guided Fractionation and Characterization. Herbal technology for the marketing of herbal drug. Model herbal products, IPR protection, CBD, Equitable Benefit Sharing, Example- Jeevani - Herbal drug with global acceptance.	12
V	Nutraceuticals: Biological Effects of Nutraceuticals. Nutraceuticals related to neural, cardiovascular diseases and renal disorders. Nutraceuticals for health promotion, immune-boosting, protection. Metabolomics (brief account) and role of soil micro flora in herbal medicine Quality.	8
VI	Regulatory measures adapted for the release of herbal product to industries, Efficacy, toxicity and allergenicity, Preclinical analysis and Clinical trials, Biotechnological interventions. Good Manufacturing Practices, Global acceptance of Herbal products , Quality Control, Repurposing of herbal products for controlling Epidemics and Pandemic, Ethical Issues.	10

Suggested Readings:

1. M. Daniel (2008) Herbal Technology: Concepts and Scope. Satish Serial Publishing House
2. Magazine R (2019) DRUGS AND COSMETICS FORMULATIONS. ISBN-13:978-8123919942. CBS Publisher : India
3. Ramesh Gupta (Ed) (2016) Nutraceuticals: Efficacy, Safety and Toxicity. Academic Press.
4. Agarwal S.S. and Paridhavi M. (2012) Herbal Drug Technology 2nd Edition Orient Blackswan Publisher. ISBN: 9788173717871

Programme/Class: M.Sc.	Year: Second	Semester: Third
Subject: Botany		
Course Code: :	Course Title: Stress Physiology	

Objective: Objective: This course aims to educate student on concepts of various types of stresses in crop production and strategies to overcome them.

Learning Outcome:

3. The students will understand various aspects of stress physiology such as physiological and molecular basis of abiotic and biotic stress tolerance in plants.
4. The knowledge in stress physiology will be useful for developing climate resilient genotypes for sustainable crop production.
5. Student also able to explain what basic processes and/or traits are affected by each one of the stresses.
6. Explain how the plant tissue responds at the biochemical and molecular level to each one of the stresses.

Credits: 4	Elective
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers of Stress Physiology, Research developments, Opportunities, Institutions and journals.	8
II	Biological stress vs. Physical Stress, Types of stresses and general methods of measurement of stress response (Strain), Stress physiology in crop improvement, Response to UV stress: Injury and resistance mechanism	12
III	Response to low temperature stress: Chilling, freezing, frost injury and mechanism of resistance, Adaptations, Response to high temperature stress: Injury and mechanism of resistance, Heat shock proteins, Adaptations	12
IV	Response to nutrient deficiency stress, Heavy metal stress, injury and mechanism of resistance, adaptations, Salinity stress, Ionic and salt stress injury, mechanism of resistance.	12
V	Response to water deficit: Desiccation, Dehydration injury; Mechanism of resistance, Adaptations. Response to water excess: Flooding, hypoxia, Mechanism of resistance, Adaptations, Causative agents for Biotic Stresses	8
VI	Mechanism of Resistance against Fungal, Bacterial and viral pathogens. Fire stress to forests. Mechanism involved to save the plant forests fire.	10

Suggested Readings:

1. Levitt, J. (1981). Plant responses to environmental stresses (vol. I &II). Academic Press, New York & London.
2. Dwivedi & Dwivedi, (2005). Physiology of abotic stress in plants. Agro bios, India.
3. Kramer, P. J. (1983). Water relations of Plants. Academic Press.
4. Panda S.K. (2002). Advances in Stress Physiology of Plants. Scientific Publishers, Jodhpur.

Programme/Class: M.Sc.	Year: Second	Semester: Third
Subject: Botany		
Course Code: : :	Course Title: Genetic Engineering	

Course Objectives: The aim of this course is to provide a profound knowledge on the methods used in Genetic Engineering allows students to apply these in basic and applied fields of biological research in an innovative way.

Course Outcomes: : Upon successfully completing this course, the students could be able to:

1. Outline the basic steps in genetic engineering. Describe the mechanism of action and use of restriction enzymes.
2. Describe the techniques used to probe DNA for specific gene of interest and also the technique used to study gene expression.
3. Conceptualize the basics and applications of genomics, proteomics and bioinformatics.
4. Discuss the methods of protein sequencing, protein and metabolic engineering and their future prospects.
5. Explain the usefulness of RNA interference and its potential for crop improvement.
6. Outline the fundamentals of genome editing.

Credits: 4	Elective
Max. Marks:	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers of Genetic engineering, Research developments, Opportunities, Institutions and journals.	12
II	Genetic Engineering (General), Restriction mapping, Restriction of Chimeric DNA-staggered cleavage, addition of oligopolymer tailing & linkers, blunt end ligation. Gene sequencing (principle & different techniques), c-DNA & genomic libraries.	12
III	DNA analysis: Labelling of DNA & RNA probes, southern & florescence in-situ hybridization, DNA fingerprinting, chromosome walking. Techniques for gene expression: Northern & western blotting, gel retardation technique, DNA foot printing, primer extension, S1 mapping, reporter assays.	12
IV	Proteomics as a tool for plant genetics, breeding & diversity studies. Protein extraction/ purification techniques viz electrophoresis & column chromatography. Protein sequencing methods, detection of post translational modifications of proteins, methods of analysis of gene expression at RNA and protein level, large scale expression such as Microarray based techniques. Protein Engineering and metabolic engineering- definition and explanation, Steps, Achievements and future prospects	12
V	RNA interference- Introduction, RNAi as tool for gene expression. RNAi as a potential therapy. Use of transposons in genetic analysis: Transposons & T-DNA tagging & its use in identification & isolation of genes. Introduction to genome editing with reference to CRISPR/Cas system.	12

Suggested Readings:

1. Howe, C. (2007). Gene Cloning and Manipulation (2nd Edition).
2. Clark, D., Pazdernik, N. and McGehee, M. (2018). Molecular biology (3rd Edition).
3. Primrose, S. B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics (7th Edition).
4. Brown, T. A. (2020). Gene Cloning and DNA Analysis: An Introduction (8th Edition).
5. Thieman, (2020). Introduction to Biotechnology (4th Edition).

Programme/Class: M.Sc.	Year: Second	Semester: Third
Subject: Botany		
Course Code:	Course Title: Biotechnology & Plant Tissue Culture	

Course Objectives: This course aims to help the students to attain an advanced understanding of the components of plant biotechnology and will provide an overview of genetic manipulation, its applications, GM crops, etc.

Learning Outcomes: Upon successfully completing this course, the students could be able to:

1. Conceptualize plant transformation and selection of desirable genes for crop improvement.
2. Learn the procedure for generating GM crops.
3. GM crops and products are in the market, their contributions towards food security, sustainable environment and medicine.

Credits: 4	Core: Elective
Max. Marks: 25+75	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Pioneer workers of Biotechnology, Research developments, Opportunities, Institutions and journals. Recombinant DNA technology, basic concept in genetic engineering, tool and techniques of recombinant DNA technology. Enzymes in genetic engineering. Restriction enzymes, DNA ligase, Polymerase, exonucleases, endonucleases, restriction endonucleases, S I nucleases, DNA ligases, reverse transcriptase and alkaline phosphatase. etc. Cloning vehicles: Plasmids, Cosmids, Lambda phage, Charon phage, shuttle vectors, 2μ DNA plasmids, yeast plasmids, M13 vector. Transposons, Primary vectors and plasmids - expression vectors.	24
II	Selection of genes, Gene libraries, Genomic and cDNA library - Gene transfer methods, Genetic organization of Ti plasmids, Ti plasmid mediated transfer - Agrobacterium tumefaciens, DNA mediated transfer. Calcium phosphate, PEG, DEAE, via liposomes - Microinjection - Macroinjection, microprojectile, and electroporation, - Selection of clones, marker and reporter genes in screening methods. Hybridizations - colony, Southern, Northern, Western Blotting. Elementary Knowledge of next generation sequencing.	12
III	Introduction to Plant Tissue culture, Terms and definitions, Tools and techniques of plant tissue culture. Culture media, culture media preparation and sterilization, callus and suspension cultures. Organ Culture and Protoplast culture. Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion-chemical. Techniques and applications of somatic embryogenesis and regeneration of plants, anther, pollen, ovule, endosperm, hairyroot cultures.	12
IV	Cell/callus line selection for resistance to herbicide, stress and diseases. Role of tissue culture in rapid clonal propagation, production of pathogen - free plants and synthetic seeds. Plant transformation: Methods of gene transfer in plants. Agrobacterium and CaMV mediated gene transfer; direct gene transfer using PEG, micro injection, electroporation, microprojectile (biolistics) method, liposome mediated DNA delivery. Transgenic plants for crop improvement: Maize, Rice, Wheat, Cotton, Brinjal and Tomato.	12

Suggested Readings:

1. Tropp, B. E. (2012). Molecular Biology. Fourth Edition, Jones and Bartlett India Pvt. Ltd, New Delhi.
2. Howe, C., (2007). Gene Cloning and Manipulation. 2nd Edition.
3. Watson, D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R. (2008). Molecular Biology of Gene. 6th Edition, Cold Spring HarborLaboratory Press Cold Spring Harbor, New York, U.S.A.
4. Clark, D., Pazdernik, N., McGehee, M. (2018). Molecular biology. 3rd Edition.
5. Freifelder, D. (1990). Molecular Biology. 2nd Edition, Narosa Publishing HouseNew Delhi.
6. Nicholl, D. S. T. (2008). An Introduction to Genetic Engineering. 3rd Edition.

7. Plant Molecular Biology - Genetic Analysis of Plant Development and Metabolism. Springer-Verlag, New York, London.
8. Grierson, D. and Covey, S. (1984). Plant Molecular Biology, Practical Approach. IRL Press, Oxford, Washington DC.
9. Henry, R. J. (2005). Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
10. Shaw, C. H. and Brown. T.A. (1988, 2020). Gene Cloning and DNA Analysis: An Introduction. 8th Edition.
11. Primrose, S. B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics. 7th Edition.
12. Tewari, K. K. and Singhal, G. S. (1997). Plant Molecular Biology and Biotechnology. Narosa Publishing House, New Delhi.
13. Tropp, B. E. (2012). Molecular Biology. Fourth Edition, Jones and Bartlett India Pvt. Ltd, New Delhi.
14. Howe, C., (2007). Gene Cloning and Manipulation. 2nd Edition.
15. Watson, D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., and Losick, R. (2008). Molecular Biology of Gene. 6th Edition, Cold Spring Harbor Laboratory Press Cold Spring Harbor, New York, U.S.A.
16. Clark, D., Pazdernik, N., McGehee, M. (2018). Molecular biology. 3rd Edition.
17. Freifelder, D. (1990). Molecular Biology. 2nd Edition, Narosa Publishing House New Delhi.
18. Nicholl, D. S. T. (2008). An Introduction to Genetic Engineering. 3rd Edition.
19. Plant Molecular Biology - Genetic Analysis of Plant Development and Metabolism. Springer-Verlag, New York, London.
20. Grierson, D. and Covey, S. (1984). Plant Molecular Biology, Practical Approach. IRL Press, Oxford, Washington DC.
21. Henry, R. J. (2005). Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
22. Shaw, C. H. and Brown. T.A. (1988, 2020). Gene Cloning and DNA Analysis: An Introduction. 8th Edition.
23. Primrose, S. B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics. 7th Edition.
24. Tewari, K. K. and Singhal, G. S. (1997). Plant Molecular Biology and Biotechnology. Narosa Publishing House, New Delhi.

Programme/Class: M.Sc.	**Year:** Second	**Semester:** Third
Subject: Botany		
Course Code:	**Course Title: Plant Physiology and Biochemistry**	
Course Objectives: To study various physiological processes and macromolecules.		
Course Outcomes: On successful completion of this course, students will be able to: • Have an understanding of physiological behavior of plants. • Learn the basic concepts of biochemistry.		
Credits: 4	**Core: Elective**	
Max. Marks: 25+75	**Minimum Passing Marks:**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
I	Photosynthesis: Efficiency and turn over. Light harvesting complexes. Photosystem I and II - Structure and function. Mechanism of electron transport. Photo inhibition. Phytochromes. CO2 fixation: C3, C4 and CAM pathways. Energetics of CO_2 fixation. Photorespiration and glycolate metabolism. Mechanism of photorespiration in C3 and C4 plants.	8
II	Respiration. Anaerobic, aerobic. Glycolysis, TCA cycle, ETS and ATP synthesis, transporters involved in exchange of substrate of products, Pentose phosphate pathway	8
III	Transport of metabolites – Xylem and Phloem sap translocation. Physiology of flowering, senescence and abscission. Plant movements. Photoperiodism and vernalization. Transpiration; stomatal movement mechanism.	12
IV	Seed metabolism, glyoxylate cycle in fatty seeds during germination. Nitrogen metabolism. Nitrate and ammonium assimilation. Symbiotic and non- symbiotic. Plant hormones – Physiological effects and mechanism of action.	8

V	Structure, function and metabolism of carbohydrates – Synthesis of starch, cellulose and sucrose. Structure, function and metabolism of lipids: Biosynthesis of fatty acids. Biosynthesis of Triacyl glycerol, diacyl glycerol, monoacyl glycerol. Gluconeogenesis. Membrane lipids. Lipid oxidation.	8
VI	Proteins and amino acids: Structure and classification of amino acids. Biosynthesis of amino acids. Classification of protein based on structure. Primary, secondary, tertiary and quaternary structure. Protein domains. Ramachandran plot.	8
VII	Enzymes: IUB system of classification and nomenclature. Distribution of plant enzymes. Soluble and membrane bound enzymes. Co enzymes, substrate specificity, regulation of enzyme activity, Inhibitors, allosteric enzymes. Isozymes. Ribozymes. Abzymes.	8

Suggested Readings:

1. Taiz, L. & Zeiger, E. 2010. Plant Physiology. 5th Edition. Sinauer Associates Inc., Publishers.
2. Öpik, H., Rolfe S.A. & Willis A. J. 2005. The Physiology of Flowering Plants. 4th Edition. Cambridge University Press.
3. Hopkins, W. G. 2002. Introduction to Plant Physiology. John Wiley & Sons. Inc. New York.
4. Salisbury, F.B. & Ross. C. 2000. Plant physiology. John Wiley & Sons, New Delhi.
5. Jain, J.L. 2000. Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
6. Hall, D.O. & Rao, K.K. 1999. Photosynthesis. Cambridge University Press.
7. Noggle, G. R. & Fritz, G. J. 1999. Introductory Plant Physiology. Prentice hall, London.
8. Devlin, R. M. & Witham, F. H. 1997. Plant Physiology. CBS Publishers and Distributors, Delhi.
9. Brett, C.T. &Waldron, K.K. 1996. Physiology and Biochemistry of Plant Cell Walls, Chapman and Hall London.
10. Dennis, D. T. & Trurpin, D. H. (Eds.) 1993. Plant Physiology, Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
11. Daphne. J. Osborne, Micheal. & Jackson, B. 1989. Cell Separation in Plants Physiology, Biochemistry and Molecular Biology. Springer – Verlag. Berlin.
12. Conn, E.E., Stumpf, P.K. Bruening G. & Doi R.Y.1987. Biochemistry. John Wiley and Sons.
13. Fitter, A.H. & Hay R.K.M. 1987. Environmental Physiology of Plants. Academic Press.
14. Wilkins, M.B. (Ed.) 1984. Advanced Plant Physiology, Pitman Publishing Co. New York.
15. Strafford, G.A. 1979. Essentials of Plant Physiology. Heinemann Publishing Co. New York.
16. Hess, D. 1975. Plant physiology. Narosa Publishing House, New Delhi.
17. Hatch, M.D. Osmond, C. B. & Slatyer, R. O. 1971. Photosynthesis and Photorespiration.
18. Becker, W. M., Hardin & Bertoni G. 2018. Becker's World of the Cell. Pearson Education Ltd.
19. Nelson D. L. & Cox, M. M. 2017. Lehninger Principles of Biochemistry. 7th Edition. W H Freeman & Co.
20. Appling D. R., Anthony-Cahill S.J. & Mathews, C.K. 2016. Biochemistry. Concepts and Connections. Pearson Education Limited.

Programme/Class: M.Sc.	Year: Second	Semester: Fourth
Subject: Botany		
Course Code:	Course Title: Phytopharmaceutical Drug Development, IPR and Patents	

Course Objectives: To understand the need for the development of new herbal drugs.

Course Outcomes: : On successful completion of this course the students will be able to

- Develop laboratory skills in the scientific testing of herbal drugs and new commercial products for safe and rational use.
- Have an indepth understanding of the ethical and commercial implications of drug development from medicinal plants.

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

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

Unit	Topics	No. of Lectures
I	Forms of phytopharmaceuticals drugs: Essential oils, Liquid extracts, tinctures, herbal tea, concentrated soft and dry extracts and Pure pharmaceutical drug. Standardization of phytopharmaceuticals to ensure efficacy, safety, toxicity and shelf life. Use of correct botanical raw material (correct plant and plant part) and the quantity. Intrinsic toxicity, External toxicity, Banned drugs, Herb -drug interaction, Shelf life determination. Cultivation of medicinal plants including good cultivation practice(pesticide free conditions), good collection practice, good processing and good storage practice and good manufacturing practices, Processing of plant drugs, purification of raw drugs using phytochemical techniques. Standard operating procedures (SOPs) and Good practices in production of Phytopharmaceuticals - The Drug Manufacturing Unit, GMP Requirements Based on WHO. Guidelines for Ayurvedic Pharmaceutical Industries by AYUSH, Scope, Requirements, Premises, Ancillary areas, Storage areas, Weighing areas, Production areas, Quality control areas. Prevention of cross-contamination and bacterial contamination during production, Finished products, Rejected, recovered, reprocessed and reworked materials, Reference samples and standards. Good practices in quality control, Stability studies, Qualification and validation. Hygiene of Workers, Health, Clothing, Sanitation and Medical Services. Labels, Packaging materials, Bar-coding.	8
II	Biological testing of herbal drugs (analgesics, anti-inflammatory and antioxidant agents). Evidence for clinical efficacy, evaluation of side effect and toxicity . Use of Bioinformatics tools in drug development. Regulatory guidelines for herbal medicine and pharmaceutical product development, Storage and distribution-General study of the drugs and Cosmetic Act and related rules. Schedules relating to Ayurvedic drugs –Schedule E (1),Schedule T. Medicinal and Toilet preparations (Excise duties) Act 1955 and rules1956. Factories Act1948. Drug dependence, misuse and abuse. Medico legal analysis with special references to Narcotic drugs and psychotropic substances Act1985. Advertisement of Drugs and Cosmetics – Prohibited and exempted advertisements. Drugs and Magic remedies (objectionable advertisements) Act 1955.	8
III	Herbal product development: Methodologies, Challenges, and Issues. Traditional herbal products and phytopharmaceuticals. Successful development of natural health products, dietary food supplements and nutraceutical products . Phases of clinical trials. Development of innovative combinations and formulations. Evidence based evaluation techniques. Herbal monographs in Indian Pharmacopoeia and Monographs by the Indian Council of Medical Research.	12

IV	Organizations involved in drug standardization in India, ASU drugs and phytopharmaceuticals. Market study of crude drugs including adulterants and substitutes using standard procedures. a .Pilot scale production b .Scaling up of herbal products c . Industrial production Challenges from lab to market. Indian Herbal product market and the overseas market, product diversification and Industries related to Herbal products in India.	**12**
V	IPR Brief history, Types of Intellectual Properties, Role of undisclosed information. Rationale of patents, Rationale of licences, Management of IPR in pharmaceutical Industry, Special aspects of drug patent specification.	**12**

Suggested Readings:

1. Dharti And Vidhi Kirti (2020) Concise Course in Industrial Pharmacy, S Vikas And Company.
2. Jai Malik (2018) Pharmacognosy and Phytochemistry, paging publishers
3. Chiragkumar J. Gohil (2018) Fundamentals of Pharmacy, IP Innovative Publication Pvt. Ltd.
4. Herbalism, Phytochemistry and Ethnopharmacology(2011).Apple Academic Press ,Florida ,. Amritpal Singh. CRC Press, Taylor & Francis Group
5. Brahmankar Jaiswal (2015) Biopharmacuitics and Pharmacokinetics - A Treatise, Vallabhaprakashan publishers
6. Amritpal Singh (2017), Regulatory and Pharmacological Basis of Ayurvedic Formulations, CRC Press.
7. An overview and implication in pharmaceutical industry technology and research. 2011.Publishing Kluwer
8. Indian Pharmacopoeia 2010. Volume-I, II & III, Indian Pharmacopoeia Commission. New Delhi.
9. Banker, Rhodes. (2009) Modern pharmaceutics. Vol 121, 4th Ed. New York: Marcel Dekker Inc
10. B. S. Kuchekar (2008) Pharmaceutical Jurisprudence Pragati Books Pvt. Ltd.
11. Herbert. (2005) Pharmaceutical dosage form- Tablets, Vol 1,2,3, 2nd Ed. New York: Marcel Dekker Inc
12. Guarino RA. (2002) New drug approval process. Vol 100. New York: Marcel Dekker Inc. Bernd Markert (1996) Instrumental Element and Multi-Element Analysis of Plant Samples: Methods and Applications, Wiley Publishers

Programme/Class: M.Sc.	Year: Second	Semester: Fourth
Subject: Botany		
Course Code:	Course Title: Phyto-techniques and Biostatistics	

Course Objectives:
To give students a firm foundation for various Phytotechniques.
To understand basic elementary knowledge and application of Statistics in field of Biological Sciences

Course Outcomes On successful completion of this course, the students will be able to:

- Develop the ability to work in industry.
- Analyze the data
- Conduct the experiments
- Help to progress the science

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

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):L-T-P:4-0-0

Unit	Topics	No. of Lectures
I	Different types of stains, their preparation and uses: Safranin, fast green, hematoxylin, iodine, cotton blue, crystal violet, ruthenium red, Janus green, Gram's stains, Acetocarmine. Microtomy: dehydration, clearing and embedding of material, section cutting, dewaxing. Collection and preparation of herbarium sheets; preservation and storage of plant materials.	12
II	4Instrumentation, principle and Methods of fractionation- Cell sorting, Chromatography, Electrophoresis, Centrifugation, X- ray diffraction. Spectrophotometry, MS, NMR, ESR, ORD/CD spectrometers, Radio-isotopic methods: Geiger Muller & Liquid Scintillation Counters. Immunological methods: immunodiffusion, immuno- electrophoresis, crossed immuno- electrophoresis, counter- RIA, ELISA, Immunoblotting.	12
III	Introduction of Biostatistics. Collection and Classification of data: Sampling and types of sampling methods. Presentation of Data: Tabular, Graphical, Line Diagrams, Frequency Polygon, Frequency Curve, Scatter or Dot Diagram, Bar Diagrams, Pie Chart. Measures of central tendency - Mean, median, mode. Measures of dispersion: Range, standard error, standard deviation, co-efficient of variations.	12
IV	Analysis of variance (ANOVA): Summary of steps involved in ANOVA. Test of hypothesis and tests of significance: Student's t-Test, Chi-square test, F-test. Introduction to life table. Parametric and Non-parametric test.	12
V	Probability: Sum rule, Product rule and Binomial expansion. Probability distribution: Normal, Binomial and Poisson. Kurtosis. Correlation and Regression: Types of correlation (linear, non-linear, positive and negative), difference between correlation and regression.	12

Suggested Readings:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition
5. Danniel, W.W., (1987). Biostatistics. New York, John Wiley Sons.
6. Sundarrao, P.S.S and Richards, J. (2012). An introduction to Biostatistics, 5th edition.
7. Selvin, S., (1991). Statistical Analysis of epidemiological data, New York University Press.
8. Bishop, O.N. (1966). The Principles of Modern Biology: Statistics for Biology. Houghton Mifflin Company,

Boston.
9. Freedman, P. (2017). The Principles of scientific research. New York, Pergamon Press.
10. Campbell, R.C. (1998). Statistics for Biologists. Cambridge University Press.

Programme/Class: M.Sc.	**Year:** Second	**Semester:** Fourth
Subject: Botany		
Course Code:	**Course Title: Bio-entrepreneurship and Innovation**	

Course Objectives: Impart knowledge and work experience based/case study-based training to students in the field of innovation and uses of various biology/ biotechnology-based products, goods, services employed in bio entrepreneurship.

Course Outcomes: On successful completion of this course the students will be able to:

1. To be able to prepare a business plan and launch career as bio- entrepreneur.
2. Being able to get employment in a bioindustry or a bioconsultancy

Credits: 4	**Core: Elective**
Max. Marks: 25+75	**Minimum Passing Marks:** ....

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers of this field, Research developments, Opportunities, Institutions and journals.	12
II	Entrepreneurship in the Life Sciences. Development of Products in the Biomedical Industry.	8
III	Integration of science, technology and business. From Lab to land: scope in agro/food processing industry	12
IV	Industrial management. Market analysis.	12
V	Business development. Regulatorymechanisms.	8
VI	Indian bioentrepreneurial scenario. Case studies of successful bioentrepreneurs.	8

Suggested Readings:

1. Rhonda, A. (2010). Six-Week Start-Up: A Step-by-Step Program for Starting Your Business, Making Money and Achieving Your Goals! Redwood City: The Planning Shop.
2. Byrne, J. A. (2011). World Changers: 25 Entrepreneurs Who Changed Business as We Knew it. New York: Penguin.
3. Edwards, S. and Edwards. (1999). Working from Home: Everything you need to Know about Living and Working under the Same Roof. New York: Penguin Putman.

Programme/Class: M.Sc.	Year: Second	Semester: Fourth
Subject: Botany		
Course Code:	Course Title: Elementary Knowledge of Computers and Bioinformatics	

Course Objectives: To give students a firm foundation in the advanced optimization techniques for the solution of the problems covered in course contents.

Course Outcomes: On successful completion of this course, the students will be able to:

- Develop the ability to formulate fairly complex optimization problems in the context of practical problems.
- Learn the use of software computer applications.
- Use the DNA, RNA, Database for further applications

Credits: 4	Core: Elective
Max. Marks: 25+75	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers in this field, Research developments, Opportunities, Institutions and journals.	8
II	Computer System- Definition; Components (Input/output unit, Control Unit., Primary Storage Unit, Arithmetic and Logic Unit); Types of Memory, Generation of Computers Number System & Logic Gates- Application of Number Systems (Decimal Number System, Binary Number System, Hexadecimal Number System) & Conversions (Decimal to Binary, Binary to Decimal, Decimal to Hexadecimal, Hexadecimal to Binary); Addition operation in Binary Number System; Introduction to Logic Gates(AND, OR, NOT, NAND, NOR, XOR XNOR); Introduction to Software.	12
III	Bioinformatics - Introduction; Definition & Concept, Role of Bioinformatics, Introduction of Internet in Biology & objectivity, Services of Internet used for Biological Data, Human Genome Project.	12
IV	Database System- Definition; Purpose of Database System; Advantages of Database System, Relational Database- Definition; Relational Data Model, Database- Primary Databases & Secondary Databases, Sequence Databases(EMBL, GenBank, DDBJ, SWISS-PROT, PIR, TrEMBL), Protein Family/Domain Databases (PROSITE, Pfam, PRINTS & SMART)	12
V	Sequence comparison algorithm, Dynamic programming, Dot plot matrix, sequence scoring schemes (weight matrix as Identify scoring, genetic code scoring scheme chemical scoring, observed Substitution matrix and Gap penalties),Sequence database similarity searching algorithms, local alignment, global alignment, FAST A, BLAST (BLASTP, BLASTN, BLASTX, TBLASTN, TBLASTX) and similarity searching scores and their statistical interpretation	8
VI	Motifs and Domains, algorithm for multiple alignments, Biological motifs, micro array, Phylogenetic prediction: Relationship of Phylogenetic analysis to sequence alignment, Genome complexity and phylogenetic analysis, concept of evolutionary trees. Maximum parsimony method, distance method, maximum likelihood method.	8

Suggested Readings:

1. Y.Wang. Z. Wang.(2023) Squence Analysis and Paralled Computing Tsinghua University press .
2. K.Stephen (2009) Bionformatics for system biology Springr.Press
3. Sharma.Vinay (2016) Text book of Bionformatics Rastogi Publication Meerut
4. R.Sundralingan and V.kumaresan (2000) Bionformatics Saras Publication T.N.
5. Ruchi Singh (2014) Bionformatics Vikas Publication .
6. Orpita Basu (2007) Bionformatics Oxford University Press
7. Pradeep.K. Sinha and Priti Sinha (2004) Computer fundamentals B.P.B Publication.

Programme/Class: M.Sc.	Year: Second	Semester: Fourth
Subject: Botany		
Course Code: : : 1020408	Course Title: Economic Botany and Food Security	

Course Objectives: The aim of this course is to provide a profound knowledge about the products of economically important plants which are of various uses.

Course Outcomes: : Upon successfully completing this course, the students could be able to know:

1. Scope of economic botany, study of economically important plants and plant products.
2. The tropical, subtropical and temperate crops that are sources of food, beverages, spices, medicines, timber and essential oil.
3. The genetic and evolutionary aspects of different plants and their health benefits.
4. The need to increase the food production to meet the demand of increasing population

Credits: 4	Core: Elective
Max. Marks: 25+75	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Origin of Cultivated Plants. The work of Vavilov. The future role of Plants in relation to mankind. Cereal Crops- Wheat, Rice, Maize, Barley, Oat, Sorghum, Millets and Pseudocereals . research center, journals and contribution of Indian Scientists.	12
II	Legumes or Pulses-Pea, Gram, Pigeon pea, Lentil, Black and Green gram. Fibres and Fibre yielding plants- Classification of fibres. Cotton, Flex, Hemp, Jute, Sann or Sunn hemp, Coir, Kapok.	12
III	Oil yielding plants- Classification of vegetable oil. Methods of oil extraction. Groundnut, Mustard, Common olive, Coconut, Castor, Cottonseed, Soya bean, Sesame. Petro-crops: our future fuel.	12
IV	Spices, Condiments and other flavourings - Classification of Spices Ginger, Turmeric, Cinnamon, Clove, Black pepper, Coriander, Cumin, Chillies, Fennel, Cardamom, Saffron. Medicinal Plants- Drug plants, Drugs obtained from Roots, Stems, Barks, Leaves, Flowers, Fruits and Seeds, Alkaloids and Cancer.	12
V	Food Safety and Security- Functions of FSSAI, Sanitary Parameters for food service premises. Challenges and Future plan of FSSAI. Food Security in India, Schemes of Central govt for Food security. Role of cooperatives in food security. Challenges and Future prospectives.	12

Suggested Readings:

1. Economic Botany-A Comprehensive Study by S. L. Kochhar. 5th Edition, Cambridge University Press, 4843/24,2nd Floor, Ansari Road, Daryaganj, Delhi – 110002, India
2. Plants and Human Welfare by O. P. Sharma, Pragati Prakashan, Meerut.
3. Economic botany : principles and practices / edited by Gerald E. Wickens. SPRINGER SCIENCE+BUSINESS MEDIA, LLC.
4. DEV, S. MAHENDRA, KANNAN, K.P. AND RAMCHANDRAN, NEERA (EdS.). 2003. Towards a Food
5. Secure India: Issues and Policies. Institute for Human Development, New Delhi.
6. Anil Chandy Ittyerah, Food Security in India: issues and suggestions for effectiveness, IIPA, Delhi.

Programme/Class: M.Sc.	Year: Second	Semester: Fourth
Subject: Botany		
Course Code:	Course Title: Biodiversity, Conservation and Plant Resources	

Course Objectives: To provide the knowledge of the biodiversity conservation of plants and sustainable use of plant resources.

Course Outcomes: : On successful completion of this course the students will be able to

- Lean about diversity of life.
- Know how to conserve the plants
- Sustainable use of plant resources.

Credits: 4	Core: Elective
Max. Marks: 25+75	Minimum Passing Marks: ....

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

Unit	Topics	No. of Lectures
I	Important contribution of pioneer workers of this field, Research developments, Opportunities, Institutions and journals.	8
II	Biodiversity: Definition; factors responsible for determination of Biodiversity; Global concern over climate change. Levels of Biodiversity: Genetic, Species, Ecological, Evolutionary and Agrobiodiversity. Diversity Measures: (Diversity Indices)- Alpha(α), Beta (β), Gamma(γ) Diversity.	8
III	Biodiversity Conservation Initiatives a) In situ Stratagy: National parks, Wild life sanctuaries, biosphere reserves and world heritage sites. b) Ex-situ Stratagy: By seeds, reclamation, Afforestation, tree Plantation, seed banks, gene banks, cryobanks c) General account of activities of BSI, NBPGR for conservation and non-formal conservation efforts d) Restoration or Rehabilitation of Endangered species.	12
IV	Biodiversity at world level: Biodiversity at global and country level, wild plant wealth. Ecosystem diversity in India: Desert, forest, Grassland ecosystem, wetland, Mangroves. Species Diversity: Endemic species, cultivated plants/Agro- diversity, Endangered plants.	12
V	Loss of Biodiversity: a) Causal factors – Developmental pressure, encroachment, exploitation, human induced and natural floods, earthquake, cyclone, landslides, Disaster management. b) Threat to Ecosystem, species and genetic Diversity. Categories of threats: Endangered, Vulnerable, Rare and Threatened	12
VI	Plant resources, Concept, Status and Concern Basic concepts of local plant diversity and its economic importance World centers of primary diversity of domesticated plants Biodiversityprotection laws and policies, management of natural resources.	8

Suggested Readings:

1. Primack, (2014). Essentials of Conservation Biology, 6th ed. Sinauer.
2. Groom, (2005). Principles of Conservation Biology, 3rd ed. Sinauer.
3. Van Dyke (2008). Conservation Biology, 2nd ed. Springer.
4. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.