M.Sc. Botany
Scheme of Courses
Semester I
Session 2018-2019

S.No.	Code (Course No.)	Subject (Course Title)	Hours /Week	Marks		
				Theory/ practical	Int. Ass.	Total
1	BOTC511	Phycology	3	37	13	50
2	BOTC512	Mycology and Plant Pathology	3	37	13	50
3	BOTC513	Genetics and Evolution	3	37	13	50
4	BOTC514	Plant Physiology	3	37	13	50
5	BOTC515	Introduction to Computers and Basic Bioinformatics	3	37	13	50
6	BOTC516	Theoretical Biology	3	37	13	50
7	BOTC551	Botany Practical I (Based on BOTC511, BOTC512 & BOTC513)	6.5	56	19	75
8	BOTC552	Botany Practical II (Based on BOTC514, BOTC515 and BOTC516)	6.5	56	19	75
Total			**31**	**450**		

Int. Ass. = Internal Assessment

M.Sc. Botany
Scheme of Courses
Semester II
Session 2018-2019

S.No.	Code (Course No.)	Subject (Course Title)	Hours /Week	Marks		
				Theory/ practical	Int. Ass.	Total
1	BOTC521	Bryology	3	37	13	50
2	BOTC522	Diversity and Biology of Gymnosperms	3	37	13	50
3	BOTC523	General Microbiology	3	37	13	50
4	BOTC524	Cell Biology	3	37	13	50
5	BOTC525	Pteridology	3	37	13	50
6	BOTC526	Ecological Modelling and Forest Ecology	3	37	13	50
7	BOTC561	Botany Practical I (Based on BOTC521, BOTC522 BOTC523)	6.5	56	19	75
8	BOTC562	Botany Practical II (Based on BOTC524, BOTC525 and BOTC526)	6.5	56	19	75
9	BOTC563	On Job Training or Assignment	Satisfactory/ Not Satisfactory			
Total			**31**	**450**		
@ In addition to the courses listed above, a candidate may be required to study additional optional course/s in Botany or other disciplines, as may be approved by the Board of Control. The marks obtained in such papers will be entered in the transcript but will not add to total marks obtained by the candidate for the award of the degree.						

Int. Ass. = Internal Assesement

M.Sc. Botany
Scheme of Courses
Semester III
Session 2018-2019

S. No.	Code (Course No.)	Subject (Course Title)	Hours /Week	Marks		
				Theory/ practical	Int. Ass.	Total
1	BOTC611	Plant Morphogenesis	3	40	10	50
2	BOTC612	Developmental Botany	3	40	10	50
3	BOTC613	Plant Molecular Biology	3	40	10	50
4	BOTC614	Plant Breeding and IPR	3	40	10	50
5	BOTC615	Plant Biochemistry	3	40	10	50
6	BOTC616	Applied Botany	3	40	10	50
7	BOTC651	Botany Practical I (Based on BOT C611, BOT C612 and BOT C613)	6.5	40	10	50
8	BOTC652	Botany Practical II (Based on BOT C614, BOT C615 and BOT C616)	6.5	60	15	75
9	BOTC653	Assignment	Satisfactory/ Not Satisfactory			
9	BOTC654	Seminar	1	20	5	25
Total			**32**	**450**		

@ In addition to the courses listed above, a candidate may be required to study additional optional course/s in Botany or other disciplines, as may be approved by the Board of Control. The marks obtained in such papers will be entered in the transcript but will not add to total marks obtained by the candidate for the award of the degree.

Int. Ass. = Internal Assessment

M.Sc. Botany
Scheme of Courses
Semester IV
Session 2018-2019

Sr.No.	Code (Course No.)	Subject (Course Title)	Hours /Week	Marks		
				Theory/ practical	Int. Ass.	Total
1	BOTC621	Plant Anatomy	3	40	10	50
2	BOTC622	Structure and Metabolism of Plant Hormones	3	40	10	50
3	BOTC623	Plant Tissue Culture and Biotechnology	3	40	10	50
4	BOTC624	Analytical Techniques	3	40	10	50
5	BOTC625	Diversity and Biology of Angiosperms	3	40	10	50
6	BOT C724	Hazardous Chemicals *	3	40	10	50
7	BOTC661	Botany Practical I (Based on BOT C621, BOT C622 and BOT C623)	6.5	60	15	75
8	BOTC662	Botany Practical II (Based on BOT C624 and BOT C625)	4.5	60	15	75
9	BOTC663	Field Study	Satisfactory/ Not satisfactory			
10	BOTC664	Research Techniques	3	Satisfactory/ Not satisfactory		
Total			**32**	**450**		

* List of Optional Papers
1. BOT C724 - Hazardous Chemicals
2. BOT C725 – Immunology

@ In addition to the courses listed above, a candidate may be required to study additional optional course/s in Botany or other disciplines, as may be approved by the Board of Control. The marks obtained in such papers will be entered in the transcript but will not add to total marks obtained by the candidate for the award of the degree.

Int. Ass. = Internal Assessment

M.Sc. (BOTANY) SEMESTER-I

BOT C511 – Phycology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Habitat and habit, Comparative account of important system of classification (Fritsch and Lee).
2. Organization of thallus, structure of algal cell, algal pigments and photosynthetic apparatus. Algal flagella, nutrition,
3. Comparative account of food reserves, reproductive diversity, life history patterns.
4. Chlorophyta (*Volvox, Hydrodictyon, Cladophora*, *Fritschiella, Oedogonium, Zygnema, Vaucheria*).
5. Charophyta (*Chara*).
6. Phaeophyta (*Ectocarpus, Laminaria, Macrocystis, Dictyota, Fucus, Sargassum*).
7. Rhodophyta (*Porphyra, Batrachospermum, Polysiphonia*).
8. Cyanophyta (*Nostoc, Oscillitoria, Rivularia, Spirulina, Stigonema*).
9. Rhythms and bioluminescence in Dinoflagellates, algal blooms.
10. Origin & evolution of sex in algae, economic importance of algae, bacterial and fungal pathogens of algae, algae as indicators of water pollution.

Books Recommended

1. Ahluwalia, A.S. (Ed.) (2003). Phycology. Daya Publishing House, New Delhi-110035
2. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae. Structure andReproduction, Prentice Hall Inc. Englewood Cliffs, New York.
3. Kumar. H.D. and Singh, H.H. (1971). A Textbook on Algae, East – West Press Pvt. Ltd. New Delhi.

4. Kumar. H.D. (1999). Introductory Phycology, East – West Press Pvt. Ltd. New Delhi
5. Trivedi, P.C. (Ed.) (2001). Algal Biotechnology. Pointer Publishers, Jaipur.
6. Fritsch F.E. (1945). The Structure and Reproduction of Algae. Vol. II. Cambridge Univ. Press. Cambridge, London.

Suggested Practicals

1. Sectioning and permanent mounting of thalli of various species of Cyanophyta, Chlorophyta, Charophyta, Phaeophyta, Rhodophyta.
2. Study of diversity of freshwater and sewage water algae.
3. Preparation of synthetic media and cultivation of algae
4. Interpretation of electron micrograph of some algae.
5. Biochemical analysis of pigments present in algal species
6. Studies on habit and habitat of various algae
7. Estimation of total carbohydrates from fresh water algae.

M.Sc. (BOTANY) SEMESTER-I

BOT C512 – Mycology and Plant Pathology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. History, classification, study of structure, development, reproduction, life history of the following

GYMNOMYCOTA

(i) Acrasiomycetes - a general account
(ii) Protosteliomycetes - a general account
(iii) Myxomycetes : *Stemonitis*

MASTIGOMYCOTA

Haplomastigomycotina

(i) Chytridiomycetes : *Chytriomyces, Allomyces*
(ii) Hyphochytridiomycetes : *Rhizidiomyces*
(iii) Plasmodiophromycetes : *Plasmodiophora*

Diplomastigomycotina

(i) Oomycetes :*Lagenidium, Saprolegnia*, and *Achlya*

AMASTIGOMYCOTA

Zygomycotina

(i) Zygomycetes :*Entomophthora* and *Pilobolus*
(ii) Trichomycetes – a general account

2. History, classification, study of structure, development, reproduction, life history of the following

AMASTIGOMYCOTA

Ascomycotina (Ascomycetes)

(i) Hemiascomycetidae: *Protomyces* and *Taphrina*
(ii) Piectomycetidae: *Talaromyces*
(iii) Pyrenomycetidae: *Melanospora* and *Nectria*.

(iv) Discomycetidae: *Monilinia* and *Morchella*
(v) Laboulbeniomycetidae: *Laboulbenia*
(vi) Loculoascomycetidae: *Mycospharella* and *Venturia*

Basidiomycotina (Basidiomycetes)

(i) Teliomycetidae: *Melampsora*, *Ustilago* and *Tilletia*
(ii) Holobasidiomycetidae-I (Hymenomycetes): *Polyporus* and *Exobasidium*.
(iii) Holobasidiomycetidae-II (Gasteromycetes): *Scleroderma*, *Clavatia* and *Nidularia*.

Deuteromycotina (Deuteromycetes)

(i) Hyphomycetidae: *StibellaRhizoctonia* and *Sclerotium*
(ii) Blastomycetidae: *Sporobolomyces* and *Cryptococcus*

3. Principles and methods for the prevention and control for plant diseases, modelling and disease forecasting, plant quarantine, defense mechanisms of plants against pathogens, plant disease clinics, prediction of disease control decisions.
4. Symptomatology, identification, etiology and control measures of the following plant disease :

   Fungal Diseases: Potato wart, damping-off diseases, blight of *Colocasia*, peach leaf curl, apple scab. Wilt of cotton and arhar, anthracnose disease of chillies, late blight of potato, early blight of potato, stem rust of wheat, loose smut of wheat, karnal bunt of rice, powdery mildew of bajra, white rust of crucifers, tikka disease of groundnut.

   Bacterial Diseases: Leaf blight of rice, ring rot of potato, citrus canker, brown rot of potato, tundu disease of wheat.

   Viral Diseases: Papaya leaf curl, leaf curl of tomato and bunchy top of banana.
5. Sex hormones in fungi, heterothallism in Basidiomycetes, heterokaryosis, parasexual cycle.
6. Mycorrhizae in agriculture and plant growth, Biological control and concept of mycoherbicides.
7. Important contributions of the following mycologists/microbiologists: E.J.Butler, K.C. Mehta, B.B. Mundkur, Robert Koch, Alexander Flemming, S.A. Waksman, W.M. Stanley and Christian Gram.
8. Important mycological and plant pathological journals and institutes.

Books Recommended

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd. 3.
3. Sumbali G. (2005). The Fungi. 1st edition. Narosa Publishing India House.
4. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
5. Webster J. (1980). Introduction to Fungi. 2nd edition. Cambridge University Press.

Suggested Practicals

1. Principles & working of instruments in the Mycology & Plant Pathology laboratory.
2. Characterization of disease symptoms and identification of pathogenic organisms (stem rust of wheat, damping off disease, white rust of crucifers, early and late blight of potato, loose smut of wheat, wilt of cotton, tikka disease of groundnut, citrus canker, leaf curl of papaya, yellow vein mosaic of bhindi, red rot of sugarcane, anthrocnose of chillies.)

3. To study type genus Eurotium, Mucor, Peziza, Geastrum, Nidularia, Lycoperdon, Morchella, Agaricus.
4. Comparative biochemical and physiological observations of healthy and infected leaves.
5. Ocular micrometry of spores of pathogenic fungi.
6. Obsevations on rhizosphere of infected plants.
7. Modelling for disease forecasting.
8. Studies on different defense mechanism adopted by plants against pathogenic attack.
9. Measurement of radial growth of fungi in petri plates.

M.Sc. (BOTANY) SEMESTER-I

BOT C513 – Genetics and Evolution

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Fine Structure of Gene:** Classical versus molecular concept of the gene, the cis-trans complementation for functional allelism, limitation of cis-trans test, fine structure of phage T4 II Locus; fine structures of gene and "Complex loci" in eukaryotes, genes within genes in phage ϕX124, over-lapping genes; concept of split gene; pseudogenes, nucleotide sequences.
2. **Genetic Material:** Properties and replication, proof that the genetic information is stored in DNA , the watson-crick model, the double helix, alternate forms of double helix, DNA replication, initiation and primer problem, complex replication apparatus, rolling circle replication of phage ϕ X124.
3. **Genetic regulation of cell cycle**: Homologous chromosomes, polytene and lampbrush chromosomes, Oncogenes, biochemistry and molecular biology of cancer, genetic disorders, Correlation between mutagenicity and carcinogenecity.
4. **Mutations:** Definition, types, detection in bacteria, *Neurospora*, maize and *Drosphila*; molecular basis of mutations; induced mutations (radiation and chemical mutagenesis), DNA repair mechanisms, DNA recombination mechanism, mutagen dosage.
5. **Transposable Genetic Elements:** Introduction, transposable elements in bacteria (Is elements, Tn 3 family), transposable elements in eukaryotes "Yeast Ty elements", maize transposons, *Drosophila* transposons, significance of transposable elements.
6. **Somatic Crossing Over:** Molecular mechanism of crossing over, gene conversion, ordered and unordered tetrad analysis, somatic cell hybridization.
7. **Regulation of Gene Expression in Prokaryotes** : The Operon model, lac, an inducible operon, trp, a repressible operon, positive control of the lac operon by CAP and cAMP, complex regulation of ara operon, attenuation.

8. **Polyploids:** Inheritance pattern in autopolyploids (chromosome and chromatid segregation), diplodization, role of polyploidy in evolution.
9. **Palaeontology and Evolutionary History:** The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants.
10. **Organic evolution:** Review of theories of evolution. Hardy-Weinberg law, speciation, modes of speciation (gradual and abrupt).

Books Recommended

1. Berger, M.W. (1976). Genetic, MacMillan Publishing Co. Inc, New York.
2. Gardner, E.J. Simons, M.J. and Snustad, D.P. (2006). Principles of Genetics, John Wiley & Sons, Inc., New York, Toronto.
3. Klug and Cummings. (1997). Concepts of Genetics, Prentice Hall International Inc.,New Jersey.
4. Khush. G.S. (1973).Cytogenetics of Aneuploids, Academic Press, New York.
5. Lewin, B. (1997) Genes VI. Oxford University Press, Oxford.
6. Martz C.P. T. and Yong, W.J. (1988). Cytogenetics.Rekha Printers, New Delhi.
7. MinKoff, E.C. (1983). Evolutionary Biology. Addison -Wesley Publishing Co.,Massachussettes.
8. Schulz -Schaeffer, J., (1980). Cytogenetics of Plants, Animals and Human, SpringerVerlag, New York.
9. Verma, P.S. and Aggarwal, V.K. (2014). Cell Biology, Genetics, Molecular Biology, Evolution & Ecology, S.Chand& Co. Ltd., New Delhi.

Suggested Practicals

1. Learning the cytogenetics laboratory-methods of microcopy, fixation, staining and dehydration
2. Meiotic and mitotic studies in *Allium cepa*
3. Polyploidy induction methods in laboratory organisms-treatment with colchicine
4. Studies on chromosomal aberrations in *Allium cepa*-using DDT and other pesticides
5. DNA isolation, purity and quantitative estimations.
6. Gel Scoring and data analysis
7. Demonstration of principles of Genetics in *Pisum sativum*
8. Numerical exercises on pedigree analysis, gene interactions, population genetics, chi-square and probability
9. Morphological observations in chromosomes- study on polytenic chromosomes of *Drosophila*.
10. Karyotypic analysis of laboratory organisms-*Allium cepa, Vicia faba, Drosophila*
11. Studies of human karyotyes and genetic diseases associated.
12. Demonstration of Hardy-Weinberg Law using pea seeds.

M.Sc. (BOTANY) SEMESTER-I

BOT C514 – Plant Physiology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Properties of water:** soil-plant relations, water relations kinetic theory, chemical and potential gradients, Raolt's Laws, rate of diffusion, free energy of water, atmospheric H_2O, measurement of water potential components.
2. **Energy metabolism (concept of the energy):** Thermodynamic principles in biology, energy rich bonds, weak interactions, coupled reactions and oxidative phosphorylations, group transfers, biological energy transducers, bioenergetics.
3. Signal transduction: Overview, receptors and G-proteins, phospholipid signalling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signalling mechanisms e.g. two-component sensor-regulator system in bacteria and plants, sucrose-sensing mechanism.
4. Nitrogen Metabolism:Introduction, Overview of nitrogen in the biosphere and in plants, Overview of nitrogen fixation, Enzymology of nitrogen fixation, symbiotic nitrogen fixation, Ammonia uptake and transport, Overview of nitrate uptake and reduction, Nitrate reduction, Interaction between nitrate assimilation and carbon metabolism,
5. Sulphur Metabolism: Overview of sulphate assimilation, Sulphur chemistry and function, Sulphur uptake and transport, The reductive sulphate assimilation pathway, Synthesis and function of glutathione and its derivatives.

Books Recommended

1. Buchanan, B.B., Gruissem, W. and Jones,R.L.(2002). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, Maryland.
2. Dennis,D.T., Turpin, D.H., Lefebvre,D.D. and Layzell,D.B.(eds) (1997). Plant Metabolism (second edition).longman, Essex.

3. Galston, A.W. (1989). Life Processes in Plants. Scientific American Library, Springer-Verlag, New York.
4. Hooykaas, P.J.J., Hall, M.A. and Libbenga,K.R. (eds) (1999). Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam.
5. Hopkins,W.G.(2013). Introduction to Plant Physiology. John Wiley & Sons, Inc., New York.
6. Lodish,H., Berk,A., Zipursky, S.I., Matsudaira, P., Baltimore, D. and Darnell,J. (2000). Molecular Cell Biology(fourth edition). W.H.Freeman and Company, New York.
7. Moore, T.C.(1989). Biochemitry and Physiology of Plant Hormones(second edition). Springer-Verlag, New York.
8. Nobel, P.S.(1999). Physiochemical and Environmental Plant Physiology (2nd Ed.). Academic Press, San Diego.
9. Salisbury, F.B. and Ross,C.W. (1992). Plant Physiology (4th edition). Wadsworth Publishing Co., California.
10. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee (1999). Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
11. Taiz, L. and Zeiger, E. (2010). Plant Physiology (5th edition).Sinauer Associates, Inc., Publishers, Massachusetts.

Suggested Practicals

1. Study on principles of pH metry, spectroscopy
2. Studies on preparation of various concentrations of solutions
3. Permeability observations on plasma membrane using different concentrations of organic solvents.
4. Effect of temperature on permeability of plasma membrane.
5. Preparation of standard curve of protein (e.g.BSA) and determine the protein content in unknown samples.
6. Estimation of activity of enzyme catalase
7. Estimation the activity of enzyme glutathione reductase.
8. Determination of osmotic potential of vacuolar sap by plasmolytic method.
9. Determination of the water potential of any tuber by constant weight method.
10. Determination of the water potential of any tuber by Chardakov's dye method.
11. Separation of amino acids in a mixture by paper chromatography and their identification by comparison with standards.

M.Sc. (BOTANY) SEMESTER-I

BOTC 515- Introduction to Computers and Basic Bioinformatics

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

Basic Computers

MS-Word-2003

Overview of word processing software, creating, saving and opening a new file in MS-Word, various formatting tools, paragraphs and sections, indents and outdents, lists and numbering, types of lists, Headings, styles, fonts and font size.Editing, positioning and viewing texts, Finding and replacing text, inserting page breaks, page numbers, book marks, symbols and dates, Inserting header, footer, mail merge.

MS-Excel-2003

Worksheet: Introduction to worksheet, worksheet basics, building a worksheet, moving within worksheet, entering data into worksheet, saving & quitting worksheet, opening and moving around in an existing worksheet,
Working with Formulae: cell referencing, use of formulae, auto sum, copying formulae, absolute & relative addressing, working with ranges- creating , editing and selecting ranges,
Previewing & Printing Worksheet: page setting, print titles, adjusting margins, page break, headers and footers.
Graphs and Charts: using wizards, various charts type, formatting grid lines & legends, previewing & printing charts.

MS–Power Point

Introduction to MS Power Point, presentation overview, power point elements, exploring power point menu, entering information, presentation creation. Opening and saving presentation, slide

view, slide sorter view,.notes view, outline view, printing slides, formatting and enhancing text formatting

Bioinformatics

1.Introduction to Bioinformatics, History of Bioinformatics, milestones, objectives and applications of Bioinformatics.
2.Introduction to Biological Databases, Types of Databases,
3.Literature Databases: PUBMED, PUBMED Central, European PUBMED Central
4.Nucleic acid and protein databases: GenBank, EMBL, DDBJ, SWISSPROT,UNIPROT.
5.Database Retrieval and Deposition Systems: SRS, Entrez, Bankit, Seqin, Webin
6.Biotechnological Databases: EST, SNP
7.Databases for species identification and classification: GBIF, taxonomy browser at NCBI.
8.Plant Genome Databases: TAIR, Rice Genome Annotation Project, Maize GDB
9.Structural Databases: PDB, NDB
10.Carbohydrates and lipid databases: GlycoSuiteDB, LIPIDAT

SUGGEESTED PRACTICALS

1) Introduction to MS Word, Creating Table in MS Word, Page Formatting, Printing, Page Layout
2) Mail Merge
3) Creating Slide Presentation in MS PowerPoint, Viewing the Slideshow, Adding Images in MS PowerPoint, Inserting Sound and Videos in MS PowerPoint
4) Introduction to MS Workbook
5) Creating different worksheets in MS Excel, Inserting Charts in MS Excel, Introduction to various functions in MS Excel
6). Introduction to various Literature Databases: PUBMED, Google Scholar, Scopus
7) Introduction to Nucleotide databases i.e. NDB, GenBank, EMBL and DDBJ
8) Introduction to protein databases i.e. PDB, SWISS-PROT
9) Carbohydrates and lipid databases: GlycoSuiteDB, LIPIDAT
10) Plant Genome Databases: TAIR, Rice Genome Annotation Project, Maize GDB

Books Recommended

1. Mount D. W. (2004).Bioinformatics & Genome Analysis.Cold Spring Harbor Laboratory Press.
2. Baxevais B.F. and Quellette F. (2004). Bioinformatics A Practical Guide to the Analysis of Genes and Proteins. Wiley-Interscience.
3. Eidhammer I., Jonassen I. and Taylor W. R. (2004). Protein Bioinformatics: An Algorithmic Approach to Sequence and Structure Analysis. Mathematics.
4. Orengo C.A., Jones D.T. and Thornton J.M. (2003). Bioinformatics: Genes Proteins and Computers. Bios Scientific Pub.
5. Bourhe P. E. and Weissig H. (2003). Structural Bioinformatics (Methods of Structural Analysis).Wiley-Liss.
6. Sinha, P.K. (1998). Computer Fundamentals.BPB Publications, New Delhi.
7. Peter Norton's (1998). Introduction to computers, Tata McGraw-Hill Publishing Company Limited, New Delhi

M.Sc. (BOTANY) SEMESTER-I

BOT C516 – Theoretical Biology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Linear Function:** y=ax and y=ax+b
2. **Power Function:** $y=ax^n$, quadratic equation.
3. **Periodic Function:** Sine and cosine, trigonometric relations.
4. **Exponential and Logarithmic Functions:** Exponential function $y=aq^x$, logarithmic function.
5. **Probability:** Concept of probability, permutations and combinations, normal distribution.
6. **Differentiation and Integration:** Limit Growth rates, instantaneous rate of change, differentiation of some important functions, product rule and quotient rule of differentiation, chain rule of differentiation.
7. **Integration:** Integrals, definite integral, rules of integration, second derivative.
8. **Exponential and Logarithmic Functions:** $d/dx(e^x)$, $d/dx(\ln x)$, integral of $1/x$.
9. **Statistics:** Mean, standard deviation, standard error, 't' test, chi square test.
10. One way ANOVA, simple linear regression and correlation.
11. **Matrix Operations**: Addition, subtraction, multiplication, inversion, latent root, latent vector.

Books Recommended

1. APHA-Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, DC. 23rd edition
2. Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plan Ecology. Benjamin/Cummings Publication Company, California. 3rd edition
3. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin. 2nd edition

4. Begon, M. Harper, J.L. and Townsend, C.R. (1996). Ecology, Blackwell Science, Cambridge. 6th edition
5. Brady,N.C. (1990). The Nature and Properties of Soils. Macmillan.
6. Chapman, J.L. and Reiss, M.J. (1988). Ecology: Principles and Applications. Cambridge University Press, Cambridge.
7. De, A.K. (1990). Environmental Chemistry. Wiley Eastern Pvt. Ltd., New Delhi. 6th edition
8. Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment. Cambridge University Press, Cambridge.
9. Hill, M.K. (1997). Understanding Environmental Pollution. Cambridge University Press,Cambridge.
10. Kormondy, E.J. (1996). Concepts of Ecology.Prentice Hall of India Pvt. Ltd., New Delhi.
11. Krebs, C.J. (1989 Ecological Methodology. Harper and Row, New York, USA.)
12. Koromody, E.J. (1981). Concepts of Ecology.Prentice Hall of India Pvt. Ltd., New Delhi. 3rd edition
13. Ludwig, J and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.

M.Sc. (BOTANY) SEMESTER-II

BOT C521 Bryology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Habitat, habit and distribution of Bryophytes, origin of bryophytes (including fossil records), primitive vs advanced/derived characters, economic importance.
2. Comparative morphological account of gametophytes and sporophytes and life cycle of Marchantiales (*Riccia, Marchantia,Targionia,Cyathodium,Lunularia*)
3. Sphaeropales (*Sphaerocarpus*)
4. Calobryales (*Calobryum*)
5. Jungermanniales (*Porella*)
6. Metzgeriales (*Pellia*)
7. Anthocerotales (*Anthoceros*)
8. Sphagnales (*Sphagnum*)
9. Andreaealas (*Andrea*)
10. Bryales (*Funaria*)
11. Origin of land habit, Evolution of gametophyte and sporogonium in liverworts and mosses (taking examples of above mentioned orders)
12. Spore dispersal, Peristome teeth in mosses, Palynology of Bryophytes, Methods to conserve Bryophytes at national level.
13. Morphogenetic changes in moss protonema, Characteristic endohydric, ectohydric and myxohydric bryophytes.

Books Recommended

1). Bower, F.O. (1908). The Origin of Land Flora. The MacMillan Press, London.
2). Campbell, D.R. (1985). The Evolution of Land Plants (Embryophyta) Reprinted Central Book Depot, Allahabad

3).Smith, G.M. (1955). Cryptogamic Botany. Vol. II, Tata McGraw Hill Publishing Co. Ltd.New Delhi.
4) Stewart, W.N. (1983). Palaeobotany and Evolution of Plants. Cambridge University Press, London.
5) Taylor, T.N. (1981). Palaeobotany.An Introduction to Fossil Plant Biology, McGraw Hill Book Company, New York.
6) Kumar, S.S.(1984) An Approach towards Phylogenetic Classification of Mosses, Jour. Hattori Bot. Lab. Nichinan, Japan.
7) Goffinet, B. and Shaw, A.J.(2000) Bryophyte Biology, Cambridge University Press, Cambridge, pp. 476

Suggested Practicals

1. Morphological, reproductive and anatomical study of representative members of the bryophytes studied in theory using cleared whole mount preparation and sectioning (*Riccia, Marchantia, Porella, Pellia, Funaria, Sphagnum, Polytrichum*).
2. Studies on habit and natural habitat of bryophytes.
3. Study of Peristome teeth (WM).
4. Study of Scales, rhizoids (WM).
5. Study of dehiscence pattern of sporogonium.

M.Sc. (BOTANY) SEMESTER-II

BOT C522 – Diversity and Biology of Gymnosperms

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Gymnosperms, the first seed plants, diversity of structure and complexity. Classification of gymnosperms and their distribution in India and in the globe in time and space.
2. Geological time scale and important geological formations in India.
3. Morphology, general account, structure and reproduction of Progymnosperms (aneurophytales, archeopteridales etc.): Cycadofilicales, Glossopteridales, Pentoxylales, Cordaitales, Cycadeoidales Cycadales. Ginkgoales, Coniferales, Taxales, Ephedrales, Welwitschiales and Gnetales.
4. Evolutionary tendencies in gymnosperm organography and life cycle with particular reference to male and female sporophylls, cones, ovules, seeds and archegonia.
5. Pollination mechanisms, cytology of Gymnosperms, general survey of the cytology of gymnosperms.

Books Recommended

1. Arnold, C.A. (1947) An Introduction to Palaeobotany. McGraw Hill Book Company, New York.
2. Bhatnagar, S.P., and Moitra, A. (1996) Gymnosperms. New age International, Private Limited.
3. Biswas, C., and Johri, B.M. (1997) Gymnosperms. Narosa Publishing House, New Delhi.
4. Brown, H.P. (1989) An Elementary Manual of Indian Tree Technology, Dehradun
5. Chamberlain C.J. (1935) Gymnosperms: Structure and Evolution CBS Publishers and Distributors, N. Delhi.

6. Coulter, J.M., and Chamberlain, C.J. (1917) Morphology of Gymnosperms (Reprinted) Central Book Dept. Allahabad.

Suggested Practicals

1. Study of morphology, structure and reproduction in *Cycas, Pinus, Cedrus, Ginkgo, Ephedra, Taxus, Podocarpus, Gnetum.*
2. Study of leaf and stem anatomy in *Pinus, Cedrus, Picea, Abies, Agathis, Taxus, Podocarpus, Araucaria, Ginkgo, Ephedra, Gnetum.*
3. Study of fossils: *Williamsonia.*
4. Understanding wood anatomy using T.S, T.L.S and R.L.S in *Pinus* and *Cedrus.*
5. Study of secondary growth in stem and root.

M.Sc. (BOTANY) SEMESTER-II

BOT C523– General Microbiology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Methods in Microbiology:** Basic principles of microscopy, micrometry, staining, sterlization methods; culture media, pure culture methods.
2. **Classification of bacteria** (Bergey's system) characteristics of each group, Nutrition of bacteria, nature of virulence, toxins and extracellular enzymes of pathogenic bacteria, conjugaton, transformation and transduction.
3. **Nomenclature and classification of plant viruses**, transmission of plant viruses with control measures, Viroids and origin of viruses, morphology and nature of virus particles, infection and replication with reference to TMV and bacteriophage, viral disease with special reference to encephalitis, hepatitis, AIDS, rabies, foot and mouth disease.
4. **Environmental Microbiology**: Sewage (waste water) treatment: Ecological impact of raw sewage on receiving water, public health impact of raw sewage discharge. Primary, Secondary and tertiary waste water treatments. Total coliform bacteria analysis, Fecal coliform bacteria analysis in drinking water. Land fills, composting. Bioremediation: Biodegradative organisms, advantages of bioremediations, problem associated with bioremediation, methodology of bioremediation.
5. **Aeromicrobiology:** Important airborne plant, animal and human pathogens, important airborne toxins, nature of bioaerosols aeromicrobiological pathways, sampling devices for the collection of bioaerosols.
6. **Industrial Microbiology:** The Microbe: Primary and secondary metabolites, major industrial products: foods, flavouring agents and food supplements, vitamins and beverages; organic acids; enzymes and microbial transformation; inhibitors; genetically engineered microorganisms – Human insulin andhuman growth hormones and vaccines.
7. **Control of Microorganisms by Physical and Chemical Means:** Fundamentals of control, physical agents, high temperature, low temperature, desiccation, osmotic pressure, radiation,

surface tension and interfacial tension, filtration, characterisation of an ideal antimicrobial chemical agent, selection of a chemical agent for practical application, major groups of antimicrobial agents.

Books Recommended

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
2. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
4. Webster, J. (1980). Introduction to Fungi, 2nd Ed., Cambridge University Press, Cambridege, London.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Suggested practicals

1. Acquaintance with working, principle, parts and precautions of most commonly used instruments in a microbiology lab
2. Calibration of microscope: determination of dimensions of microorganisms
3. Acclimatization with aseptic techniques-sterilisation, preparation and cultivation media for bacteria
4. To prepare temporary and permanent cotton plugs
5. To prepare solid and liquid culture media
6. To culture or cultivate bacteria
7. To stain and study bacteria
8. To measure bacterial cells through ocular micrometry
9. Microscopic examination of milk and curd
10. To isolate micro-organisms from mixed culture and grow a pure culture
11. Isolation of microbes from soil sample by streaking method
12. Isolation of micro organisms from given water sample by serial dilution.
13. Methylene blue reduction test for examining the microbial activity of milk
14. To study radial growth of fungi on nutrient media
15. To determine antibiotic staining of bacterial strain
16. Demonstration of Lambart Beer's law by colorimeter

M.Sc. (BOTANY) SEMESTER-II

BOT C524 – Cell Biology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Levels of Structural Organization:** Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.
2. **Membrane Structure and Function:** Structure of model membrane, lipid bilayer and membrane proteins, diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
3. **Structural Organization and Function of Intracellular Organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.
4. **Organization of Genes and Chromosomes:** Operon, interrupted genes, gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons.
5. **Cell division and Cell Cycle:** Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Microbial Physiology:Growth, yield and characteristics, strategies of cell division, stress response.
6. **Cell Signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.
7. **Cellular Communication:** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Books Recommended

1. Alberts, B. Bracy, P. Lewis, J. Raff, M. Roberts K and Watson, J. (eds) (1994). Molecular Biology of the Cell, Garland Publishing , New York.
2. Cooper, G. M. (1997). The cell, A Molecular Approach ASM press, Washington, D. C.
3. Chandra Roy, S and DE Kumar, K. (2001) Cell Biology. New Central Book Agency (P) Ltd. Kolkata.
4. Darnell, J. Lodish, H. and Baltimore, D. (1990). Molecular Cell Biology, 2nd edition, Freeman, New York.
5. Derobertis, E. D. P. and Derobertis, E.M.F. (1987). Essentials of Cell and Molecular Biology. Hold Saunders – Philadelphia.
6. Holtzman, E. and Novikoff, A. B. (1984). Cells and Organelles. Saunder Philadelphia.
7. Hopkins, C. L. (1978). Structure and Functions of Cells . Saunders – Philadelphia.
8. Karp, G. (1984). Cell Biology 4th Edition, McGraw Hill, New York.
9. Karp G. (1999). Cell and Molecular Biology.Concepts and Experiments, 2nd Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
10. Loewy, A. G., Siekevitz, P, Menningee, J. R., and Allant, J. A. N. (1991). Cell structure and Functions.An integrated Approach 3rd edition. Saunders College Publishing, Philadelphia, London.
11. Pollard. T.D. and Earnshaw, W.C. (2002) Cell Biology. Saunders, Philadelphia London. New York, St. Luis Sydney, Toronto.
12. Powar, C. B. (1990). Cell Biology.Himalaya Publishing House, Bombay.
13. Sadava, D. E. (1993). Cell Biology – Organelle, Structure and Fucntions. H. Jones and Bartlett- Boston.
14. Sheeler, P. and Binachi, D. E. (1983). Cell Biology, John Wiley, New York.

Suggested practicals

1. Understanding the cytology laboratory- components of compound/electron microscope.
2. Examination of electron micrographs of eukaryotic cells with special reference to organelles.
3. Examination of various stages of mitosis and meiosis using appropriate plants material (e.g. onion root tips, onion flower buds).
3. Calculation of Mitotic and meiotic index from dividing root tip cells and pollen grains.
4. Study on cyclosis in *Tradescantia* and *Hydrilla* leaves.
5. Observations on Barr bodies in Squamous epithelium.
6. Preparation of Feulgen stained chromosomes in root tip cells.
7. Effect of colchicine on chromosome movements during mitosis.
8. Use of fluorescent dye to visualise cell components.

M.Sc. (BOTANY) SEMESTER-II

BOTC525 - Pteridology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Origin of land floras, differentiation of organs in vascular plants – Telome and Enation theories, significance and short comings.
2. Monophyletic vs polyphyletic origin of pteridophytes, pteridophytic life cycle with reference to alternation of generations, homologous and the antithetic theories of the origin of the sporophyte.
3. General characters and classification of pteridophytes, occurrence, comparative organography, systematics, reproduction and types of life cycle in:
4. Rhyniales (*Rhynia, Psilophyton*)
5. Psilotales (*Psilotum*)
6. Lycopodiales (*Lycopodium*)
7. Sellaginallales (*Sellaginella*)
8. Equisetales (*Equisetum*)
9. Ophioglossales (*Ophioglossum*)
10. Marattiales (*Marattia*)
11. Filicales (*Pteris, Dryopteris*)
12. Marseliales (*Marsilea*)
13. Salviniales (*Salvinia, Azolla*)
14. Evolutionary trends in pteridophytes, prothallial evolution, organization and evolution of sorus in ferns, role of polyploidy and hybridization in speciation in ferns, apomictic life cycle, apogamy, apospory, heterospory and seed habit.
15. Spore structure, pattern of spore germination in ferns, Utility of fern for phytoremediation.

Books Recommended

1) Bower F.O. (1928). The Ferns, Vols. I – III. Cambridge University Press, Cambridge.
2) Parihar, N.S. (1992). The Biology and Morphology of Pteridophytes, Central Book
3) Rashid, A. (1991). An Introduction to Pteridophytes. Vikas Publishing House Pvt. Ltd. Distributors, Allahabad.
4) Sinnott, E.W. (1960). Plant Morphogenesis. McGraw Hill Book Company Inc. New York, Toronto, London.
5) Sporne, K.R. (1962). Morphology of Pteridophytes, BI Publications, New Delhi.
6) Stewart, W.N. (1983). Palaeobotany and Evolution of Plants. Cambridge University Press,London.
7) Taylor, T.N. (1981). Palaeobotany. An Introduction to Fossil Plant Biology, McGraw Hill Book Company, New York.
8) Sporne, K.R.(1982) The morphology of Pteridophytes, B.I., Publications, Bombay, Delhi, Madras.

Suggested Practicals

1. Morphological, reproductive and anatomical study of representative members of the pteridophytes studied in theory using cleared whole mount preparation and sectioning (*Selaginella, Lycopodium, Equisetum, Pteris, Dryopteris, Marsilea, Salvinia*).
2. Studies on habit and natural habitat of Pteridophytes.
3. Study of spore morphology.
4. Study of spore germination on Knop's medium.

M.Sc. (BOTANY) SEMESTER-II

BOT C526 – Ecological Modelling and Forest Ecology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks: 50**
Theory: 37; Int. Ass.: 13

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (7 Marks): It will consist of one question having seven parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (12 Marks): It will consist of nine questions. Candidates will be required to attempt six questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Exponential Population Growth:** Differential equations, finite rate of increase, intrinsic rate of natural increase, stable age distribution, matrix model for population growth.
2. **Logistic Population Growth:** Differential model for population growth in limited environment.
3. **Interaction Between Two Species:** Competition – Differential equations, Leslie-Gower Model, Lotka-Volterra model for predator – prey interaction, Leslie model, simple epidemics.
4. **Association Analysis and Community Classification:** Chisquare, Cole's measures and point correlation coefficient for association,continuum concept.
5. **Species Diversity:** Species area relationships, species abundance relationships – information measures of diversity. Brillouin's measure, Shannon-Weaver measure, Simpson's measure. Extinction and formation of single populations, McArthur – Wilson theory of biogeography.
6. **Production and Energy Flow:** Production in animal populations, efficiency, measurement of ingestion. Measurement of production in plants, litter decomposition.
7. Forest types, climatic region of India, Central, characters and distribution of different forest type of India, Salient features of Indian forest act 1972, different methods employed for conservation of forest, Social and urban forestry.
8. **Environmental Law & Policy:** Constitutional provisions, Water (prevention and control of pollution) Act, 1974, Air (prevention and control of pollution) Act, 1981, Environment ProtectionAct, 1986, Forest (Conservation) Act, 1980, Wildlife (Protection) Act, 1972, the concept of biosphere reserves, International environmental perspectives.

9. **Remote Sensing:** Aerial photography image interpretation, digital image processing, remote sensing in ecology and forestry, agriculture, landscape analysis, Methods & theory of remote sensing.

Books Recommended

1. APHA-Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washingtonn, DC.
2. Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plan Ecology, Benjamin/Cummings Publication Company, California.
3. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.
4. Begon,M. Harper, J.L. and Townsend, C.R. (1996). Ecology, Blackwell Science, Cambridge.
5. Brady,N.C. (1990). The Nature and Properties of Soils. Macmillan.
6. Chapman, J.L. and Reiss, M.J. (1988). Ecology: Principles and Applications, Cambridge University Press, Cambridge.
7. De, A.K. (1990). Environmental Chemistry. Wiley Eastern Pvt. Ltd., New Delhi.
8. Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment, Cambridge University Press, Cambridge.
9. Hill, M.K. (1997). Understanding Environmental Pollution. Cambridge University Press, Cambridge.
10. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.
11. Krebs, C.J.(1989 Ecological Methodology. Harper and Row, New York, USA.)
12. Koromody, E.J. (1981). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.
13. Ludwig, J and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
14. Magurran, A.E. (1988). Ecological Diversity and its Measurement. Chapman & Hall, London.
15. Mason, C.F. (1991). Biology of Freshwater Pollution, Longman.
16. Misra, R.(1968). Ecology Work Book. Oxford & IBH, New Delhi.
17. Moldan, B. and Billharz, S. (1997). Sustainability Indicators. John Wiley & Sons, New York.
18. Moore, P.W. and Chapman, S.B. (1986). Methods in Plant Ecology. Blackwell Scientific Publications, Cambridge.
19. Muller-Dombois, D. and Ellenberq, H. (1974). Aims and Methods of Vegetation Ecology, Wiley, New York.
20. Odum, E.P. (1971). Fundamentals of Ecology, Saunders , Philadelphia
21. Odum, E.P. (1983). Basic Ecology. Saunders , Philadelphia.
22. Pielou, E.C. (1984). The Interpretation of Ecological Data, Wiley, New York.
23. Poole, R.W. (1974). An Introduction to Quantitative Ecology. McGraw Hill Book Co., New York.
24. Smith, R.L. (1996). Ecology and Field Biology. Harper Collins, New York

25. Forest Ecology (3rd Edition) by James P. Kimmins Publisher Benjamin Cummings (2003)
26. Introduction of Forestry and Natural Resources (2013) by Donald L. Grebner, bettinger and Siry, Publisher Academic Press.
27. Forest Ecosystem by David A. Perry, Ram Oren and Stephan C. Hart (2nd Edition, 2008) Publisher Johns Hopkins University Press.
28. Introduction to remote sensing (5th Edition,2011) by Jmes B. Compbell and Randolph H. Loynne, Publisher The Guilford Press.

Suggested Practicals

1. To determine minimum size and number of quadrats required for reliable estimate of biomass in grassland.
2. To find out association between grassland species using chi square test.
3. To analyse plant communities using Bra-Curtis ordination method.
4. To determine soil moisture content, porosity, bulk density of different soil samples collected from different locations.
5. To determine Na, K concentration of water sample using flame photometer.
6. To determine water holding capacity of different soil samples.
7. To determine percent organic C and organic matter in different soil samples.
8. To estimate chlorophyll content in SO_2 fumigated and unfumigated plant leaves.
9. To estimate rate of CO_2 evolution from different soil using soda lime or alkali absorption method.
10. To determine sulphate content of water samples.
11. To determine O_2 content of water sample.

M.Sc. (BOTANY) SEMESTER-III

BOT C611 – Plant Morphogenesis

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Correlation:** Physiological and genetic correlations.
2. **Polarity:** Polarity as expressed in external and internal structures, polarity in isolated cells, polarity in plasmodia and coenocytes, physiological manifestations of polarity, developmental patterns.
3. **Symmetry:** Inorganic and organic symmetries, radial symmetry, bilateral symmetry, dorsiventral symmetry, development of symmetry.
4. **Differentiation:** Growth and differentiation, differentiation as expressed in structure, external and internal differentiation, differentiation during ontogeny, differentiation in relation to environment, physiological differentiation, differentiation without growth.
5. **Regeneration:** Regeneration in lower plants, regeneration in higher plants, reconstitution, restoration, reproductive regeneration.
6. **Tissue Mixtures:** Stock – scion interrelations, chimeras, somatic mutations.
7. **Abnormal Growth:** Abnormal development of organs, production of new types of organized structures, amorphous structures.
8. **Morphogenetic Factors:** Introduction to factors-light, water, temperature, physical factors, genetic factors and chemical factors in general.

Books Recommended

1. Ainsworth C (2006) Flowering and its Manipulation, Annual Plant Reviews, Vol. 20. Blackwell Publishing, Oxford, U.K. 2. Brown, TA. (2002) Genomes, BIOS Scientific Publishers Ltd, Oxford, UK.

2. Bhojwani, S.S. and Bhatnagar, S.P. (1975). The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd, Delhi.
3. Eames, A.J. (1961) Morphology of the Angiosperms. Tata McGraw Hill Publishing Co. Ltd. Bombay.
4. Maheshwari, P. (1950), An Introduction to the Embryology of Angiosperms.
5. Sinnet, E.W. (1960), Plant Morphogenesis, McGraw Hill Book Company Inc., New York.
6. Tata McGraw Hill Publishing Company Ltd. Bombay – New Delhi.

Suggested Practicals

1. Emasculation, bagging, hand pollination to study pollen germination, seed set and fruit development. Study of cleistogamous flowers and their adaptations.
2. Study of nuclear and cellular endosperm through dissection and staining.
3. Isolation of zygotic globular, heart shaped, torpedo stage and mature embryos from suitable seeds.
4. Study of seed dormancy and methods to break dormancy.
5. To Study the primitive and advanced characters of plants in angiosperms.
6. Study of various methods of asexual reproduction and vegetative reproduction.
7. To Study the effects of light, gravity, humidty temperature on plants.
8. To study effect of bending on plant morphogenesis.

M.Sc. (BOTANY) SEMESTER-III

BOT C612 – Developmental Botany

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks : 50**
Theory: 40; Int. Ass.: 10

Instructions for Paper Setters : The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Pollination**: Ultrastructural and histochemical details of style and stigma, self and interspecific incompatibility, significance of pollen-pistil interaction, role of pollen pistil interaction, role of pollen wall proteins and stigma surface proteins, barriers to fertilization, methods of over coming incompatibilities, intra-ovarian pollination, in vitro pollination.
2. **Fertilization**: Heterospermy, differential behaviour of male gametes, discharge and movement of sperms, syngamy and triple fusion, post fertilization metabolic and structural changes in embryo sac.
3. **Endosperm**: Types, ultrastructure, cellularization in nuclear endosperm, endosperm haustoria, their extension and persistence, function, storage, metabolities, endosperm culture.
4. **Embryo**: Polarization of zygote, embryogenic types963.0258741, histology and organogenesis of dicot embryos, organless (undifferentiated) embryos, delayed and differentiation of embryo, structure, cytology and function of suspensor, physiological and morphogenetical relationship of endosperm and embryo, embryo culture for rescue of hybrid embryo. Polyembryony: Types, genetic and somatic, pollen embryos.
5. **Apomixis**: Apospory, Parthenogenetic Development of Embryo, Importance. Seed: Growth and Development, Seed Appendages.
6. **Embryology & Taxonomy:** Diagnostic embryological characters, Primitive and advanced characters, Role of embryology and palynology in taxonomy.
7. **Role of Embryology in Plant Breeding:** Embryology of hybrids, disfunction of endosperm, arrested development of embryo.

Books Recommended

1. Bhojwani, S.S. and Bhatnagar, S.P. (1975). The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd, Delhi.
2. Eames, A.J. (1961) Morphology of the Angiosperms. Tata McGraw Hill Publishing Co. Ltd. Bombay.
3. Maheshwari, P. (1950), An Introduction to the Embryology of Angiosperms. Tata McGraw Hill Publishing Company Ltd. Bombay – New Delhi.
4. Parihar, NS (1993) An Introduction to Embryophyta: Vol I – Bryophyta, Vol II – Pteridophyta, Central Book Dept. Allahabad.
5. Raghavan, V (2000) Developmental Biology of Flowering Plants, Springer, Netherlands
6. Raghavan, V (1997). Molecular Embryology of Flowering Plants. Cambridge. University Press.
7. Richards, AJ (1986) Plant Breeding System, George Allen and Unwin.
8. Shivanna, KR (2003) Pollen Biology and Biotechnology, Science Publisher.
9. Sinnet, E.W. (1960), Plant Morphogenesis, McGraw Hill Book Company Inc., New York.

Suggested Practicals

1. Examination of the following with the help of hand sections, dissections and prepared longitudinal, transaction of Flowers:
    A. Transmitting tissue/canal in the stigma and style.
    B. Various types of flowers and placentation.
    C. Special types of flowers with emphasis on vasculature of androecium and gynoecium.
2. Study from permanent preparations, development and structure of anther, pollen, ovules, megasporogenesis, embryo sac, endosperm and embryo.
3. Study of microsporogenesis and gametogenesis in sections of anther.
4. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa*, *Crotolaria*, *Tradescentia*, *Brassica*, *Petunia*, *Solanum melongena*).
5. Test for pollen viability using strain and *in vitro* pollination. Pollen germination using hanging drops, sitting drop culture and suspension culture.
6. Estimating percentage and average pollen tube length *in vitro*.
7. Field study of several types of flowers with different pollination mechanisms (wind, insects, bird pollination)

M.Sc. (BOTANY) SEMESTER-III

BOT C613 – Plant Molecular Biology

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks : 50**
Theory: 40; Int. Ass.: 10

Instructions for Paper Setters : The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. The Law of DNA constancy and C-value paradox, DNA sequencing. Organization of transcriptional units; mechanism of transcription of prokaryotes and eukaryotes; RNA processing (capping, polyadenylation, splicing, introns and exons); ribonucleo–proteins, structure of mRNA.
2. Recombinant DNA technology, host cell restriction, restriction endonucleases, DNA ligases, topoisomerases, gyrases and methylases. Cloning strategies, selection and screening of recombinant clones, genomic DNA and cDNA libraries, biological and physical containment of recombinant DNA clones. Agarose gel electrophoresis, Southern/Northern/Western blotting.
3. Cloning vehicles, plasmids, bacteriophages, viruses, cosmids, Ti-plasmid, CaMv plasmid, construction of plasmid vectors, M13 vectors, their use in cloning and sequencing, expression vectors, lysogenic and lytic cycles in bacteirophages.
4. Genetic colonization of plants by *Agrobacterium* infection and tumour growth, Ti – plasmids, neoplastic transformation of plant cells, organization of T-DNA, nucleotide sequences of T-DNA. PCR, DNA fingerprinting by RAPDs and RFLPs.
5. Genomics and proteomics : Genetics and physical mapping of genes, molecular markers for transgenic plants, artificial chromosomes, high throughput sequencing, genome projects, bioinformatics, functional genomics, microarrays, protein profiling and its significance.

Books Recommended

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
5. Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.
6. Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani Publishers, Delhi
7. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

Suggested practicals

1. Identification of the parts of bright- field microscope and demonstration of its use and care.
2. Perform basic microbiological techniques such as sterile plating and isolation of single colonies.
3. Isolation of DNA from biological samples.
4. Characterization of isolated DNA using agarose gel electrophoresis.
5. Graph and analyze agarose gel data.
6. Genetic transformation of bacteria.
7. Screening and selection of transformants.
8. Demonstration of PCR technique.
9. Spectrophotometric estimation of DNA.
10. Demonstration of DNA sequencing technique.

M.Sc. (BOTANY) SEMESTER-III

BOT C614 – Plant Breeding and IPR

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks : 50**
Theory: 40; Int. Ass.: 10

Instructions for Paper Setters : The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Primary and secondary centres of diversity, utilization of wild plants in crop improvement, introduction and domestication as methods of plant breeding.
2. Types and introduction, vegetative, sexual and apomictic, their effects on generating and fixing genotypic variation, male sterility and self incompatibility mechanisms.
3. Breeding systems of crop species; systems of mating in sexually reproducing species and their genetic consequences. Breeding methods for self and cross pollinated crops; pureline and mass selection, recurrent selection and clonal selection.
4. Hybridization in self and cross pollinated crops. Inbreeding depression and hybrid vigour, genetic and physiological basis of heterosis, hybrid varieties, synthetic and composite varieties.
5. Breeding for disease resistance, classification of resistance, responses of the host to pathogens, variability systems of pathogenic fungi, breeding disease resistant varieties; multiline varieties.
6. Heritability, genetic advance, correlation of characters, path analysis, multiple comparison test, discriminant function and cluster analysis.
7. Mutations, aneuploidy and polyploidy as methods of plant improvement, interspecific and intergeneric hybrids, role of genetic engineering.
8. Intellectual Property Rights: (IPR/TRIPS), International Intellectual Property System; Plant Variety Protection; the regular patent systems, trade secrecy, biosafety; laws and conventions related to intellectual property rights.

Books Recommended

1. Agrawal, R.L. (1998). Fundamentals of Plant Breeding and Hybrid Seed Production. Oxford and IBM Publ. Co. Pvt. Ltd., New Delhi.
2. Allard, R. W. (1981), Principles of Plant Breeding. John Wiley & Sons, N. York.
3. Anonymous (1997). National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
4. Bhandari, M.M. (1974). Practicals in Plant Breeding. A Manual cum practical record. Oxford and IBH Publ. Co. New Delhi.
5. Chopra, F.L. (Ed.) (2001). Plant Breeding: Theory and Practice. (Reprint 1994). Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi.
6. Gupta SK. 2005. Practical Plant Breeding. Agribios
7. Poehlman, J.M. and Sleper, D.A. (1995). Breeding Field Crops (4th Edition) Panima Publishing Corporation, New Delhi.
8. Raghuvanshi, R.K., Chauhan, A.K.S and Sidhigui, B.A. (1995). Practical Excercises in Cytology, Genetics, Plant Breeding and Biostatistics (1st Edition). CBS Publishers and Distributors, New Delhi.
9. Roy Darbeshwar(2000). Plant Breeding - Analysis and Exploitation of Variation. Narosa Publishing Hourse, New Delhi.
10. Sharma, A.K. and Sharma A. (1999). Plant Breeding. Lecture Notes on Patents. November 1999). Technology Information, Forecasting and Assessment Council (TIFAC), Department of Science and Technology(DST), Technology Bhavan, New Mehrouli Road, New Delhi.
11. Sharma, J.R. (1994). Principles and Practice of Plant Breeding, Tata McGraw Hill Publ. Comp. Ltd., New Delhi.
12. Singh, B.D. (2005), Plant Breeding - Principles and Methods, Kalyani Publishers, Ludhiana.
13. Singh, BD. 2006. Plant Breeding. Kalyani.
14. Singh, S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding
15. Stoskopf, N.C., Tames D.T. and Chrisie B.R. (1993). Plant Breeding -Theory and Practice. West view Press, Boulder
16. Sundararaj, D.D. and Thulsidas G. (1993). Botany of Field Crops (2nd Edition), MacMillan India Ltd., New Delhi.
17. Vijendra, L.D (1998). Plant Breeding. New Age International Publishers, New Delhi.

Suggested Practicals

1. Floral biology in self and cross pollinated species.
2. Selfing and crossing techniques.
3. Numerical exercises on probability and biostatistics
4. Maintenance of experimental records.
5. Learning techniques in hybrid seed production.
6. To study Breeders kit.
7. Studies on centres of origin of various useful crops.
8. To study Vegetative Propagation in –Potato , Onion bulb, Sugarcane, Ginger.

9. To perform exploration for determination of male sterility.
10. To perform Field exploration for determination of Dichogamy, Heterostyly and Dioecy.
11. To estimate Pollen viability in *Zea mays* and *Hibiscus*.

M.Sc. (BOTANY) SEMESTER-III

BOT C615 – Plant Biochemistry

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks : 50**
Theory: 40; Int. Ass.: 10

Instructions for Paper Setters : The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Cellular Chemistry:** Covalent and noncovalent interactions, hydrogen bond, electrostatic interactions, hydrophobic interactions, Van der Walls forces and their significance, structure and properties of water and its biological significance, pH and its significance, pH scale, Handerson-Haselbach equation, buffers (inorganic and organic) and their importance, ATP-the energy currency, phosphorylation / dephosphorylation of proteins.
2. **Metabolism of Carbohydrates:** Overview of intermediary metabolism, carbohydrates and lipids of physiologic significance, glycolysis and oxidation of pyruvate, citric acid cycle, catabolism of acetyl-CoA, metabolism of glycogen, gluconeogenesis and control of the blood glucose, pentose phosphate pathway and other pathways of hexose metabolism like uronic acid fructose metabolism pathways.
3. **Lipid Metabolism:** Biosynthesis of fatty acids, oxidation of fatty acids, ketogenesis, metabolism of fatty acids, ketogenesis, metabolism of acylglycerols and sphingolipids, lipid transport and storage, cholesterol, synthesis, transport and excretion, integration of metabolism and provision of tissue fuels.
4. **Enzymology:** Introduction to enzymology, history of enzymes, nomenclature and classification. Specificity of enzymes: group specificity, absolute specificity, stereochemical specificity. Mechanism of enzyme catalysis: Activation energy, Nature of active sites, enzyme-substrate complex, induced fit hypothesis, strain and distortion theory.
5. **Enzyme Kinetics:** Michaelis-Menton Equation, Lineweaver-Burk plot. Regulation of enzyme activity and concentration: Brief account of enzyme induction and repression, covalent modification, isoenzymes and allosteric enzymes.

Books Recommended

1. Buchanan, B.B., Gruissem, W., and Jones, R.L. (2002). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland.
2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D., and Layzell, D.B. (eds) (1997). Plant Metabolism. Longman, Essex.
3. Dryer, R.L. and Lata, G.F. (1989). Experimental Biochemistry, Oxford University Press, New York.
4. Goldsby, R.A. Kindt, T.J., Oxborne B.A., Kuby, J. (2003). Immunology.W.H. Freemen & Company, NewYork.
5. Murray, R.K., Grammer, D.K., Mayes, P.A. and Rodwell V.W. (1990). Harper's Biochemistry. Prentice Hall International Inc., London.
6. Nelson, D.L. and Cox, M.M. (2000). Lehninger's Principles of Biochemistry. Worth Publishers, New York.
7. Stanley, J. (2002). Essentials of Immunology and Serology. Delmar Thomson Learning, USA.
8. Tryer, L. (1995). Biochemistry W.H. Freeman & Co., New York.
9. Westhoff, P. (1998). Molecular Plant Development: From Gene to Plant. Oxford University Press, Oxford
10. Wilson, K. and Goulding, K.H. (Eds.) 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry, Edward Arnold, London.
11. Zubay G. (1993). Biochemistry. WCB Publishers, IOWA.

Suggested practicals

1. Preparation of the solutions of different concentrations.
2 Preparation of the inorganic and organic buffers of different conc. and pH.
3. Preparation of the standard curve of protein and determine the protein content in unknown samples by Lowry's method.
4. Estimation of the protein content in given plant sample by Bradford's method.
5. Estimation of the protein content in given plant sample by Biuret's method.
6. stimation of the carbohydrates in given plant sample by Anthrone's reagent.
7. Estimation of the carbohydrates in given plant sample by Dubois's method.
8. Estimation of the activity of enzyme catalase.
9. Estimation of the activity of enzyme peroxidase.
10. Preparation of the standard curve of proline and determine the proline content in unknown samples by Bates's method.
11. SDS-PAGE for soluble proteins extracted from the given plant material and comparison of their profile by staining with Coomassie brilliant blue.

M.Sc. (BOTANY) SEMESTER-III

BOT C616 – Applied Botany

Time: 3 Hours
Theory Lectures: 3 Credit Hours/Week **Max. Marks : 50**
Theory: 40; Int. Ass.: 10

Instructions for Paper Setters : The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Food Plants:**History and nature of food plants, major and minor cereals, legumes and pulses, vegetables, fruits and nuts, vegetable oils and fats. Extraction of sugar from sugar cane. Flow diagram of the process with a critical study of the steps involved, problems faced by the sugar industry in India. Bye-products of sugar industry, distillation of alcohol and other products with special reference to distilleries in Punjab. Food adjuncts: Spices condiments and other flavouring agents, beverages, fumitory and masticatory materials; functional foods.
2. **Forest Products:**Wood & Oak, gums and resins, rubber, oils.Physical characteristics of Indian woods, methods of seasoning and chemical treatment of specialized use, fire proofing of the wood. Industrial manufacturing of packing material and plywood and the classifications of plywoods according to their use. Some important commercial woods: *Dalbergia spp., Shorea robusta, Tectona grandis, Cedrus deodara,* Bamboo-the 'green gold' of India.
3. **Industrial Plant products:** Fibre yielding plants, essential oils, fatty oil and waxes, tanning and dyeing materials, rubber and other latex yielding products, gums and resins, sugars, starches and other cellulose products. Manufacturing of paper and board from raw plant material. Manufacturing of crude and high quality paper, recycled paper; soils; bio-fuel producing plants.

4. **Fibres:** Classification of fibres, physical and chemical processes involved in the manufacuring of fibres from different types of fibre yielding plants.
5. The Rubber Plants of India, Extraction of Raw Rubber and its Chemical Processing for the Manufacturing of Finished Rubber.
6. Sources of gums and resins and their classifications according to their chemical nature. Extraction of the raw resin and down the line processing for terpentine and other products.
7. Essential oil yielding plants of India, their use in perfumary.
8. Sources of natural dyes in India and their extraction methods, merits and limitations of plant based dyes.

Books Recommended

1. Ambasta S P (1994). The Useful Plants of India. (3rd Ed.). Publications & Information Directorate, New Delhi.
2. Brown H P (1989). An Elementary Manual on Indian Wood Technology (Reprinted). International Book Distributors, Dehra Dun, India.
3. Kochhar S. L. (1998). Economic Botany in the Tropics. MacMillan India Limited, Delhi.
4. Pandey B P (1984). Economic Botany (3rd Ed.). S. Chand & Company Ltd., New Delhi.
5. Shankar Gopal Joshi (2000). Medicinal Plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Trotter H (1982). The Common Commercial Timbers of India and Their Uses. The Controller of Publications, Delhi.
7. Wickens GE (2004) Economic Botany: Principles and Practices, Springer, ISBN 978-0-7923-6781-9.

Suggested practicals

To study economic importance, distribution, centres of origin of following specimens:

1. Study of morphology and microchemical tests for stored food material for cereals: Wheat (*Triticum aestivum),* Rice (*Oryza sativa)* , Maize *(Zea mays)*
2. Study of morphology and microscopic study of fibres:
   Cotton (*Gossypium sp*, Jute (*Corchorus capsularis*), Flax (*Linum usitatissimum)*
3. Sugar yielding plant:
   Sugarcane (*Saccharum officinarum)*
4. Study of morphology of oil yielding plants:
   Groundnut (*Arachis hypogea*), Mustard (*Brassica sp),*Coconut (*Cocos nucifera*),Castor (*Ricinus communis),* Soyabean (*Glycine max)*and performing tests for oil.
5. Study of morphology and alkaloid present in spices:
   Ginger (*Zingiber officinale),* Turmeric (*Curcuma longa),*Coriander (*Coriandrum sativum),*Clove (*Eugenia aromaticum*), Black Pepper (*Piper nigrum),* Cinnamon (*Cinnamomum zeylanicum*)

6. Study of morphology and medicinal value for medicinal plants:
   Amla (*Emblica officinalis)*, Bahera (*Terminalia belerica)*, Harhar (*Terminalia chibula)*, Sarpagandha (*Rauwolfia serpentine*), Ashwagandha (*Withania somnifera*), Liquorice (*Glycyrrhiza glabra*), Poppy (*Papaver somniferum*), Arjuna (*Terminalia arjuna)*
7. Study of morphology and nutrition value for pulses:
   Green Gram (*Phaseolus aureus*), Black Gram (*Phaseolus mungo)*, Pigeon Pea (*Cajanas cajan)*, Kidney Bean *(Phaseolus vulgaris)*
8. Study of morphology of plants producing fruits
   Citrus (*Citrus sp)*, Apple (*Malus pumila)*, Mango (*Mangifera indica)*, Banana (*Musa sapientum)*, Pineapple (*Ananas comosus)*, Grapevine (*Vitis sp)*
9. Vegetables:
   Potato (*Solanum tuberosum*), Radish (*Rapahnus sativus*), Turnip (*Brassica rapa*)
10. Study of morphology of Beverages:
    Tea (*Thea sinensis*), Coffee (*Coffea arabica*) and knowledge of processing method.

M.Sc. (BOTANY) SEMESTER-IV

BOT C621 – Plant Anatomy

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **The shoot and Root System:** Primary structure and basic vasculature, the root-stem transition, secondary growth in stems and roots , the origin of cambium and its activity, anamalous secondary growth, polycyclic vasculature, secondary meristems, origin and function, the role of pericycle, phellogen, phellem, phelloderm, distribution of sclerenchyma in leaves, stems and roots.
2. **Nodal Anatomy:** Types of nodes in dicots and monocots, the node-internode transition, formation of leaf and branch traces.
3. **Histology of Wood** : Growth rings, types and ultrastructure of tracheids, vessels and wood rays, longitudinal parenchyma and its arrangement, grain and texture, knots, formation of resin cavities and tyloses, anatomy and chemistry of lignification, physical and anatomical features of hard and soft woods of common trees grown in India, importance of density and weight in commercial utilization of woods.
4. **Floral Anatomy:** The anatomy of floral axis and the whorls, the leaf origin of carpel, evidences from anatomy of essential and accessory whorls,
5. **Fruit and Seed Anatomy**: Gross and ultrastructural surface features of the fruits and seeds, role in taxonomy, internal anatomy of dicot and monocot seeds, organ and cellular anatomy of typical monocot and dicot seeds.
6. **Laticifers and Lenticels**: Types and distribution, anatomy in relation to physiological roles,
7. **Functional Anatomy**: Anatomy of leaf in relation to photosynthesis and transpiration, modification of the root stem and leaf anatomy in relation to habit and habitat with special reference to aquatics, nitrogen fixers, xerophytes parasites and mycorhizas.

Books Recommended

1. Carlquist S (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.
2. Cutler DF (1978). Applied Plant Anatomy, Longman, United Kindom.
3. Cutter EG (1978) Plant Anatomy, Part I & II, Edward Arnold, United Kingdom.
4. Dickinson WC (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
5. Nair MNB (1998). Wood Anatomy and Major Uses of Wood, Faculty of Forestry, University of Putra Malaysia, Malaysia.

Suggested practicals

1. Study of apical meristems with the help of dissections, whole mount preparations, sections and permanent slides.
2. Study of xylem and phloem elements using maceration, staining, light and electron. micrographs (xerophytes, hydrophytes and halophytes).
3. Study of secretory structures (nectaries and laticifers).
4. Study of leguminous roots with different types of nodules.
5. Anatomical studies of young and mature stem of *Helianthus*.
6. Comparative anatomy of dicot and monocot root, stem and leaf.
7. To study anomalous stem behaviour in stem(*Mirabilis jalapa.,Nyctanthes, Boerhaavia diffusa, Bignonia sp., Dracaena sp.)*
8. Study of anatomical features in xerophytes e.g. (leaf of *Nerium*. stem and leaf of *Calotropisprocera*, phyllocladode of *Ruscus sp.*)
9. Study of anatomical features in hydrophytes e.g. (*Nelumbo* petiole, *Hydrilla* stem and leaf, *Eichhornia crassipes* petiole, leaf lamina, *Typha sp.*)
10. To study anatomy of storage roots ofe.g. (*Raphnus sativa*, *Beta vulgaris*,)
11. To study anatomy of halophytes e.g. (*Chenopodium* stem).
12. To study permanent tissues slides.

M.Sc. (BOTANY) SEMESTER-IV

BOT C622 – Structure and Metabolism of Plant Hormones

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **General Features of Plant Hormones, their Analysis, and Quantitation :** Discovery of auxin and other hormones , characteristics of plant hormones, hormones vs plant growth regulators, hormonal responses to a physiological state, bioassays, hormone extraction, analysis, and quantitation, determination of hormone synthetic pathways, regulation of hormone levels (hormonal homeostasis).
2. **Auxins:** Structure of auxins, physiological roles of IAA, IAA biosynthesis in higher plants, regulation of IAA levels (IAA homeostasis), inhibitors of IAA action, other naturally occuring auxins, synthetic auxins, structural diversity in auxins.
3. **Gibberellins:** Discovery, structure of gibberellins (GAs) in higher plants, physiological roles of GAs in higher plants, terpenoid pathway, biosynthesis of GAs, regulation of GA levels in the plant, endogenous levels, why are there so many GAs, other substances with GA-like activity.
4. **Cytokinins:** Discovery, biological functions and bioassays, structure of cytokinins, occurrence of cytokinins in the cytoplasm and as components of tRNA, relative distribution of natural cytokinins among plants, biosynthesis in higher plants , regulation of cytokinin levels, synthetic compounds with cytokinin-like activity, cytokinin antagonists (anticytokinins).
5. **Brassinosteroids:** Discovery, structure and distribution, physiological roles and bioassays, biosynthesis of brassinolide, synthesis mutants and their wild-type genes, inhibitors of brassinosteroid biosynthesis, brassinosteroid structure and biological activity, regulation of castasterone and brassinolide levels.

6. **Abscissic Acid:** Discovery, structure and occurrence in plants and fungi, physiological roles of abscissic acid (ABA), biosynthesis of ABA, carotenoids and/or ABA synthesis, mutants, ABA synthesis inhibitiors, regulation of ABA levels.
7. **Ethylene:** Discovery as a hormone, structure, distribution, and internal concentrations, physiological roles and bioassays, biosynthesis in higher plants, ethylene synthesis mutants, regulation of ethylene levels in the plant, synthetic compounds that produce ethylene, inhibitors of ethylene action.
8. **Jasmonates and other Defense-Related Compounds:** Introduction, discovery, distribution, and structure of jasmonates, physiological roles of jasmonates , biosynthesis of jasmonic acid (JA), JA synthesis mutants, JA synthesis inhibitors, regulation of endogenous levels of JA.
9. **Microbial Synthesis of Plant Hormones:** Microbial associations with plants, infection by *Agrobacterium*, tumor induction by Pseudomonas, microbial genes involved in IAA and CK biosynthesis, expression of bacterial genes in higher plants, biology of genetic transformation by *A.tumefaciens*, production of plant hormones by other microorganisms.

Books Recommended

1. Buchanan, B.B., Gruissem, W., and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants.American Society of Plant Physiologists, Maryland.
2. Dennis, D.T., Turpin, D.H., Lefebvre, D.D., and Layzell, D.B. (eds) (1997). Plant Metabolism. Longman, Essex.
3. Galston, A.W. (1989). Life Processes in Plants. Scientific American Library, Springer-Verlag, New York.
4. Hooykaas, P.J.J., Hall, M.A., and Libbenga, K.R. (eds) (1999). Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam.
5. Hopkins, W.G. (1995). Introduction to Plant Physiology. John Wiley & Sons, Inc., New York.
6. Lodish, H., Berk, A., Zipursky, S.l., Matsudaira, P., Baltimore, D., and Darnell, J. (2000). Molecular Cell Biology. W.H. Freeman and Company, New York.

Suggested Practicals

1. Study the effect of IAA on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
2. To study the effect of IBA on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
3. Study the effect of Gibberellins on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
4. Study the effect of Cytokinin on morphological parameters such as shoot length, root length, fresh weight and dry weight of seven days old seedlings.
5. Estimation of the catalase activity by Aebi's Method.
6. Study of bioassays of Auxins, Gibberellins, Cytokinin, Ethylene, Absicisic Acid and Brassinosteroids.
7. Study of antagonistic effect of cytokinin/ethrel on senescence behavior of leaves of different field crops.

M.Sc. (BOTANY) SEMESTER-IV

BOT C623 – Plant Tissue Culture and Biotechnology

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Cytogenetics and differentiation in cell and tissue culture, plant regeneration from callus, shoot apex culture and anthers.
2. Micropropagation: Stages, somatic embryogenesis, usefulness, hardening of micropropagated plantlets, advantages and disadvantages, application of the technique in crop improvement.
3. Somaclonal variations and isolation of useful mutants at cellular level, disease resistance, herbicide resistance and salt tolerance. Production of pathogen free plants through tissue culture. Production of artificial seeds, their uses and applications.
4. Techniques for the production of transgenic plants: Concept, vectorless transgenosis, gene targeting tools, crop improvement through transgenics, benefits and risk of producing transgenic plants, commercialization of transgenics.
5. Cell culture and secondary metabolites like cinnamic acid, shikonins, flavonoids and related compounds production.
6. Cryobiology of plant cell cultures and establishment of plant banks, freeze preservation technology, factors influencing revival of frozen cells and future prospects. Terminator technology, verminator technology, apprehensions and challenges.
7. Role of plant tissue culture and biotechnology in agriculture, medicine and human welfare, prospects of genetic engineering of plants.

Books Recommended

1. Bhojwani, SS and Dantu, PK (2013) Plant Tissue Culture : An introductory text, Springer Publications.

2. George, F.E., Hall, M., Klerk G. J (2008) Plant propagation by Tissue culture 3rd edition Vol I , Springer Publications.
3. Gupta P.K., (1990), An Introduction to Biotechnology, Rastogi Publications, Meerut.
4. Kung, Shain – Dow and Arntzen, C.J. (1989). Plant Biotechnology, ButterWorths, London.
5. Old, R.W. and Primrose S.B. (1991). Principles of Gene Manipulation, An Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.
6. Reinert, J. and Bajaj, Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell,
7. Tissue and Organ Culture, Springer Verlang, Berlin.

Suggested Practicals

1. To study the functions and operations of various instruments used in PTC like Laminar Air Flow, Autoclave, incubators, oven, Distilllation unit, Weighing balance, pH meter etc.
2. Laboratory design set up of PTC lab.
3. Sterilisation techniques.
4. Different types of Enclosures used in PTC.
5. Preparation of stock solutions and media preparation.
6. Selection, preparation and inoculation of explant.
7. Synthetic Seed Production.
8. Micropropagation and its different steps.
9. Significance of growth hormones in culture.
10. Induction of callus from different explants.
11. Anther culture and ovary culture.

M.Sc. (BOTANY) SEMESTER-IV

BOT C624 – Analytical Techniques

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Principles and application of light, phase contrast, fluorescence scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining.
2. Principles and applications of gel filteration, ion-exchange and affinity chromatography, thin layer and gas chromatography, high pressure liquid (HPLC) chromatography, electrophoresis and electrofocussing, ultra centrifugation (velocity and density gradient).
3. Principles of biophysical methods used for analysis of biopolymeric structure, X-ray diffraction fluorescence UV/CD, visible NMR and ESR spectroscopy, hydrodynamic methods, Atomic absorption and plasma emission spectroscopy.
4. Principles and techniques of nucleic acid: hybridisation and Cot curves; Sequencing of proteins and nucleic acids; Southern, Northern and Southwestern blotting techniques; Polymerase chain reaction.

Books Recommended

1. Hackett PB, Fuchs JA & Messing JW. 1988. An Introduction to Recombinant DNA Technology - Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.
2. Principles of Electroanalytical Methods. John Wiley and Sons Ltd. , Chichester, England.
3. Sambrook J & Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.
4. Sheehan, D. (2000). Physical Biochemistry : Principles and Applications, John Wiley and Sons Ltd. , Chichester, England.
5. Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani Publishers, Delhi
6. Wilson K. and Walker J. (Eds.) (2012). Practical Biochemistry : Principles and

Techniques, Cambridge University Press, U.K. Riley, T. and Tomilson, C. (1987).

Suggested practicals

(Experiments based on following techniques):

1. Paper Chromatographgy
2. Thin Layer chromatography
3. Column chromatography
4. Gel Filtration Chromatography
5. Ion Exchange Chromatography
6. Affinity Chromatography
7. Electrophoresis: PAGE and SDS-PAGE
8. UV-Vis Chromatography
9. Demonstration of PCR
10. Centrifugation
11. Flourescent Microscopy

M.Sc. (BOTANY) SEMESTER-IV

BOT C625 – Diversity and Biology of Angiosperms

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. Historical perspective of plant classification, phenetic versus phylogenetic system; cladistics in taxonomy, relative merits and demerits of major system of classification, a study of phylogenetic system of classification after Engler & Prantl, Bessey, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne.
2. Principles of plant nomenclature; salient features of the International code of Botanical Nomenclature, working knowledge of Botanical Latin, important herbaria of the World.
3. Origin of angiosperms; inter-relationships of dicots and monocots; Phylogeny of ranales, amentiferae, centrospermae, tubifilorae and helobiales and their treatment in the modern systems of classification.
4. Principles of plant taxonomy, alpha taxonomy vs modern taxonomy; chemotaxonomy, cytotaxonomy, numerical taxonomy, anatomy, palynology and embryology in relation to taxonomy.
5. Biosystematic approach to taxonomy, biosystematic categories parameters in biosystematic analysis with particular examples of taxonomic problems; taxonomic study of agamic, hybrid and polyploid complexes; phylogenetic trees.
6. Taxonomic tools: Herbarium; floras; serology; electrophoresis; nucleic acid hybridization; computers and GIS.
7. Concepts of phytogeography and its relevance, phytogeographic regions of the world and India, approaches to phytogeography, principles and practices; factors determining vegetational types, endemism, hotspots and hottest hotspots, plant explorations, invasions and introductions, local plant diversity and its socio-economic importance.

Books Recommended

1. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Cole, A.J. 1969. Numerical Taxonomy,Academic Press, London
3. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition)
4. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.: Brown, H.P. (1989). An Elementary Manual of Indian Tree Technology, Dehradun
5. Davis P.H. and Heywood, V.H. (1973). Principles of Angiosperms Taxonomy. Robert E. Kreiger Pub. Co., New York.
6. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002) Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
7. Nei M and Kumar S (2000) Molecular Evolution and Phylogenetics. Oxford University Press, New York.
8. Raven PH, Begr LR, Hassenzahl DM (2008) Environment. 6th edition. John Wiley & Sons, Inc., New York.
9. Semple C and Steel MA (2003) Phylogenetics. Oxford University Press, Oxford.

Suggested Practicals

1. Description of specimen from representatives. Locally available families. This list is indicative only
    - Ranunculaceae: *Ranunculus, Delphinium*
    - Brassicaceae: *Brassica, Iberis*
    - Malvaceae: *Hibiscus*
    - Rutaceae: *Murraya,Citrus*
    - Fabaceae: *Lathyrus,Cassia, Acacia, Mimosa*
    - Rosaceae: *Rosa, Prunus*
    - Asteraceae: *Helianthus, Ageratum, Sonchus*
    - Apiaceae: *Coriandrum, Foeniculum*
    - Apocynaceae: *Vinca, Nerium,Thevetia*
    - Asclepiadaceae: *Calatropis*
    - Solanaceae: *Petunia, Solanum,Datura*
    - Euphorbiaceae:*Euphorbia, Phyllanthus*
    - Lamiaceae:*Ocimum, Salvia*
    - Chenopodiaceae:*Chenopodium*
    - Liliaceae:*Asparagus, Asphodelus*
    - Poaceae:*Triticum, Avena*
2. Location of key character and use of keys at family level.
3. Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated.

4. Training in using flora and herbaria for identification of specimens described in the class.
5. Comparison of different species of a genus and different genera of family to calculate similarity coefficients.

M.Sc. (BOTANY) SEMESTER-IV

BOT C724 - Hazardous Chemicals
(Optional Paper)

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **Physical Properties of Chemicals**: Vapour pressure, vapour density, solubility, octanol/ water partition, coefficient odour.
2. **Toxic Properties :** Absorption and excretion, detoxification and bioactivation, common terms used for toxicology.
3. **Target Organs:** Injury to: liver, kidney, immune system, respiratory tract, skin, eyes, nervous system, cardiovascular system, carcinogens and teratogens.
4. **Combustible and Explosive Properties:** Flashpoint and autoignition temperature of some chemicals, explosive properties.
5. **Aldehydes:** Acrolein.
6. **Alkaloids:** Nicotine, Morphine, Heroin, LSD, Colchichine.
7. **Amines:** Ethylenimine, aniline, benzidine, O-toluidine, Phenylhydrazine.
8. **Azodyes:** Acid Yellow 3, Sudan orange, acid red 18, acid blue-9, acid green-3.
9. **Chlorohydrins:** Ethylene, chlorohydrin.
10. **Nitriles:** Acrylonitrile, acetonitrile.
11. **Cyanides:** HCN, Sodium cyanide, potassium cyanide, cyanogen.
12. **Organic Isocyanates:** Methyl isocyanate.
13. **Dioxins**: 2,3,7,8 – Tetrachlordibenzo-p-dioxin (TCDD).
14. **Epoxy Compounds:** Ethylene dioxide.
15. **Halogenated Hydrocarbons:** Chloroform, carbon tetrachloride, dichlorobenzene.
16. **Aromatic Hydrocarbons:** Benzene, Xylene.

17. **Polynuclear Aromatics:** Benzo -α- pyrene, Benzo - α- anthracene.
18. **Toxic Gases:** Arsine, Mustard Gas, Phosgene.
19. **Explosives:** Nitroexplosives – Nitroglycerine, dynamite, Nitrocellulose, 2,4,6-Trinitrotoluene, Picric acid.
20. **Pesticides:** Structure, LD_{50}/ LC_{50} , health hazards and exposure limit of following pesticides:
    (i) **Carbamates:** Aldicarb, Carbaryl, Carbofuran, Methiocarb.
    (ii) **Organochlorines**: Aldrin, Dieldrin, Endrin , Heptachlor, Chloradane, Endsulphan, DDT, Methoxychlor, Lindane.
    (iii) **Organophosporus Pesticides:** Parathion, Dichrotophos, Monocrotophos, Chloropyriphos.
21. **Herbicides:** 2,4 D, 2,4, T, Silvex, Atrazine, Metribuzin, Monouron, Diuron, Paraquat, Tribunil, Alchlor

Book Recommeded

1. Patnaik, P. (1999). A Comprehensive Guide to the Hazardous Properties of Chemical Substances. Wiley, New York.

M.Sc. (BOTANY) SEMESTER-IV

BOT C725 - Immunology
(Optional Paper)

Time: 3 Hours **Max. Marks: 50**
Theory Lectures: 3 Credit Hours/Week **Theory: 40; Int. Ass.: 10**

Instructions for Paper Setters: The question paper will consist of three sections. Candidate will be required to attempt all the sections.
Section A (8 Marks): It will consist of one question having eight parts. Candidates will be required to attempt all the parts each part carrying one mark. Answer to any part should not exceed four lines.
Section B (14 Marks): It will consist of ten questions. Candidates will be required to attempt seven questions, each question carrying two marks. Answer to any of the questions should not exceed two pages.
Section C (18 Marks): It will consist of five questions. Candidates will be required to attempt three questions, each question carrying six marks. Answer to any of the questions should not exceed four pages.

1. **An Overview of the Immune System:** Historical perspective, an introduction to the immune system – innate and adaptive immunity. Immunodeficiencies : secondary immunodeficiency disorders.
2. **Antigens and Antigen Recognition:** Antigens: prerequisites for immunogenicity, relative immunogenicity of different types of molecules, Molecules that enhance immunogenicity. Activators of lymphocytes: antigens, superantigens, mitogens. Antigen recognition by cells of innate immunity & adaptive immunity.
3. **Antibodies:** Gamma globulins; structure, bifunctional property of antibodies, determining bifunctionality, cross reactivity, Antigen antibody interactions: primary interactions, secondary interactions. Classification of antibodies: Isotypes, Allotypes, properties & biological functions of antibody isotypes, IgG, IgE, IgM, IgD, IgA, Monoclonal antibodies
4. **Cells and Tissues of Immunity:** Lymphoid tissues: primary & secondary lymphoid tissues, cells of innate immunity : phagocytes, antigen presenting cells, natural killer cells, Eosinophils, mast cells and basophil, B- cells, secondary immune responses.The major histocompatibility complex, antigen process and antigen presentation, complement.
5. The immune system in Health & Disease, specially AIDS.

Books Recommended

1. Goldsby, R.A. Kindt, T.J., Oxborne B.A., Kuby, J. (2003). Immunology.W.H. Freemen & Company, NewYork.
2. Stanley, J. (2002). Essentials of Immunology and Serology. Delmar Thomson Learning, USA.

M.Sc. (CHEMISTRY) SEMESTER-II

CH414 (b): Biology for Chemists
For Medical Students

Time: 2 Hours **Max. Marks: 25**
Theory Lectures: 30 Hrs. **Theory: 19; Int. Ass.: 06**

Instructions for paper setters and candidates

1. Examiner will set total of ten questions comprising THREE questions from each unit carrying 3 marks and ONE compulsory question of short answer type of 4 marks covering the whole syllabi.
2. The students are required to attempt SIX questions in all, atleast ONE question from each unit and a Compulsory question.

UNIT-I

1. The Organization of life (10 Hrs.)

- Biologically important molecules: Carbohydrates, lipids, proteins and nucleic acids.
- The life of cells- The cell theory, general characteristics of cells, difference between prokaryotic and eukaryotic cells, difference between plant and animal cells, Cell organelles.
- Animal tissues; epithelial tissues, connective tissues, muscle tissue, nervous tissue and neoplasias; plant tissue: meristematic tissue, permanent tissues.

UNIT-II

2. Genetics(10Hrs.)

- The basic principle of heredity: Mendel's laws, monohybrid cross, dihybrid cross.
- DNA-Double helix structure and replication.
- Genes expression: Transcription and translation, genetic code.

UNIT-III

3. The Diversity of Life(10Hrs.)

- The classification of living things- criteria of classification, Whittaker's system of classification.
- Viruses, structure of viruses.

Book Recommended:

1. Cord Biology – South Western Educational Publications, Texas, 2000