Enclosure/Annexure 1

Chaudhary Charan Singh University, Meerut

Syllabus of:
M.Sc. (Botany); CBCS/NEP
(Online BoS held on 11.01.2024; Revised & effective from 2023-24 onwards)
(For fourth and fifth years of Higher education (PG)
(As per guidelines of U.P. Government in accordance with
National Education Policy-2020 w.e.f. the session 2023-2024)
(For both University Campus and Colleges)

Members from the Board of Studies

S. No.	Name	Designation	College/ University
1.	Prof. Hare Krishna	Dean, Science Faculty	C.C.S. University Campus, Meerut
2.	Prof. Vijai Malik	Convener-I	Botany Department, CCS University, Meerut
4.	Prof. Rup Narayan	Member	Botany Department, CCS University, Meerut
5.	Dr. R. C. Arya	Convener-II	Meerut College, Meerut
6.	Dr. Ashok Kumar	Member	M. M. H. College, GZB
7.	Dr. (Mrs.) Poonam Paliwal	Member	IP College, Bulandshahr
8.	Prof. Sundip Kumar	External Subject Expert	Department of Molecular Biology & Genetic Engineering, GBP University, Pant Nagar
9.	Prof. Upendra Kumar	External Subject Expert	Department of Plant Science MJP Rohilkhand University, Bareilly
10.	Prof. Navneet	External Subject Expert	Department of Botany & Microbiology, Gurkul Kangari University, Haridwar
11.	Dr. Ashwani Goel	Retired Principal	Saheed Mangal Pandey Degree College, Madhav Puram Meerut
12.	Prof. Narendra Singh	Member	Head Department of Botany, KU, Kurukshtra

SUBJECT: Botany (Online BoS held on 11.01.2024); CBCS/ NEP

Semester wise Titles of the Papers in M.Sc. (Botany)

Year	Sem	Course Code	Paper Title	Core Compulsory/ Elective/Value added	Theory/ Practical	Credits
1	I	B040701T	Microbiology	Core Compulsory	Theory	04
		B040702T	Algae, Bryophytes, Pteridophytes and Gymnosperms	Core Compulsory	Theory	04
		B040703T	Plant Systematics	Core Compulsory	Theory	04
		Any one of the following		Core Elective	Theory	04
		B040704T	a. Applied Mycology			
		B040705T	b. Biostatistics			
		B040706P	Practical Lab 1	Core Compulsory	Practical	04
		B040707R	Industrial Training/ Research Project/ Survey	Core Compulsory& Value added	Project	04
		QB040701T	Disaster management	Minor-Open Elective for other subjects & Value Added	Theory	04
	II	B040801T	Genetics	Core Compulsory	Theory	04
		B040802T	Cell biology	Core Compulsory	Theory	04
		B040803T	Developmental Botany	Core Compulsory	Theory	04
		Any one of the following		Core Elective & (b) Value added	Theory	04
		B040804T	a. Elementary Biotechnology			
		B040805T	b. Pharmacognosy			
		B040806T	c. Applied Phycology			
		B040807T	d. Stress Physiology of Plants			
		B040808P	Practical lab 2	Core Compulsory	Practical	04
		B040809R	Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	Project	04
		QB040801T	Fascinating plants	Minor-Open Elective for other Subjects	Theory	04

Year	Sem	Course Code	Paper Title	Core Compulsory/ Elective/Value added	Theory/ Practical	Credits
2	III	B040901T	Medicinal Botany and Ayurvedic System of Medicine	Core Compulsory& Value added	Theory	04
		B040902T	Plant Biochemistry and Molecular Biology	Core Compulsory	Theory	04
		B040903T	Environmental Chemistry	Core Compulsory	Theory	04
		Any one of the following		Core Elective	Theory	04
		B040904T	a. Genetic Engineering			
		B040905T	b. Evolutionary Biology			
		B040906T	c. Plant Nomenclature			
		B040907P	Practical Lab 3	Core Compulsory	Practical	04
		B040908R	Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	Project	04
	IV	B041001T	Environmental Issues & Challenges	Core Compulsory	Theory	04
		B041002T	Ethnobotany and Intellectual Property Rights	Core Compulsory	Theory	04
		Any one of the following		Core Elective; (b) Value Added, & Entrepreneurship	Theory	04
		B041003T	a. Biophysical Chemistry			
		B041004T	b. Bioentrepreneurship and Innovation			
		B041005T	c. Molecular Systematics and Phylogenomics			
		B041006T	d. Nanobiotechnology			
		Any one of the following		Core Elective	Theory	04
		B041007T	a. Glycobiology			
		B041008T	b. Plant tissue culture			
		B041009T	c. Microbial Biotechnology			
		B041010T	d. Herbal products			

redits

		B041011P	Practical lab 4	Core Compulsory	Practical	04
		B041012R	Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	Project	04

Subject Prerequisites: To study this subject a student must have had the subject(s) Botany at UG Level.

Course Structure: The courses will be based on Choice Based Credit System (CBCS)/ NEP 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 subjects 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 different branches of Botany like Phytotecnique, Plant taxonomy, Anatomy, Mycology, Microbiology, Physiology, Biochemistry, Cell biology, Genetics, Molecular biology, Medicinal Botany, 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

List of All Papers in All Four Semesters (Online BoS held on 11.01.2024)

Programme	Year	Semester	Course Title	Core Compulsory/ Elective/ Value added	Credits	Teaching Hours
M.Sc.	I	First	Microbiology	Core Compulsory	04	60
			Algae, Bryophytes, Pteridophytes and Gymnosperms	Core Compulsory	04	60
			Plant Systematics	Core Compulsory	04	60
			Any one of the following a. Applied Mycology b. Biostatistics	Core Elective	04	60
			Practical Lab 1	Core Compulsory	04	120
			Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	04	60
			Disaster management	Minor-Open Elective for other subjects	04	60
		Second	Genetics	Core Compulsory	04	60
			Cell biology	Core Compulsory	04	60
			Developmental Botany	Core Compulsory	04	60
			Any one of the following a. Elementary Biotechnology b. Pharmacognosy c. Applied Phycology d. Stress Physiology of Plants	Core Elective& (b) Value Added	04	60
			Practical lab 2	Core Compulsory	04	120
			Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	04	60
			Fascinating plants	Minor-Open Elective for other subjects	04	60

Programme	Year	Semester	Course Title	Core Compulsory/ Elective/	Credits	Teaching Hours

				Value added		
M.SC.	**II**	**Third**	Medicinal Botany and Ayurvedic System of Medicine	Core Compulsory& Value Added	04	60
			Plant Biochemistry and Molecular Biology	Core Compulsory	04	60
			Environmental Chemistry	Core Compulsory	04	60
			Any one of the following 1. Genetic Engineering 2. Evolutionary Biology 3. Plant Nomenclature	Core Elective	04	60
			Practical Lab 3	Core Compulsory	04	120
			Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	04	60
		Fourth	Environmental Issues & Challenges	Core Compulsory	04	60
			Ethnobotany and Intellectual Property Rights	Core Compulsory	04	60
			Any one of the following a. Biophysical Chemistry b. Bioentrepreneurship and Innovation c. Molecular Systematics and Phytogenomics d. Nanobiotechnology	Core Elective; (b) Value Added& Entrepreneurship	04	60
			Any one of the following a. Glycobiology b. Plant tissue Culture c. Microbial Biotechnology d. Herbal Products	Core Elective	04	60
			Practical lab 4	Core Compulsory	04	120
			Industrial Training/ Research Project/ Survey	Core Compulsory& Value Added	04	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 selected 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 subjects, 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 30 marks + External Assessment 70 marks). Teaching hours for each of the course will be 60 hours. Duration of Theory and Practical examination of each paper shall be 3 hours. The distribution of Internal Marks will be as follows

Internal Assessment	Marks
Class Interaction	5
Quiz	10
Seminar	7
Assignment(Charts/Flora/RuralService/TechnologyDissemination/field visits with report)	8
Total	30

For Practical the distribution of marks will be as follow

Internal Assessment	Marks
Practical Class Interaction	5
Viva voce	5
Two practical based exercises	10
Charts/model/ Collection	10
Total	30

For External practical examination the distribution of marks will be as follow

External Assessment	Marks
Viva Voce on Practical's	10
Report of Botanical Excursion/ Lab Visits/Industrial training/ Survey/Collection/ Models with reports	10
Table work / Experiments	40
Practical Record File	10
Total	70

Research Project:

B.Sc. IV year will be equivalent to M.Sc. 1st year. At the end of the 2nd(even) semester (B.Sc. VIII semester or MSc IInd semester) & 4th/10th semester (M.Sc.), the candidate will submit a research project, which will be evaluated by an external examiner & internal supervisor along with a presentation and viva-voce examination.

In Fourth year (B.Sc.) or MSc first year and Fifth year (MSc final) the topic of the research project will be chosen from among the core compulsory courses/core elective courses of that year.

In each semester, each student will work 4 hour/ week/ semester for 4 credit. In this way a project work will be of 8 credits (i.e. 16 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 PhD 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 Thomsom rueter, 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 52 credits whereas MSc 2nd year will be of 48 credits. Each semester will be of 20 credits of courses (4 theory+1 practical, each will be of 4 credits) and thus the credits of two years (4 semesters) will be 80 credits.

A project work will be of 8 credits (i.e. 16 credits for two years). In other words it will be of 4 credits/semester i.e. a total of 16 credits.

A minor elective will be of 4 credits.

Thus M.Sc Programme will be of 100 credits (52+48).

Semester 1

Subject : **M.Sc. Botany 1st semester**	
Course Code : B040701T	Course Title : **Microbiology**

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 : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction**:Viral genomics and viral proteomics. Viral phylogeny. Viral database. A general account of archaea classification including 16s r-DNA sequencing. Evolutionary aspects of plant microbe interaction. **Growth & Nutrition**: Microbial nutrition, growth kinetics and metabolism	15
II	**Agricultural Microbiology**: Breeding for virus resistance, natural mechanism and transgenic strategies, relevance to Indian agriculture. BNF, Mycorrhiza, Microbial Mineralization, Biocontrol of plant diseases. **Environmental Microbiology**: Biodegradation, Bioremediation, Microbes in nanotechnology, Biosensors.	15
III	**Host Parasite Interaction:** Recognition and Entry process of bacteria and virus into animal and plant host cells, Alteration of host cell and viruses, Virus induced cancers, Two component signalling systems, Chemotaxis, Quorum sensing.	15
IV	**Antimicrobial Substances**: Complement system, Interferons, Iron-binding proteins, Antimicrobial peptides. **Resistance to Antimicrobial Drugs**: Mechanism of resistance in microbes, Antibiotic misuse,. Origin and evolution of virus like- covid-19.	15

Suggested Readings:

1. Salyers, A. A., Whitt, D. D. (2000). Microbiology: Diversityand 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'sMicrobiology. 11th Edition.

Subject : M.Sc. Botany 1st semester			
Course Code : B040702T	Course Title : **Algae, Bryophytes, Pteridophytes and Gymnosperms**		
Objectives: To study phylogeny and inter-relationships of Algae, Bryophyta, Pteridophyta and Gymnosperms **Course Outcomes:** 1. Students will have clear idea of the characteristics of the important plant groups. 2. Concepts in the evolution of plants will be clear to students.			
Credits : 4		Core Compulsory	
Max Marks : 30+70		Min. Passing Marks :	
Total no of Lectures-Tutorials- Practicals (in hours per week):4-0-0			
Unit	**Topic**		**No. of Lectures (60 hrs)**
I	**Algae**: A general account, Phylogenetic definitions, Phylogeny, Classification and apomorphies of Chlorophyta, Charophyta, Phaeophyta Rhodoplantae, Rhodophyta, Cyanidiales, Proteorhodophytina and Eurhodophytina with ecological and economic importance.		15
II	**Bryophyta**: A general account, Phylogenetic definitions, Phylogeny, classification and apomorphies of Hepaticae, Anthocerotae, and Musci with ecological and Economic Importance.		15
III	**Pteridophyta**: A general account, Phylogenetic definitions, Phylogeny, classification and characteristics/apomorphies of Pan-Trachaeophyta, Apo-Trachaeophyta, Trachaeophyta, Pan-Lycopodiophyta, Lycopodiophyta, Pan-Euphyllophyta, Euphyllophyta and Monilophyta. Heterospory, and Soral Evolution.		15
IV	**Gymnosperms**: A general account, Phylogenetic definitions, Phylogeny, classification and apomorphies of Pan-Spermatophyta, Apo-Spermatophyta, Spermatophyta, Pan-Coniferae, Coniferae, Pan-Gnetophyta, Gnetophyta, and Cupressophyta with Economic Importance of Gymnosperms.		15

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. Bold, H.C. and Wynne, M. J. (1985). Introduction to the algae; Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey.

6. Cavers, F. (1976). The inter relationships of the bryophyte. S.R. Technic, Ashok Rajpath, Patna.

7. Chapman, V.J. and Chapman D.J. (1975). The algae. 2nd Edition, Mac. Millan Publ. Inc. New York.

8. Chopra, R. N., and Kumar, P. K. (1988). Biology of Bryophytes. John Wiley and Sons, New York (NY).

9. Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi.

10. Hoek, C. van den, Mann, D. G. and Jahns, H. M. (1995). Algae: An introduction to Phycology. Cambridge University Press, UK.

11. Kashyap, S. R. (1929). Liverworts of the Western Himalayas and the Punjab Plain. Part1, Chronica Botanica, New Delhi.

12. Kashyap, S. R. (1932). Liverworts of the western Himalayas and the panjab plain (illustrated). Part 2, The Chronica Botanica, New Delhi.

13. Parihar, N.S. (1976). Biology and morphology of the Pteidophytes. Central Book Depot.

14. Parihar, N. S. (1980). Bryophytes: An introduction to Embryophyta.VolI,Bryophyta, Central Book Depot.

15. Puri, P. (1981). Bryophytes: Morphology, Growth and Differentiation. Atmaram and Sons, New Delhi.

16. Prescott, G. W. (1969). The algae: A review. Nelson, London.

17. Rashid, A. (1999). An Introduction to Pteridophyta.Vikas Publishing House Pvt. Ltd., New Delhi.

18. Ramanujan, C.K.G. (1970). Indian Gymnosperms in time and space. Today &Tomorrow 's Printers & Publishers.

19. Round, F.E. (1981). The Ecology of Algae. Cambridge University Press, Cambridge.

21. Sporne, K.R. (1965). Morphology of Gymnosperms. Hutchinson University Library.

22. Sporne, K.R. (1986). The morphology of Pteridophytes. Hutchinson University Press, London.

23. de Queiroz, K., & Cantino, P. (2020). International Code of Phylogenetic Nomenclature (PhyloCode) (1st ed.). CRC Press. https://doi.org/10.1201/9780429446320

24. de Queiroz, K., Cantino, P., & Gauthier, J. (Eds.). (2020). Phylonyms: A Companion to the PhyloCode (1st ed.). CRC Press. https://doi.org/10.1201/9780429446276.

Subject : M.Sc. Botany 1st semester		
Course Code : B040703T	Course Title : Plant Systematics	
Course Objectives: This course aims to add to understanding of the students about basic concepts of plant systematics, clades of Angiosperms **Course Outcomes:** The students will be learning 1. What do we mean by systematics & Cladistics? What are different Types of clade? How to name the clades. Principles &Protologue of Phylocode 2. What are Characteristics, and Classification of Angiospermic clades 3. What are the sources of variations and how speciation takes place? 4. What are the data for molecular systematics. How phylogenetic analysis is carried out. What is DNA barcoding.		
Credits : 4		Core Compulsory
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	Topic	No. of Lectures (60 hrs)
I	**Cladistics:** Systematics (concept & definitions), Phylogeny & Ontogeny. Concept of Clade, Grade, Clan, Lineages, & Component of Cladogram. How to read the tree/Cladogram. Clades at different hierarchical level. Identification of Clade, Crown clade, and Total Clade. **Evolutionary concepts:** monophyly, paraphyly, polyphyly, plesiomorphy, apomorphy, anagenesis, cladogenesis, homology, analogy, homoplasy, parallelism and convergence, synapomorphy, symplesiomorphy and Semaphoront. Apomorphies in Angiosperms.	10
II	**Phylocode:** Preamble & Principles (with explanation) of Phylocode. Formulation & Illustrations of Phylogenetic definitions and naming of clades, Specifiers, qualifying clause. Parts of protologue (complete name/clade entry). Comparison of Traditional & Phylocode. **Clades in Angiosperm:** ANA/ANITA grade, Concept of Paleoherbs; Phylogenetic definitions, Phylogeny and Characteristics/apomorphies of following clades: Mesangiospermae; Pan-Angiospermae; Apo-Angiospermae; Angiospermae; Magnoliidae; Monocotyledoneae, Tricolpatae, Eudicotyledoneae, Superrosidae; and Superasteridae.	20
III	**Variation & Speciation:** Isolation: Definitions, classification & Mechanism. Variations: Definitions, Types & mechanism. Speciation: Definitions, causes, types & mode. Origin & Evolution of Flowering Plants.	15
IV	**Data for Plant Systematics:** Morphological & Molecular data. Structure and Role of Chloroplast Genome in Plant Systematics; Mitogenomics and Mitochondrial Genome in Plant Systematics; Nuclear Ribosomal DNA: Structure and uses in Systematics. DNA barcoding.	15

Suggested Readings:

1. Christenhusz, M. J. M., Chase, M. W. and Michael F. F. (2017). Plants of the World: An Illustrated Encyclopedia of Vascular Plants. University of Chicago Press.

2. de Queiroz, K., & Cantino, P. (2020). International Code of Phylogenetic Nomenclature (PhyloCode) (1st ed.). CRC Press. https://doi.org/10.1201/9780429446320

3. de Queiroz, K., Cantino, P., & Gauthier, J. (Eds.). (2020). Phylonyms: A Companion to the PhyloCode (1st ed.). CRC Press. https://doi.org/10.1201/9780429446276.

4. Angiosperm Phylogeny Group, (2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnaean Society, 181: 1-20.

5. Davis, P.H., & Heywood V. H. (1965). Principles of Angiosperm Taxonomy. Oliver & Boyd. Edinburgh.

6. Jones, S.B., & Luchsinger, A.E. (1987). Plant Systematics. 2nd Edition. McGraw-Hill Book Company. New York.

7. Judd, W. S., Campbell, C. S., Kellog, E. A., Stevens, P. F & Donoghue, M. J. (2015). Plant Systematics – A phylogenetic approach. Sinauer Associates, Inc, Massachusetts, USA

8. Radford, A.E., Dickinson, W.C., Massey, J. R. & Bell, C.R. (1974). Vascular Plant Systematics. Harper & Row. New York.

9. Simpson, M. G. (2006). Plant Systematics. Elsevier Academic Press, California, USA.

10. Singh, G. (2019). Plant Systematics: An Integrated Approach (4th Edition) CRC Press of Tailor and *Taylor* & Francis.

11. Soltis, D. E., Soltis, P.S., Endress, P. K. & Chase, M.W. (2017). Phylogeny and Evolution of Angiosperms. Sinauer Associates, Inc, Massachusetts, USA/ University of Chicago Press.

12. Stace, C.A. (1989). Plant Taxonomy and Biosystematics. Edward Arnold, London.

13. Stuessy, T. F. (2002). Plant Taxonomy. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

14. Takhtajan, A. (1969). Flowering Plants, Origin and Dispersal. Tr. Jeffery, Edinburgh.

15. Takhtajan, A. (1987). Flowering Plants, Origin and Dispersal: the cradle of the Angiosperms revisited. pp. 26-31 in Whitmore, T.C. Biogeographical Evolution of the Malay Archipelago. Clarendon Press, Oxford.

16. Radford, A.E. (1986). Fundamental of Plant Systeamtics. Harper and Row, Publisher, Inc.

Subject : M.Sc. Botany 1st semester	
Course Code : B040704T	Course Title : (a) Applied Mycology

Objectives:

1. To understand the detailed structure of fungus
2. To study the evolution of fungi.
3. To study the economic importance of fungi

Course Outcomes:

1. Students will understand the every aspects of fungi.
2. Students will able to endeavor the arena of mushroom cultivation and be the future entrepreneur.
3. Students will able to use locally available strains of fungi as biocontrol agents.

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Diversity of fungi** : General account of fungi, classification of fungi and contribution of scientists, Cultivation, isolation and selection of some useful fungi Common genera – *Saccharomyces, Rhizopus, Penecillium, Erysiphe, Neurospora, Agaricus*	15
II	**Detailed account of fungi**: Isolation and multiplication of mycorrhizae, role in crop productivity and forestry. Phosphate solubilizing fungi. General account of mushroom cultivation –*Agaricus bisporus, Volvariella volvaceae, Calocybe indica.* Medicinal and nutritional value of edible and medicinal mushroom Effect of environmental, nutritional and chemical factors on mushroom cultivation. Genetic improvements in mushroom.	15
III	**Role of fungus in Biotechnology**: Fermentation process and biomass production of fungi, growth kinetics, fermenter systems scale up. Yeast genome: Genetic analysis of yeast, Baker's yeast, food and feed yeast, industrial products (glycerol, adhesive, bio-polymer from yeast). **Economic importance**: Fungi in industry, Fungi in medicine, Fungi in agriculture, Fungi as food.	15
IV	**Fungal pathology**: Disease caused by fungi in plants, Fungi as human and animal parasites, Nematophagus fungi, entomogenous fungi, Exploitation of biocontrol agents by genetic manipulation. Management of fungal diseases.	15

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W. and Blaclwell, M. (2007). Introductory Mycology. Fourth Edition,Wiley India Pvt. Limited.
2. Mehrotra, R.S. (2017). Plant Pathology. 3rd Edition, McGraw-Hill Education, New Delhi.
3. Okafor, N. and Okeke, B.C. (2018). Modern Industrial Microbiology and Biotechnology. 2nd Edition, CRC Press, Boca Raton
4. Sethi, I.K. and Walia, S.K. (2018). Text book of Fungi & Their Allies, Second Edition. Mac Millan Publishers Pvt. Ltd., Delhi, India
5. Webster, J. and Weber, R. (2007). Introduction to Fungi. Third Edition, Cambridge University Press, Cambridge and New York.
6. Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 10th Edition, McGraw-Hill, USA

Subject : M.Sc. Botany 1st semester		
Course Code : B040705T	Course Title : (b) **Biostatistics**	

Objective: To study basic of statistics for Biology students.

Course Outcomes: After completion of this course, the students will be able to learn

1. Presentation & Sampling
2. Basics of Correlation and Regression
3. Various test of significance
4. Experimental design for research purposes

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials- Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Presentation of Data**: Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves. **Sampling**: Concept of population and sample; random samples; methods of taking a simple random sample.	10
II	**Correlation and Regression**: Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes.	15
III	**Tests of significance**: Sampling distribution of mean and standard error; z and t-test (equality of means; paired and unpaired t-test); t-test for comparison of means when variances of two populations differ; Chi-square test for goodness of fit; independence of attributes, and homogeneity of samples; interrelation between t-test and F-Test	20
IV	**Experimental Designs:** Principles of experimental designs; completely randomized, randomized complete block design (missing plot value in RBD); latin square designs; augmented block design; simple factorial experiments (mathematical derivations not required); analysis of variance (ANOVA) and its use including estimation of LSD (CD)	15

Suggested readings:

1. Mikulski, H. (2014). Intuitive biostatistics: a nonmathematical guide to statistical thinking. Oxford University Press, USA. Amazon link

2. Van Belle, G., Fisher, L. D., Eagerly, P. J., & Lumley, T. (2004). Biostatistics: a methodology for the health sciences. Vol. 519, John Wiley & Sons.

3. Le, C. T., & Eberly, L. E. (2016). Introductory biostatistics. John Wiley & Sons.

Subject : M.Sc. Botany 1st semester		
Course Code: B040706P	Course Title : **Practical Lab 1**	
Objective: To perform 20 experiments from the given list (at least 6 experiments from each units). **Course outcomes:** After completion of this, the students will be able to learn- 1. Isolation and culture of microbes. 2. Vegetative &reproductive part of cryptogams. 3. Taxonomic description and construction of phylogenetic trees.		
Credits : 4		Core Compulsory
Max Marks : 25 Internal +75 External		Min. Passing Marks :
Total no of Lectures-Tutorials-Practical's (in hours per week):0-0-4		

Unit	Topic	No. of Lectures (120 hrs)
I	1. Isolation and maintenance of pure cultures using common microbiological media. 2. Phylloplane microflora- visualization and isolation. 3. Rhizosphere microflora- visualization and isolation. 4. Examination of gram character of bacteria. 5. Methods of isolation and culturing of bacteria or fungi: colony characters; microscopic observations. 6. Study of reproductive structures of different genera of fungi. 7. Study of fungal physiology in pure colonies – characterization of fungal colonies. 8. Study of as many as possible viral, bacterial and fungal diseases of crop plants (cereal, vegetable, fruit, and plantations) from surrounding habitats in Meerut region.	40
II	1. Study of vegetative and reproductive features of important algal groups with the available representatives; Chlorophyta, Charophyta, Euglenophyta, Chrysophyta, Cryprtophyta, Pyrrhophyta, Phaeophyta, and Rhodophyta. 2. Study of vegetative and reproductive features of important bryophyte groups with the available representatives -Hepaticae, Anthocerotae and Musci. 3. Study of vegetative and reproductive features of important Pteridophyte groups with the available representatives: Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales, Ophioglossales, Marattiales, Osmundales, Filicales, Marsileales and Salviniales.	40
III	1. Writing of technical descriptions.	40

	2. Construction of keys. 3. Identification of local species using Floras, keys and campus field trips. 4. Identification of common families using diagnostic characters. Illustrate diagnostic characters. 5. Construction of phylogentic tree based on gene sequences available at NCBI database (each student may be given different gene sequences/taxa). 6. Construction of Cladogram on the basis of given characters.	

Suggested Readings:

1. Bold, H.C. and Wynne, M. J. (1985). Introduction to the algae: Structure and reproduction. Prentice Hall, Englewood cliffs, New Jersey.
2. Desikachary, T.V. (1959). Cyanophyta ICAR, New Delhi.
3. Parihar, N.S. (1976). Biology and morphology of the Pteridophytes. Central Book Depot.
4. Parihar, N. S. (1980). Bryophytes: An introduction to Embryophyta. Vol I, Bryophyta central Book Depot.
5. Puri, P. (1981). Bryophytes: Morphology, Growth and Differentiation.Atmaram and Sons, New Delhi.
6. Prescott, G. W. (1969). The algae: A review. Nelson, London.
7. Rashid, A. (1999). An Introduction to Pteridophyta. Vikas Publishing House Pvt. Ltd., New Delhi.
8. Sporne, K.R. (1986). The morphology of Pteridophytes. Hutchinson University Press, London.
9. Smith, G. M. (1995). The fresh water Algae of the United States. Mc-Graw Hill, New york.
10. Srinivasan, K. S. (1969). Phycologia India. Vol I &Vol II, B.S.I. Calcutta.
11. Vashishta, B.R. (1988). Algae. S. Chand & Co., New Delhi.
12. Sharma, P.D. (2004).The Fungi for University students. Rastogi Publications, Meerut.
13. Srivastava, J.P. (1998). Introduction to Fungi. Central Book Depot, Allahabad.
14. Sumbali, G. (2005).The Fungi. Narosa Publishing House, New Delhi.
15. Agrios, G.N. (1997).Plant Pathology. Academic Press, New Delhi.
16. Bilgrami, K.S. and Dube, H. C. (1990). A text book of Modern Plant Pathology. Vikas Publishing House, New Delhi.
17. Butler, E.J. and Jones, S. G. (1949). Plant Pathology. McMillan, London.
18. Chatterjee, P.B. (1997). Plant Protection Techniques. Bharati Bhavan, Patna.
19. Chattopadhayay, S.B. (1991). Principles and Procedures of Plant Protection. Oxford &IBH, New Delhi.

Semester I

Industrial Training/Research Project/Survey (Value Added)

Course Code:B040707R (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research work and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

Subject : **M.Sc. Botany 1st semester**	
Course Code: QB040701T	Course Title : **Disaster Management**

Course objectives: To learn management of disaster risk and act with reference to India

Course outcomes: After completion of this course the students will be able to-

1. Gain knowledge about foundations of hazards, disasters, associated natural/social phenomena and disaster management theory (cycle, phases).
2. Understand Indian disaster management system, and role of NIDM.
3. Develops understanding of Methods of community involvement as an essential part of successful DRR, value of humanitarian assistance before and after disaster and technological innovations in Disaster Risk Reduction: Advantages and problems.
4. Take appropriate actions at all points in the disaster management cycle such as preparedness, better warnings, reduced vulnerability or the prevention of disasters during the next iteration of the cycle.
5. Obtain, analyze, and communicate information on risks, relief needs and lessons learned from earlier disasters in order to formulate strategies for mitigation in future scenarios with the ability to clearly present and discuss their conclusions and the knowledge and arguments behind them.

Credits : 4	Minor-Open Elective for other subjects & Value Added
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Introduction to Disasters: definitions of Disaster, Hazard, Vulnerability, Resilience and Risks. Disasters: Classification, natural hazards and Man-made disasters, Causes, Impacts (including social, economic, political, environmental, health, psychosocial.) Global trends in disasters, urban disasters and climatic change.	15
II	Disaster Risk reduction (DRR): Disaster management cycle-Phases, Disaster risk reduction four pillars of DRR viz (1) Disaster Prevention and Mitigation; (2) Disaster Preparedness; (3) Disaster Response; and (4) Disaster Rehabilitation and Recovery, National Disaster Risk Reduction and Management Council (NDRRMC). Sendai frame work for DRR.	15
III	Organizations of Disaster management: Role and structure of NDMA, NIDM, NDRF, SDRF, SDMA, NPDRR, UNDRR, FEMA and DM Act and Policy, Disaster Response Fund	15
IV	Disasters and Development: Impact of Development projects such as dams, embankments changes in Land-use, Climate Change.	15

Suggested Reading:

1. David, A. (2000). Introduction in Confronting Catastrophe. Oxford University Press.
2. Andharia, J. (2008). Vulnerability in Disaster Discourse. JTCDM, Tata Institute of Social Sciences, Working Paper no. 8.

3. Blaikie, P., Cannon, T., Davis, I., Wisner, B. (1997). At Risk Natural Hazards, Peoples Vulnerability and Disasters, Routledge.
4. Damon, C. P. (2007). Introduction to International Disaster Management.
5. Nick, C. (1991). Disaster Management: A Disaster Manager's Handbook. Asian Development Bank, Manila Philippines.

Semester 2

Subject: **M.Sc. Botany 2nd semester**	
Course Code : B040801T	Course Title : **Genetics**

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

Course Outcome:

The syllabus will provide an understanding of - inheritance of qualitative and quantitative traits.

2. The syllabus will provide an understanding of - the structure and organisation of different components of the eukaryotic genomes.
3. The unit will enable the students to learn about - mapping genes in bacteria and gene regulation in prokaryotes.
4. The syllabus will also provide an understanding of - morphology of chromosomes and its relevance in genetics.-Sex chromosomes and their role in sex determination.-The basic concepts of epigenetics.
5. After completion of this syllabus students will able to crack competitive examinations such as Agriculture Research Services, CSIR, TIFR/NCBS, IISc (Bangalore), GATE, and JRF.

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Recent advances in Mendelian vs. non-Mendelian inheritance, quantitative and population genetics. Fine structure of gene. Prokaryotic gene regulation- operons, CRISPR-cas, sigma factors, micro RNAs.	15
II	Eukaryotic genome: Components- repeated elements, transposons, organization and evolution. Eukaryotic gene regulation: cis and trans regulation: promoters, transcription factors, post-transcriptional regulation. Higher order structure of chromatin and its role in regulation different biological processes.	15
III	Genetic & physical mapping of genes in eukaryotes: Linkage and crossing over, molecular mechanism of recombination, molecular markers and construction of linkage maps.	15
IV	Cytogenetics and Epigenetics: Molecular structure of centromere and telomere; Sex determination in plants, sex chromosome, chromosomal aberrations. Introduction, methylation, histone modifications, histone code, Genome imprinting, Genome annotation and epialleles.	15

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.

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040802T	Course Title : **Cell Biology**

Objectives:

1. To understand the structures and Function of the cell Junction.
2. To understand steps of cell signaling.
3. To understand molecular events during cell cycle.
4. To understand vesicular transport and protein targeting .

Course Outcomes:

1. Students who undergo the teaching of cell biology will develop a solid foundation of knowledge regarding the structure and function of cells.
2. Students will gain in-depth knowledge of Cell Interactions
3. Students will develop a detailed understanding of the functioning of plasma membrane
4. Students will have a comprehensive overview of Cell Cycle Regulation and Signaling Pathways.
5. After completion of this syllabus students will able to crack competitive examinations like GATE and CSIR-JRF

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Cell interactions:** Extra cellular matrix, Cell adhesion molecules; cadherins, integrins, selectins, fibronectins, laminin and Immunoglobin superfamily. Cell-cell adhesions (Junctional and non junctional adhesive mechanisms; occluding junctions, anchoring junctions, communicating junctions (Connexons) and plasmodesmata. **Membrane structure**: Plasma membrane: the lipid bilayer, fluidity of the lipid bilayer, phospholipids, sphingolipids, cholesterol, glycolipids, rafts, Membrane proteins, and membrane transport (Active & Passive).	15
II	**Protein Targeting:** Protein secretion, synthesis and targeting of mitochondria, chloroplast, Nucleus, & Peroxisomes. **Posttranslational Modification of protein:** Glycosylation in the Rough Endoplasmic Reticulum and Golgi Complex. **Vesicular Transport:** Transport From the ER to the Golgi Complex; Transport of Materials through the Golgi Complex; Mechanism of transport to Lysosomes. **Types of Vesicle Transport and Their Functions:** COPII-Coated Vesicles: COPI-Coated Vesicles & Clathrin coated vesicles. **Targeting Vesicles to a Particular Compartment:** Movement, Tethering, Docking & Fusion of Vesicles with target membrane.	15
III	**Cell Cycle**: Overview of Cell Cycle Phases; Cell Cycle Checkpoints; Regulation of cell cycle: **Positive regulation** (Cyclin, Cdk Phosphorylation/dephosphorylation; Activation of cyclin-dependent kinases, Mechanism of Cdk regulation; DNA replication licensing; CDK inhibitors, Maturation promoting factor (MPF) Regulation). **Negative**	15

	Regulation: (Retinoblastoma protein (pRb); p53, (Mechanism of p53). **Protein Degradation in Cell-Cycle Control**: SCF (Skp1-Cullin-F-box protein complex) and the APC (Anaphase-Promoting Complex). Structural Maintenance of Chromosomes (SMC); Spindle formation and its disintegration, mechanism of chromosome movement and separation during anaphase. Spindle Assembly Checkpoint and Progression to Anaphase.	
IV	**Cell Signalling**: General principle, ligands and receptors, types of cell signaling, Component of cell signaling. Features of signal-transducing systems, Types of signal transducers. **Molecular switch:** Kinase/Phosphatase Molecular Switch, GTPase Molecular Switch. **G Protein:** G Cycle, G Protein-Coupled Receptors and Second Messengers. **Cell surface receptors:** cAMP/PKA Signal Transduction, The Phospholipase C/Calcium Signal Transduction Pathway, Receptor Tyrosine Kinases (RTKs), The MAP Kinase Signaling Cascade **Intracellular Receptors:** Nitric Oxide Cell Signalling, Calmodulin signaling pathway, Role of Ca ion as an intracellular messenger in the stomatal movement.	15

References:

1. Alberts, B., et. al. (1983). Molecular Biology of The Cell. W. W. Norton & co., 1464pp, Sixth edition, United states.
2. Cooper, G. (2000). The Cell, A molecular approach. Second edition.
3. Lodish, H., et. al. (2021). Molecular Cell Biology. Ninth edition.

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040803T	Course Title : **Developmental Botany**

Course Objectives: To explore the development in plants with pattern and diversity growth, development and reproduction aspects needs to be understood. This course emphasizes on these goals to make the student in depth understanding and evokes curiousness.

Course Outcome: The students after completing this course will become able to:

1. Understand the relevance that how plant development is regulated by genes, environment and hormones.
2. How cell signalling is important for plant development.
3. Understand the molecular mechanism underlaying diverse developmental process involving both vegetative and reproductive organ development
4. Understand the role of epigenetic that regulates development and adaptation.

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Growth regions:** Meristems and their types, Root Apical Meristem (RAM) and Shoot Apical Meristem (SAM) at molecular level, Comparative study of RAM & SAM from lower to higher plants and evolutionary tendencies, Lateral meristem, Intercalary Meristem Programmed cell death and plant development, (molecular mechanism).	15
II	**Plant Reproductive Biology:** Floral evocation and development of the Floral Meristem; Acquisition of floral competence, control of floral identity, regulation by differentiation, physiology, photoperiod and temperature (Molecular level). ABC Model. Structure and development of microsporangium, megasporangium male and female gametophyte (molecular level)	15
III	**Pollen-Pistil Interactions:** Pollen-Stigma Interactions (Pollen Tube Guidance, Pollen recognition by the Stigma Pollen Tube Traffic in the Style and ovule) Self-Incompatibility: Structural and Biochemical Aspects Molecular Aspects of Gametophytic Self-Incompatibility Molecular Aspects of Sporophytic Self-Incompatibility Genes and events involved at Fertilization, Development of dicot and monocot embryo (at	20

	cellular and molecular level), Molecular study of Endosperm development.	
IV	Seed & Fruit development (at molecular level) Apomixis and Polyembryony: Concept, Developmental mechanisms and applications.	10

Suggested Readings:

1. Barrett, S.C.H. (2008). Major Evolutionary Transitions in Flowering Plant Reproduction. Univ. of Chicago Press.
2. Beck, C. (2010). An Introduction to Plant Structure and Development. Cambridge University Press, 465pp.
3. Bhattacharya et. al. (2007). A textbook of Palynology. Central, New Delhi.
4. Bhojwani, S.S. and Bhatnagar, S. P. (2000). The Embryology of Angiosperms. 4th Ed., Vikas Publishing House.
5. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
6. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). Biochemistry and Molecular Biology of Plants. Wiley Publisher, 1264pp.
7. Davies, P. J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
8. Davies, P.J. (2010). Plant Hormones: Biosynthesis, Signal Transduction, Action. Springer, Netherlands, 802pp.
9. Dickinson, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
10. Dutta, A.C. (2016). Botany for Degree Students. Oxford University Press.
11. Eames, A. J. (1936). Morphology of Vascular Plants. Standard University Press.
12. Evert, R.F. (2006). Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Functional Development. John Wiley and Sons, Inc.
13. Faegri, K. and van der Pijl, L. (1979). The Principles of Pollination Ecology. Pergamon Press, Oxford. 291 pp.
14. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
15. Harder, L.D. and Barrett, S.C.H. (2006). Ecology and Evolution of Flowers. Oxford Univ. Press.
16. Howell, S.J. (1998). Molecular Genetics of Plant Development. Cambridge University Press,365pp.
17. Johri, B. M. (1984). Embryology of Angiosperms. Springer-Verleg, Berlin.
18. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering. 2nd Edition, CABInternational, U.K.
19. Karp, J.G. (2007). Cell and Molecular Biology. John Wiley & Sons, USA.
20. Leyser, O. and Day, S. (2003). Mechanism in Plant Development. Blackwell Publishing Ltd. 241pp.
21. Maheswari, P. (1971). An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London
22. Meyer, P. (2005). Plant Epigenetic. Blackwell Publishing Ltd. 281pp.
23. Raghavan, V. (2000). Developmental Biology of Flowering Plants. Springer Verlag, New York.
24. Scott, R.J. and Stead, A.D. (2008). Molecular andCellular Aspects of Plant Reproduction. Society for Experimental Biology, Seminar Series 55.

Subject : M.Sc. Botany 2nd semester		
Course Code : B040804T	Course Title : (a) **Elementary Biotechnology**	
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. Design binary vectors and learn the procedure for generating GM crops. 3. Describe GM crops and what products are in the market, their contributions towards food security, sustainable environment and medicine. Evaluate critically the safety issues of GM crops and products in the society		
Credits : 4		Core Elective
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	1. Definition, Basic concepts, Principles and scope of Biotechnology 2. Recombinant DNA technology, basic concept in genetic engineering, tool and techniques of recombinant DNA technology.	15
II	1. Enzymes in genetic engineering - exonucleases, endonucleases, restriction endonucleases, S I nucleases, DNA ligases, polymerase, Kinases, reverse transcriptase and alkaline phosphatase. 2. Gene cloning vectors – primary vectors-Plasmids, Phages, Cosmids, shuttle vectors, 2μ DNA plasmids, Yeast plasmids Transposons, and expression vectors. Recombinant Protein expression, Fermentation and enzyme technology	15
III	Selection of genes, Gene libraries, Genomic and cDNA library - Gene transfer methods, Genetic organization of Ti plasmids, Ti plasmid mediated transfer - *Agrobacterium tumifaciens*, 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.	15
IV	**1.** DNA fingerprinting, gene therapy and genetic counselling. 2. Use of transposons in genetic analysis: Transposon tagging and its use in identification and isolation of genes. 3. Elementary Knowledge of next generation sequencing. 4. Biosafety regulation: Physical and Biological containment.	15

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. 2ndEdition,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.

Subject : **M.Sc. Botany 2nd semester**		
Course Code : B040805T	Course Title : (b) **Pharmacognosy**	

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 Elective & Value Added
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Definition, history, scope and development of Pharmacognosy. Phytochemical and Pharmacological literature review of *Azadirahcta indica, Asparagus Ocimum sanctum, Convolvulus* etc	15
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*	15
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.*	15
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*	15

Suggested Books

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. IstEdn, 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&Pharmacobiotechnology.

10. The formulation and preparation of cosmetic, fragrances and flavours.

11. Remington's Pharmaceutical sciences.

12. Vyas, S. P. and Dixit, V. K. (2019).Text Book of Biotechnology.

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040806T	Course Title : (e) **Applied Phycology**

Objective: To study commercial production and utilization of algae

Course Outcome: After completion of this course the students will be able to learn

1. Mass cultivation of algae
2. Controlling of biofouling of ships.
3. Hydrogen production by algae.
4. Production of biofertilizer

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	A brief account on genetic metabolic understanding in microalgae. Algae in environment: Bioremediation, Carbon sequestration, waste water treatment. Value added product derived from microalgae. Hydrogen and biofuel production from algae.	15
II	**Microalgae in liquid waste treatment and reclamation**. Biological waste treatment system, Design consideration (Algal concentration, algal productivity) Operation of integrated algal bacterial system, current application, future application (Sewage grown algae, energy system, toxin removal. Algal toxins in aquatic environment.	15
III	Isolation, purification, development of unialgal cultures and culturing of microalgae Single cell protein from *Spirulina, Dunaliella* and *Chlorella*, desiging of photobioreactor and algal cultivation in photobioreactor. Algal Transgenics and Biotechnology	15
IV	Paddy field cyanobacteria: Qualitative and quantitative assessment of their biodiversity using molecular tools; their use as biofertilizer, reclamation of usar lands. Influence of salt, heavy metals and acid rain on algae: Physiological and biochemical effects; biochemical and molecular mechanisms of tolerance.	15

Suggested Readings:

1. Car, N. G. and Whitton, B. A. (1982). The Biology of Cyanobacteria. Blackwell.
2. Rai, L. C., Gaur, J. P. and Soeder, C. J. (1994). Algae and Water Pollution.Schweizerbart'sche Stuttgart, Germany.

3. Borowitzka, M. A. and Borowitzka, L. J. (1988). Microalgal Biotechnology. Cambridge University Press, New York, USA
4. Shubert, L. E. (1984). Algae and Ecological Indicators. Academic Press.
5. Rai, L. C. and Gaur, J. P. (2001). Algal Adaptation to Environmental Stresses: Physiological, Biochemical and Molecular Approaches. Spriger.
6. Fogg, G. E. and Thake, B. (1987). Algal culture and Phytoplankton Ecology. Univ. Wisconsin Press.
7. Singh, R. N. (1961). Role of Blue-green Algae in Nitrogen Economy of Indian Agriculture. I.C.A.R., Monograph on Algae, New Delhi.
8. Seckbach, J. (2007). Algae and Cyanobacteria in Extreme Environment. Springer.
9. Bagchi, S. N., Kleiner, D. and Mohanty, P. (2010). Protocols on Algal and Cyanobacterial Research. Narosa.
10. Feng, C. and Jiang, Y. (2001). Algae and their Biotechnological Potential. Kluwer.

Subject : **M.Sc. Botany 2nd semester**	
Course Code : B040807T	Course Title : (d) **Stress Physiology of Plants**

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:

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

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	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	15
II	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	15
III	Response to nutrient deficiency stress, Heavy metal stress, injury and mechanism of resistance, adaptations, Salinity stress, Ionic and salt stress injury, mechanism of resistance	15
IV	Response to water deficit: Desiccation, Dehydration injury; Mechanism of resistance, Adaptations, Response to water excess. Causative agents for Biotic Stresses, Mechanism of Resistance against Fungal, Bacterial and viral pathogens	15

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.

Subject : **M.Sc. Botany 2nd semester**		
Course Code: B040808P	Course Title : **Practical Lab 2**	
Objective: To perform 20 experiments from the given list (at least 6 experiments from each units). **Learning Outcomes:** On completion of this course, the students will be able to study cell division, cell's type, genetical experiments & experimental related to developmental botany.		
Credits : 4	Core Compulsory	
Max Marks : 30+70	Min. Passing Marks :	
Total no of Lectures-Tutorials-Practical's (in hours per week):0-0-04		

Unit	Topic	No. of Lectures (120 hrs)
I	1. Exercise based on Mendelian experiments (monohybrid, dihybrid and test cross). 2. Exercise based on gene mapping. 3. Exercise based on gene regulation 4. Laboratory exercises in probability and chi-square; 5. Chromosome mapping using three-point test cross 6. Study of co-dominance. 7. Study of lethal allele 8. Study on different gene interaction (Epistasis) 9. Numerical exercise on multiple factor hypothesis	40
II	1. Mitotic studies in suitable material: Squashing of the root tip and selection of metaphase plate. 2. Mitotic studies in suitable material: Camera Lucida drawing, Karyotype analysis, ideogram and derivation of karyotypic formula. 3. To study chromosomal aberrations in *Rheo* spp. 4. Meiosis in *Allium cepa*. 5. To measures the cell's size. 6. To study cell's inclusion. 7. To study different cell's types and their camera lucida drawing. 8. Histochemical analysis of the following chemical compounds: a) Alkaloids b) Steroids c) Quinones d) Resins e) Glucosides f) Pigments g) Volatile oils. 9. Organoleptic evaluation of the following: a) *Glycyrrhiza* (Root) b) Ginger (Rhizome) c) *Eucalyptus* (leaf) d) *Terminalia arjuna* (Bark) f) *Strychnos nux-vomica* (seed). 10. Powder analysis. a) Curcuma b) Cloves c) Senna d) Fennel e) Cinnamon: Market drugs: a) Turmeric b) Chillies c) Coriander d) Wheat and Jowar.	40
III	1. Comparative anatomy of monocotyledon and dicotyledon root, stem and leaf. 2. Anatomical basis of identification C3& C4 sub types in grasses. 3. Phytoliths of grasses and their potential use in identification. 4. Anatomy of lenticels and periderm in plants.	40

	5. Anatomy of monocotyledonous and dicotyledonous seeds. 6. Study of different types of stomata and trichomes. 7. Maceration of wood to study xylem components. 8. Study of microsporangium and microsporogenesis. 9. Study of megasporangium and embryo sac development. 10. Study of types of endosperm and its modifications. 11. Study of development of embryo in dicot and monocot. 12. Study of different ornamentation patterns in pollen grains by acetolysis. 13. Analysis of honey samples to identify uni-floral or multi-floral honey.	

Suggested Readings:

1. Strickberger, M. W. (1985). Genetics. 3rd Edition, MacMillan Pub. Co., Philadelphia.
2. Gupta, P. K. (2000). Cytology, Genetics and Evolution. 6th Edition, Rastogi Publications, Meerut.
3. Lewin, B. (2008). Genes IX. Oxford Univ. Press, New York.
4. Darlington, C. D. (1965). Cytology. Churchill, London.
5. De Robertis, E.D.P. and De Robertis, E.M.F. (1987). Cell and Molecular Biology. 8th Edition, B. I. Waverly, New Delhi.
6. Watson, J. D. et al. (2009). Molecular Biology of the Gene. 6th Edition, Benjamin Cummings, New York.
7. Broda, P. W. (1979). Plasmids. Freeman, Oxford.
8. Swaminathan, M. S., Gupta, P. K., and Sinha, U. (1983). Cytogenetics of crop plants. MacMillan India Pvt. Ltd., New Delhi.
9. Swanson, C. P. and Webster, P. L. (1989). The Cell. 7th Edition, Prentice-Hall of India Pvt. Ltd., New Delhi.
10. Shivanna, K. R. and Rangaswamy N. S. (1992). Pollen Biology - A Laboratory Manual. Narosa Publishing House, New Delhi.
11. Batygina T. B. (2009). Embryology of Flowering Plants Terminology and Concepts, Volume 12, Reproductive Systems, Science Publishers, USA.
12. Raghavan, V. (2000). Developmental Biology of Flowering Plants, Springer-Verlag, New York.
14. Bhojwani, S. S. and Bhatnagar, S. P. (1992). The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd., New Delhi.
15. Johri, B.M. (1984). Comparative Embryology of Angiosperms. Ind. Nat. Sci. Acad., New Delhi.
16. Maheshwari, P. (1985). An Introduction to Embryology of Angiosperms. Tata McGraw Hill, New Delhi.
17. Fahn, A. (1990). Plant Anatomy. 4th Edition, Pergamon press, New York, Oxford.
18. Esau, K. (1985). Plant anatomy. 2nd Edition, Wiley Eastern Limited, New Delhi.
19. Metcalf, C. R. and Chalk, L., (1950). Anatomy of Dicots. Vol. I & II, London Press, Oxford.
20. Romberger, J. A. Hejnowicz, Z. and Hill J. F. (1993). Plant Structure: Function and Development. Springer-Verlag.
21. Nair, P.K.K. (1985).Essentials of Palynology, Asha Publishing House, New York.
21. Shivanna, K. R. and Sawhney, V. K. (1997). Pollen Biotechnology for Crop Production and Improvement. Cambridge University press, U.K.

22. Lyndon, R. F. (1990). Plant Development, the Cellular Basis. Cambridge University Press, UK.
23. Evans, W. C. (2009). Trease and Evans Pharmacognosy. 16th edition, W.B. Sounders & Co., London.
24. Kokate, C. K. and Gokhlae, P. (2007). Text book of Pharmacognosy. 37th Edition, Nirali Prakashan, New Delhi.

Semester 2

Industrial Training/Research Project/Survey(Value Added)

Course Code: B040809R (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research work and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

Subject : **M.Sc. Botany 2nd semester**	
Course Code:QB040801T	Course Title : **Fascinating Plants**

Course Objectives:
The course aims to have understanding of Plant & Religion, strange & Economic important Plants.

Course Learning Outcomes:
The students will be learning?

1. What are the sacred plant?
2. What are morphological modifications, adaptation on plants?
3. What are economic important plants?
4. What are conservation strategies of threatened taxa?

Credits : 4	Minor-Open Elective for other subjects
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Plants & Religion:** Tree worship in Vedic Period, Puranas, Buddhism & Jainism; Plant & Astrology; Sacred Groves; Venerated plants of your locality. Plantsin Worship,Myths, Plants in Epic like Mahabharata, Ramayana.	15
II	**Plants with Unique Morphology**: *Welwitschia*, Cacti, Orchids, *Wolffia, Rafflesia, Sepria, Sequoia* & it allied Taxa, *Victoria amazonica, Amorphophallus*, Baobab (*Adansonia*), *Selaginella lepidophylla,* Dancing Grass (*Desmodium gyrans*), *Mimosa pudica*; Insectivorous plants (*Dionaea, Nepenthes, Drosera, Utricularia* etc Parasitic Plants.	15
III	**Economic important Plants**: Ornamental, Medicinal, poisonous & Timber yielding plants of your Locality.	15
IV	Special pollination mechanisms (*Ficus, Calotropis, Ophrys, Salvia*), Signature Plants & Plants that thrills (Stumulants, Depressants etc), Conservation of Rare, Endangered and threatened plants, Exotic & Invasive Plants.	15

SuggestedReadings:

1. Raven, P.H., Evert, R.F. and Eichhorn, S.E. (2005). Biology of Plants (7th ed.). New York: W. H.Freemanand Company.
2. Sakai, A. and Larcher, W. (1987). Frost Survival of Plants. Springer-Verlag, New York NY. 321pp.
3. Kochhar, S.L. (2016). Economic Botany: A Comprehensive Study. Cambridge University Press.
4. Trewavas, A. (2003).Aspects of plant Intelligence.Annals of Botany. 92 (1):1–20.
5. Prance, G.T. (2001). Discovering the plant world.Taxon,50 (2, 4): 345–359.

Semester 3

Subject: **M.Sc. Botany 3rd semester**		
Course Code : B040901T	Course Title : **Medicinal Botany and Ayurvedic System of Medicine**	
Objectives: To acquire knowledge on the methods of preparation and use of formulations of various systems of medicines. **Course Outcomes**: The students will be able to learn principles and concepts of alternative systems of medicine like ayurvedic medicine. Besides the students will also be able to learn knowledge on the methods of preparation and use of formulations of various systems of medicines.		
Credits : 4	Core Compulsory & value added	
Max Marks : 30+70	Min. Passing Marks :	
Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	Introduction to various systems of Indigenous Medicine. Introduction to basic concepts of folk medicine and Ayurveda. Principles and Concepts of Ayurveda, History and Development of Ayurvedic medicine.	15
II	**Study of some Ayurvedic drugs & Their Plant sources**: Haldi, Guggul, Ashoka, Shatavar, Sarapgandha, Kalmegh, Gokhru, Punarnava, Ashwagandha, Jatamansi, Isabgol, Vasaka, Shilajit, Neem, Curry Patta, Giloe, Kachnar, Arjun, Harad, Bahera, Amla, Amaltas, Banyan, Tulsi, Sadabahar and mint.	15
III	Role of plants in medicine. Morphology, active principles and medicinal value of the following: *Andrographis paniculata, Moringa oleifera, Clitoria ternata Phyllanthus emblica* and *Gymnema sylvestre* Plant secondary metabolite of medicinal importance: alkaloids, glycosides, mucilage, sterols. Some common herbal practices used to cure – fever, worms, diarrhea, cough, cold, Arthritis, rheumatism, stone in urinary tract, eczema or fungal infections.	15
IV	Introduction to Ayurvedic formulations with methods of preparation & Uses: Churna, Vati, Avleh, Asava, Arishta, Taila and Bhasma. **Ayurvedic Products:** Triphala, *Chyawanprash,* Ghutti, etc Knowledge of ancient equipment like khalwa yantra, Arka yantra, Patana yantra	15

Suggested readings

1. Awadesh, N., Ghoeami, A. and Sharma, R., Indigenous Health Care and Ethnomedicine, Sarup and Sons.
2. Glimpses of Indian Ethano-Pharmacology by P. Pushpangadam. Ulf Nyman. V. George Tropical Botanic Garden & Research Institute.
3. Textbook of Pharmacognosy by C. K. Kokate, Purohit, Ghokhale, Nirali Prakashan.
4. Ayurvedic formulary of India, Govt. of India

5. Pharmacopoeial standards for Ayurvedic formulations CCRAS,Delhi
6. Ayurvedic pharmacopoeia
7. Indian herbal pharmacopoeia vol.1 & 2 RRLIDMA
8. Vaidya Yoga Ratnavali (Formulary of Ayurvedic Medicines)
9. Sivarajan, V. V. (1994). Ayurvedic drugs and their plant sources. Oxford & IBH Publishing Company.
10. Rajpal, V. (2008). Tandardization by Botanicals. Voll, Eastern Publishers, New Delhi.
11. Parrota, J. A. (2001). Healing plants of peninsular India.CABI Publications.
12. Principles of integrated medicines by Mathur PR

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040902T	Course Title : **Plant Biochemistry and Molecular Biology**

Objective: This course aims to educate student on concepts of proteins, enzymes, basic plant signaling mechanisms, sensory photobiology. The course further deals with plant secondary metabolites and plant-plant interaction.

Course Outcomes:

1. Impart an insight into the various biochemical and molecular mechanism of plant biology.
2. Take students to higher levels of biochemical and molecular learning about plant system.
3. Understand the biochemical and molecular role of various biomolecules.
4. Acquire knowledge about signal transduction and sensory photobiology.
5. After completion of this syllabus students will able to crack competitive examinations such as Agriculture Research Services, CSIR, TIFR/NCBS, IISc (Bangalore), GATE, and JRF

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	**No. of Lectures (60 hrs)**
I	Thermodynamics, Protein structure and Enzymes: Application of principles of thermodynamics in biology; enzyme kinetics and inhibition of enzymatic activity. Hierarchical structure of proteins; purification of protein via chromatography, precipitation and antibody.	15
II	Signal Transduction: Signalling mechanisms of plant hormones viz. auxin, cytokinin and ethylene.	15
III	**Sensory Photobiology**: Molecular Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; Light induced stomatal movement; Molecular events during scotomorphogenesis and photomorphogenesis.	15
IV	Molecular structure of Secondary metabolites, Natural products (secondary metabolites), their range and eco-physiological functions. Overview of terpenoids, alkaloids, and phenolics.	15

Suggested Readings:

1. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
2. Davies P. J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.

3. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering. 2nd Edition, CAB International, U.K.
4. Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th ed.). W.H. Freeman & Co., New York.
5. Taiz, L. and Zeiger, E. (2010). Plant Physiology. 5th Edition. Sinauer Associates, USA.
6. Heldt, H. W. and Piechulla, B. (2010). Plant Biochemistry, 4th Edition. Academic Press, NY.

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040903T	Course Title : **Environmental Chemistry**

Objective: To impart the students about the environment that he/she can put across bills and policies that can help protect the world from disasters such as Global Warming, Climate Change and to keep its country eco-friendly.

Course Outcome: Upon successful completion of the course the student will be able to:

1. Classification of elements, composition of air, the characteristics of hydrocarbons, biogeochemical cycles, pesticides, and their effects
2. Demonstrate knowledge of chemical and biochemical principles of fundamental environmental processes in air, water, and soil.
3. Recognize different types of toxic substances & responses and analyze toxicological information.
4. Describe causes and effects of environmental pollutant by and discuss some mitigation strategies.
5. Get job as Water Treatment Specialist in Water Treatment and Waste Disposal, Environmental Assessment Analyst, Environmental Auditor, Chemist, Environmental Consultant, Government Scientist (Provincial and Federal), Research Associate in Universities, Environmental Health & Safety Coordinator in Chemical Product Distributors, Quality Assurance in Manufacturing (Food, Paper, Chemical, Plastics), Analytical Specialist in Engineering Consulting and crack UGC NET

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Environmental Chemistry Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes.	15
II	Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog.	15
III	Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and	15

	COD, Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh).	
IV	Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur. Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O3, PAN, VOC and POP. Carcinogens in the air.	15

Suggested readings:

1. Baird, C. and Cann, M. (2012). Environmental Chemistry, 5th Edition.
2. Subramanian, V. (2020). A Textbook of Environmental Chemistry. Dreamtech Press, ISBN: 9789389583908.
3. DE, A. K. (2016). Environmental Chemistry, New Age Publisher International Pvt Ltd, ISBN: 9789385923890, 9385923897, Edition: 1.

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040904T	Course Title : (a) **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.

CourseOutcomes: 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	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	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.	15
II	**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 footprinting, primer extension, S1 mapping, reporter assays.	15
III	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	15

	prospects	
IV	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.	15

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).

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040905T	Course Title : (b) **Evolutionary Biology**

Course Objectives: The objective of the course is to provide an understanding of the trends inchanges occurring in living organism over period of time through various process and pattern.

Course Outcomes: Students will be able to grasp understanding of:

1. Evolution and its relevance in biological organism
2. How evolution works (Patterns and trends).
3. Learn how to study evolution and what are evolutionary processes.
4. develop ability to incorporate knowledge of evolution in other streams of study.

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction** - Pattern and process components of scientific theories: biological variation and evolutionary change (evidence for evolution). Darwin and Wallace – natural selection, adaptation. Microevolution, macroevolution. Evolutionary history: reading trees, monophyly, Tree of life. Evolutionary trends: maximum parsimony, origin and evolution of traits across life and green plants.	20
II	The fossil record. Geological fundamentals. Phylogeny and the fossil record. Evolutionary trends. Rates of evolution. The geography of life. Major patterns of distribution. Historical biogeography, phylogeography.	10
III	The Modern Synthesis: Population Genetics. Forces of evolution: Genetic drift – Sampling error; Mutation. Migration/Gene Flow. Adaptation – Fitness, coefficient of selection. Onelocus models, multi-locus models, modes of selection. Non adaptive traits. Molecular evolution. Neutral theory. Molecular clock. Testing for selection. Modes of selection. Pairwise distances and molecular divergence. Molecular models.	15
IV	Species. Reproductive isolation. Species concepts and processes of speciation. Drivers of speciation. Geographic patterns. Evolutionary mechanisms. Post-zygotic and pre-zygotic isolation in allopatry and sympatry, reinforcement, character displacement. Hybrid speciation,	15

	hybrid zones. Adaptive Radiation.	

Suggested Readings:

1. Baum, D. A. and Offner, S. (2008). Phylogenies and tree thinking. American Biology Teacher 70:222-229.
2. Futuyma, D. J. (1998). Evolutionary Biology (3rd Edition). Sinauer Associates.
3. Hall, B.K. and HallgrÃ-msson, B. (2014). Strickberger's Evolution (4th Edition). Jones &Bartlett.
4. Herron, J.C. and Freeman, S.C. (2015). Evolutionary Analysis (5th Edition). Prentice Hall. ISBN13: 978-0321616678. ISBN-10: 0321616677.
5. Nei, M. and Kumar, S. (2000). Molecular Evolution and Phylogenetics. Oxford University Press. ISBN 0 19 513584 9.
6. Page, R. D. M. and Holmes E. C. (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell.
7. Ridley, M. (2003). Evolution (3rd edition). Blackwell..
8. Zimmer, K. and Emlen, D.J. (2013). Evolution - Making Sense of Life. ISBN 978 1936221172,978 1936221363.
9. Research and review articles on relevant topics.

Subject : **M.Sc. Botany 3rd semester**	
Course Code : B040906T	Course Title : (c) **Plant Nomenclature**

Course Objectives:

This course aims to add to understanding of the students about International code of Nomenclature for algae, fungi & Plants

Course Outcomes:

The students will learn

1. What are different methods of naming plants? What are different principles & Rules of nomenclature? Why name changes?

Credits : 4	Core Elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Polynomial System of Nomenclature. Binomial System of Nomenclature, Uninomial System of Nomenclature. History and Development of the Code of Botanical Nomenclature, Important dates in the *Code*, Structure and organization of the *Code*. How to publish a new name.	15
II	Principles of ICN and their explanation. Ranks & Taxa: Ranks and Nomenclature of Taxa. Type Method, How to designate a type? Principle of Priority and Its Limitations, How to find the correct name for a taxon? Effective and Valid Publication	15
III	Citation, How to cite names of authors? Conservation, Protection, Retention of Names and Epithets of Taxa, Choice of Name, Rejection of Names and Epithets, suppressed works, and binding decisions, Nomina Conservanda	15
IV	Orthography of Names, How to spell names? Nomenclature of Hybrids and Cultivated Plants Publication of a New Species How to change the *Code*?	15

Suggested Readings

1. Turland et al. (2018). International code of nomenclature for algae, fungi and plants.
2. Turland, N. (2019). The Code Decoded, A user's guide to the international code of nomenclature for algae fungi & plants. Pensoft Publisher.

Subject : **M.Sc. Botany 3rd semester**		
Course Code: B040907P	Course Title : **Practical Lab 3**	
Objective: To perform 20 experiments from the given list (at least 6 experiments from each units) and to performs exercises related to Medicinal botany, ethnobotany, floral and molecular biology. **Course outcomes:** Identification of various plant parts used as medicines by ethnic groups, and preparation of Ayurvedic product. The students will be able to learn technique of molecular and floral biology.		
Credits : 4	Core Compulsory	
Max Marks : 30+70	Min. Passing Marks :	
Total no of Lectures-Tutorials-Practical's (in hours per week):0-0-04		

Unit	Topic	No. of Lectures (120 hrs)
I	1. Ethnobotanical specimens as prescribed in theory syllabus. 2. Detailed morphological and anatomical study of medicinally important part(s) of locally available plants used in traditional medicine. 3. Field visits to identify and collect ethno medicinal plants used by local tribes/folklore. 4. Preparation of Churna, and Vati, 5. Preparation of Avleh, Asava, Arishta, Taila and Bhasma. 6. Preparation of Triphala, Chywanprash, Ghutti. 7. Collection and Conservation of Medicinal plants in garden of your institute.	40
II	1. Isolation and purification of genomic DNA from plant materials. 2. Isolation and purification of RNA from plants. 3. Culture of plasmid and maintenance of culture. 4. Isolation of plasmid DNA. 5. Quantitative estimation of genomic DNA and RNA using spectrophotometer. 6. Agarose gel electrophoresis of genomic DNA and RNA and detection using gel documentation system. 7. Digestions of DNA by restriction enzymes and size fractionation of fragments. 8. Ligation of digested fragments. 9. Primer designing. 10. cDNA formation using reverse transcriptase.	40
III	1. Floral biology of *Oryza sativa*. 2. Floral biology of *Zea mays*. 3. Effect of chemical mutagen (DES/HZ/EMS) on germination, growth and yield characteristics in *Brassica juncea /Impatiens balsamina*.	40

	4. Crossing techniques in *Oryza sativa*. 5. Crossing techniques in *Zea mays*. 6. In vitro embryo culture of pea (*Pisum sativum*). 7. Nomenclature based exercises.	

Suggested Readings:

1. Kokate,C. K. and Ghokhale, P. (2018). Textbook of Pharmacognosy. Nirali Prakashan.
2. Ayurvedic formulary of India, Govt. of India.
3. Pharmacopoeial standards for Ayurvedic formulations CCRAS, Delhi.
4. Ayurvedic pharmacopoeia. Indian herbal pharmacopoeia vol.1 & 2 RRL, IDMA.
5. Vaidya Yoga Ratnavali (Formulary of Ayurvedic Medicines)
6. Sivarajan, V. V. (1994). Ayurvedic drugs and their plant sources.
7. Brown, T. A. (2007). Genomes. Third Edition. Garland Science Publishing, New York. U.S.A.
8. Lewin, B. (2008). GENES IX. Jones and Bartlett Publishers, London, UK.
9. Schuler, M. A. and Zielinski, E. R. (2005). Methods in Plant Molecular Biology. Academic Press, USA.
10. Henry, R. J. (2005). Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
11. Shaw, C. H. (1988). Plant Molecular Biology, Practical Approach. IRL Press, Oxford, Washington DC.
12. Grierson, D. and Covey, S. (1984). Plant Molecular Biology. Panima Educational Agency, New Delhi.
13. Coruzzi, G. (1994). Plant Molecular Biology - Genetic Analysis of Plant Development and Metabolism. Springer Verlag, New York, London.
14. Tewari, K. K. and Singhal, G. S. (1997). Plant Molecular Biology and Biotechnology. Narosa Publishing House, New Delhi.
15. Singh, B. D. (2003). Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.
16. Sharma, J. R. (1994). Principles and Practice of Plant Breeding. Tata Mc Graw-Hill Publishing, Co. Ltd., New Delhi.
17. Poehlman, J. M. and Borthakur, D. (1969). Breeding Asian Field Crops. Oxford and IBH Publishing, Co. New Delhi.

Semester 3

Industrial Training/Research Project/Survey(Value Added)

Course Code: B040908R (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research work and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

Semester 4

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041001T	Course Title : **Environmental Issues and Policies**

Objectives: To study environmental issues at global level

Course outcomes: After completion of this course the students will be able to learn-

1. The causes of global climate change.
2. Understand the causes of global water & energy crisis
3. National policies on environment
4. Causes of biodiversity loss

Credits : 4	Core Compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Environmental Pollution**: Causes and effects of air, water, soil, noise, radioactive pollution; Basic pollution abatement practices and technologies **Global Change**: Global land cover and land use change; Multiple impacts of land use change; Causes, effects and mitigation strategies for global climate change and stratospheric ozone loss	15
II	**Biotic Invasions**: Extent and mechanisms of biological invasions; Ecological and economic impacts; Management strategies. **Loss of Biodiversity**: Threats and pattern of biodiversity loss; Natural and anthropogenic causes; IUCN threat categories, Red data books; Conservation and restoration of biodiversity	15
III	**Global Water Crisis**: Distribution, withdrawal and consumption patterns; Causes and effects of water crisis; Water conservation approaches. **Global Energy Crisis**: Sources of energy supply; Current potential and future prospects of energy sources; Energy crisis; Energy conservation strategies	15
IV	**Challenges of Urbanization**: Trends of urbanization; Environmental impact of urbanization; Concept of green cities. **National Policies on Environment**: National Forest Policy; National Water Policy; National Energy Policy; National Action Plan on Climate Change; National Biodiversity Action Plan.	15

Suggested Readings:

1. McConnell, R. (2008). Environmental issues: An introduction to sustainability. Pearson.

2. Wali, M.K., Fatih Evrendilek, M., Fennessy, S. (2009). The environment: science: Issues and solutions. CRC Press.

3. Neelin, J. (2011). Climate change and climate modelling. Cambridge University Press.

4. Marshall, J. and Plumb, R. A. (2008). Atmosphere, ocean and climate dynamics: An introductory text. Elsevier

5. Phillips, B., Thomas, D., Fothergill, A. and Blinn-Pike, L. (2009). Social vulnerability to disasters. CRC Press.

6. Hill, M. (2010). Understanding environmental pollution. Cambridge University Press.

Subject : M.Sc. Botany 4th semester		
Course Code : B041002T	Course Title : **Ethnobotany & Intellectual Property Rights**	
Course Objectives: This course will provide the necessary introduction about ethnobotany & IPR **Course Outcomes:** Students will be able to grasp understanding of: 1. Ethnobotanical studies in India and what is ethnobotany 2. What are IP rights, their types and how they are connected with biological resources, ethnobotanical knowledge and can it be used to protect/conserve resources, rights of people and prevent biopiracy. 3. Utility of ethnobotanically important plants		
Credits : 4		Core Compulsory
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practical's (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	**Introduction**; a brief history of ethnobotanical studies in the world and in India; scope of ethnobotany. Subdisciplines of ethnobotany	10
II	**Origin, utilization, cultivation and uses of plants**: food, forage and fodder crops; fiber crops; vegetable oil-yielding crops; timber-yielding plants; non-wood forest products (NWFPs) such as bamboos, rattans, raw materials for paper making, gums, tannins, dyes, resins and fruits	20
III	**Intellectual Property Rights**: Concept, types, Need and Relevance of IPRs, National IPR Policy International IP regimes: WTO-TRIPS and other key international legal instruments **Copyright:** concept, Subject matter of Copyright, Term, ownership, moral rights, infringement, remedies, defence/fare uses. Patent: History, Patentability Requirements, Patent Specification, Patent Procedure, Infringement, Defence, Remedies.	10
IV	Traditional knowledge and utility of some medicinal plants in UP & Neighbouring states – *Solanum trilobatum, Cardiospermum halicacabum, Vitex negundo, Adathoda vasica, Azadirachta indica, Gloriosa superba, Eclipta alba, Aristolochia indica, Phyllanthus fraternus* and *Boerhaavia diffusa.*	20

Suggested Readings:

1. Miller, A. R. and Davis, M. H. (2000). Intellectual Property: Patents, Trademarks and Copyright in a Nutshell. WestGroup Publishers.
2. Colton, C.M. (1997). Ethnobotany – Principles and applications. Chichester, England: John Wiley and sons.
3. Farooqui, A. A. and Sreeraman, B. S. (2001). Cultivation of medicinal and aromatic crops. Universities Press.
4. Faulks, P.J. (1958). An Introduction to Ethnobotany. London, U.K.: Moredale pub. Ltd.
5. Harborne, J. B. (1998). Phytochemical methods – a guide to modern techniques of plant analysis. 3rd edition, Chapmanand Hall.
6. Jain, S. K. and Mudgal, V. (1999). A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun .
7. Jain, S.K. (1981). Glimpses of Indian Ethnobotany. New Delhi, Delhi: Oxford & IB H.
8. Jain, S.K. (1990). Contributions of Indian Ethnobotany. Jodhpur, Rajasthan: Scientificpublishers .
9. Jain, S.K. (1995). Manual of Ethnobotany. Rajasthan: Scientific Publishers.
10. Jain, S.K. (1989). Methods and approaches in Ethnobotany. Lucknow, U.P.: Society ofethnobotanists.
11. Watal, J. (2001). Intellectual property rights in the WTO and developing countries. Oxford University Press, Oxford.
12. Joshi, S. G. (2000). Medicinal Plants. Oxford and IBH, New Delhi.
13. Kalsi, P. S. and Jagtap, S. (2012). Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for NarosaPublishing House Pvt. Ltd. New Delhi.
14. Kokate, C. et al. (2010). Pharmacognosy. NiraliPrakashan, NewDelhi.
15. Krishnamurthy, K.V. (2004). An Advanced Text book of Biodiversity - Principles and Practices. Oxford and IBHPublications Co. Pvt. Ltd., New Delhi.
16. Guru, M. and Rao, M. B. (2003). Understanding Trips: Managing Knowledge in Developing Countries. Sage Publications.
17. Maurya, A.K. (2016). Basic Intellectual Property Rights Law: Concepts and Cases. Book Age Publisher, New Delhi. (ISBN: 978-93-83281-15-9).
18. Acharya, N. K. (2001). Textbook on intellectual property rights. Asia Law House.
19. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw-Hill.
20. Pieroni, A. and Vandebroek, A.I. (2007). The Ethnobiology and Ethno-pharmacy of Human Migrations. ISBN 978-1-84545-373-2.
21. Rama, R. N., Henry A.N. (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh. Howrah, West Bengal: Botanical Survey of India.
22. Sinha, R.K. (1996). Ethnobotany the Renaissance of Traditional Herbal Medicine. SHREE Publishers, Jaipur, Rajasthan.
23. Ahuja, V. K. (2009). Intellectual Property Rights in India (Lexis Nexis, Butterworths, Wadhwa, Nagpur.
24. Research and review articles on relevant topics

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041003T	Course Title : (a) **Biophysical Chemistry**

Objective Developing of general understanding how physical laws govern biological processes and acquire basic knowledge about how physical methods can be applied to understand biological processes.

Course Outcome:

On completion of the course, the student should be able to:

1. Account for the different interactions that are important for the formation of structures in biological systems and for how thermodynamic parameters can be measured.
2. Account for basic concepts of laboratory reagents preparation and their uses.
3. Account for functions of biological buffer system and titration of acid and base.
4. Explain and apply methods for the determination of functional molecular mass of biological macromolecules in solution as well as determination of equilibrium - and rate constants for macromolecule-ligand interactions.
5. Students will be able to qualify CSIR NET, GATE and other entrance examinations.

Credits : 4	Core elective,
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Solution:**Normality, molarity and molality of the solution, ppm and percent solutions, colligative properties of electrolyte solution: the Donnan effect.	10
II	**Acid and Bases:** Definition of acid and base, acid-base properties of water, concept of pH and pK_a, acid (amino acids) and base titration, diprotic and polyprotic acids, preparing a buffer solution with specific pH, dissociation of amino acid, isoelectric point, titration of protein.	10
III	**Bioenergetics:** Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions, Gibbs energy of biological membrane transport. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change. High energy phosphate compounds: introduction, phosphate group	20

	transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Free energy of enzymatic equation: activation energy, binding energy, relation between activation energy and free energy.	
IV	**Kinetics of biochemical reaction**: Biochemical equilibrium and protein ligand binding mechanism. Concept of ES complex, active site, specificity, derivation of Michaelis-Menten equation for uni- substrate reactions. Different plots for the determination of K_M& V_{max}. Importance of K_{cat}/K_M. Kinetics of zero & first order reactions. Classification of multi substrate reactions with examples of each class. Derivation of the rate of expression for Ping Pong, random & ordered Bi-Bi mechanisms, denaturation and renaturation kinetics of DNA and protein, Cot curve.	20

Suggested readings:

1. Nelson, D.L., Cox, M.M. and Freeman, W. H. (2013). Lehninger: Principles of Biochemistry. 6th ed., (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.
2. Nicholas, C.P. and Lewis, S. (1999). Fundamentals of Enzymology. 3rd ed., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
3. Schimmel, C.R.C. (2013). Biophysical Chemistry. Macmillan Higher Education, ISBN: 0716738619, 9780716738619.
4. Sheehan, D. (2010). Physical Biochemistry: Principles and Applications. 2nd ed., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470- 85603-1.
5. Wilson, K., and Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th ed., Cambridge University Press, (New Delhi), ISBN: 978-0-521-73167-6 / ISBN: 978-0-521-51635-8.

Subject : M.Sc. Botany 4th semester		
Course Code : B041004T	Course Title : (b) **Bioentrepreneurship and Innovation**	
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 bioentrepreneurship. **Course Outcomes**: 1. To be able to prepare a business plan and launch career as bioentrepreneur. 2. Being able to get employment in a bioindustry or a bioconsultancy		
Credits : 4		Core elective; (b) Value added, & Entrepreneurship
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	1. Entrepreneurship in the Life Sciences. 2. Development of Products in the Biomedical Industry. 3. Integration of science, technology and business. 4. From Lab to land: scope in agro/food processing industry 5. Industrial management. 6. Market analysis. 7. Business development. 8. Regulatory mechanisms. 9. Indian bioentrepreneurial scenario. 10. Case studies of successful bioentrepreneurs.	Each part will be of 6 hours

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,P. (1999). Working from Home: Everything you need to Know about Living and Working under the Same Roof. New York: Penguin Putman.

4. Bruce, J. (2004). Go it alone! The Secret to Building a Successful Business on Your Own. New York: HarperCollins.

5. Little S. S. (2005). The 7 Irrefutable Rules of Small Business Growth. Hoboken: John Wiley & Sons, Inc. 2005.

6. Jacquelyn, L. (2007). The Entrepreneur's Almanac: Fascinating Figures, Fundamentals and Facts at your Fingertips. Canada: Entrepreneur Media Inc.

7. Angie, M. (2008). Finance and Grow Your Own Business. North Vancouver: International SelfCounsel Press Ltd.

8. David, R. (2011). EntreLeadership: 20 Years of Practical Business Wisdom from the Trenches. New York: Howard Books.

9. Eric, R. (2009). The Lean Startup: How today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. New York: Crown Business.

10. Lisa, R. (1999). Smart Guide to Starting a Small Business. New York: John Wiley & Sons, Inc.

11. Wilson, S. S., Kadin, E. R. and Weiner, E. (2011). It's Your Biz: The Complete Guide to Becoming Your Own Boss. New York: AMACOM.

12. Strauss, S. D. (2008). The Small Business Bible: Everything you need to know to succeed in your small business. Hoboken: John Wiley & Sons, Inc.

13. Allen, K. (1995). Launching New Ventures: An Entrepreneurial Approach. Upstart.

14. Applegate, J. (1992). Succeeding in Small Business: The 101 Toughest Problems and How to Solve Them, Plume/Penguin.

15. Bangs (Jr.), D. H. (1992). The Start Up Guide: A One-Year Plan for Entrepreneurs. Upstart.

Subject : M.Sc. Botany 4th semester		
Course Code : B041005T	Course Title : (c) **Molecular Systematics and Phylogenomics**	
Objectives: To understand concepts of phylogenomics and Molecular evolution **Course Outcomes:** After completion of this course the students will be able to learn 1. Analyse phylogeny and phylogenetic analysis using molecular data 2. Construct cladogram 3. Phylogenetic software		
Credits : 4		Core elective
Max Marks : 30+70		Min. Passing Marks :
Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0		
Unit	**Topic**	**No. of Lectures (60 hrs)**
I	**Phylogenomics**: Phylogenomics and the tree of life, data used in Phylogenomics, Steps and tools in Phylogenomics, Phylogenomic reconstruction, Methods of phylogenomic inference. Approaches of Phylogenomics.	15
II	**Molecular Evolution:** Concepts of Neutral Evolution and Evolution at Molecular Level, Molecular Clocks; Evolution of Gene and Genome; The RNA World: Origin of Life; Homology: Orthology, Paralogy & Xenology.	15
III	**Phylogenetic Systematics/Cladistics:** *Cladogram Construction*: Apomorphy, Recency of Common Ancestry, Monophyly, Parsimony Analysis, Unrooted Trees, Evolutionary trees & rooting; Character & Tree Optimization (Acctran & Deltran), Polytomy, Reticulation, Taxon Selection and Polymorphic Characters, Polarity Determination: Outgroup Comparison, Ancestral versus Derived Characters,	15
IV	**Phylogenetic Analysis:** Consensus Trees (Consistency Index, Retention Index, Bremer Support (Decay Index), Bootstrap Analysis), Long Branch Attraction, Maximum parsimony, Maximum Likelihood, Bayesian Analysis, Measures of Homoplasy, Cladogram Robustness.	15

Suggested Reading

1. Bleidorn, C. (2017). Phylogenomics: An Introduction. Springer.
2. Crawford, D. J. (1990). Plant Molecular Systematics: A Macromolecular Appproach. John Wiley & Sons.
3. Judd, W. S, Campbell, C. S., Kellog, E. A., Stevens, P. F. and Donoghue, N. J. (2013). Plant Systematics – A phylogenetic approach. SinauerAssociates, Inc, Massachusetts, USA.
4. Trivedi, S., Rehman, H., Saggu, S., Panneerselvam, C. and Ghosh, S. K. (2018). DNA Barcoding and Molecular Phylogeny. Springer
5. Soltis, D. E., Soltis, P. S., Endress, P. K. and Chase, M. W. (2005). Phylogeny and Evolution of Angiosperms. SinauerAssociates, Inc, Massachusetts, USA.

6. Simpson, M. G. (2006). Plant Systematics. Elsevier Academic Press, California, USA.
7. Stuessy, T. F. (2002). Plant Taxonomy. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
8. Radford, A.E. (1986). Fundamental of Plant Systematics. Harper and Row, Publisher, Inc.
9. Scotland, R. W. and Pennington, T. (2000). Homology and systematics: coding characters for phylogenetic analysis. Systematics Association.
10. Wiley, E.O., Siegel-Causey, D., Brooks, D.R., Funk, V.A. (1991). The Compleat Cladistic: A Primer of Phylogenetic Procedures, Museum of Natural History Dyche Hall The University of Kansas Lawrence, Kansas.
11. Wiley, E.O, and Lieberma, B. S. (2001). Phylogenetics: Theory and Practice of Phylogenetic Systematics. John Wiley & Sons, Inc., Hoboken, New Jersey.

Subject : M.Sc. Botany 4th semester	
Course Code : B041006T	Course Title : (d) **Nanobiotechnology**

Objectives: This course aims at developing sound knowledge of scope of nanbiotechnology in biological systems, their properties, techniques used in nanobiotechnology, and its applications in medical and agricultural fields.

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

1. Studying the basics and scope of nanobiotechnology.
2. Acquiring theoretical knowledge of applications of nanoparticles in medicine, agriculture and environment.
3. Describes the various techniques used for characterization of nanoparticles.
4. Learn about the potential hazards of nanoparticles.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Introduction to Nano biotechnology and its scope, history of nanobiotechnology, nanobiomaterials, challenges for nanobiotechnology, synthesis of nanoparticles. Microbes for the evaluation of nanomaterial toxicity.	15
II	Properties and characterization of nanoparticles- 1) Optical (UV-Vis/ fluorescence), 2) X-ray diffraction 3) Size and imaging- electron microscopy, light scattering. 4) Surface and composition- EDAX, AFM/STM. 5) Vibrational FT-IR and Raman spectroscopy.	15
III	Interaction of nanomaterial and biosystem (protein, nucleic acid, carbohydrates and lipids). Nanomaterial- cell interaction.	15
IV	Nanobiotechnology and its applications in agriculture. Nanobiotechnology and its applications in medicine and pharmaceuticals. Microbes in nanobiotechnology; production of nanoparticles using bacteria. Nanotoxicology- nanoparticles and their potential toxicity in organisms/ toxicity and environmental risks of nanomaterials.	15

Suggested Readings:

1. Charles (Jr.), P. P. and Owens, F. J. (2003). Introduction to Nanobiotechnology.
2. Niemeyer, C. M. and Mirkin, C. A.,(2004). Nanobiotechnology: Concepts, Applications and Perspectives.
3. Donovan, R. (2016). Application of Nanotechnology in Drug Delivery.
4. Varghese, T. and Balakrishna, K. M. (2021). Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials.

Subject : M.Sc. Botany 4th semester	
Course Code : B041007T	Course Title : (a) **Glycobiology**

Objective:

1. To study chemistry of carbohydrates, the enzymology of glycan formation and degradation,
2. To study the recognition of glycans by specific proteins (lectins and glycosaminoglycan-binding proteins), glycan roles in complex biological systems, and their analysis or manipulation by a variety of techniques.

Course Outcome

1. Be able to understand the role of glycans in biosphere and biotechnology.
2. Being able to understand role of glycans in health and disease and medicinal field.
3. Having Prospects to work in pathology andhematological laboratories.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**General Principles:** Historical Background and Overview, Saccharide Structure and Nomenclature, Exploring the Biological Roles of Glycans.	10
II	**Biosynthesis, Metabolism, and Function**: Monosaccharide Metabolism, N-Glycans, O-Glycans, Glycosphingolipids, Glycophospholipid Anchors, Proteoglycans and Glycosaminoglycans, Sialic Acids, overview of Glycosyltransferases, Degradation and Turnover of Glycans, Bacterial Polysaccharides.	20
III	**Protein-Glycan interactions:** Discovery and Classification of Animal, Plant and fungal Lectins, Selectins, Galectins, Microbial Carbohydrate-binding Proteins, Plant Lectins, their Classification , Structure, Uses and functions; Fungal lectins, their structural diversity, biological functions, molecular characterization.	20
IV	**Methods and Applications**: Principles of Structural Analysis and Sequencing of Glycans, Chemical and Enzymatic Synthesis of Glycans, Natural and Synthetic Inhibitors of Glycosylation, Glycobiology in Biotechnology and Medicine	10

Suggested Readings:

1. Varki, A. (2002). Essentials of glycobiology. Cold Spring Harbour Laboratory Press.

2. Townsend, R. R. and Hotchkiss, A. T. (1997). Techniques in glycobiology. TF-CRC.

3. Dwek, S. A. and Schumacher, M. V. (2002). Functional and Molecular Glycobiology. Brooks, U.PAP Edition.

4. Minoru, F. and Ole, H. (2000). Molecular and Cellular Glycobiology. Paperback Edition.

5. Lindhorst, T. K. (2007). Essentials of Carbohydrate Chemistry and Biochemistry. Wiley.

6. Wittmann, V. (2007). Glycopeptides and Glycoproteins - Synthesis, Structure, and Application. Edited, Springer.

7. Brito-Arias, M. (2007). Synthesis and Characterization of Glycosides. Springer.

8. Taylor, M. E. and Drickamer, K. (2002). Introduction to Glycobiology. OUP.

9. Sharon, N. and Lis, H., (1999). Lectins. Springer.

10. Doyle, R. (1994). Lectin-Microroganism interaction. CRC.

11. Ginsburg, V. (1972). Complex Carbohydrates. Part B. Methods Enzymol., Vol 28, Academic Press, San Diego, California.

12. Gottschalk, A. (1972). Glycoproteins: Their composition, structure and function. Elsevier, New York.

13. Ginsburg, V. (1978). Complex carbohydrates. Part C. Methods Enzymol., Vol. 50, Academic Press, San Diego, California.

14. Lennarz, W.J. (1980). The biochemistry of glycoproteins and proteoglycans. Plenum Press, New York.

15. Ginsburg, V. and Robbins P. (1981). Biology of carbohydrates. vol. 1. Wiley, New York.

16. Ginsburg, V. (1982). Complex carbohydrates. Part D, Methods Enzymol., vol. 83. Academic Press, San Diego, California.

17. Horowitz, M. and Pigman, W. (1982). The glycoconjugates. Academic Press, New York.

18. Schauer, R. (1982). Sialic acids, chemistry, metabolism, and function. Springer-Verlag, New York.

19. Ivatt, R.J. (1984). The biology of glycoproteins. Plenum Press, New York.

20. Ginsburg, V. and Robbins, P. (1985). Biology of carbohydrates. vol. 2. Wiley, New York.

21. Beeley, J.G. (1985). Glycoprotein and proteoglycan techniques. Elsevier, Amsterdam, The Netherlands.

22. Liener, I.E., Sharon, N. and Goldstein, I.J. (1986). The lectins: Properties, functions, and applications in biology and medicine. Academic Press, Orlando, Florida.

23. Feizi, T. (1989). Carbohydrate recognition in cellular function. Ciba Foundation Symposium, vol. 145. Wiley, New York.

24. Ginsburg, V. and Robbins P. (1991). Biology of carbohydrates. vol. 3. Wiley, New York.
25. Fukuda, M. (1992). Cell surface carbohydrates and cell development. CRC Press, Boca Raton, Florida.
26. Allen, H.J. and Kisailus E.C. (1992). Glycoconjugates: Composition, structure, and function. Dekker, New York.
27. Fukuda, M. (1992). Glycobiology: A practical approach. IRL Press, Oxford, United Kingdom.
28. Lennarz, W.J. and Hart, G.W. (1994). Guide to techniques in glycobiology. Methods Enzymol., vol. 230, Academic Press, San Diego, California.
29. Bock, K. and Clausen, H. (1994). Complex carbohydrates in drug research: Structural and functional aspects. Munksgaard, Copenhagen, Denmark.
30. Fukuda, M. and Hindsgaul, O. (1994). Molecular glycobiology. Oxford University Press, New York.
31. Alavi, A. and Axford, J.S. (1995). Advances in experimental medicine and biology. vol. 376, Glycoimmunology, Plenum Press, New York.
32. Montreuil, J., Vliegenthart, J.F.G. and Schachter, H. (1995). Glycoproteins. Elsevier, New York.
33. Verbert, A. (1995). Methods on glycoconjugates: A laboratory manual. Harwood Academic Publishers, Switzerland.
34. Townsend, R.R. and Hotchkiss, A.T. (1997). Techniques in glycobiology. Marcel Dekker, New York.
35. Iozzo, R. (2000). Proteoglycans: Structure, biology and molecular interactions. Marcel Dekker, Inc., New York

Subject: **M.Sc. Botany 4th semester**	
Course Code: B041008T	Course Title : (b) **Plant Tissue Culture**

Objectives: The course aims at applied aspects of plant tissue culture. After completing this course the students should be able to:

1. Define the basic concepts of plant tissue culture.
2. Study of various culture techniques used in plant tissue culture.
3. Recognition of the importance and applications of plant tissue culture.
4. Job oriented skill developments of students to start or work in commercial plant tissue culture laboratory

Course Outcomes: After completing this syllabus, students will be able to:

1. Use various in vitro culture techniques for plant / crop improvement.
2. Become an entrepreneur by developing his/her own Plant Tissue Culture lab.
3. Can enhance secondary metabolite content in different medicinal plants through in vitro culture techniques.
4. Have relevant knowledge and skill to establish and maintain green house for Hi Tech Agriculture/ Farming.

1.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Introduction to Plant Tissue culture** Introduction to Plant Tissue culture, Terms and definitions, Historical background, Laboratory organization, Tools and techniques, methods of sterilization, basic techniques of plant tissue culture. Culture media, culture media preparation and sterilization, callus and suspension cultures.	15
II	**Organ Culture and Protoplast culture** Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion- chemical, Viral, electrofussion. Practical application of somatic hybridization and cybridization. Techniques and applications of somatic embryogenesis and regeneration of plants, anther, pollen, ovule, endosperm, hairy root cultures.	15
III	Somaclonal variation, its genetic basis and application in crop improvement. 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.	15
IV	**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, liposme mediated DNA delivery. Transgenic plants for crop improvement: Maize, Rice, Wheat, Cotton, Brinjal and Tomato.	15

Suggested Readings

1. Bhojwani, S.S. And Rajdan, M.K. (1996). Plant Tissue Culture: Theory and practice. Publisher: Elsevier, North Holland, ISBN: 0-444-81623-2.
2. Razdan, M. K. (2002). Introduction to Plant Tissue Culture. Science Publishers Inc. USA.
3. Roberta, H. (2006). Smith Plant Tissue Culture: Techniques and Experiments. Publisher Academic Press, USA.
4. Gamborg, O.L. and Phillips, G.C. (1998). Plant Cell, Tissue Organ Culture. Narosa Publishing House, NewDelhi.
5. Chawla, H.S. (2000). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Thorpe, T.A. (1981). Plant Tissue Culture. Academic Press, London.
7. Trigiano, R. N. and Gray, D. J. (2000). Plant Tissue Culture Concepts and Laboratory Exercises. 2nd edit., CRC Press LLC, 454 pp.
8. Reinert, J. and Bajaj, Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Springer - Verlag, Berlin.
9. Gupta, P. K. (2010). Elements of Biotechnology. Rastogi Publication, Meerut, UP, India.
10. Singh, B. D. (2016). Biotechnology. Kalyani Publication Ludhiana, Punjab, India

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041009T	Course Title : (c) **Microbial Biotechnology**

Course Objectives: The aim of this course is to enlighten the students about various microbes and their applications in industry as well to give a profound knowledge on fermentation technology, enzyme immobilization, etc.

Course Outcomes:

2. To understand the bioprocess engineering, basic techniques, methods, functions and industrial products.
3. To know about the different microorganisms and their products (enzymes, polymers, metabolites, etc.)
4. To learn about IPR (Patents, Copyrights, Trademarks, etc.) and its issues.
5. Conceptualize the basics of mutagenesis and its role in directed evolution of microbes.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	Value addition in industrially important microorganisms using recombinant DNA technology. Fermentation technology; microbial growth, batch, fed batch and their continuous cultures of microbes, application of fermentation. Fermentation Economics.	15
II	Proteomics: Basic concept and importance. Metagenomics: types and applications. RNA Interference, Antisense RNA Technology, miRNA and Gene silencing. Mutagenesis (site-directed & random), directed evolution of microbes.	15
III	Industrial sources of enzymes; Cellulases, Xylanases, Pectinases, Amylases, Lipases, and Proteases, their production and applications. Immobilization of microbial enzymes and whole cells and their applications in industries. Microbial applications in food, feed and dairy. Synthetic Biology: A novel approach for Microbiology with example.	15
IV	Microbiology and up gradation of alcoholic beverages (i) C:H ratio balancing (ii) Trace elements (iii) RDT. Commercial production of important amino acids, insulin, steroids, vitamins and perfumes. Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives. IPR (Patents, Copyrights, Trademarks) & its issues, WIPO (world intellectual property rights).	15

Suggested Readings:

1. Nygel, H. (2019). Biotechnology of Microbial Enzymes.
2. Casida, L.E.I. R. (2007). Industrial Microbiology.
3. Kun, L. Y. (2013). Microbial Biotechnology: Principles and Application (3rd Edition).
4. Kumar, P., Patra, J. K. and Chandra, P. (2018). Advances in Microbial Biotechnology: Current Trends and Future Prospects.
5. Saikai, R. and Bezharuah, R. L. (2008). Microbial Biotechnology.
6. Singh, U. S. and Kapoor, K. (2010). Microbial Biotechnology.

Subject : **M.Sc. Botany 4th semester**	
Course Code : B041010T	Course Title : (d) **Herbal Products**

Objectives: To study preparation herbal medicinal product and herbal cosmetics

Course outcomes: Upon completion of the course, the students shall be able to understand following

1. Key ingredients used in herbal products and cosmetics
2. Key building blocks for various herbal formulations.
3. Various key ingredients and basic science to develop aromatherapy, cosmetics, cosmeceuticals.
4. Scientific knowledge to develop cosmetics and cosmeceuticals with desired Safety, stability, and efficacy.

Credits : 4	Core elective
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):4-0-0

Unit	Topic	No. of Lectures (60 hrs)
I	**Herbs as raw materials:** Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation. Source of Herbs. Selection, identification and authentication of herbal materials. Processing of herbal raw material. Preparations of Decoction, Infusion, Fluid extract, Tincture, Aromatic water, Hair care Botanicals, Herbal Cream, Herbal Shampoo, Herbal Syrup	15
II	**Herbal Cosmetics:** Scope, Formulation development and quality control of Herbal cosmetics used in: Hair care, skin care, anti-wrinkles & anti-aging.	15
III	**Herbs in cosmetics:** A brief account of following herbals or herb extracts or herbal products of cosmetic importance such as *Acacia concinna* pods, *Aloe Vera*, Almond oil, Neem, *Citrus aurantium* peels, Henna, Turmeric, Liquorices, Olive oil, tea tree oil and wheat germ oil with special emphasis on their source, active principles and cosmetic properties.	15
IV	**Herbal formulations**: Conventional herbal formulations like syrups, mixtures and tablets and Novel dosage forms like phytosome. **Aromatherapy**: Various essentials oils used in Aromatherapy with their Significance. **Evaluation of Drugs**: WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs.	15

Suggested Readings:

1. Sharma, P. P. (2008). Cosmetics - Formulation, Manufacture and quality control, 4th edition, Vandana publication, Delhi.

2. Skaria,B. P. et al. (2021). Aromatic Plants. Horticulture Science Series, New India Publishing Agency, New Delhi.

3. Keville, K. and Green, M. (2008).Aromatheraphy (A Complete Guide to the Healing Art). Sri Satguru Publications, New Delhi.

4. Chattopadhyay, P. K. (2018). Herbal Cosmetics & Ayurvedic Medicines (EOU). National Institute of Industrial Research, Delhi.

5. Balsam, M. S. and Sagarin, E. (1972-1974). Cosmetics Science and Technology. Wiley Inter-science, New York.

6. Barel, A. O., Paye, M. and Maibach, H. I. (2009). Handbook of cosmetic science and Technology. 3rd edition.

TEXT BOOKS:

1. Herbal Cosmetics Hand Book- H. Panda

2. Herbal Cosmetics by P.K Chattopadhyay

3. The Complete Technology Book on Herbal Perfumes and Cosmetics by H. Panda

4. Supriya K B. Handbook of Aromatic Plants, Pointer Publishers, Jaipur.

Subject : **M.Sc. Botany 4th semester**	
Course Code: B041011P	Course Title : **Practical Lab 4**

Objective: To perform 20 experiments from the given list (at least 6 experiments from each units).

Course outcomes: Upon completion of the course, the students shall be able to learn followings-

1. Herbal preparations.
2. Pollen & pollen germination.
3. Ethnomedicinal plants & test related to Glycobiology

Credits : 4	Core compulsory
Max Marks : 30+70	Min. Passing Marks :

Total no of Lectures-Tutorials-Practicals (in hours per week):0-0-04

Unit	Topic	No. of Lectures (120 hrs)
I	1. Preparation and evaluation of gels like Shaving gels, Anti dandruff Shampoo and Hair styling gels. 2. Preparation of Mouth washes. 3. Preparation and evaluation of Cold Creams, Vanishing Creams. 4. Preparation of Hand and Body Lotions. 5. Preparation and evaluation of Face Masks. 6. Preparation of Hair oils to prevent hair fall. 7. Preparation and evaluation of *Aloe vera* Gel. 8. Preparation of Antiseptic cream (Turmeric). 9. Preparation and evaluation of Perfumes. 10. Preparation and evaluation of Herbal Henna. 11. Preparation of essential oils used in Aromatherapy.	40
II	1. Wodehouse technique and preparation of temporary pollen slides. 2. Acetolysis technique and Preparation of Permanent pollen slides. 3. Study of acetolysed pollen preparation of the following pollentypes- i). ***Hibiscus*** ii), ***Gossypium*** iii). ***Brassica*** iv), ***Eucalyptus*** v). ***Psidium*** vi), ***Sesamum*** vii). ***Citrus*** viii). ***Tridax***ix). ***Vernonia*** x). ***Boerhaavia*** xi). ***Cocos*** xii). ***Borassus.*** 4. Pollen production, pollen viability, pollen germination in vitro and pollen tube growth.	40
III	1. Plant tissue culture-based exercise. 2. Study of ethnobotanically important plant of your locality. 3. Simple chemical tests to detect biological glycans. 4. Extraction of exocellular polysaccharides (EPS) from yeasts/fungi. 5. Quantitative Extraction of starch from plant storage organs. 6. Extraction of soluble lectins from any one plant and fungal source.	40

	7. Study of plant gums/Acidic polysaccharides.	

Suggested Readings:

1. Sharma, P.P. (2008). Cosmetics - Formulation, Manufacture and quality control. 4th edition, Vandana publication, New Delhi.
2. Skaria P. (2007). Aromatic Plants (Horticulture Science Series). New India Publishing Agency, New Delhi.
3. Keville, K. and Green, M. (2008). Aromatheraphy (A Complete Guide to the Healing Art), Sri Satguru Publications, New Delhi.
4. Chattopadhyay, P. K. (2018). Herbal Cosmetics & Ayurvedic Medicines (EOU), National Institute of Industrial Research, Delhi.
5. Balsam, M. S.and Sagarin, E. (1972-1974). Cosmetics Science and Technology, Wiley Interscience, 2nd edition, New York.
6. Barel, A.O.,Paye, M. and Maibach, H.I. (2009). Handbook of cosmetic science and Technology. 3-rd edition.
7. Shivanna, K. R. and Rangaswamy, N. S. (1992). Pollen Biology: A Laboratory Manual.
8. Shivanna, K. R. and Johri, B. M. (1985). The Angiosperm pollen: Structure and Function. New Delhi. India. Willey Eastern.
9. Shivanna, K. R. (2003). Pollen Biology and Biotechnology. Enfield, New Hampshire. USA Science Publishers.
10. Shivanna, K. R. and Tondon, R. (2009). Reproductive Ecology of Flowering Plants: A Manual. Springer, New Delhi.
11. Townsend, R. R. and Hotchkiss, A. T. (1997). Techniques in glycobiology, TF-CRC.
12. Lindhorst, T. K. (2007). Essentials of Carbohydrate Chemistry and Biochemistry, Wiley.
13. Ginsburg, V. and Robbins P. (1981). Biology of carbohydrates. vol. 1. Wiley, New York.
14. Fukuda, M. (1992). Glycobiology: A practical approach. IRL Press, Oxford, United Kingdom.
15. Lennarz, W.J. and Hart G.W. (1994). Guide to techniques in Glycobiology. Methods Enzymol., vol. 230. Academic Press, San Diego, California.
16. Verbert, A. (1995). Methods on glycoconjugates: A laboratory manual. Harwood Academic Publishers, Switzerland.
17. Townsend, R.R. and Hotchkiss A.T. (1997). Techniques in glycobiology. Marcel Dekker, New York.

Semester 4

Industrial Training/Research Project/Survey (Value Added)

Course Code: B041012 (Research Project)

Duration: 60 Hrs.

Course Objectives: The objective of this course is to provide students with hands-on training in specialized areas of plant sciences

Course Outcomes: After completion of this course the students will acquire the following:

1. Training in experimental design and execution
2. Knowledge on techniques and tools of research
3. Designing of research proposal.
4. Writing of research and review paper

Contents

The topic of the research project will be chosen from among the core compulsory courses/core elected courses of that year.

CHAUDHARY CHARAN SINGH UNIVERSITY, MEERUT

Proceedings of the meeting of Board of Studies in Botany held on 11–01-2024

A meeting of Board of Studies (University Campus and Affiliated Colleges) in the subject of Botany in Chaudhary Charan Singh University, Meerut was held on January 11, 2024 at 11.00 AM in hybrid mode through Zoom App. The following members were present:

1. Prof. Hare Krishna	Dean, Science faculty
2. Prof. Vijai Malik	Convener-I
3. Prof. Rup Narayan	Member
4. Dr. Ramesh C. Arya	Convener-II
5. Dr. Ramakant	Member
6. Dr. Mrs. Poonam Paliwal	Member
7. Prof. Ashok Kumar	Member
8. Prof. Sundip Kumar	External Expert
9. Prof. Upendra Kumar	External Expert
10. Prof. Navneet	External Expert
11. Prof. Ashwani Goel (Retd.)	Principal
12. Prof. Narendra Singh	Professor/Director of Research Institute

The Board met for the revision of the syllabus of the subject Botany for MSc. courses. The Board unanimously revised the syllabus for the same after thorough discussions. The revised courses are applicable to the university campus and affiliated colleges of the University. A copy of the final revised syllabus is enclosed herewith.

(*Prof. Sundip Kumar)
External Expert

(*Prof. Upendra Kumar)
External Expert

(*Prof. Navneet)
External Expert

(Prof. Rup Narayan)
Member

(Dr. Ramakant)
Member

(*Dr. Mrs. Poonam Paliwal)
Member

(*Prof. Ashok Kumar)
Member

(Prof. Ashwani Goel (Retd.)
Principal

(*Prof. Narendra Singh)
Prof./Director of Research Institute

(*Prof. Hare Krishna)
Dean, Science faculty

(Prof. Vijai Malik)
Convener-I

(Dr. Ramesh C. Arya)
Convener-II

Members from the Board of Studies for Botany

S. No.	Name	Designation	College/ University	Signature
1.	*Prof. Hare Krishna	Dean, Science Faculty	C.C.S. University Campus, Meerut	
2.	Prof. Vijai Malik	Convener-I	C.C.S. University Campus, Meerut	
3.	Prof. Rup Narayan	Member	C.C.S. University Campus, Meerut	
4.	Prof. Ramesh C. Arya	Convener-II	Meerut College, Meerut	
5.	Dr. Ramakant	Member	C.C.S. University Campus, Meerut	
6.	*Dr. Mrs. Poonam Paliwal	Member	IP College, Bulandshahr	
7.	*Prof. Ashok Kumar	Member	MMH College, Ghaziabad	
8.	*Prof. Sundip Kumar	External Subject Expert	GB Pant University Agriculture & Technology, Pantnagar	
9.	*Prof. Upendra Kumar	External Subject Expert	MJP Rohilkhand University, Barielly	
10.	*Prof. Navneet	External Subject Expert	Gurukul Kangri University, Haridwar, Uttrakhand	
11.	Prof. Ashwani Goel (Retd.)	Principal	Shahed Mangal Pandey Degree College, Madhavpuram, Meerut	
12.	*Prof. Narendra Singh	Prof./Director of Research Institute	Kurukshetra University, Kurukshetra	

***Attended meeting online**