UNIVERSITY OF KOTA

SEMESTER SCHEME

(W. E. F. 2024-25)

M.Sc. (Botany)

MBS Marg, Near Kabir Circle, KOTA (Rajasthan)

Syllabus of M.Sc. Botany Semester-I & II, III & IV according to CBCS for Session : 2024-25

Syllabus of M.Sc. Botany

Semester-I

BOT-12101 - Paper 1.1 Biology and Diversity of Lower Plants

BOT-12102 - Paper 1.2 Pteridophyte, Gymnosperms and Paleobotany

BOT-12103 - Paper 1.3 Plant Physiology

BOT-12104 - Paper 1.4 Microbiology and Plant Pathology

BOT-12105 - Paper 1.5 Lab Course I

Semester-II

BOT-12111 - Paper 2.1 Plant Ecology

BOT-12112 - Paper 2.2 Plant Resource Utilization and Conservation

BOT-12113 - Paper 2.3 Cell and Molecular Biology

BOT-12114 - Paper 2.4 Biochemistry

BOT-12115 - Paper 2.5 Lab Course-II

CHO 101 Students are advised to visit website of UOK to choose one paper/course of 50 marks for CBCS.

Semester-III

BOT-12121 - Paper 3.1 Plant Development and Reproduction

BOT-12122 - Paper 3.2 Cytogenetics

BOT-12123 - Paper 3.3 Taxonomy of Angiosperms

BOT-12124 - Paper 3.4 Lab Course-III (General)

BOT-12125 - Paper 3.5 Advanced Plant Pathology

BOT-12125 - Paper 3.6 Advanced Plant Ecology

BOT-12125 - Paper 3.7 a-Lab Course-III, Advance Plant Pathology-I (Special Paper)

BOT-12125 - Paper 3.7 b-Lab Course-III, Advance Plant Ecology-I (Special Paper)

CHO 102 Students are advised to visit website of UOK to choose one paper/ course of 50 marks for CBCS.

Semester-IV

BOT-12131 - Paper 4.1	Biotechnology and Biometrics
BOT-12132 - Paper 4.2	Plant Morphology and Anatomy
BOT-12133 - Paper 4.3	Seed Biology and Plant Breeding
BOT-12134 - Paper 4.4	Lab Course-IV (General)

Elective paper -

BOT-12135 - Paper4.5	Advanced Plant Pathology-II
BOT-12136 - Paper 4.6	Plant Ecology-II (Arid Zone Ecology)
BOT-12137 - Paper 4.7	(a) Dissertation (Advanced Plant Pathology)
BOT-12137 - Paper 4.7	(b) Dissertation (Advanced Plant Ecology)

Note :- Dissertation will carry 50 marks from special paper.

M.Sc. Botany Semester-I

Paper 1.1. Biology and Diversity of Lower Plants

1.2. Pteridophyta, Gymnosperms and Paleobotany

1.3. Plant Physiology

1.4. Microbiology and Plant Pathology

1.5. Lab Course I

Objectives

1. Provide knowledge of the habitat, morphology, classification, internal structure and life cycle of algae, fungi, bryophytes, pteridophytes and gymnosperms.
2. To prepare the absorption spectrum and determine the photosynthetic pigments.
3. Study about the bioassay and physiological effects of different plant growth regulators.
4. To impart basic understanding of the archaebacteria, eubacteria and viruses, and general account about the immunity, antigens and antibodies.

Paper 1.1 - Biology and Diversity of Lower Plants

Course Code : BOT-12101

Duration of Examination : 3 Hours

Maximum Marks : 100 Marks

Semester Assessment : 70 Marks

Continuous (Internal) Assessment : 30 Marks

Note : The syllabus is divided into five independent units and question paper will be divided into two sections.

There will be two sections A and B in the paper. Section A will be comprised of 10 questions having two questions from each unit having no choice. The weightage of each question is 2 marks hence the total weightage of section A is 20 marks.

In Section B, there will be 10 questions. Two questions from each unit having internal choice. Students have to attempt total 5 questions (one question from each unit). The weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

Unit-I

Phycology : Algae in diversified habitats (terrestrial, fresh water, marine), thallus organization, cell ultra structure, reproduction (vegetative, asexual, sexual). Criteria for classification of algae: pigments, reserve food, flagella. Modern classification.

Unit-II

Salient features of Cynophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta with special reference to *Microcystis, Hydrodictyon, Chara, Drapernaldiopsis, Sargassum, Dictyota, Batrachospermum.* Algal blooms, algal biofertilizers : algae as food, feed and usage in industry.

Unit-III

Mycology : General characters of fungi, substrate relationship in fungi, cell ultra structure, unicellular and multi cellular organization, cell wall composition, nutrition (saprobic, biotrophic, symbiotic), heterothallism, heterokaryosis, parasexuality, recent trends in classification, phylogeny of fungi.

Unit-IV

General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina with special reference to *Pilobolus, Chaetomium, Morchella, Melampsora, Polyporus, Drechslera and Phoma.* Fungi in industry, medicine and as food, mycorrhizae, fungi as biocontrol agents. Usages of fungi as food, medicine and in Industry. Fungi biocontrol agents Micorrhizae.

Unit-V

Bryophyta : morphology, structure, reproduction and life history, distribution, classification, general account of Sphaerocarpales - *Sphaerocarpos,* Jungermaniales-*Porella,* Calobryales-*Calobryum,* Anthocerotales - *Notothylus,* Sphagnales-*Sphagnum,* Polytrichales-*Pogonatum.* Economic and ecological importance.

Suggested Reading

1. Alexopoulus, C.J., Mims. C.W. and Blackwel, M. 1996. Introductory Mycology, John Wiley & Sons Ind.
2. Mehrotra, R.S. and Aneja, R.S. 1998. An Introduction to Mycology, New Age Intermediate Press.
3. Morris, I.1986. An Introduction to the Algae. Cambridge University Press, U.K.

4. Parihar, N.S. 1991. Bryophyta. Central Book Depot, Allahabad.
5. Puri, P. 1980, Bryophytes. Atma Ram & Sons, Delhi.
6. Round, F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.

Hyperlinks of e-books :

https://uou.ac.in/sites/default/files/slm/BSCBO-201.pdf

1.5 I :

Suggested Laboratory Exercises :

Morphological study of representative members of algae, fungi and bryophytes : *Microcystis, Aulosira, Oocysits, Pediastrum, Hydrodictyon, Ulva, Pithophora, Stigeoclonium, Draparnaldiopsis. Closterium, Cosmarium Batrachospermum Chara, Stemonitis, Peronospora, Albugo, Mucor, Pilobolus, Yeast, Emericella, Chaetomium, Pleospora, Morchella, Melampsora, Phallus, Polyporus, Drechslera, Phoma, Penicillium, Aspergillus, Colletotrichum, Plagiochasma, Asterella, Notothylus, Polytrichum, Shaerocarpos, Porella, Calobryum, Sphagnum, Pogonatum.*

Symptomology of some diseased specimens : White rust, downy mildew, powdery mildew, rusts, smuts, ergot, groundnut leaf spot, red rot of sugarcane, wilts, paddy blast, citrus canker, bacterial blight of paddy, angular leaf spot of cotton, tobacco mosaic, little leaf brinjal, sesame phyllody, mango malformation. Study of morphology, anatomy and reproductive structures of bryophytes.

Identification of fungal cultures : *Rhizopus, Mucor, Aspergillus, Penicillium, Emericella, Chaetomium, Drechslera, Curvularia, Fusarium, Phoma, Colletotrichum, Graphiu*

Paper 1.2 - Pteridophyta, Gymnosperm and Paleobotany

Course Code : BOT-12102

	Maximum Marks	: 100 Marks
Duration of Examination : 3 Hours	Semester Assessment	: 70 Marks
	Continuous (Internal) Assessment	: 30 Marks

Note : The syllabus is divided into five independent units and question paper will be divided into two sections.

There will be two sections A and B in the paper. Section A will be comprised of 10 questions having two questions from each unit having no choice. The weightage of each question is 2 marks hence the total weightage of section A is 20 marks.

In Section B, there will be 10 questions. Two questions from each unit having internal choice. Students have to attempt total 5 questions (one question from each unit). The weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

Unit-I

General characters and classification of pteridophyta, Stelar system, Telome theory, Heterospory and origin of seed habit. Introduction to Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

Unit-II

Life history of *Psilotum, Lycopodium, Gleichenia, Isoetes, Botrychium* and *Ophioglossum.*

Unit-III

General characters, classification and economic importance of Gymnosperm, Evolution of Gymnosperm, Distribution in India, Life History of *Ginkgo, Taxus* and *Gnetum.*

Unit-IV

General Characters and life history of fossil gymnosperm *Lyginopteris, Medullosa, Caytonia, Glossopteris, Cycadeoidea, Pentoxylon* and *Cordaites.*

Unit-V

General introduction of Paleobotany, fossilization, types of fossils, Techniques of fossil study, Geological time scale, General characters of fossil members of pteridophyta with special reference to *Horneophyton, Asteroxylon* and *Cladoxylon.* Paleobotany and evolution of vascular plants.

Suggested Reading.

1. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperm New Age International pvt. Ltd., NewDelhi.
2. Parihar, N.S. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad.
3. Singh, M. 1978, Embryology of Gymnosperms, Encyclopaedia of Plant Anatomy. X. Gebruder Bortraeger, Berlin.
4. Sporne, K.K. 1991. The morphology of pteridophytes. B.I. publishing Pvt. Ltd. Mumbai.
5. Stewart, W.N and Rathwell, G.W.1993. Paleobotany and the evolution of plants, Cambridge University press.
6. Sunderrajan, S.2007. Introduction to pteridophyta, New Age International Publishers, New Delhi.

Hyperlinks of e-books :

https://uou.ac.in/sites/default/files/slm/BSCBO-103.pdf

1.5.1 :

Suggested Laboratory Exercises

Morphology and anatomy of vegetative and reproductive part of *Psilotum, Lycopodium, Selaginella, Equisetum, Gleichenia, Isoetes, Ophioglossum, Botrychium, Pteris, Cycas, Ginkgo, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Pedocarpus, Agathis, Taxus, Ephedra and Gnetum* and the members in their natural habitat found in your locality.

Study of important fossil of Pteridophytes and Gymnosperms from specimens.

Paper 1.3 - Plant Physiology

Course Code : BOT-12103

	Maximum Marks	: 100 Marks
Duration of Examination : 3 Hours	Semester Assessment	: 70 Marks
	Continuous (Internal) Assessment	: 30 Marks

Note : The syllabus is divided into five independent units and question paper will be divided into two sections.

There will be two sections A and B in the paper. Section A will be comprised of 10 questions having two questions from each unit having no choice. The weightage of each question is 2 marks hence the total weightage of section A is 20 marks.

In Section B, there will be 10 questions .Two questions from each unit having internal choice .Students have to attempt total 5 questions (one question from each unit). The weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

Unit-I

Water relation of plants : Unique physicochemical properties of water, chemical potential, water potential, apparent free space, bulk movement of water. Soil plant atmosphere continuum (SPAC), stomatal regulation of transpiration, signal transduction in guard cell.

Membrane Transport : Passive-non-mediated transport and Ernst equation, passive-mediated transport, ATP driven active transport, Uniport, Symport, Antiport, Ion channels.

Unit-II

Enzyme: nomenclature, structure, function and mode of action.

Structure of proteins : primary, secondary, tertiary, quaternary domain structure, reverse turn and Ramchandran plot. Protein ability: electrostatic forces, hydrogen bonding, di-sulfide bonding hydrophobic interaction.

Unit-III

Photosynthesis : Photosynthetic pigments, absorption and transformation of radiant energy, photooxidation, four complexes of thylakoid membranes : photo system I, cytochrome b-f complex, photosystem II and coupling factors, photolysis of water and C_4 evolution, noncyclic and cyclic transportation of electrons, proton gradient and photophosphorylation,

calvin cycle regulation of RUBISCO activity. C_4 pathway and its adaptive significance, CAM pathway, differences between C_3 and C_4 plants. Glycolate pathway and photorespiration chlororespiration and CO_2 concentrating mechanism in micro-organism.

Unit-IV

Respiration : Anaerobic and aerobic respiration amphibolic nature of TCA cycles, pentose phosphate pathway, glyoxylate pathway, oxidative phosphorylation, gluconeogenesis, high energy compounds: their synthesis and utilization.

Unit-V

Plant growth regulators : Auxins-chemical nature, bioassay, physiological effects and mode of action.

Chemical nature, bioassay, physiological effect and mode of action of Gibberellins, Cytokinins and Abscisic acid.

N_2 fixation, Abiological, Biological, mechanism of N_2 fixation.

Suggested Reading :

1. Bachanan, B.B. Gruissim, W. and lones, R.L. 2000, Biochemistry and Molecular Biology of Plants. American Society Plant physiologists, Maryland, USA.
2. Dennis, D.T. Turpin, D.H. Lefebvre, D.D. and Layzell, D. (Eds) 1997. Plant Metabolism (second edition). Longman sex, England.
3. Galston, A.W. 1989. Life Processes in Plants. Scientific American, SpringerVerlag. New York, USA.
4. Hooykaas, P.J.J., Hall M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elservier, Amsterdam, The Netherlands.
5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
6. Lodish, II., Berk, A., Zipursky, S.L., Matsudaira P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (fourth edition). W.M. Freeman and Company, New York USA.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. (second edition). Springer-Verlag, New York, USA
8. Nobel, P.S. 1999. Physiochemical and Environmental Plant Physiology (second edition), Academic Press, San Diego, USA.
9. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA.

10. Singhal, G.S. Renger, G., Sopory. S.K., Irrgang, K.D. and Govindjle 1999., Concepts in Photobiology : Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
11. Taiz. I., and Zeiger, E., 1998. Plant Physiology (2nd edition) Sinaucr Associates, Inc., Publishers, Massachusetts, USA.
12. Thomas, B. and Vince-Preu, D. 1997 Photoperiodism in Plants (second edition). Academic Press, San Diego, USA.
13. Westhoff, P. 1998. Molecular Plant Development from Gent to Plant, Oxford University Press, Oxford, U.K.

Hyperlinks of e-books :

https://uou.ac.in/sites/default/files/slm/BSCBO-103.pdf

1.5 II

Suggested Laboratory Exercises :

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. acid phosphatase nitrate reductase).
2. Effect of substrate concentration on activity on any enzyme and determination of its Km value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
5. To determine the chlorophyll a. chlorophyll b. ratio in C3 and C4 Plants.
6. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
7. To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoproteins by SDS-PAGE and perform autoradiography.
8. Extraction of seed proteins depending upon the solubility.
9. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.
10. Desalting of proteins by gel filtration chromatography employing Sephadex.
11. Preparation of the standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry or Bradford's method.
12. Fractionation of proteins using gel filtration chromatography by Sephadex G100 or Sephadex. G200.

13. SDS-PAGE for soluble proteins extracted from the given plant materials and comparison of their profile by staining with Coomassie Briliant Blue or silver nitrate.
14. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.
15. Radioisotope methodology, autoradiography, instrumentation (GM count and Scintillation counter) and principles involve.
16. Principles of colorimetry, spectrophotometry and fluorimetry.

Paper 1.4 - Microbiology and Plant Pathology

Course Code : BOT-12104

Maximum Marks : 100 Marks

Duration of Examination : 3 Hour

Semester Assessment : 70 Marks

Continuous (Internal) Assessment : 30 Marks

Note : The syllabus is divided into five independent units and question paper will be divided into two sections.

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In Section B, there will be 10 questions .Two questions from each unit having internal choice .Students have to attempt total 5 questions (one question from each unit). The weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

Unit-I

Important landmarks in the history of microbiology archaebacteria and eubacteria : General account, ultrastructure, nutrition and reproduction, economic importance, cyanobacteria-salient features and biological importance.

Viruses : Classification, characteristics and ultrastructure of isolation and purification of viruses, chemical nature, replication, transmission of viruses, cyanophages, economic importance.

Phytoplasma : General characteristics and role in causing plant diseases.

Unit-II

General account of immunity, allergy, properties of antigens, antibodies, Antibody structure and function, affinity and antibody specificity. Monoclonal antibodies and their uses, antibody engineering, serology, types of vaccines. Preliminary account of Biofilms, biochips, biosensors and biosurfactants.

Unit-III

History and scope of plant pathology : General account of diseases caused by plant pathogens. Pathogen attack and defense mechanisms Morphological, physiological, biochemical and molecular aspects.

Plant disease management : Chemical, biological, IPM systems, development of transgenics, biopesticides, plant disease clinics.

Unit-IV

Symptomatology, identification and management of following plant diseases.

Fungal diseases : Wheat (Rust, Smut, Bunt), Bajra (Green ear, ergot and smut), crucifer (Rust).

Paddy (Paddy blast), Cotton (Wilt), Grapes (Downy mildew and powdery mildew).

Unit-V

Preliminary account of application of Biotechnology in plant pathology.

Bacterial disease : Wheat (Tundu), Soft rot of vegetables.

Viral disease : Tobacco mosaic, Bhindi yellow mosaic.

Phytoplasma disease : Little leaf of brinjal.

Nematode disease : Root-knot of vegetables.

Suggested Reading :

1. Alexopoulus, C.J., Minis, C.W. and Blackwel, M. 1996 Introductory Mycology. John Wiley & Sons Inc.
2. Agrios, G.N. 1997. Plant Pathology. Academic Press, London.
3. Albajes, R., Cullino, M.L., Van Lenteren, J.C. and Elad, 2000 Integrated Pest and Disease Management in Greenhot Crops. Kiluwel Academic Publishers.
4. Bridge, P. Moore, D.R. & Scotf, P.R. 1998. Information Technology. Plant Pathology and Biodiversity. CAB International, U.K.
5. Clifiton, A. 1958. Introduction to the Bacteria. McGraw Book Co., New York.
6. Mandahar, C.I. 1978. Introduction to plant viruses. Chan Co. Ltd. Delhi.
7. Mehrotar R.S. Plant Pathology. Tata McGraw Hill.
8. Rangaswamy, G. & Mahadevan, A. 1999. Diseases of crop plants in India (4th edition) Prentice Hall of India, Pvt. New Delhi. Horsfall, J.G. & A.L. Dimond. Plant Pathology Vols. 1, 2 & 3. Academic Press, New York, USA.
9. Trivedi, P.C. 1998. Nematode Diseases in Plants, CBS Publisher & Distributor, New Delhi.

Hyperlinks of e-books :

https://uou.ac.in/sites/default/files/slm/BSCBO-101.pdf

1.5 II

Suggested Laboratory Exercises (Microbiology).

1. Calibration of microscope : determination of dimensions of micro-organisms (suggested model organisms : yeast, lactobacilli, cyanobacteria)
2. Cultivation media of autotrophic and heterotrophic micro-organisms (cleaning of glasswares, mineral media, complex media, solid media, sterilization).
3. Isolation of microorganisms, streaking on agar plates/pour plate method, isolation of clones, preservation.
4. Determination of growth of a microorganism (model organism : *Escherichia coli,* effects of nutrients, e.g. glucose, fructose, sucrose, principle of colorimerty/spectrocolorimeter).
5. Determination of microbial population size (suggested model organism yeast, use of haemocytometer, serial dilution techniques, relationship between dilution and cell count, determination of standard error, reliability in cell counts)
6. Preparation of Winogradsky column using pond bottom mud. Observations on temporal sequence of appearance of microbes (visual appearance, microscopic, observations)
7. Observation on virus infected plants (symptoms).
8. Fermentation by yeast (inverted tube method, use of different substrates, e.g. glucose, fructose, cane sugar, starch).

Course Outcomes

1. Knowledge will help to know the diversity, distribution and economic importance of algae, fungi, bryophytes, pteridophytes and gymnosperms.
2. Students will know the principle and working of chromatography, spectrophotometry and fluorimetry.
3. Students will understand about the calibration of microscope and preparation and sterilization of cultivation media for micro-organisms.
4. Awareness about the biopesticides, biological control and Integrated Pest Management.

University of Kota (Kota)
M.Sc. Semester-I (2024-25)
Botany (BOT-12105) Skeleton Paper
1.5 Lab. Course –I

Time : 6 Hrs. **Max Marks : 200**

Q1. Identify the below mentioned Plant material. Draw a labelled diagram. Discuss Systematic position and Characterstics.

(i) Material A (Algae any two) 6 + 6 = 12

(ii) Material B (Fungi) 10

(iii) Material C (Bryophyta) 10

Q2. Make a suitable preparation of given Material to show Veg / Reproductive part of the given Plant material.

(i) Material E (Pteridophyte) 10

(ii) Material F (Gymnosperm) 12

(iii) Material G (Paleobotany) 10

Q3. Perform the Physiological Exercise . Draw a well labelled diagram , Write Principle, Observation and Result.

(i) Major Exercise 20

(ii) Minor Exercise 10

Q4. (i) Perform the Microbiological exercise (A). 15

(ii) Perform the Microbiological exercise (B). 10

Q5. Pathological exercise 10

Q6. Spots 3x7=21

Q7. Record 15

Q8. Seminar 20

Q9. Viva –voce 15

CHO-101 Students are advised to visit website of UOK to Choose one paper/course of 50 marks for CBCS

M.Sc. Botany Semester-II

BOT-12111 - Paper 2.1	Plant Ecology
BOT-12112 - Paper 2.2	Plant Resource Utilization and Conservation
BOT-12113 - Paper 2.3	Cell and Molecular Biology
BOT-12114 - Paper 2.4	Biochemistry
BOT-12115 - Paper 2.5	Lab Course-II

Objectives

1. To determine the diversity indices, soil moisture content and water holding capacity and estimate the IVI of the plant species of study area.
2. Provide knowledge of the world centers of cultivated plants, in-situ and ex-situ strategies for conservation and national and international efforts.
3. Study about the genome organization of chloroplast and mitochondria, RFLP, cytoskeleton and protein sorting.
4. To determine the total soluble carbohydrate, protein, proline, fats and fixed oils in different plant materials.

Paper 2.1- Plant Ecology
Course Code : BOT-12111

Duration of Examination : 3 Hours

Maximum Marks : 100 Marks
- Semester Assessment : 70 Marks
- Continuous (Internal) Assessment : 30 Marks

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In Section B, there will be 10 questions .Two questions from each unit having internal choice .Students have to attempt total 5 questions (one question from each unit). The weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

UNIT – I

Climate, soil and vegetation patterns of the world : Life zones, major biomes, and major vegetation and soil types of the world. Environment – Holistic environment, factors and their interactions, animals and man.

UNIT - II

Vegetation organization : Concepts of community and continuum, analysis of communities (analytical and synthetic characters), community coefficients, interspecific associations, ordination, concept of ecological niche.

Vegetation development : Temporal changes (cyclic and non-cyclic), mechanism of ecological succession (relay floristic and initial floristic composition, facilitation, tolerance and inhibition models), changes in ecosystem, properties during succession.

UNIT – III

Ecosystem organization : Structure and functions, primary production (methods of measurement, global pattern, controlling factors), energy dynamics (trophic organization, energy flow pathways, ecological efficiencies), litter fall and decomposition (mechanism, substrate quality and climatic factors), Concept of global biogeochemical cycles.

Biological diversity : Concept and levels, role of biodiversity in ecosystem functions and stability, speciation and extinction, IUCN categories of threat, distribution and global patterns, terrestrial biodiversity hot spots, inventory.

UNIT – IV

Air, water and soil pollution : Kinds, sources, quality parameters, effects on plants and ecosystems.

Climate change : Greenhouse gases (CO_2, CH_4, N_2O, CFCs : sources, trends and role), ozone layer and ozone hole, consequence of climate change (CO_2 utilization, global warming, sea level rise, UV radiation), carbon sequestration.

UNIT – V

Ecosystem stability : Concept (resistance and resilience), ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems, ecology of plant invasion, environmental impact assessment, ecosystem restoration.

Ecological management : Concepts, sustainable development, sustainability indicators, role of International Union for Conservation of Nature & Natural Resources (IUCN), World Wide Fund for Nature (WWF), UNEP, UNESCO, IGBP etc.

Suggested Readings :

1. Smith, R.L. 1996. Ecology and Field Biology, Harpr Collins, New York
2. Muller-Dombois, D. and Ellenberg, H., 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
3. Begon, M. Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
4. Ludwig. J. and Reynolds, J.F. 1988, Statistical Ecology. John Wiley & Sons.
5. Odum, E.P. 1971. Fundamentals of Ecology, Saunders, Philadelphia.
6. Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
7. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology, Benjamin / Cummings Publication Company, California.
8. Kormondy, E.J. 1996 Concepts of ecology, Prentice- Hall of India Pvt. Ltd., New Delhi.
9. Chapman, E.J. and Reiss, M.J. 1988. Ecology, Principles and Applications, Cambridge University Press, Cambridge, U.K.
10 .Molan, B. and Billharz, S. 1997. Sustainability Indicators, John Wily Sons, New York.
11. Treshow, M. 1985. Air Pollution and Plant Life, Wiley Interscience.
12. Heywood, V.H. and Watson, R.T. 1985. Global Biodiversity Assessment, Cambridge University Press.
13 .Mason, C.F. 1991. Biology of Freshwater Pollution, Longman.
14. Hill, M.K. 1997. Understanding Environmental Pollution, Cambridge University Press.
15. Brady, N.C. 1990. The Nature and Properties of Soils, Macmillan

Hyperlinks of e-books :

https://uou.ac.in/sites/default/files/slm/BSCBO-203.pdf

2.5-I

Suggested Laboratory Exercises :

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use t-test for comparing two means related to ecological data.
2. To prepare ombrothermic diagram for different sites on the basis of given data set and to comment on climate.
3. To find out the relationship between two ecological variables using correlation and regression analysis.
4. To determine minimum size and number of quadrats required for community study.
5. To find out association between important grassland species using chisquare test.

6. To compare protected and unprotected grassland stand using community coefficients (similarity indices).
7. To analyze plant communities using Bra-Curtis ordination method.
8. To determine diversity indices (Shannon – Wiener, concentration of dominance, species richness, equitability and biodiversity) for protected and unprotected grassland stands.
9. To estimate IVI of the species in a woodland using point centered quarter method.
10. To determine gross and net phytoplankton productivity by light and dark bottle method.
11. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
12. To determine the Water holding capacity of soils collected from different locations.
13. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.
14. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Wrinkler's method.
15. To estimate chlorophyll content in SO_2 fumigated and unfumigated plants leaves.
16. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
17. To study environmental impact of a given developmental activity using checklist as a EIA method.

Paper 2.2-Plant Resource Utilization and Conservation

Course Code : BOT-12112

Maximum Marks : 100 Marks

Duration of Examination : 3 Hours

Semester Assessment : 70 Marks

Continuous (Internal) Assessment : 30 Marks

Note : The syllabus is divided into five independent units and question paper will be divided into two sections.

There will be two sections A and B in the paper. Section A will be comprised of 10 questions having two questions from each unit having no choice. The weightage of each question is 2 marks hence the total weightage of section A is 20 marks.

In Section B, there will be 10 questions .Two questions from each unit having internal choice. Students have to attempt total 5 questions (one question from each unit). The

weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

UNIT–I

Plant Diversity : Concept, status in India, utilization and concerns.

Sustainable Development : Basic Concepts, origin of agriculture.

World Centers of primary diversity of domesticated plants : According to vavilov, the Indo-Burmese center, plant introduction and secondary centers.

UNIT–II

Cultivation and uses : Fodder, Fiber, medicinal and vegetable oil yielding crops of Rajasthan.

Important firewood and timber yielding plants and non wood forest products (NWFPs) such as bamboos, rattans, raw materials for paper making, gums, dyes, and fruits.

UNIT–III

Green revolution : Benefits and adverse consequences, innovations for meeting world food demands.

Plants used as avenue trees for shade, pollution control and aesthetics : Principles of conservation, environmental status of plants based on IUCN.

UNIT–IV

Strategies for conservation – in situ conservation : International efforts and Indian initiatives, protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs conservation of wild biodiversity.

UNIT–V

Strategies for conservation – ex situ conservation : Principles and practices, botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks, general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources [NBPGR], Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR) and the Department of Biotechnology (DBT) for conservation.

1. Anonymous 1997. National Gene Bank : Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
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3. Baker, H.G. 1978. Plants and Civilization (3rd edn.) C.A. Wadsworth, Belmont.
4. Bole, P.V. and Vaghani, Y. 1986. Field Guide to Common Indian Trees. Oxford University Press, Mumbai.
5. Chandel, K.P.S., Shukla, G. and Sharma, N. 1996. Biodiversity in Medicinal and Aromatic Plans in India: Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.
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10. Conway, G.and Barbief, E. 1994. Plant. Genes and Agriculture. Jones and Bartlett Publishers, Boston.
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14. Directory of Indian Wetlands, 1993. WWF INDIA, New Delhi and AWB, Kuala Lumpur.
15. Falk, D.A., Olwel, M. and Millan C. 1996. Restoring Diversity, Island Press. Columbia, USA.
16. FAO/IBPGR 1989. Technical Guidelines for the Safe Movement of Germplasm. FAO/IBPGR, Rome.
17. Frankel, O.H., Brown, A.H.D. and Burdon, J.J. 1995. The Conservation of Plant Diversity. Cambridge University Press, Cambridge, U.K.
18. Gadgil, M. and Guha, R. 1996. Ecology and Equity: Use and Abuse of Nature in Contemporary India. Penguin, New Delhi.
19. Gaston, K.J. (Ed.) Biodiversity: a Biology of Numbers and Differences. Blackwell Science Ltd., Oxford, U.K.
20. Heywood, V. (Ed). 1995 Global Biodiversity Assessment. United Nations Environment

Programme. Cambridge University Press, Cambridge, U.K.

21. Heywood, V.H, and Wyse lackn, P.S. (Eds) 1991. Tropical Botanical Gardens. Their Role in Conservation and Development. Academic Press, San Diego.
22. Kocchar, S.L. 1998. Economic Botany of the Tropics, 2nd edition. Macmillian India Ltd., Deihi.
23. Kothari, A. 1997. Understanding Biodiversity: Life Sustainability and Equity. Orient Longman.
24. Kohli, R., Arya, K.S., Singh, P.H. and Dhillon, H.S. 1994. Tree Directory of Chandigarh. Lovdale Educational, New Delhi.
25. Nair, M.N.B. et. al. (Eds.) 1988. Sustainable Management of Nonwood Forest Products. Faculty of Forestry, University Putra Malaysia. 43004 PM Serdong. Selangor, Malaysia.
26. Paroda, R.S. and Arora, R.K. 1991. Plant Genetic Resources Conservation and Management. IPGRI (Pubiication) South Asia Office, C/o NBPGR. Pusa Campus, New Delhi.
27. Pimentel, D. and Hall, C.W. (Eds.) 1989. Food and Natural Resources, Academic Press, London, New York.
28. Pinstrup-Anderson, P. et. al. 1999. World Food Prospects: Critical Issues for the Early 21st Century. International Food Policy Research Institute. Washington, D.C., USA.
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34. Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. 1.td., New Delhi.
35. Swaminathan, M.S. and Kocchar, S.L. (Eds.) 1989. Plants and Society. Macmillan Publication Ltd., London.
36. Thakur, R.S., Puri, H.S.and Husain, A. 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.
37. Thomas, P. 2000. Trees: Their National History. Cambridge University Press, Cambridge.

38. Wanger, H., Hikino, H. and Farnswarth, N. 1989. Economic and Medicinal Plant Research. Vols. 1-3. Academic Press, London.
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Hyperlinks of e-books :

https://www.uou.ac.in/sites/default/files/slm/MSCBOT-603.pdf

2.5-I

Suggested Laboratory Exercises The Practical course is divided into three units :

(1) Laboratory work, (2) Field survey and (3) Scientific visits. **Laboratory Work**

1. Forge/fodder crops : Study of any five important crops of the locality (for example fodder sorghum, bajra, berseem, clove, guar bean, gram, *Ficus* sp.)
2. Plant fibers :

(a) Textile fibres : cotton, jute, linen, sunn hemp, *Cannabis.*

(b) Cordage fibres : coir

(c) Fibres for stuffing : silk cotton or kapok.

Morphology, anatomy, (microscopic) study of whole fibres using-appropriate staining procedures.

3. Medicinal and aromatic plants : Depending on the geographical location college/ university select five medicinal and aromatic plants each from a garden crop field (or from the wild only if they are abundantly available).

Papaver somniferum, Atropa belladonna, Catharanthus roseus. Adhatoda zeylanica, (syn A. vasaca) Allium sativum, Rauwolfia serpentina, Withania somnifera, Phyllanthus amarus, (P. fraternus), Andrographis paniculata, Aloe barbadens, Mentha arvensis. Rosa sp., Pogostemon cablin, Origanum vulgare, Vetiveria zizanioides. Jasminum grandiflorum, Cymbopogon sp., Pandanus odoratissimus.

Study of live or herbarium specimens or other visual materials, to become familiar with these resources.

4. Vegetaible oils : Mustard, groundnut, soyabean, coconut, sunflower, castor, Morphology, microscopic structure of the oil-yielding tissues, tests for oil and iodine number.

5. Gums, resins, tannins, dyes : Perform simple tests for gums and resins. Prepare a water extract of vegetable tannins *(Acacia, Terminalia, mangroves, tea, Cassia spp., Myrobalans)* and *dyes (Curcuma longa, Bixa orellana, Indigofera sps., Butea monosperma, Lawsonia inermis)* and perform tests to understand their chemical nature.

Field Survey

6. **Firewood and timber yielding plants and NWF's :**

(a) Prepare a short of 10 most important sources of firewood and timber in your locality. Give their local names, scientific names, and families to which they belong. Mention, their properties.

(b) Prepare an inventory of the bamboos and rattans of your area giving their scientific and local names and their various uses with appropriate illustrations.

(c) A survey of a part of the town or city should be carried out by the entire class, In batches, Individual students will select one avenue/road and locate the trees planted on a graph paper. They will identify the trees, mention their size, canopy shape, blossoming and fruiting period and their status (healthy, diseased, infested, mutilated, misused or dying) and report whether or not the conditions in which they are surviving are satisfactory. The individual reports will be combined to prepare a larger map of the area, which can be used for subsequent monitoring either by the next batch of students/teachers/local communities/NGOs/or civic authorities. The purpose of exercise in item C above is to make the students aware of the kinds of trees and value in urban ecosystems and ecological services.

Scientific Visits

The students should be taken to one of the following :

Paper 2.3-Cell and Molecular Biology

Course Code : BOT-12113

Duration of Examination : 3 Hours

Maximum Marks : 100 Marks
Semester Assessment : 70 Marks
Continuous (Internal) Assessment : 30 Marks

Note : The syllabus is divided into five independent units and question paper will be divided into two sections.

There will be two sections A and B in the paper. Section A will be comprised of 10 questions having two questions from each unit having no choice. The weightage of each question is 2 marks hence the total weightage of section A is 20 marks.

In Section B, there will be 10 questions .Two questions from each unit having internal choice .Students have to attempt total 5 questions (one question from each unit). The weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

Unit-I

The dynamic cell : Structural organization of the plant cell, specialized plant cell types, chemical composition, biochemical energetics.

Cell wall : Structure and functions, biogenesis, growth.

Plasma membrane : Structure, models and functions, sites for ATPases, ion carriers, channels and pumps, receptors.

Plasmodesmata : Structure, role in movement of molecules.

Unit-II

Chloroplast : Structure, genome organization, gene expression, RNA editing, nucleochloroplastic interactions.

Mitochondria : Structure, genome organisation, biogenesis.

Plant vacuole : Tonoplast membrane, ATPase, transporters as storage organelle.

Nucleus : Structure, nuclear pores, nucleosome organization, DNA structure-A, B and Z forms, DNA replication, damage and repair, transcription, plant promoters and transcription factors, mRNA Transport, Nucleolus, rRNA Biosynthesis.

Unit-III

Restriction enzymes : Cleavage of DNA into specific fragments, construction of a restriction map from the fragments, restriction sites as genetic markers, RFLP and their use in plant breeding.

Ribosomes : Structure, Protein synthesis, mechanism of translation, initiation, elongation and termination, structure and role of tRNA.

Unit-IV

Protein sorting : Targeting of proteins to organelles.

Cell shape and motility : The cytoskeleton, organization and role of microtubules and microfilaments, motor movements, implications in flagellar and other movements.

Cell cycle and apoptosis : Control mechanisms, role of cyclins and cyclindependent kinases, retinoblastoma and E2F proteins. Cytokinesis and cell plate formation, mechanisms of programmed cell death.

Unit-V

Other Cellular organelles : Structure and functions of microbodies, Golgi apparatus, Lysosomes, Endoplasmic Reticulum (ER).

Techniques in cell biology : Immunotechniques, insitu hybridization to locate transcripts in cell types, (FISH, GISH), confocal microscopy.

Suggested Readings :

1. Lewis, B. 2000 Genes VII. Oxford University Press, New York.
2. Alberts, B., Bray, D. Lewis, J., Raff, M., Roberts, K and Watson, J., 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.
3. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing USA.
4. Rost, T, etal. 1998. Plant Biology. Wadsworth Publishing Co., California USA.
5. Krishnamurthy, K.V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
6. Buchanan, B.B., Gruissem, W., and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists. Maryland, USA.
7. De, D.N. : 2000. Plant Cell Vacuoles : An Introduction. CSIRO Publication Collingwood, Australia.

8. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York USA.
9. Lodish, H., Berk, A. Zipursky, S.L. Matsudaira, P., Baltimore D. and Darnell, J. 2000. Molecular Cell Biology (4th Edition) W.H. Freeman and Co., New York, USA.

See the following Review Journals

Annual Review of Plant Physiology and Molecular Biology.

Current Advances in Plant Sciences.

Trends in Plant Sciences.

Nature Reviews : Molecular and Cell Biology.

Hyperlinks of e-books :

https://www.uou.ac.in/sites/default/files/slm/BSCBO-301.pdf

2.5-II

Suggested laboratory Exercises

1. Isolation of mitochondria and the activity of its marker enzyme succinate dehydrogenase (SDH).
2. Isolation of chloroplasts and SDS-PAGE profile, of proteins demarcate the two subunits of Rubisco.
3. Isolation of nuclei and identification of histones by SDS-PAGE.
4. Isolation of plant DNA and its quantitation by spectrophotometric method.
5. Isolation of DNA. And preparation of 'cot' curve.
6. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
7. Isolation of RNA and quantitation by a spectrophotometric method.
8. Separation of plant RNA by agarose gel electrophoresis and visualization by EtBr staining.
9. Southern blot analysis using a gene specific probe.
10. Northern bolt analysis using a gene specific probe.
11. Immunological techniques : Ouchterlony method, ELISA and western blotting.
12. Fluorescence staining with FDA for cell viability and cell wall staining with calcofluor.
13. Demonstration of SEM and TEM.

Note : Chemicals and kits for conducting some of the above molecular biology experiments are available in India, for example from M/s Bangalore Genei and Centre for Biotechnology (CSIR) Mall 'Road, Delhi.'

Suggested Reading (For laboratory exercises)

1. Glick, B.R. and Thompson, J.E. 1993, Methods in Plant Molecular, Biology and Biotechnology, CRC Press, Boca Raton, Florida.
2. Glover, D.M. and Hames, B.D. (Eds.), 1995. DNA Cloning 1: A Practical Approach, Core techniques. 2nd edition. PAS, IRL Press at Oxford University Press, Oxford.
3. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology : Structure and Function Jones and Bartlett Publishers, Boston, Massachusetts.
4. Hackett, P.B., Fuchs, J.A.and Messing, J.W. 1988. An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin Cummings Publishing Co. Inc. Menlo Park, California.
5. Hall, J.E. and Moore, A.L. 1983. Isolation of Membranes md Organelles from Plant Cells. Academic Press, London, U.K.
6. Harris, N and Oparka, K.J. 1994, Plant Cell Biology : A Practical Approach, IRL Press, at Oxford University Press, Oxford, U.K.
7. Shaw C.H. (Ed.), 1988. Plant Molecular Biology : A Practical Approach IRL press, Oxford.

Paper 2.4-Biochemistry

Course Code : BOT-12114

Duration of Examination : 3 Hours

Maximum Marks : 100 Marks
Semester Assessment : 70 Marks
Continuous (Internal) Assessment : 30 Marks

Note : The syllabus is divided into five independent units and question paper will be divided into two sections.

There will be two sections A and B in the paper. Section A will be comprised of 10 questions having two questions from each unit having no choice. The weightage of each question is 2 marks hence the total weightage of section A is 20 marks.

In Section B, there will be 10 questions .Two questions from each unit having internal choice .Students have to attempt total 5 questions (one question from each unit). The weightage of each question is 10 marks hence the total weightage of the section B is 50 marks.

Unit-I

Energy flow : Principles of thermodynamics, free energy and chemical potential, redox reactions, structure and functions of ATP.

Enzyme : Discovery and nomenclature, characteristics of enzyme, concept of holozymes, apozymes, coenzyme, ribozyme, abzyme and artificial enzyme, regulation of enzyme activity, mechanism of enzyme action and Michaelis-Menten equation.

Unit-II

Carbohydrates Metabolism: Classification, structure and function of monosaccharides, disaccharides, polysaccharides and glycoproteins including starch, cellulose and pectins.

Unit-III

Amino acids, Proteins and Nitrogen Metabolism : Nod factor, root nodulation, structure of amino acids, stereo-monomers, Amphoteric properties, synthesis of amino acids by reductive amination, GS-GOGAT system and transamination.

Unit-IV

Lipid metabolism : Structure and function of lipids, fatty acid biosynthesis, synthesis of membrane lipids, structural lipids storage and their catabolism. Sulphur metabolism : sulphur uptake, transport and assimilation.

Unit-V

Biomolecules : General structure, classification properties, distribution, biosynthesis and function of primary metabolites (carbohydrates, proteins, amino acids, lipids) and secondary metabolites (flavonoids, alkaloids, steroids etc).

Suggested Reading :

1. Dennis, D.T. Turpin, D.H. Lefebvre, D.D. and Layzell, D. (Eds) 1997. Plant Metabolism (second edition). Longman sex, England.
2. Hooykaas, P.J.J., Hall M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elservier, Amsterdam, The Netherlands.
3. Westhoff, P. 1998 Molecular Plant Development from Gent to Plant, Oxford University Press, Oxford, U.K.
4. Taiz. L and Zeiger, E. 2006. Plant Physiology, 4th Edition, Sinauer Associates, Inc., Publishers, Massachusetts, USA.
5. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology. Asia Ltd. Singapore.
6. Devlin, R.M. and Witham, F.H. 1986. Plant Physiology, 4th Ed. CBS Pub. Delhi.

7. Voet, D and Voet J.G. 1995. Plant Biochemistry, John wiley, New York.
Lehnenger, A.L. 1982. Principles of biochemistry, CBS Publication.

Hyperlinks of e-books :

https://uou.ac.in/sites/default/files/slm/BSCBO-303.pdf

2.5-II

Suggested Laboratory Exercises :

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. acid phosphatase nitrate reductase)
2. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.
3. Principles of colorimetry, spectrophotometry and fluorimetry.
4. Estimation of Lipids
5. Separation of chlorophyll by paper chromatography.
6. Separation of amino acids by paper chromatography.
7. Separation of chlorophyll by HPLC.
8. Test of phenols, alkaloids and terpenoids.
9. Isolation of VAM fungi.
10. Determination of amylase activity
11. Separation of aliphatic wax components by thin layer chromatography (TLC)
12. Isolation of root nodule bacteria from roots of legume plant.
13. Quantification of protein in given plant sample.
14. Quantification of carbohydrates in given sample.
15. The effect of temperature on enzyme activity.
16. The effect of pH on enzyme action.
17. To determine total soluble carbohydrates in given plant material.
18. To determine proline in given plant material.

Course Outcomes

1. Course will provide knowledge about the major vegetation and soil types of the world, effect of climate change and important organisation of world related to environmental conservation.
2. Aware about the sustainable utilization and conservation of nature and natural resources.

3. Students will Perform the molecular biology exercises and will know about the different molecular techniques.
4. Students will learn about the phytochemical analysis and different metabolism pathways (Carbohydrates, proteins, amino acids, lipid and nitrogen).

M.Sc. Semester-II (2024-25)
Botany (BOT-12115) Skeleton Paper
2.5 Lab. Course –II

Time : 6 Hrs. **Max. Marks : 200**

1. (a) Calculate the quantitative characters of the plant community by quadrat method in college campus. 20

   (b) To investigate the water content/air content/soil particles in given various samples. 10

   Or

   Investigate the pH/chloride content/oxygen content in given water sample.

2. (a) Identify any two materials from the given samples. Give economic importance with special reference to origin, cultivation, part used and processing, if any. 20

   (b) Mark the highest yield producing areas in the map (Rajasthan/India) provided to you 14

   Or

   Mark the area of centre of origin of cultivated plants according to Vavilov.

3. Perform the given exercise of Cell biology 15
4. Perform the given exercise of Molecular biology. 15
5. Perform exercise of Biochemistry in the given sample.

   (a) Estimation 20

   (b) Biochemical test 15
6. Spots 7x3= 21
7. Record 15
8. Seminar/Project/Field excursion 20
9. Viva Voce 15