Syllabus and Examination Scheme

For

M.Sc. BOTANY
(SEMESTER I to IV)

Department of Botany

Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

(2019-20)

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M.Sc. Botany
Study & Evaluation Scheme

Summary

Programme : M.Sc. Botany
Duration : Two years (Four Semesters)
Minimum Attendance Required : 75%
Total Credits : 106

Assessment/Evaluation of

Theory examination:

Internal Marks	ajor Test (End Semester Exam) Marks	Total Marks
20	80	100
10	40	50

Internal Evaluation:

Minor Test Marks	Attendance Marks	Assignment/Quiz Marks	Total Marks
10	5	5	20
5	3	2	10

Duration of Examination:

Minor Test	Major Test
1 hr. or ½ hr.	3 hrs.

To qualify the course, a student is required to secure a minimum of 40% marks in aggregate including the internal evaluation and Major Test (End Semester Examination).

Note: The student should also be involved in extracurricular activities through Hobby Clubs (Non CGPA) such as photography, drama, poetry, science club etc. and will be awarded a letter grade. The policy on clubs is available on University website.

RESEARCH STUDY AND SEMINAR Max.Marks-50

Objective: This course intends to create habits of reading books and to develop scientific writing and communication skills in a manner of creativity and originality. The students are to emphasis his/her own ideas/wordswhich he/she has learnt from different books, journals and newspapers and deliberate the sameby adopting different ways of communication techniques and adopting time schedulingtechniques in their respective fields.

This course aims:

- To motivate the students for innovative, research and analytical work
- To inculcate the habit of self-study and comprehension
- To infuse the sense of historical back ground of the problems
- To assess intensity of originality and creativity of the students

Students are guided to select topic of their own interest in the given area in consultation with their teachers/In charge/Resource Person.

a) General Instructions for Research study writing:

1. Choose the topic of your interest in the given areas and if necessary, seek the help of your teacher.
2. Select a suitable title for your paper.
3. You are expected to be creative and original in your approach.
4. Submit your paper in two typed copies of A4 size 5-6 pages (both sides in 1.5 line spaces in Times New Roman Font size 12).
5. Organize your research review/paper in three broad steps:

(a) Introduction
(b) Main Body
(c) Conclusion
(d) References

6. Use headings and sub-headings
7. Use graphics wherever necessary
8. Give a list of books/references citedused

Distribution of Marks

The evaluation is divided into different segment as under:	**(25 Marks)**
(i) Selection of Topic	5 Marks
(ii) Logical Organization of subject matter	10 Marks
(iii) Conclusions	5 Marks
(iv) References	5 Marks

b) Seminar

Every candidate will have to deliver a seminar of 30 min. duration on a topic (not fromthe syllabus) which will be chosen by him / her in consultation with the teacher of thedepartment. The seminar will be delivered before the students and teachers of the department. Athree-member committee (one coordinator and two teachers of the department of differentbranches) duly approved by the departmental council will be constituted to evaluate the seminar.

Distribution of marks **(25 Marks)**

The following factors will be taken into consideration while evaluating the student'spresentation.

1. Way of presentation 10 marks
2. Knowledge of the subject 10 marks
3. Answers to the questions 5 marks

Examination scheme *(Question Paper Structure)*

There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

SEMESTER I **CREDITS: 26** **MARKS: 550**

.No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	**Total**
1.	19BOT 101	Cell Biology	CC	04	-	04	04	-	04	80	20	-	100
2.	19BOT102	Phycology, Mycology and Pathology	CC	04	-	04	04	-	04	80	20	-	100
3.	19BOT 103	Biology of Bryophytes, Pteridophytes and Gymnosperms	CC	04	-	04	04	-	04	80	20	-	100
4.	19BOT 104	Plant Genetics	CC	04	-	04	04	-	04	80	20		100
5.	19BOT 105	**Lab course I ***	CC	-	04 X 4	16	-	04 X 2	08	-	-	100	100
6.	19 LS 101	Communication Skills	AECC	02	-	02	02	-	02	40	10	-	50
TOTAL				**18**	**16**	**34**	**18**	**8**	**26**	**360**	**90**	**100**	**550**

C.C = Core Course **A.E.C.C.= Ability Enhancement Compulsory Course**

*** Lab course I Based on Core Courses (CC)**

SEMESTER II **CREDITS: 26** **MARKS: 550**

S.No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	**Total**
1.	19BOT 201	Molecular Biology	CC	04	-	04	04	-	04	80	20	-	100
2.	19BOT 202	Plant Biochemistry	CC	04	-	04	04	-	04	80	20	-	100
3.	19BOT 203	Plant Systematics and Economic Botany	CC	04	-	04	04	-	04	80	20	-	100
4.	19BOT 204	IPR and Biosafety	DSE#	04	-	04	04	-	04	80	20	-	100
5.	19BOT 205	Bioinformatics											
6.	19BOT 206	**Lab course II ***	CC	-	04 X 4	16	-	04x2	08	-	-	100	100
7.	19 LS 201	Biostastistics	SEC	02	-	02	02	-	02	40	10	-	50
TOTAL				**18**	**16**	**34**	**18**	**8**	**26**	**360**	**90**	**100**	**550**

C.C = Core Course **DSE=Discipline Specific Elective# Select one out of two** **SEC=Skill Enhancement Course**

Note: The Discipline Specific Elective paper can be offered depending upon the availability of the Resources and faculties.

*** Lab course II based on Core Courses (CC) & Discipline Specific Elective (DSE)**

SEMESTER III **CREDITS: 26** **MARKS: 600**

S.No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	**Total**
1.	19BOT 301	Plant Physiology	CC	04	-	04	04	-	04	80	20	-	100
2.	19BOT 302	Plant Anatomy nd Developmental Biology	CC	04	-	04	04	-	04	80	20	-	100
3.	19BOT 303	Plant Ecology	CC	04	-	04	04	-	04	80	20	-	100
4.	19BOT 304	Microbiology	DSE#	04	-	04	04	-	04	80	20	-	100
5.	19BOT 305	Cytogenetics and plant breeding											
6.	19BOT 306	**Lab course III ***	CC	-	04 X 4	16	-	04 X 2	08	-	-	100	100
7.		Open elective I **	OEC	02		02	02		02	80	20	-	100
TOTAL				**18**	**16**	**34**	**18**	**8**	**26**	**400**	**100**	**100**	**600**

C.C = Core Course **DSE=Discipline Specific Elective** **# Select one out of two** **OEC=Open Elective Course**

Note: The Discipline Specific Elective paper can be offered depending upon the availability of the Resources and faculties.

***Lab course III based on Core Courses (CC) & Discipline Specific Elective (DSE)**

****For Open Elective-I, Students will have to choose a course out of list of open electives offered by other departments of University.**

SEMESTER IV **CREDITS: 28** **MARKS: 650**

S.No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			Total
1.				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	
2.	19BOT 401	Biodiversity and Conservation	CC	04	-	04	04	-	04	80	20	-	100
3.	19BOT 402	Biochemical and Biophysical Techniques	CC	04	-	04	04	-	04	80	20	-	100
4.	19BOT 403	Plant Biotechnology Genetic Engineering	CC	04	-	04	04	-	04	80	20	-	100
5.	19BOT 404	Evolutionary Biology	CC	04	-	04	04	-	04	80	20		100
6.	19BOT 405	**Lab course IV***	CC	-	04 X 4	16	_	04 X 2	08	-	-	100	100
7.	19BOT 406	Research work and Seminar	CC	02		02	02		02			-	50
8.		Open elective II**	OEC #	02		02	02		02	80	20	-	100
TOTAL				**20**	**16**	**36**	**20**	**8**	**28**	**400**	**100**	**100**	**650**

C.C = Core Course **OEC = Open Elective Course**

***Lab course IV based on Core Courses (CC)**

** **For Open Elective-II, Students will have to choose a course out of list of open electives offered by other departments of University and it should not be same course in both semesters.**

Duration: 2 Years (4 Semester)
Total Credit: 106
Total Marks: 2350

Session 2019-20

M.Sc. Botany
Semester I

19BOT-101
Cell Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objective: *This course is intended to provide the basic understanding of structures and purposes of basic components of cell especially membranes, organelles, cell division and it's regulation.*

Outcome: *After studying this paper students will be able to understand how cell ultrastructure is related to cell function and these learning will prepare the students to develop their queries into the life processes.*

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Introduction to Cell biology: Ultrastructure of prokaryotic & eukaryotic cells, Structural organization & function of plant cell wall.

Membrane structure and function : Molecular composition of the cell membrane, Structural models of membrane, lipid bilayer and membrane proteins, diffusion, osmosis, ion channels, active transport, pumps, mechanism of sorting and regulation of intracellular transport ,electrical properties of membranes.

Unit-II

Structural organization and function of intracellular organelles: Mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, Nucleus; structure and organization, nuclear pores, nucleolus.

Cell shape and motality: cytoskeleton, organization and role of microtubule and microfilaments, Motor movements; implications in flagella and other movements.

Unit-III

Cellular communication: Regulation of homeostasis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Cell cycle: Mitosis and meiosis; various stages in cell cycle, regulation and control of cell cycle, cyclin and cyclin dependent kinases.

Unit-IV

Protein Localization: Synthesis of secretory and membrane proteins, Protein sorting and targeting of proteins into nucleus, mitochondria, chloroplast, vacuoles and peroxisomes, Receptor mediated endocytosis.

Apoptosis (Programmed cell death); its Mechanism and inducing factors, apoptosis triggered by internal and external pathway

Suggested readings:

1. Essential Cell Biology by Bruce Albert, Garland Science (2nd Ed).
2. Cell and Molecular Biology by Phillip Sheeler and Donald E. Bianchi, John Wiley and Sons (3rd Ed).
3. The World of Cell by W.M Becker, L.J. Kleinsmith and J. Hardin. Pearson Education (5th Ed).
4. Molecular Cell Biology by Harvey Lodish, W H Freeman & Co (8th Ed)
5. Cell Biology by P S VermaandV K Agarwal, S Chand Publishing (1st Ed)
6. Brown and Berke: Text Book of Cytology, Blackstains Sons & Co.
7. Lewin, B. 2000. Genes VII, Oxford University Press, USA.

M.Sc. Botany
Semester I

19BOT-102
Phycology, Mycology & Pathology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Objective*: To educate and train the students for professional and research career in the field of phycology, mycology and plant pathology.*

Outcome*: By studying this course the students will learn about general account and economic importance of algae and fungi with their impact on human life.*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit: I

Phycology: Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization, cell ultrastructure, reproduction (vegetative, asexual and sexual), Classification of algae, criteria for classification (pigments, reserve food and flagella).

Unit: II

Algal Classes: Overview and characteristics ofProtochlorophyta,Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

Economic importance of algae: as food, feed, in medicine and industry, Algal blooms, algal biofertilizers

Unit: III

Mycology: Generalcharacters,Organization of thallus, nutrition and reproduction; General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina; Heterokaryosis, Heterothallism, Parasexuality,Economic importance of fungi

Unit: IV

History of plant pathology, Various levels of parasitism ,Classification of plant diseases, Pathogenesis.

Plant Diseases: Causal organisms, symptoms and management of –

A) Diseases caused by Bacteria – Bacterial blight of paddy, Crown gall of stone fruits

B) Diseases caused by Viruses- TMV, Tristza of Citrus, Yellow vein mosaic of Okra

C) Diseases caused by Mycoplasma - Sandal spike

D) Diseases caused by fungi-Wart of potato, Apple scab, karnal bunt of wheat, Black, yellow and brown rust of wheat, Tikka diseases of groundnut, Red rot of sugarcane, Late and early blight of potato, Downy mildew of grapes, Smut of Bajra

Suggested readings:

1. Ahluwalia, A.S. (Ed.). *Phycology: Principles, Processes and Applications.* DayaPublishing House, New Delhi. 2003.
2. Becker, E.W. 1994. Microalgae - Biotechnology & Microbiology, Cambridge University Press, Cambridge, U.K.
3. Carr, N.G. &Whitton, B.A. 1982. The biology of Cyanobacteria Blackwell Scientific Publ., Oxford, U.K.
4. Dubey, R.C. 2006. Introduction to Biotechnology, Delhi Book Trust, New Delhi.
5. Dubey, R.C. 2014. Advanced Biotechnology, S Chand &Cmpany Pvt. Ltd., New Delhi.
6. Agrios, G.N. *Plant Pathology.* 5th Ed. Elsevier Acadmic Press, San Diego. 2005.
7. Bilgrami, K.S. and H.C. Dube. *A Textbook of Modern Plant Pathology.*Vikas Publishing House, New Delhi. 1990.
8. Bilgrami,K.S. and R.N.Verma. *Physiology of Fungi.* 2nd Ed.VikasPubl House, NewDelhi.1994.
9. Mehrotra, R.S. and A. Aggarwal. *Plant Pathology.*2nd Ed. Tata McGraw Hill Co. Ltd., New Delhi. 2003

Session 2019-20

M.Sc. Botany
Semester I

19BOT 103
Biology of Bryophytes, Pteridophytes and Gymnosperms

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objective: *This course is intended to provide the basic understanding of morphology and reproduction in Bryophytes, Pteridophytes, Gymnosperms and their Economic importance .It also give details of the various fossil gymnosperms*.

Outcome: *After studying this paper students will be able to classify Bryophytes, Pteridophytes and Gymnosperms. They will also be able to describe heterospory, origin of seed habit and evolutionary trends in stele and spore producing organs. Besides above, they will also be able to understand the phenomena of apogamy, apospory and their experimental induction.*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit: I

Introduction to Bryophyta: Morphology, structure, reproduction and life history , Evolution and distribution of sporophyte in Bryophytes.
Comparative account of the morphology, anatomy and reproduction: Marchantiales, Jungermanniales, Anthoceratales, Sphagnales, Funariales and Polytrichales.

Unit: II

Introduction to Pteridophyta: General characteristics, morphology, anatomy, reproduction and classification of Pteridophytes.
Evolution of stele and stelar system, heterospory and origin of seed habit.
Comparative account of the morphology, anatomy and reproduction: Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

Unit-III

Introduction to gymnosperms: General characters, life cycle, diversity, origin and Classification,Apogamy, Apospory,Evolution of gymnosperms.**Comparative account of the morphology, anatomy and reproduction**: Cycadales (Cycas), Coniferales (Pinus), Ephedrales (Ephedra), Ginkgoales (Ginkgo), Welwitschiales (Welwitschia) and Gnetales (Gnetum).

Unit-IV

General account of few fossil members: (Orders); Cycadeoidales, Pentoxylales and Cordaitales.(Families); Lyginopteridaceae, Medullosaceae, Glossopteridaceae and Caytoniaceae. **Modern methods of propagation of gymnosperms**: somatic embryogenesis, haploids and protoplast culture.

Economic and ecological importance: Bryophytes, Pteridophytes and Gymnosperms

Suggested Readings:

1. Rashid, A. 1998. An Introduction to Bryophyta. Vikas Publishing House Pvt. Ltd. New Delhi.
2. Watson, E.V. 1967. The Structure and Life of Bryophytes. B.I. Publications, New Delhi.
3. Glime, J.M and Saxena D. 1991. Uses of Bryophytes. Today and Tomorrow's Printers and Publishers, New Delhi.
4. Sporne, K.R. 1985 (reprint) The Morphology of Pteridophytes. B.I. Publications Pvt. Ltd., Delhi.
5. Sambamurty,A.V.S.S. 2005,A Text book of bryophytes,Pteriophytes,Gymnosperms and Paleobotany I.K. Int. Pvt. Ltd.
6. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Pvt. Ltd., New Delhi.
7. Biswas, C. and Johri, B.M. 1999. The Gymnosperms. Narosa Publishing House, New Delhi.
8. Chamberlain, C.J. 2000. Gymnosperms. C B S Publishers and Distributors, New Delhi.
9. Sporne, K.R. 1986. Morphology of Gymnosperms. Hutchinson University Press.
10. Vashishta, P.C. 1999. Gymnosperms, S. Chand & Company Ltd. New Delhi.
11. Sharma, O.P. and S. Dixit. Gymnosperms. PragtiPrakashan, Meerut. 344 pp. 2002.

Session 2019-20

M.Sc. Botany
Semester I

19BOT-104
Plant Genetics

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objective: *This course is intended to provide the basic understanding of genetic, Inheritance, variation, mapping and mutation.*

Outcomes: *The students are expected to have better understanding of basic principles of Mendelian inheritance, concept of linkage and mutagenesis. It also develops the understanding of management of inherited diseases.*

Note*:* *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-I

Gene and DNA: Genome, gene, Double helical structure of DNA, molecular organization of chromatin.
Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance.
Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions.

UNIT-II

Allelism and Linkage: Multiple Allele, Pseudo-alleles, Complementation tests, Pleiotropy, Penetrance and Expressivity, Phenocopy, Linkage and Crossing over, Sex Linkage, Sex limited and Sex influenced characters.
Genomic equivalence and cytoplasmic determinants, genomic imprinting.

UNIT-III

Gene Mapping methods: Linkage maps, Tetrad analysis, Centromere mapping in linear tetrads and analysis of unordered tetrad
Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping
Genetic fine structure: Cis-trans test; Dosage compensation and mechanism of sex determination in plants.

UNIT-IV

Mutations and mutagenesis : Types, causes and detection, mutant types-lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, Mutagens and their molecular mechanisms of occurrence; directed mutagenesis; DNA methylation, chemical mutagens and their effect ,ames test ,mutagenesis, inspectional mutagenesis by transposons, in-vitro mutagenesis.

Suggested readings:

1. Robert J Brooker(2009).Genetics:Analysis and principles(III Edition).McGraw Hill.
2. Hartl DL and Jones EW (2007). Genetics – Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers.
3. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006). Genetics – From Genes to Genomes, 3rd edition, McGraw Hill.
4. Lewin B (2008). Genes IX, Jones and Barlett Publishers.
5. Strickberger MW (2008). Genetics, 3rd Edition, Pearson (Prentice Hall).
6. Gardner E J,Simmons M J,Snustad D P(1991).Principles of genetics(III edition).John Wiley and Inc.
7. William S Klug, Michael R Cumming(1994). Concepts of Genetics, Prentice Hall.

M.Sc. Botany
Semester I

19BOT 105 **Time :8 hours**
Lab course I **Total Marks:100**

Evaluation scheme in examination:

Practical Performance & Evaluation	Viva-voce	Practical Record/File
70	20	10

1. Study of Ultrastructure of the cell.
2. Cell staining and visualization under microscope.
3. Mitotic division in onion root tip cells.
4. Slide preparation of chromosomes.
5. Effect of different factors on cell membrane permeability.
6. Effect of tonicity on plant cells.
7. Taxonomy/ morphological study of representative members of algae-
   Volvox, Cladophora, Coleochaete, Oedogonium ,Zygonema, Spirogyra,Chara, Vaucheria, Ectocarpus, Fucus, Polysiphonia, Oscillatoria, Nostoc, , Euglena
8. To study permanent slides of Algae and Fungi.
9. To study the symptoms and diagnostic features of causal organisms and their reproductive spores by section cutting of diseased plant parts of the following plant diseases:
   - Downy mildew of grapes
   - Smut of bajra
   - Late and early blight of potato
   - Tikka disease of groundnut
   - Black rust of wheat
   - Bacterial blight of paddy
   - Red rot of sugarcane
10. Collection and submission of plant disease specimens.
11. Taxonomy/ morphological study of representative members of Bryophytes and Pteridophytes
    - Bryophytes: *Marchantia, Anthoceros, Funaria, Polytrichum, Pellia, Porella, Sphagnum*.
    - Pteridophytes: *Lycopodium, Selaginella, Psilotum, Equisetum, Adiantum, Marsilea, Azolla,Pteris, Ophioglossum, Dryopteris, Nephrolepis*.
12. Comparative study of anatomy of vegetative and reproductive parts of *Cycas, Pinus, Ginkgo, Cedrus ,Aurocaria , Ephedra, Gnetum and Taxus.*
13. To study permanent slides of Bryophytes and Pteridophytes (both vegetative and reproductive phases) and Gymnosperms.
14. Collection and submission of locally available plant species (Bryophytes, Pteridophytes, Gymnosperms)
15. Genetic problem on gene mapping in higher plants.
16. Study of problems on Mendelian Genetics, Multiple allele and multiple gene inheritance.
17. Preparation of Linkage Maps in Diploids using three points test cross method.
18. Tetrad analysis and Centromere mapping in ordered and unordered tetrads.
19. Pedigree analysis.

- **Field visit to Botanical Gardens/various labs etc. and preparation of report.**

M.Sc. Botany
Semester I

19LS101
Communication Skills

Maximum Marks: 50
Theory Examination: 40
Internal Assessment: 10
Time: 2 hrs

Objectives and scope of the course
To enable the students to achieve professional and scientific expertise with the help of improved communication skills including writing, speaking, presenting and grooming.

Note*:* *There shall be nine questions in all. Question no. I shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Internal Assessment will be a continuous evaluation process on the basis of the students' expression of effective communication skills through participation in activities like presentations, group-discussions, mock-interviews, etc.

Internal Assessment	Attendance Marks	Assignment, Quiz etc. Marks	Total Marks
	3	7	10

Unit I
Human communication; verbal and non verbal communication; barriers to communication; the seven C's of effective communication; preparation for an interview; preparing CV/Biodata.

Unit II
Public speaking skills (preparation, body language and voice modulation); oral presentation; debates; elocution and extempore; delivering a presentation; greeting and introducing, making requests, giving instructions and directions.

Unit III
Personality development skills: Personal grooming; assertiveness; improving self-esteem; significance of critical thinking; confidence building; SWOC analysis; recognizing and managing emotions and situations; stress and anger management; positive thinking; developing sense of humour.

Unit IV
Science/scientific writing (theory and practice): Goals and objectives; ethics in writing structure of documents; language and grammar; illustrations and aids; writing proposals and instructions; making presentations; formatting documents; drafts and revisions; editing and writing popular science/journal article; writing scientific reports.

Suggested readings:

1. Kumar, Sanjay and PushpLata. English for Effective Communication. OUP, 2016.
2. Mohan, Krishna and MeeraBanerji. Developing Communication Skills 2nd ed. Trinity Press, 2013.
3. Dutt, P. Kirammai and GeethaRajeevan et al., A Course in Communication Skills. Foundation Books, CUP, 2016.

Session 2019-20

M.Sc. Botany
Semester II

19BOT-201
Molecular Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objective*:This course deals about how nucleic acids and proteins interact with in the cell to promote proper growth, division and development by the process of replication,transcription and translation.This course also emphasize on DNA damage and repair, gene regulation.*

Outcome*: The students are expected to have better understanding of basic life processes. It will also impart knowledge about the regulation of molecular mechanisms involved in the control of gene expression and regulation.*

Note*:* There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT I

Replication:,Evidences of DNA and RNA as the genetic material for bacteria,virus and eukaryotes,Mechanism of prokaryotic replication; Initiation, Elongation and Termination ,Replicons ;linear, circular and D-loops , enzymes and proteins involved in replication,Fidelity of replication and coordinating synthesis of leading and lagging strands,Okazaki fragments .

DNA damage and repair: Causes of DNA damage and molecular mechanism of repair-excision repair system in bacteria and eukaryotes base excision ,recombination repair systems and SOS repair.

UNIT II

Transcription and post transcription changes: Types of RNA,mRNA structure, prokaryotic and eukaryotic RNA polymerase,Transcriptional factors, promoter sequences , binding sites for RNA polymerase, transcription initiaton ,promoter clearance and elongation ,termination, attenuation and anti-termination, Role of Enhancers, repressors,mediators, silencers and inhibition of transcription regulation.

RNA splicing and processing: Capping,polyadenylation, splicing, spliciosome, mRNA stability,Group I introns and trans-esterification, ribozymes and RNA editing.

UNIT III

Translation: Ribosome ,Structure of tRNA, genetic code, Initition; formation of initiation complex,initiation factors and their regulation, Elongation ; elongation factors, aminoacylation of tRNA,aminoacyltRNAsynthatase ,termination in prokaryotes and eukaryotes, translational inhibitors, Co - translational and Post- translational modification of proteins.

Genetic Recombination : Recombination ; Types, Molecular Mechanism of Recombination, Holliday junction, Role of RecA and RecBCDenzymes,Site-specific recombination , FLP/FRT andCre/Lox recombination

UNIT IV

Gene Regulation : Regulation of gene expression(in viruses);Lytic and lysogenic cycle. Regulation of gene expression(in prokaryotes); Lac and Trp operons, positive and negative controls. Regulation of gene expression(in eukaryotes); Differential gene expression,regulation of chromatin structure;Histone modification ,DNA methylation, Epigenetic inheritance,Regulation of transcription Initiation ;Role of transcription factors, enhancers,Post transcriptional regulation, gene silencing,RNA interference ;effect of miRNA and siRNA .

Suggested readings:

1. Benjamin Lewin. 2012 Gene XI, 11th Edition, Jones and Barlett Publishers.
2. J D Watson et al,2013, Molecular Biology of Gene, 7th Edition, Benjamin Cummings publishers Inc.
3. Alberts et al.2014, Molecular Biology of the Cell,6th Edition, Garland Science.
4. Primrose SB, 2001 Molecular Biotechnology, Panima, 1.
5. Karp G.2013. Cell and molecular Biology 7th edition Wiley publication. 2.
6. Cooper GM, Hausmann, RE.2013. The Cell –A Molecular Approach.6th edition Sinaur Associates.
7. Lolish,H.,Berk,A.,Zipursky,S.L.,Matsudaira,P.,Baltimore, D. Darnell. J 2000 Molecular cell biology(4th edition).W.H.Freeman and Co., New York,USA.

Session 2019-20

M.Sc. Botany
Semester-II

19BOT 202
Plant Biochemistry

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objectives*: The course has been designed to train students with the knowledge of various biomolecules and their synthesis with metabolism. In addition the course also deals with different biochemical tests to identify various biomolecules.*

Outcome*: After completing the course the students will learn different biochemical cycles pathways and their direct and indirect effects on various physiological process of plants as well the identification of various biomolecules practically.*

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT-I

Principles of Biochemistry: Structure of atom, molecules, forces stabilizing macromolecules, weak bonds and covalent bonds, buffers and pKa values.

Bioenergetics: Principles of thermodynamics, free energy, chemical and redox potential, Structure and function of ATP, Exergonic and endergonic reaction, Entropy and energy.

UNIT-II

Fundamentals of enzymology: General aspects, nature of enzyme catalysis, enzyme kinetics, enzyme regulation and inhibition, isozymes, Allosteric enzyme and cofactors.

Amino acids and Proteins: Structure types, properties and Metabolism of Amino acids; Primary, Secondary, Tertiary and Quaternary structure of proteins; Domains, motif and folds; Stability of protein structure; Classification of proteins based on composition, solubility function; Reverse turns and Ramachandran plot.

UNIT-III

Carbohydrates: Structure and classification. Metabolism of carbohydrates (polysaccharide, glycoprotein and peptidoglycan); Stereoisomerism, transformation of carbohydrates, synthesis and degeradation of sucrose, starch and cellulose

Lipids: Composition, structure and classification, Biosynthesis and oxidation of structural and storage lipids.

UNIT-IV

Nitrogen fixation and N & S metabolism: Overview of biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation. Sulfate uptake, transport and assimilation.

Vitamins: structure and function of Thiamine, Riboflavin, Nicotinic Acid, Pantothenic Acid, Pyridoxine, Biotin, Folic Acid, Vitamin B12 , Ascorbic Acid, Vitamin A , D , E and K.

Suggested Readings

1. Lehninger, A. Principles of Biochemistry. Worth Publishers. 1011 pp. 1982.
2. Voet, D. and J.G. Voet. Biochemistry. 3 rd Ed. John Wiley &Sons_Inc. 1264 pp. 2008.
3. Jain, J.L., N. Jain and S. Jain. Fundamentals of Biochemistry. S. Chand & Co. Ltd., New Delhi. 1264 pp. 2007..
4. Nelson, D.L. & M.M. Cox. Lehninger's Principles of Biochemistry. 5th Ed. W.H.Freeman& Co., USA. 1100 pp. 2008.
5. Palmer, T. Enzymes Biochemistry,Biotechnology,Clinical Chemistry. Affiliated East – West Press Pvt. Ltd. 2004.
6. Plummer, D.T. An Introduction to Practical Biochemistry.2 nd Ed. T.M.H. Publishing Co., New Delhi. 352pp.1979.
7. Prince, N.C and L. Stevens. Fundamental of Enzymology. Oxford University Press, Oxford. 1984.
8. Stumpf, P.K. and E.E. Conn. The Biochemistry of Plants-A Comprehensive Treatise. Academic Press, London. 1981.

Session 2019-20

M.Sc. Botany
Semester II

19BOT- 203
Plant Systematics and Economic Botany

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Objective: *The course would deal with the basic concepts of plant taxonomy and nomenclature. The course is also designed to provide the knowledge about economic importance of various plants.*

Outcome: *The students will be able to understand the concept of taxonomy of plants and their botanical naming. They will also be able to identify the major sources of medicines, spices, oil, fibres, dyes, gum and timbers etc. from plants.*

Note*:* There shall be nine questions in all. Question no. 1 shall be compulsory, consisting ofeight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit: I

Principles of Plant Classification with emphasis modern tools of taxonomy: Taxonomy as a synthetic discipline, Modern tools of Taxonomy (Cytotaxonomy, Chemotaxonomy, Numerical Taxonomy, Serology)
Botanical Nomenclature and International Code of Botanical Nomenclature (ICBN)
Important Botanical Gardens and Herbaria.

Unit: II

Systems of classification: Benthem & Hooker, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne
Salient features of following families:
(Monocotyledons) Orchidaceae, Liliaceae, Palmae, Cyperaceae Araceae, and Graminae.
(Dicotyledon) Ranunculaceae, Magnoliaceae Cruciferae, Papaveraceae, Malvaceae, Leguminosae, Solanaceae, Cucurbitaceae, Umbelliferae, Compositae, Asclepediaceae, Euphorbiaceae.

Unit: III

Cultivation and uses of Important Crops: Food (cereals, pulses), forage and fodder (sorghum,bajra), Fiber yielding plants (cotton,hemp,jute), Medicinal plants (poppy, tulsi, amla, sarpgandha, ashwgandha), Aromatic plants, Oil yielding plants (mustard,coconut,groundnut,sunflower).
Innovations for meeting world food demands (Green revolution, Hybridization and GM crops)

Unit: IV

General account of Important Plants: Fire-wood & Timber-yielding plants (Acacia, teak, sal, eucalyptus, casurina), Raw materials for paper-making, Non-wood forest products (Gums, tannins, dyes, resins).
Plants used as pollution control, Plant as a source of renewable energy.

Suggested readings:

1. Kocchar, S.L. 1998. Economic Botany of Tropics.
2. Gupta, R.K. 1981.Systematic Botany. Atma Ram and Sons, New Delhi.
3. Hutchinson, J. 1950.The families of flowering plants.Vol.I , II. Clarendon Press, Oxford.
4. Naik, V.N. 1984. Taxonomy of Angiosperms.Tata McGraw Hill, New Delhi.
5. Pandey, S.N. and S.P. Misra. 2008. Taxonomy of Angiosperms. Ane Books, India.
6. Singh, G.Plant Systematic: 1999. Theory and Practice.Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
7. Sharma, O.P. 2002. Plant Taxonomy. Tata McGraw Hill Publishing Co. Pvt. Ltd., New Delhi.
8. Thakur, R.S. et al., Major Medicinal Plants.
9. Richard B. Primack. 1993. Essentials of Conservation Biology.
10. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment

Session 2019-20

M.Sc. Botany
Semester II

19BOT 204
IPR and Biosafety

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Objective: *The main objective of this course is to familiarize the students with the issues of intellectual property rights and disputes arising due to biotechnological patents. The course also emphasizes on biosafety of GMOs and other ethical issues.*

Outcome: *Students will become aware of biosafety, bioethics and IPR. They are now expected to follow the regulatory framework in their future venture to ensure product safety and benefit the society*

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit I

Introduction to intellectual property: Types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge and geographical indications.

Establishment and functions of GATT, WTO and WIPO; main features of TRIPS agreement; WIPO treaties and PCT.

Unit II

Concept of 'prior art': Invention in context of ‒prior art‖; patent databases; basics of patents: types of patents, Indian Patent Act 1970 and recent amendments; types of patent applications: PCT and convention patent applications; patent application forms and guidelines, fee structure, time frames; international patenting-requirements, procedures and costs; patent infringement- meaning, scope, litigation, case studies and examples.

Unit III

Introduction to bioethics: Bioethical issues related to genetically-modified organisms and gene therapy/gene editing; international bioethics advisory committees and their tasks (IBC, IBA, IBS etc.);ethical issues in human cloning; ethics for using animals in research;social and ethical implications of biological weapons.

Unit IV

Introduction to biosafety; biological safety cabinets; primary containment for biohazards; biosafety levels for microorganisms, infectious agents and infected animals; biosafetyguidelines of Government of India; GMOs & LMOs; Internationalregulations of GMOs:Cartagena protocol, OECD, consensus documents and codex alimentarius; Indian regulations of GMOs: EPA act and rules, guidelines; regulatory frameworkRCGM, GEAC, IBSC etc.

Suggested Readings:

1. Laws relating to Intellectual Property Rights by VKAhuja, Lexis Nexis Publishers.
2. IPR,Biosafey and Bioethics byDeepaGoel and SominiPrashar, Pearson.
3. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nabisan, Elsevier Publishing.
4. Biotechnology and Intellectual Property Rights by Kshitij Kumar Singh, Springer.

M.Sc. Botany
Semester II

19BOT 205
Bioinformatics

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs.

Objectives: *It involves the integration of computers, software tools, and databases in an effort to address biological questions. It applies information technology and computer science into the area of biology for the purpose of studying, analyzing, and processing genomic information as well as other forms of biological information*.

Outcome: *Bioinformatic tools help in the comparison of genetic & genomic data and more generally in the understanding of evolutionary aspects of molecular biology. At a more integrative level, it will help analyse the different biological pathway and networks that are an important part of system biology.*

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit I

Introduction to bioinformatics: Branches, scope and research areas of bioinformatics; introduction to various sequence file formats; introduction to PERL: scalar variables, strings and numbers, arrays, hashes, operators, loops, regular expression; applications of PERL in bioinformatics**.**

Introduction to databases: Classification scheme and features of biological databases; overview of various primary and secondary databases dealing with protein and nucleic acid sequences.

UnitII

Major biological databases: Primary databases of nucleic acid and protein: NCBI-Gen bank, EMBL, DDBJ; Swiss Prot, PIR.

Other databases: Secondary protein database Prosite and PRINTS; secondary genomic database OMIM and OMIA, literature database Pub Med, metabolic database KEGG, *Plasmodium* database Plasmo DB, specialized databases including MIPS, TIGR, TAIR.

Unit III

Sequence comparison methods: Methods for the comparison of two sequences viz., dot matrix plots, Needleman Wusch& Smith Waterman algorithms; analysis of computational complexities and the relative merits and demerits of each method; theory of scoring matrices and their use for sequence comparison; difference between PAM and BLOSUM; sequence similarity tools: CLUSTAL X/W; molecular phylogeny.

Unit IV

Database search algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms; BLAST and its types; PSI-BLAST and RPS-BLAST; concept of position specific weight matrices and their use in sequence analysis; theory of profiles and their use with special reference to PSI BLAST; Markov chains and models; concept of HMMS, Viterbi algorithm; forward algorithm and Baum welch algorithm.

Suggested readings:

1. Essential Bioinformatics by Jin Xiong, Cambridge publisher.
2. Bionformatics: Principles and Applications by Zhumur Ghosh and Bibekanand Mallick, Oxford University Press publisher.
3. Bioinformatics by Orpita Bosu and Simminder Kaur Thukral, Oxford University Press publisher
4. Introduction to Bioinformatics by M Lesk, Oxford University Press publisher.
5. Fundamental Concepts of Bioinformatics by Dan E Krane, Michael L Raymer, Michaeel LRaymer, Elaine Nicpon Marieb, Benjamin/Cummings.
6. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by P Rastogi and N Mendiritta, Prentice-Hall of India Pvt.Ltd.

M.Sc. Botany
Semester II

19 BOT 206
Lab course II **Total Marks:100**
Time :8 hours

Evaluation scheme in examination:

	Practical Performance & Evaluation	Viva-voce	Practical Record/File	
	70	**20**	**10**	

1. Isolation of Genomic DNA.
2. Isolation of plasmid DNA
3. Separation and visualization of DNA fragments by agrose gel electrophoresis.
4. Determination of size of DNA by comparison with DNA ladder electrophoretically.
5. Quantitative analysis of DNA using spectrophotometer..
6. Restriction digestion of DNA and ligation of DNA fragments.
7. To study the separation of proteins with the help of electrophoresis (SDS-PAGE).
8. Detection of reducing, non-reducing and total sugars: Molisch test, Fehling's test, Benedict's test, Barfoed's test, and Iodine test.
9. Quantitative estimation of total carbohydrates by Anthrone reagent. Preparation of potato starch, its microscopic structure and solubility test.
10. Qualitative tests of protein like Biuret test, Xanthoproteic test, Ninhydrin test, Bradford's test.
11. Quantitative estimation of amino acid by using Spectrophotometer.
12. Isolation, assay and determination of specific activity of plant enzymes of germination, growth and fruit ripening, viz amylase, lipase, protease, peroxidase, polyphenol oxidase
13. Extraction and estimation of total phenols.
14. Determination of antioxidants in plant tissues – ascorbic acid, tocopherol, β – carotene
15. Study of basic structure of flower, variations, floral parts in details, floral symmetry, insertion of floral parts etc. of various angiospermic families.
16. Morphology and anatomy of various plants:
    - **Food Crops:** Wheat, Maize, Potato, Sugarcane.
    - **Fodder Crops:** Sorghum, Bajra, Oat.
    - **Plant Fibres:** Cotton, Jute
    - **Medicinal and Aromatic Plants:** *Papaver somniferum, Catharanthus roseus, Allium sativum, Rauwolfia serpentine, Withania somnifera, Phyllanthus niruri, Aloe barbadensis, Mentha arvensis, Ricinus communis, Abutilon indicum, Datura sp., Ocimum sanctum,*
    - **Gums, Resins, Tannins, Dyes:**
      Acacia, Terminalia, Tea, Turmaric, Indigo, Lawsonia inermis.
17. Study of angiosperm in various habitats and preparation of herbarium.
18. Prepare a list of important sources of firewood and timber in your locality.
19. Patent searching on international data basis.
20. Preparing prior art search report.
21. Preparation of charts based on biosafety and bioethics.
22. Good lab practices-sterilization, gloves, lab coat use/not use.
23. Case study and plagiarism check.

24. Study the working of biosafety cabinets.
25. Retrieve single nucleotide sequence from NCBI serve.
26. Retrieve multiple nucleotide sequences through Entrez.
27. Retrieve Protein sequences from PDB.
28. Analysis of sequence similarity using BLAST.
29. To predict homology of any nucleotide/ protein sequence against respective database.
30. Perform multiple sequence alignment by using Clustal W.

- **Field Visit Various labs/ Museum/ Botanical Gardens etc. and a Report on such survey.**

Session 2019-20

M.Sc. Botany
Semester-II

19LS 201
Biostatistics

Maximum Marks: 50
Theory Examination: 40
Internal Assessment: 10
Time: 3 hrs.

Objectives and scope of the course:
The course is designed to train students in basic statistical applications in biology.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit I

Preliminary concepts: Variables and constants; random samples; discrete and continuous variables; variables in biology; accuracy and precision.

Presentation of data: Types of graphs;modes of graphical representation of data; line graph; bar diagram; pie, circle and sector chart; histogram;frequency polygon; frequency curve; frequency distribution; relative and cumulative frequency distribution.

Unit II

Measures of central tendency: Mean; median; mode; empirical relationship between mean, median and mode; quartile and percentile.

Measures of dispersion: Variability; range; mean deviation; coefficient of mean deviation; standard deviation; merits, demerits and uses of standard deviation; calculation of standard deviation.

Unit III

Regression analysis: Regression coefficients; properties of regression coefficients; student's t-test; chi-square test; f-test; one- and two-way ANOVA.

Unit IV

Correlation analysis: Correlation; co-variance; calculation of co-variance; correlation analysis; correlation coefficient calculated from ungrouped data; Spearson's rank correlation coefficient; estimation of correlation coefficient using scattered diagrams.

Suggested Readings:

1. Biostatistical Analysis, Zar, Pearson Education India
2. Textbook of computer applications and biostatistics by SB Bhise*et al*., Trinity Publishing house
3. Gupta, S.P.,Statistical Methods., S. Chand & Sons, New Delhi.
4. Biostatistics by P.N. Arora and P.K. Malhan, Himalayan publishing house.

Session 2019-20

M.Sc. Botany
Semester III

19BOT 301
Plant Physiology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

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

Outcome:*The students will be able to understand how terrestrial vascular plants acquire and use the energy and material resources required to complete their life cycle.*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-I

Water relations of plants: Mechanisms of absorption of water (active and passive transport); Apoplast and symplast concept; movements of water in the soil-plant-atmosphere continuum, Hydraulic shift, Comparison of xylem and phloem transport, molecular mechanism of phloem loading and unloading.

Stomatal physiology: Mechanism of stomatal movement and transpiration, antitranspirants; Macro & Micro nutrients, Beneficial nutrient elements, their functions and deficiency symptoms; Toxic effects of minerals.

UNIT-II

Photosynthesis: Chloroplast as an energy transduing organelle; Composition and characterization of Light harvesting systems; Electron flow through cyclic, non-cyclic and pseudo-cyclic photophosphorylations; Pathways of CO_2 fixation; (C3, C4 and CAM) and regulation of photorespiration.

Respiration: Glycolysis, Oxidative pentose phosphate pathway, Kreb's cycle and its significance, Electron transport system, Gluconeogenesis, factors affecting respiration.

UNIT-III

Phytohormone: Biosynthesis, physiological role and mode of action of auxins, gibberellins, cytokinins. Structure and function of ABA, ethylene, ascorbic acid, brassinosteroids, polyamines, nitric oxide, jasmonic acid and salicylic acid.

Stress physiology: Mechanism of plant response to abiotic stress(water, low and high temperature and salt stress) and biotic stress(pathogen and insects); Secondary plant metabolites: role of terpenes, phenols and nitrogenous compounds, allelopathy

UNIT-1V

Sensory Photobiology: Photomorphogenesis, Tropism, Phytochrome, Cryptochromes.

Latent life- Seed dormancy, Bud dormancy, Various methods to overcome dormancy, Vernalisation.

Signal transduction: Overview, Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors , phospholipid signaling, , Ca^{2+} -calmodulin cascade; Regulation of signaling pathways, second messengers, bacterial chemotaxis and quorum sensing, Specific signaling mechanisms; Bacterial and Plant two-component signaling systems

Suggested Readings:

1. Lincoln Taiz and Eduardo Zeiger, 2010. Plant Physiology. The Benjamin/ Cummings publishing Company, Inc.
2. Noggle and Fritz, 1999. Introductory Plant physiology. Prentice hall, London.
3. Salisbury, F.B. and Ross. C. 2000, Plant physiology. John Wiley & Sons, New Delhi
4. Brett, C.T. and Waldron, K.K. 1996. Physiology and Biochemistry of Plant Cell Walls, Chapman and Hall London.
5. David T. Dennis and David H. Trurpin (Eds.) 1993. Plant Physiology, Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
6. Devlin and Witham, 1997. Plant Physiology. CBS Publishers and Distributors, New Delhi.
7. Taiz et al., 2015. Plant Physiology and Development, 5th edition.

Session 2019-20

M.Sc. Botany
Semester III

19BOT 302
Plant Anatomy and Developmental Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objective*:The course would deal with concepts of plant structure, growth and development, sexual reproduction, formation of male and female gametophytes, pollination, double fertilization, and embryo development.*

Outcome*: The student will be able to know details about various tissue system in plants . The students will also understand the scope and importance of anatomy and embryology in plants .*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt sone question from each unit. Each question shall carry equal marks.*

UNIT I

Concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; Cell layer and Chimeras, role of mutants and transgenics in understanding of developmental mechanisms.
Plant tissue system: Meristems; their classification and functions, organization of root and shoot apices-RAM,SAM,Developmental changes in zonation of SAM,Leaf development and phyllotaxy,Differentiation of cells; stomata,trichomes,tracheary elements.

UNIT II

Structure of xylem and phloem: Transition of vascular tissues from root to stem ,
Anatomy of monocot (stem, root, leaves) and dicot (stem, root, leaves)
Primary and secondary growth: Anomalous structure and Abnormal secondary growth in monocot stem (*Dracaena*) and dicot stem (*Boerhavia*, *Bougainvillea*).

UNIT III

Pathways to flowering, inflorescence and floral meristems, floral organ development in *Arabidopsis* and *Antirrhinum,* ABC model of flower development.
Developmental biology of male and female gametophytes: Anther and Ovule development, microsporogenesis and microgametogenesis, megasporogenesis and megagametogenesis
Pollination, Pollen-pistil interaction and fertilization: Pollination syndromes, structure of pistil, pollen–pistil interactions, Structure of pollen wall, pollen development, *In vivo* and *in vitro* pollen germination, pollen tube growth and guidance, double fertilization, self incompatibility(cytological, biochemical and molecular aspects)

UNIT IV

Embryogenesis: Early events in embryo development, Polarity during embryogenesis, Pattern mutants, Apical-basal axis mutants ; Short integuments mutants, Segment deletion mutants; Monopteros mutants , Gurke mutants and Radial axis mutants; Knoll mutants,
Endosperm: Various types of Endosperms, Endosperm development, Apomixis, polyembryony.

Suggested readings:

1. Howell, S.H. 1998. Plant Growth and Development. A Molecular approach. Academic Press, San Diego.
2. Mauseth, J.D. 1988. Plant Anatomy. Benjamin Cummings. California.
3. Lyndon, R.F. 1990. Plant Development. The Cellular Basis. Unnin Hyman, London.
4. Waisel, Y., Eshel, A. and Kafkaki, V. (eds) 1996. Plant Development (2nd edition), Cambridge University Press, Cambridge.
5. Dekker.M. 2013. Plant Roots: the Hidden Half (4th edition), CRC press, New York.
6. Taiz et al., 2015. Plant Physiology and Development, 5th edition.

Session 2019-20

M.Sc. Botany
Semester III

19BOT-303
Plant Ecology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

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

Outcomes*: By understanding the concepts of ecological principles and environmental issues, the student will be able to develop attitude, value system and ethics towards environment related issues.*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-I

Environment: Physical environment, biotic environment, biotic and abiotic interactions; Tolerance range and limiting factors, ecotypes

Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population ecology: Concept, characteristics, population growth and regulation, species interactions mutualism, competition, allelopathy, predation, parasitism, Life-history strategies and r-and K selection, concept of metapopulation demes and dispersal, interdemic extinctions, age structured populations

UNIT-II

Community: Structure and organization; Nature of communities, community structure and its attributes; species diversity, Edges and ecotones, vegetation characteristics (analytical and synthetic characters, methods of analysis.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

UNIT-III

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

UNIT-IV

Species interactions: Types, mutualism, competition, predation, parasitism, allelopathy, herbivory, carnivory.

Global atmosphere changes: Environmental pollution, global environmental change and its consequences (CO2 fertilization, global warming sea level rise and UV radiation).

Suggested Readings :

1. Botkin, D.B. and E.A. Keller (2004). Environment Science: Earth as a Living Planet, John Wiley & Sons Inc., New York.
2. Miller (Jr.) and G. Tyler (1994) : Living in the Environment. Wadsworth Publishing Company, Belmont, California.
3. Odum, E.P. (1983), Basic Ecology, Sanders, Philadelphia.
4. Peter H. Raven, P.H. and Berg , L. R. Berg. 2005. Environment, 5th Edition. John Wiley & Sons Inc., New York.
5. Ramakrishnan, P.S. 2000. Ecology and Sustainable Development. National Book Trust, India
6. Robert Ricklefs (2001). The Ecology of Nature.Fifth Edition. W.H. Freeman and Company.
7. Mishra and Kumar, (2017). Concepts of Environmental Science, Rajesh Publication, New Delhi – 110002.

M.Sc. Botany
Semester-III

19BOT 304
Microbiology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objectives: *This course will provide the understanding of structure, nutrition, metabolism, growth, classification and identification of microorganism.*

Outcome*: Students will get the knowledge of basic microbiological techniques and applications of microbes in food industry and medical sciences.*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Introduction to Microbiology: Introduction, branches and applications of microbiology; Structural features of bacteria, archaea, and viruses.
Microbial taxonomy, metabolism and diversity: Microbial classification and taxonomy; conventional and molecular approaches for identification of microorganisms; Bergey's manual of bacteriology.

Unit-II

Microbial nutrition: Nutritional requirements of microbes, Nutritional types of bacteria, Cultivation of microbes in pure culture, Isolation of selected microbes by enrichment culture. Microbial Growth:

Characteristics of microbial growth, measurement of microbial growth, Effect of environmental factors on microbial growth, preservation of microbial cultures.
Control of microbial growth: control by physical, chemical and chemotherapeutic agents.

Unit-III

Metabolism: Basic principles of energy generation in microbes, Photosynhetic diversity in microorganism: Purple non sulphur, Green Sulphur Bacteria, Cynobacteria
Characteristics of specialized microbes: Nitrogen fixing bacteria, acetic acid bacteria and Iron oxidizing bacteria

Unit-IV

Genetic variations and mutagenesis: Transformation, conjugation and transduction in bacteria; types of mutations; Ames test for mutagenesis.
Food and medical microbiology: Food preservation by different methods (high and low temperature, chemical additives and irradiation); basic concept of D-value, Z-value, 12-D and F-value; microbial toxins and food poisoning caused by *Clostridium botulinum*, Salmonella sp., Characteristics of disease causing microbes with special emphasis on *mycoplasma, rickettsias, chlamydias.*

Suggested Books:

1. Principles and Explorations by Black JG, Prentice Hall.
2. Microbiology by Pelczar Jr MJ, Chan ECS, and Krieg NR, 5th edition, Tata McGraw Hill.
3. General Microbiology by Stanier RY, Ingraham JL, Wheelis ML and Painter PR, 5th edition, McMillan.
4. Prescott Microbiology by Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education.
5. Microbiology: An Introduction by Gerard J Tortora et al., Pearson publications.

M.Sc. Botany
Semester III

19BOT-305
Cytogenetics and Plant Breeding

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

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

Outcomes*:* *This paper would help the students to know the role of chromosomes and chromosomal rearrangements in generation of variations. They will also be familiar with methods used to change the traits of a plant to create the desired genotype/phenotype.*

Note*:* *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

Unit-I

Chromatin structure and organization: Molecular organisation of chromatin, centromere and telomere; Euchromatin and heterochromatin. Nucleosomes , DNA Packaging.

Karyotype analysis; Chromosome banding technique (Q,G,R and their uses); Flow cytometry and Confocal microscopy in karyotype analysis,
Specialized types of chromosomes: Polytene, Lampbrush, Bchromosomes and sex chromosomes.

Unit-II

Extrachromosomal Inheritance: The Genetics of Plastids, mitochondria and chloroplasts.
Structural alterations in chromosomes – Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes.
Variation in chromosome number: Haploids, aneuploids and euploids- origin, production, effects and uses; polyploidy and crop improvement
Meiotic behaviour and use of trisomics, monosomics and nullisomics in chromosome

Unit-III

Molecular Cytogenetics: FISH, GISH, FIBER-FISH, Flow Cytogenetics, Flow karyotyping, Applications of molecular cytogenetics.
Principles of plant breeding: Principles and objectives; methods of breeding self and cross pollinated crops, heterosis and hybrid vigour; utility of hybrids in genetics and plant breeding

Unit-IV

Asexual Breeding Systems: Methods of breeding of vegetatively propagated crops; Non- conventional methods; polyploidy; gene variability.

Male Sterility: Concept, Types, Genetic control and Breeding utility,
Multigene families:Multigene families and their evolution

Suggested Readings:

1. Simmonds NW.1990. Principles of CropImprovement.English Language Book Society.
2. Gustafron JP (2002) Genomes, Kluwer Academic Plenum Publishers, New York, USA.
3. George Acquaah 2012 Principles of Plant Genetics and Breeding
4. Krebs JE, Goldstein ES and Kalpatrick ST (2010) Lewin's Essential Genes (2nd Ed.), Jones and Barlett Publishers.
5. Lewin B (2010) Gene X, Jones and Barlett Publishers.
6. Pierce BA (2012) Genetics- A Conceptual Approach (4th Ed.), W.H. Freeman and Company, New York, USA.
7. Russell PJ (2006) Genetics (5th Ed.), Addison Wesley Longman, California, USA.
8. Snustad P and Simmons MJ (2011) Principles of Genetics. (6th Ed.), John Wiley, New York.
9. Brown and Caligari 2008.An introduction to Plant Breeding. Blackwell Publishing.

M.Sc. Botany
Semester III

19 BOT 306
Lab Course III **Total Marks: 100**
Time: 8 hours

Evaluation scheme in examination

Practical Performance & Evaluation	Viva-voce	Practical Record/File
70	20	10

1. Study of stomatal activity from suitable plant material (Stomatal opening & closing).
2. Spectroscopic determination of chlorophyll –a‖, chlorophyll –b‖, total chlorophyll and carotenoids.
3. Determination of chlorophyll –a‖ and chlorophyll –b‖ ratio in C3 and C4 plants.
4. Seed germination as affected by environmental factors.
5. Estimation of various plant growth regulators in leaf discs (Normal &Senescencing)
6. Bioassay of Auxin, Gibberellin, Cytokinin.
7. Study of Cytohistological zonation in the shoot apical meristem in sectioned doublestained permanent slides.
8. Examination of L.S. of root apical meristem from a permanent slide preparation.
9. Study of phyllotaxy in different plants.
10. Study of V.T.S. of leaves of dicots and monocots plants.
11. Study of epidermal peels of leaves of dicots & monocots to study the development and final structure of stomata and prepare stomatal index.
12. Study of T.S. of stem of various plants having primary and secondary anomalous structure.
13. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface cultures.
14. Study of ovules in cleared peparations; study of monosporic, bisporic and tetrasporic type of embryosac development through examination of permanent, stained serial sections.
15. Isolation of zygotic globular, heart shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun, etc.by dissections.
16. Study of Physical and chemical characters of soil
17. Assessing influence of soil nutrient status on plant germination and growth
18. Community/ecosystem studies
19. Assessment of density, frequency and abundance of plants/animal in a community using various techniques i.e. transect, quadrate etc.
20. Comparison of stands/communities and ordination
21. To study soil Profile
22. Nutrient uptake and budget for various communities/Food chain assessment
23. Understanding ecosystem succession by studying various stages of vegetation/community assemblages development.
24. Demonstration and learning Light microscope demonstration
25. Isolation of pure culture by different methods as pouring, streaking method.
26. Measurement of microbial growth by turbidometry method using spectrophotometer.
27. Microscopic examination of bacteria by Gram's stain.

28. Structural staining for spores and capsule.
29. Biochemical characterization of selected microbe e.g. *E. coli*,*Bacilli*
30. Isolation of Plasmids/genomic DNA and their analysis using electrophoresis
31. Vegetative propagation methods of important crops of your locality.
32. Karyotype analysis in any two plant species.
33. Mitotic and meiotic behavior of chromosomes in polyploidy plants
34. Induction of polyploidy using Colchicine.
35. Study meiotic behaviour of chromosom es in Anthers of Allium sp. or *Tradescantia*.
36. To study chromosomal banding pattern.

- **Field visit of any protected area and to /laboratories etc.**

M.Sc. Botany
Semester IV

19BOT- 401
Biodiversity and Conservation

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

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

Outcomes: *The student will be able to appreciate the value of biodiversity. They will also develop the skills necessary to work efficiently in areas of in-situ and ex-situ conservation.*

Note*:* *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-I

Biodiversity: Significance of biodiversity; levels of biodiversity- species, genetic and ecosystem diversity, threats to biodiversity; habitat loss and fragmentation, exotic species, overexploitation, endemism and extinction.

Biodiversity and ecosystem services , IUCN categories of threat, Red Data Book

Hotspots: Introduction, Terrestrial and marine hotspots of biodiversity; Hottest hotspots, Hotspots of biodiversity in India.

UNIT-II

Principles of conservation: Major approaches to biodiversity management, Biodiversity Conservation strategies; In- situ conservation; Wildlife sanctuaries, National parks, Biosphere reserves, Ex-situ conservation; Principles and practices, seed banks, field gene banks and cryobanks, Role of botanical gardens .

Wetlands and Ramsar convention.

UNIT-III

Plant exploration: BasicConceptof plant introduction and invasion, National Bureau of Plant Genetic Resources (NBPGR), National Biodiversity Authority (NBA) ,

Phytogeography: Major terrestrial biomes, Theory of island biogeography, Biogeographical zones of India , Forest types of India, Ecological and economic importance of forests, Social forestry, Desertification and Wasteland reclamation .

UNIT-IV

International and National efforts to conserve biodiversity: Convention of Biological Diversity (CBD), Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES), Indian initiatives in biodiversity conservation.

United Nations Framework Convention on Climate Change (UNFCC), Kyoto Protocol and Emission Trading, Post Kyoto World: Problems and Prospects, Montreal protocol.

Suggested Readings:

1. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology (5th Ed.) Brooks/Cengage Learning India Pvt. Ltd., New Delhi.
2. Kormondy, E.J. 2008. Concepts of Ecology. Prentice Hall of India., New Delhi.
3. Subrahmanyam, N.S. and Sambamurty, A.V.S.S. 2008. Ecology (2nd s Ed.) NarosaPublishing House, New Delhi
4. Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi.
5. Stiling, P. 2009. Ecology: Theory and Applications (4Th Ed.). PHI Learning Pvt. Ltd. New Delhi.
6. Rana,S.V.S. 2009. Essentials of Ecology and Environmental Sciences (4th Ed.) PHI Learning Pvt. Ltd. New Delhi..
7. A. Rosencranz and S. Divan. 2004, Environmental Law and Policy in India: Cases, Materials and Statutes. Oxford University Press, New Delhi.
8. Sahasranaman, P. B. 2009. Handbook of Environmental Law. Oxford University Press, New Delhi, India.
9. Upadhyay, C. B.2001. Forest Laws: Central and States. Hind Publishing House, Allhabad, India.

M.Sc. Botany
Semester-IV

19BOT 402
Biochemical and Biophysical Techniques

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

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

Outcome: *This paper is expected for students to gain in-depth knowledge of numerous methods used in characterization the biomolecules.*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT-I

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, Confocal microscope, scanning and transmission electron microscopes. Different fixation and staining techniques (Preparation of permanent slides)
Centrifuge technique: Principle, Types of centrifuge, Density gradient centrifuge, differential centrifugation and Ultra centrifugation

UNIT-II

Chromatography: Principles and Types; Paper chromatography, Thin layer Chromatography, Gel filtration Chromatography, Ion-exchange Chromatography, Affinity Chromatography, Gas chromatography and High Pressure Liquid Chromatography (HPLC) and FPLC. Application of chromatographic technique in biology.
Electrophoresis: Principles and applications of Agarose, Polyacrylamide gel electrophoresis, 2D Gel Electrophoresis , Differential in-gel Electrophoresis (DIGE), Electrophoretic Mobility Shift Assay (EMSA)

UNIT-III

Spectroscopy: UV, visible, Infra-red, Fluorescence, Atomic absorption spectroscopy, NMR and ESR spectroscopy; Mass spectrometery (LC-MS, GC-MS), X-ray diffraction. Surface Plasmon Resonance (SPR), Flow cytometery
Tracer Biology: Nature and types of radiation, preparation of labeling biological sample, Safety measurement in handling radioisotopes detection and measurement of radiation, GM counter, Scientillation counter Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography. Application of different spectroscopic technique in biology.

UNIT-IV

Immunotechniques: Detection of molecules us ing, ELISA, RIA, Western blot and immuno precipitation, In-situ localization by techniques as Fluorescence In-situ Hybridization (FISH) and Genomic In-situ Hybridization (GISH).
Quantitation and quality determination of RNA and DNA, Microarray (DNA and protein)

Suggested reading:

1. Wilson K and Walker J (2018) Principles and Techniques of Biochemistry and Molecular Biology (8th Ed.), Cambridge University Press, New Delhi.
2. Sawhney SK and *Singh R (2000)* Introductory *Practical Biochemistry (Ed.),* Narosa Publishing House Pvt. Ltd., New Delhi.
3. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.
4. Hegyi G, Kardos J, Kovacs M, Csizmadia AM, Nyitray L, Pal G, Radnai L, Remenyi A Venekei I (2013) Introduction to Practical Biochemistry, EotvosLorand University, Hungary.
5. Plummer DT (1990) An Introduction to Practical Biochemistry, Tata Mc-Graw-Hill Publishing Company Ltd., New Delhi.
6. Ranade R and Deshmukh S (2013) Handbook of Techniques in Biotechnology, Studium Press (India) Pvt. Ltd. New Delhi.

M.Sc. Botany
Semester-IV

19BOT 402
Plant Biotechnology and Genetic Engineering

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3 hrs

Objectives: The main objective of this course is to familiarize students with techniques of plant tissue culture, genetic manipulations of plants and quality enhancement of plant products through the use of biotechnological tools.

Outcome: Students should be able to learn the basics of plant tissue culture techniques and also the utility of genetic engineering tools that are helpful in creation of transgenic plants for better production.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Scope and basic concepts of plant biotechnology and tools. Relevance of plant biotechnology to sustainable agriculture and food security, Status of transgenic plant research in India; Terminator seed technology.
Plant tissue culture: Tissue culture media preparation and sterilization techniques; Callus and suspension cultures
Concept of cellular differentiation and totipotency: Regeneration and somatic embryogenesis. Somaclonal and gametoclonal variations.

Unit-II

Micropropagation: Methods, Applications and limitations;
Production of virus free plants; Germplasm conservation; haploid plant production through plant tissue culture (Androgenesis and Gynogenesis);
Distant hybridization: Embryo rescue and *in vitro* pollination, Somatic hybridization.

Unit-III

Recombinant DNA technology, Tools of rDNA technology: Enzymes, Cloning vectors (Plasmids, Bacteriophages, Cosmids, Phagemids, Shuttle vectors, transposons vectors, artificial chromosomes as vector and eukaryotic vectors);
Gene constructs: Promoters, Expression systems, Reporter genes.
Constriction of genomic library and cDNA library, screening libraries;
Polymerase Chain Reaction (PCR): Principles, technique and modifications;

Unit-IV

Gene transfer methods in plants: Plasmid mediated, electroporation, cation precipitation, liposomes, microinjection and particle gun technology;
***Agrobacterium* mediated gene transfer:** Molecular genetics of T-DNA transfer from *Agrobacterium* to plants;
Production of transgenic plant with respect to: herbicide resistance, resistance against biotic (insect, fungal and viral) and abiotic (salinity, drought, chill) factors;
Nutritional quality improvement in plants for: Starch, Oil and Protein content; Golden rice and other developments.

Suggested Readings

1. Plant Biotechnology, B.D. Singh (2015) 3rd edition, Kalyanil Publishers.
2. Plant Tissue culture: theory and practices (Vol. 5 of Studies in Plant Science) (1996) Revised 1st edition, S.S. Bhojwani and M.K. Razdan, Elsevier Publishing.
3. Plant Biotechnology: The Genetic Manipulation of Plants (2008) 2nd edition, Adrian Slater Oxford.
4. Principles of gene manipulation and Genomics (2010) 8th edition, S.B Primose and R.M Twyman, Blackwell publishing.
5. Gene cloning and DNA analysis – An Introduction (2016) 7th edition, T.A Brown, Blackwell publisher

M.Sc. Botany
Semester IV

19BOT-404
Evolutionary Biology

Maximum Marks: 100
Theory Examination: 80
Internal Assessment: 20
Time: 3hrs

Objective*: The aim of this course is to provide students with a deeper insight into the evolutionary process including origin and evolution of organisms and also about population genetics.*

Outcome*: Understanding evolution helps us to solve biological problems that impact our life.Researcherscanalso understands evolutionary pattern of hereditary disease in people and by treating them they can improve the quality of human life.*

Note*: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of eight short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.*

UNIT- I

Emergence of evolutionary thoughts: Lamarckism, Darwinism–concepts of variation, adaptation, struggle, fitness and natural selection,Mendelism, spontaneity of mutations, the evolutionary synthesis.
Origin of cells and unicellular evolution: Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin and Haldane, experiment of Miller (1953)

UNIT-II

Origin and Evolution of prokaryotic and eukaryotic cells , anaerobic metabolism, photosynthesis and aerobic metabolism.
Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks, molecular tools in phylogeny , protein and nucleotide sequence analysis, origin of new genes and proteins; gene duplication and divergence.

UNIT-III

Biological diversity: Species and classification, Phylogenetic trees, ,Geological fundamentals, Phylogeny and the fossil record, Evolutionary trends, Rates of evolution, Major patterns of distribution, phytogeography,Sources of phenotypic variation, Genetic variation in populations, Variation among populations.

UNIT-IV

Population genetics : Populations, gene pool, gene frequency,Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift, adaptive radiation and modifications; isolating mechanisms, speciation; allopatricity and sympatricity, convergent evolution ,sexual selection ,co-evolution.

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Suggested Readings:

1. David Briggs, Stuart Max Walters (1997). Plant Variation and Evolution, Cambridge University Press.
2. Douglas J. Futuyma (1998). Evolutionary Biology (3rd Edition), Sinauer Associates.
3. Mark Ridley (2003) Evolution (3rd edition), Blackwell.
4. Roderic D. M. Page, Edward C. Holmes (1998). Molecular Evolution: A Phylogenetic Approach, Blackwell.
5. Scott R, Freeman and Jon C. Herron (2003). Evolutionary Analysis, Prentice Hall.

M.Sc. BOTANY
Semester IV

19 BOT 405
Lab course IV **Total Marks:100**
Time :8 hours

Evaluation scheme in examination:

Practical Performance & Evaluation	Viva-voce	Practical Record/File
70	20	10

1. Understanding the concept of sampling: Random sampling, sample size, quadrat, transect and point method for the study of community structure.
2. Study the community structure using quadrate method by establishing minimum size and minimum number of quadrates.
3. Study of community structure and assessment of cover and basal area of species present and determine the IVI (Importance Value Index) of the species
4. Study of community structure and assessing frequency of the species. Prepare a frequency diagram and divide the species into classes based on percentage frequency
5. Study of community structure and assess the density and abundance of the species
6. Understand the concept of community coefficient by comparing the frequency of two communities.
7. Demonstration of Chromatography i.e. TLC, HPLC, GC.
8. To demonstrate the separation of proteins with the help of electrophoresis (SDS-PAGE).
9. To demonstrate the separation of DNA with the help of electrophoresis (AGE)
10. To study various molecular biology techniques i.e. PCR,ELISA,RIA
11. Purification of protein by Column Chromatography.
12. Preparation of plant tissue culture Media
13. Surface sterilization of explants
14. Organ culture. Induction of callus, callus propagation, Organogenesis
15. DNA isolation from plant tissues and quantitation
16. Amplification of gene using PCR.
17. Bacterial culture and antibiotic selection medias. Prepration of competent cells.
18. Transformation of bacterial cell.
19. Study of Angiosperm fossil record with the help of chart/model.
20. Study of Phenotypic morphological variation: Intraspecific variation in size and shape of leaves of various angiospermic groups
21. Study of problems on population size fluctuations with respect to migration.
22. Study of phylogenetic tree of Angiosperms with chart.

- **Students should be taken to any protected area, a recognized botanical garden or museum(such as FRI, BSI, NBRI), to a CSIR laboratory doing research on plants and their utilization and an ICAR research institute or a field station dealing with crops**.