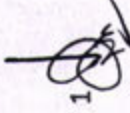
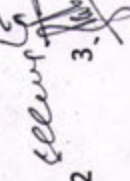
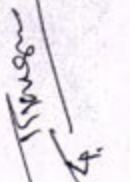
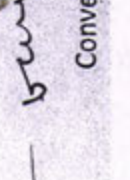
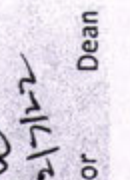
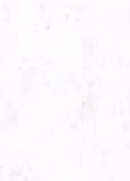
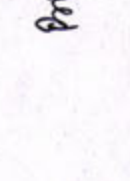
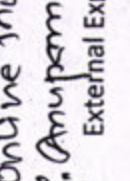
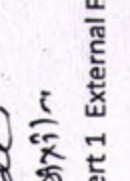
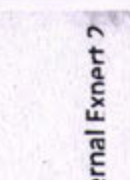
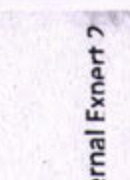


Bundelkhand University, Jhansi

Board of Studies

In accordance with NEP-2020

S.No	BOS member	Name of Course	M.Sc.	Subject	Revision of Syllabus (mentioned in percentage)	Credit Course	Non Credit Course	multidisciplinary Courses	Vocational/Skilled Orientation course	Number of value added course with title(Semester wise)
1	Dr. H.D. Bhattiya	Associate Professor	New NEP Syllabus	25-30%	100	—	—	08	04	Semester III 1. Industrial
2	Dr. Satya Prakash Gupta	Asst. Prof.	"		Sem I-28 Sem II 24	—	—			Microbiology 2. Mushroom
3	Dr. Praveen Kumar	Asst. Prof.	"		Sem III 24 Sem IV 24	—	—			Cultivation Technology
4	Dr. Raj Kumar Verma	Asst. Prof.	"		100	—	—			3. Pharmacognosy Semester IV
5	Prof. Anupam Dixit	Professor Allahabad University	"		96 Credit Subject	—	—			1. Herbal Science
6	Prof. Arinash Tiwari	V.C. Jiwaji University	"		04 Credit Minor	—	—			2. Horticulture & Land Scaping
7	Dr. V.K. Yadav Convenor	Associate Prof.	"							
Comments External Expert joined the BOS through online mode										

Internal members 1  2  3  4  5  6  7  8  9  10  11 

Online mode
Prof. Anupam Dixit
External Expert 1 External Expert 2

Convenor Dean

BUNDELKHAND UNIVERSITY, JHANSI (UP)

Curriculum of

M.Sc. BOTANY

Choice Based Credit System (CBCS)

Online attended

(Prof. Anupam Dixit)

Subject expert

[Signature]
(Prof. Avinash Tiwari)

Subject expert

[Signature]
(Dr. R.K. Verma)

Invitee Member

[Signature]
(Dr. Praveen Kumar)

Member

[Signature]
(Dr. S.P. Gupta)

Member

[Signature]
(Dr. H.D. Bhartiya)

Member

[Signature]
(Dr. V.K. Yadav)

Convenor

Bundelkhand University, Jhansi UP 284128

M.Sc. BOTANY (CBCS) 2022-24

Course Structure and Scheme of Examination

As per NEP: 2020

FIRST SEMESTER										
Semester	Course Code	Title of Paper (s)	Course Type	Credit				Marks		
				L	T	P	Total	IA	EA	Total
FIRST	BOT-1001-C	Cell and Molecular Biology	C	4	-	-	4	25	75	100
	BOT-1002-C	Phycology and Bryology	C	4	-	-	4	25	75	100
	BOT-1003-C	Mycology	C	4	-	-	4	25	75	100
	BOT-1004-C	Microbiology	C	4	-	-	4	25	75	100
	BOT-1005-P	Practical-1 C-1 & C-2	CP		-	2	2	13	37	50
	BOT-1006-P	Practical-2 C-3 & C-4	CP		-	2	2	13	37	50
	BOT-1007-M	Minor Course	OE	4	-	-	4	25	75	100
	BOT-1008-T	Research Project / Industrial Training / Survey	T	4	-	-	4	25	75	100
	Total				24	-	4	28	176	524
MINOR COURSE (Compulsory* and chose any One)										
1. Indian Constitution										
2. Climate Change and Environmental Degradation										
3. Medicinal and Aromatic plants, cultivation, extraction and nutraceutical values										
4. Disaster mitigation and management										
C: Core / E: Elective / P: Practical / M: Minor / T: training, Survey, Project / L: Lecture / T: Tutorial / E: Elective / EP: Elective Practical / IA : Internal Assessment / EA: External Assessment										

SECOND SEMESTER											
Semester	Course Code	Title of Paper (s)	Course Type	Credit				Marks			
				L	T	P	Total	IA	EA	Total	
SECOND	BOT-2001-C	Pteridophytes, Gymnosperms and palaeobotany	C	4	-	-	4	25	75	100	
	BOT-2002-C	Plant Physiology and Biochemistry	C	4	-	-	4	25	75	100	
	BOT-2003-C	Genetics, Cytogenetics and Biostatistics	C	4	-	-	4	25	75	100	
	BOT-2004-C	Morphology, Anatomy and Embryology of angiosperms	C	4	-	-	4	25	75	100	
	BOT-2005-P	Practical-1 C-1 & C-2	CP	-	-	2	2	13	37	50	
	BOT-2006-P	Practical-2 C-3 & C-4	CP	-	-	2	2	13	37	50	
	BOT-2007-T	Research Project / Industrial Training / Survey			4	-	-	4	25	75	100
	Total				20		4	24	151	449	600
C: Core / E: Elective / P: Practical / M: Minor / T: training, Survey, Project / L: Lecture / T: Tutorial / E: Elective / EP: Elective Practical / IA : Internal Assessment / EA: External Assessment											

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As per NEP: 2020

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SEMESTER I CORE COURSE
CORE COURSE- CELL AND MOLECULAR BIOLOGY
COURSE CODE- BOT 1001-C CREDITS: 4 MARKS: EA.75+IA.25=100

Objective

- To understand the structure and function of basic components of prokaryotic and eukaryotic cells, especially its membrane organization and organelles.
- To introduce to rapid contemporary changes witnessed in plant molecular biology.
- To analysis the basic organization of genetic material and the realms of events associated with replication and gene expression will be examined.
- To understand the molecular mechanism of gene regulation and gene expression.

UNIT I Cell and Cell organelles

General account of Prokaryotic and Eukaryotic Cell, Cell wall, plasma membrane. Ultra structure, Chemistry and Functions of Mitochondria, Dictyosomes, lysosomes, endoplasmic reticulum, ribosomes, peroxisomes, Glyoxysomes, vacuoles, chloroplast, Nucleus – history, Ultrastructure, chemistry and functions of cytoskeleton and its role in motility. Structure and functions of Nucleolus—importance of nucleolus in cell division.

UNIT II Chromosomes and Cell Cycle

Chromosomes: Types, Fine structure of eukaryotic chromosome, chemistry –Kinetochore, chromomeres, satellite chromosome, Euchromatin and Heterochromatin, Special types of chromosomes – lampbrush chromosome, polytene chromosome. Karyotype analysis. Cell reproduction, events of the eukaryotic cell cycle, variations in cell-cycle organization, cell cycle control system. Model organisms in cell cycle analysis. Mitotic inducers and inhibitors, variations in mitosis and meiosis.

UNIT III Cell Signaling

Hormones and their receptors, Cell surface receptors, signalling through G – Protein, coupled receptors, signal transduction pathways, second messengers, regulation of signalling pathways, Light signalling in plants. Ion Channel –Leaked receptors, Enzyme linked receptors, Cytoplasmic and Nuclear receptors.

UNIT IV DNA Replication

DNA Replication: Methods of replication, various enzymes involved, Replication origin and replication fork, Fidelity of replication, extra-chromosomal replicons. Repair and Recombination: DNA damage and repair mechanisms. RNA synthesis and processing– Transcription mechanism - Factors - Formation of initiation complex, Transcription activator and repressor, RNA polymerases, Capping, Elongation. RNA processing – RNA editing, Splicing and polyadenylation, structure and function of different types of RNA, RNA transport, Transcription inhibitors, post-transcriptional modification of gene.

UNIT V Transcription and Gene Regulation

Protein synthesis and processing – Genetic code, properties, codon assignment and wobble hypothesis, Ribosome, Formation of Initiation complex, Initiation factors and their regulation complex, Elongation and Elongation factors, Termination, Amino acylation of tRNA, tRNA identity, tRNA synthetase, Proof reading, Translational inhibitors, Post-translational modification of proteins. Gene Regulation – Operon concept: Trp Operon and Ara Operon.

Outcome of the course

Students will gain knowledge about the basic and fundamental organization of life and genetic material and their applications in molecular aspects.

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Suggested Laboratory exercises

Cell Biology

1. Study of the microscope.
2. Study of the size and shape of the cell.
3. Staining and study of flagellum.
4. Isolation of mitochondria and chloroplast (Demonstration).
5. Study of chloroplasts.
6. Cytoplasmic streaming.
7. Study of cell division – Mitosis (*Allium* and *Vicia*)
8. Study of cell division - Meiosis (*Allium cepa*, *Helianthus*, *Tradescantia* flower buds).
9. Measurement of meiosis chromosomes and comparison of their sizes.
10. Karyotype analysis – preparation of ideogram.
11. Study of special types of chromosomes.
12. Study of chromosome aberration like ring, anaphase bridges etc.
13. Camera-Lucida diagrams of chromosome.
14. Study of ultra structure of various cell organelles from electron micrographs.
15. Collection, fixation and preparation of paraffin blocks of materials.
16. Microtomy and staining of the slides by various methods.

Molecular Biology

1. Preparing Buffer solutions and pH determinations; Centrifugation techniques
2. DNA extraction from plant material.
3. Isolation of plasmid DNA from microbes.
4. Separation of plant genomic DNA by electrophoresis
5. Separation of plant proteins by vertical electrophoresis.
6. Southern blotting (Demonstration)
7. Western blot detection of proteins (Demonstration)

Suggested reading:

1. David R Hyde. 2010. Genetics and Molecular biology. Special Indian edition, Tata Mc Graw Hill P.Ltd., New Delhi.
2. Gerald Karp. 2010. Cell and Molecular Biology (6th edn). John Wiley and Sons Inc. ISBN – 13 978-0-470-48337-4.
3. Klein Smith, L. J. and V. M. Kish. 1995. Principles of Cell and Molecular Biology (2nd edition). Harper Collins College Publishers, New York, USA.
4. 4. Peter H. Raven, George B. Johnson Jonathan B. Losos, Kenneth A. Mason and Susan R. Singer. 2008. Biology. (8th Edition).
5. Alberts, B. and D. Bray, J. Lewis, M. Raff, K. Roberts and J. D. Watson. 1999. Molecular Biology of Cell. Garland Publishing, Inc., New York.
6. David Freifelder. 2008. Essentials of Molecular Biology. Narosa Publishing house. New Delhi.
7. Krishnamurthy, K. V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
8. Lewin, B. 2000. Genes VII. Oxford University Press, New York. M.Sc., Botany: Syllabus (CBCS)
9. Wolfe. S. L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.
10. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). The world of the cell (6th edn). Pearson.
11. Geoffrey M Cooper, Robert E Hausman (2009). The Cell: A molecular approach (5th edn). Sinauer.
12. Gerald Karp (2008). Cell and Molecular biology: Concepts and experiments (5 edn). John Wiley & Sons.
13. Allison.A. 2007. Fundamental Molecular Biology. Blackwell Publishing, UK.
14. H. Lodish et al. 2012. Molecular Cell Biology, 7th Ed. W.H Freeman and Company,

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15. De Robertis & De Robertis, 2004. Cell and Molecular Biology. Williams and Wilkins. USA.
16. Freifelder, 1990. Molecular Biology, Narosa Publishing House, New Delhi.
17. Mary A. Schuler Raymond and E. Zrelinski, 2005. Methods in Plant Molecular Biology, Academic Press an imprint of Elsevier.
18. Peter Porella, 1998. Introduction to Molecular Biology, Mc Graw – Hill, New York.
19. Rastogi, S.C. 2010. Cell Biology. New age International Pub. New Delhi.
20. Watson Baker Bell, Gana Levine Losick, 2004. Molecular Biology of the gene, Pearson Education.
21. Daniel L Hartl, Elizabeth W Jones (2012). Genetics: Analysis of genes and genomes (VII Edn). Jones and Bartlett publishers.
22. Geoffrey M. Cooper and Robert E. Hausman 2015. The Cell: A Molecular Approach. 7th edn. Sinauer Associates is an imprint of Oxford University Press.

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SEMESTER - I CORE COURSE
CORE COURSE - PHYCOLOGY AND BRYOLOGY
COURSE CODE: BOT1002C CREDITS: 4 MARKS: (EA.75+IA.25=100)

Objectives

- To understand the salient features and economic importance of algal diversity
- To study the structure and reproduction of various genera mentioned in the field of lower plants.
- To familiarize the salient features and economic importance of Bryophytes

Unit – I

Classification and general characters of Algae, Contributions of Indian Phycologist, Criteria for algal classification, F.E. Fritch classification of algae, Range of thallus organization, Algae of diverse habitats, Algal pigments and its significance in classification, ultra-structure of flagella, eyespot and pyrenoids, Algal reproduction- (vegetative, asexual and sexual), life cycles and molecular phylogeny of algae, fossil algae.

Unit -II

Study of Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, and Rhodophyta up to the order level with reference to following genera- *Anabaena*, *Oscillatoria*, *Bulbochaete*, *Cladophora*, *Pithophora*, *Nitella*, *Navicula*, *Ectocarpus* and *Batrachospermum*. General characteristic of Cryptophyceae, Dinophyceae, Euglenophyceae and Chrysophyceae.

Unit – III

Useful and harmful aspects of Algae, Algae as source of food for human, animal feed, Nutraceuticals, Pharmaceuticals, biofuel, bio-ethanol, bio fertilizers, and industrial applications of algae. Role of algae in global climate regulation: carbon concentration and sequestration mechanisms including calcification; DMSP and DMS production, pollution indicator, bioremediation and soil fertility. Mass cultivation of algae- seaweed cultivation methods - Rope cultivation, net cultivation and raft cultivation. Microalgae Culturing techniques and photo bioreactor-based production; downstream processing. heterotrophic production. Algal blooms – triggering factors, dynamics of bloom formation, Bloom control measures and algal toxins. Phycoviruses

Unit- IV

General introduction of Bryophytes including broad outline of classification and evolutionary trends. Distribution of the group in India, general features and adaptation to land habit. Origin and evolution of gametophyte and sporophyte generation. Endemism and endemic liverwort genera of India. Bryophyte ecology, Moss protonema, protonemal differentiation and bud induction. Regeneration in bryophytes. Economic uses, chemistry of bryophytes, fossil history. Hepaticopsida / Marchantiophyta: distribution: General characteristics, morphology, anatomy and life history of Marchantiales: *Plagiochasma*, *Asterella*, *Cryptomitrium*, *Targionia*, *Cyathodium*; Sphaerocarpaceae: *Sphaerocarpus*, *Riella*; Calobryales: *Calobryum*, Metzgeriales: *Riccardia*, *Metzgeria*, Jungermanniales: *Porella*, *Frullania*, etc.; Treubiales: *Apotreubia*

Unit –V

Anthocerotophyta: distribution: Global and Indian, general features, Morphology, anatomy and life history of Anthocerotales: *Anthoceros*, *Notothylas* etc. Bryopsida/Musci: distribution: Global and Indian, general features, morphology and anatomy, life history of Sphagnales: *Sphagnum*, Andreaeales: *Andreaea*,

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Andreaeobryales: *Takakia*, Polytrichales: *Polytrichum*, *Pogonatum*; Tetraphidales: *Tetraphis* (Georgia), Buxbaumiales: *Buxbaumia*, Bryales: *Bryum*, *Rhodobryum*, *Funaria*, etc

Outcome of the course

Students will understand the morphology and organization of the thallus and their role in medicine, industrial and food. Students will understand the interrelationship of algae, bryophytes..

Suggested Laboratory exercises

1. Morphological study of representative members of division Cyanophyta, Charophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta, etc.
2. Preparation of synthetic medium and cultivation of algae, unialgal and axenic culture and their maintenance.
3. Collection, preservation of algal from nearest locality (Atleast 10 specimens).
4. Study of permanent slides and specimens of various representative members of division Thallophyta.
5. Morphology and structural study of representative member of the following group using cleared whole amount preparation, dissection and section: Jungermanniales – *Pellia* and *Porella* (or any other leafy liverwort); Marchantiales-*Plagiochasma*, *Dumortiera*, *Fimbriaria*, (*Astralla*, *Reboulia*, *Targionia*, *Conocephalum*/ *Weisnerella*, *Sphagnum*/ *Bryales*
6. Study of permanent slides and specimens of various representative members of Bryophyta.
7. Experiments to study spore germination, formation of protonema and bud development.
8. Study of Bryophytes in their natural habitats

Suggested readings

1. Barsanti L, Gualtieri P (2006) *Algae: Anatomy, Biochemistry and Biotechnology*, CRC Press, Taylor and Francis, Boca Raton.
2. Bold HC, Wynne MJ (1985) *Introduction to the Algae*, 2nd edition, Prentice-Hall Inc, New Jersey.
3. Kumar HD (1999) *Introductory Phycology*, 2nd edition, Affiliated East-West Press Pvt. Ltd., New Delhi
4. Fritsch FE (1935) *The Structure and Reproduction of the Algae*, Vol I, Cambridge University Press, Cambridge.
5. Fritsch FE (1945) *The Structure and Reproduction of the Algae*, Vol II, Cambridge University Press, Cambridge.
6. Lee RE (2008) *Phycology*, 4th edition, Cambridge University Press, Cambridge.
7. Pandey A, Chisti Y, Lee D J, Soccol CR (2013) *Biofuels from Algae*, 1st edition, Elsevier Publishing Group, USA.
8. Rossini GP, (2014) Ed: *Toxins and Biologically active Compounds from Microalgae*, Vol 2, Biological Effects and Risk Management, CRC Press, Taylor and Francis Group, Boca Raton.
9. South GR, Whittick A (1998) *Introduction to Phycology*, Blackwell Scientific Publication, London.
10. Tebbani S, Filali R, Lopes F, Dumur D, Pareau D (2014) *CO₂ Biofixation by Microalgae: Modelling, Estimation and Control*, Wiley-ISTE, New York.
11. Watson, 1975. *Bryophytes*. Hutchinson Library, Series, London.
12. . Pandey, S.N., S.P.Misra and P.S. Trivedi. 2002. *A Textbook of Botany Volume II*. Vikas Publishing House Pvt Ltd, New Delhi.
13. . Rashid, A. *An Introduction to Bryophyta*. 1st Ed. Vikas Publishing House Pvt. Ltd., New Delhi. 298 pp. 1998.
14. . Vashishta. B.R., Sinha, A.K. and Adarsh Kumar, 2005. *Botany for Degree students- Bryophyta*. S. Chand and Company Ltd., New Delhi.
15. .AfrozAlam. 2015. *Text Book of Bryology*. I K International Publishing House Pvt. Ltd.
16. Alain Vanderpoorten, 2009. *Introduction to Bryophytes*, 1st Edition, Cambridge University Press.

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SEMESTER I CORE COURSE
CORE COURSE - MYCOLOGY

CORSE CODE: BOT 1003-C

CREDITS: 4

MARKS (EA.75+IA.25=100)

Objectives

- To understand and realize the classification, structure, reproduction and economic importance of Mycology.
- To acquire knowledge on pathogen causing diseases in plants and mode of action and its control measures.

Unit I

Introduction to fungi and their significance to humans, general characteristics and classification of fungi, Fungal Cell, cell walls and fungal cell organelles, systematics, molecular methods of fungal taxonomy, reproduction and spores in fungi, heterothallism, parasexual cycle and sex hormones in fungi, degeneration of sexuality in fungi.

Unit II

Biology, general characteristics and importance of Plasmodiophora, dictyosteliomycota, acrasiomycota and myxomycota. Biology, general characteristics, classification and brief introduction with comparative study of -Mastigomycotina- Chytridiomycetes, Hypochytridiomycetes and Oomycetes; Zygomycotina - Mucorales, Endogonales, Glomales, Entomophthorales and Zoophagales with special reference to evolutionary tendencies in thallus, asexual and sexual reproduction

Unit III

Ascomycotina- General characteristics and brief introduction of Taphrinales, Schizosaccharomycetales, Saccharomycetales, Eurotiales, Hypocerales, Melanosporales, Phyllachorales, Ophiostomatales, Dioporthales, Xylariales, Sordariales, Meliolales, Rhytismales, Helotiales, Pezizales, Dothidiales, Pleosporales and Erysiphales with special reference to evolutionary tendencies in asexual and sexual reproduction.

Unit IV

Basidiomycotina- General characteristics and brief introduction of Agaricales, Lycoperdales, Sclerodermatales, Phallales, Nidulariales, Aphyllophorales, Uredinales, Ustilaginales, Auriculariales and Tremellales; Deuteromycotina- Hyphomycetes, Coelomycetes, Form order sphaeropsidales, melanoconiales, moniliales and mycelia sterilia. Comparative study of subdivision Ascomycotina, Basidiomycotina and Deuteromycotina. Mushroom cultivation, mycorrhizal application in agriculture and forestry.

Unit V

Introduction to lichens, the symbiotic relationship and classification of lichens, methodology for lichens. Taxonomy, morphology and anatomy of thallus, reproduction, physiology, ecological aspects and chemistry. Conservation, culture and economic importance of lichens.

Outcome of the course

Students will understand the morphology and organization of the thallus and their role in industrial, medicine and food. Students will understand the interrelationship of amycology, lichenology, bacteriology, virology and plant pathology
Suggested laboratory work

Suggested Field/Laboratory Exercises:

Suggested Field / Laboratory Exercises corresponding to theory courses, covering all units.

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Suggested readings:

1. Webster, John, 1980, Introduction to Fungi, Cambridge University Press
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996, Introductory Mycology, Wiley
3. Carlile, M.J., Watkinson S.C. and Booday, G.W. , 2001, The Fungi, Academic Press
4. Deacon, J.W., Blackwell, M, 1997, Introduction to Modern Mycology, Oxford
5. Webster, John and Roland, W.S., 2007, Introduction to Fungi, Cambridge University Press.
6. Hale, M.E. (1983), The biology of lichens (3rd ed.). Edward Arnold.
7. Hawksworth, DL & Hill, DJ 1984: The Lichen-Forming Fungi. - Blackie, Glasgow and London. 158 pp
8. Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume III. - CRC Press, Inc., Boca Raton
9. Brown D. H., Hawksworth D. L. & Bailey R. H. 1976, Lichenology: Progress & problems, Academic Press. London.

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SEMESTER - I CORE COURSE
CORE COURSE: MICROBIOLOGY

COURSE CODE: BOT 1004-C CREDITS: 4 MARKS (EA.75+IA.25=100)

Objectives

- To provide advanced knowledge, understanding, and critical judgment appropriate for the application of microbiology.
- To explain the processes of reproduction, adaptation, survival, and interaction of microorganisms with their associated hosts and environment.
- To explain the theoretical basis of the tools, technologies and methods commonly used in microbiology.
- To develop practical skills in the use microbiological methodologies, tools, techniques and highlight the role microorganisms in the human welfare.

Unit I

General characteristics, classification of bacteria by Bergey's (1944), ultrastructure of cell, staining technique of bacteria. Brief history, present status and future challenges of microbiology, a brief account of microbial diversity; evolution of micro-organisms – RNA world hypothesis, endosymbiotic theory; A general account of Archaea. Isolation, purification and establishment of pure culture of micro-organisms; major types of cultures – batch, continuous and synchronous.

Unit II

Nutritional types of micro-organisms; symbiotic associations- *Rhizobium*-legume symbiosis and mycorrhiza, bacterial growth curve, anoxygenic photosynthesis with special reference to light reaction in purple bacteria; methanogenesis. Genetics of bacteria: Genetic recombination- an overview; mechanisms of transformation, conjugation and transduction in bacteria; role of microorganisms in genetic engineering.

Unit III

Lytic cycle in T even phages and its regulation; lysogeny and its regulation in lambda phage; a brief account of viroids and prions. Water-borne pathogenic microbes; role of microbes in wastewater treatment with special reference to activated sludge. Basic design of a fermenter; bioremediation of hydrocarbon and metal polluted waters. biosensors and their applications.

Unit IV

General feature, evolution, classification and nomenclature of plant viruses. Transmission, multiplication, cultivation, purification and isolation of viruses. Evolutionary significance of plant viruses.

Unit V

Recognition and entry process of different pathogens like bacteria and viruses into animal and plant host cells. Plant microbe interactions (PMIs). Antibiotics and their mode of action. Biopesticides, basic principles of immunology, vaccines and antibodies.

Outcome of Course :

Outcome of the Course Student Learning Outcomes. Upon graduation, Microbiology majors should have a thorough knowledge and understanding of the core concepts in the discipline of Microbiology. Microbiology students will be able to: Describe how microorganisms are used as model systems to study basic biology, genetics, metabolism and ecology.

Suggested Practical Work:

Based on the Syllabus of above five unit

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Suggested readings:

1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganiss. 13th edition, Pearson Education Inc.
2. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., Painter, P.R., 1987. General Microbiology. Fifth edition. MacMillan.
3. Atlas, R.M. 1995. Principles of Microbiology. Mobsy.
4. Lim, DV. 2003. Microbiology. Kendall/Hunt.
5. Boundless.2013. Microbiology. Boundless Learning, Incorporated.
6. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology. Lippincott Williams & Wilkins.
7. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition. McGraw-Hill.
8. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.
9. Agrios, G. N., 1988. Plant Pathology, Academic Press.
10. John A Lucas, 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
11. Dickinson, C. M., 2003. Molecular Plant Pathology, Bios Scientific Publisher
12. Robert, N., Trigiano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.
13. Bridge, P.D and Clarkson, J.M., 1998. Molecular Variability of Fungal Pathogens, CAB, International
14. Singh, R. S., 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd
15. Pelczar, JM, Chan, ECS and Krieg, MR. 1993. Microbiology. Tata McGraw Hill.

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SEMESTER II CORE COURSE
CORE COURSE: PTERIDOPHYTES, GYMNASPERMS AND PALAEOBOTANY
COURSE CODE: BOT 2001-C CREDITS: 4 MARKS: EA.75+IA.25=100

Objectives

- To understand the enormous, range of diversity and range of diversification of all species in the world.
- To realize the fundamental values of diversity and their importance of human welfare.
- To define and characterize diversity of lower vascular plants to understand the dynamics of diversity to realize the significance of diversity and its fossil forms.

Unit I

General characters - recent classification of Pteridophytes. Range of structure, reproduction and evolution of the gametophytes, Gametophyte types – sex organs. Apogamy and Apospory. Life cycles. Stellar evolution-Protostele – types, Siphonostele, Solenostele and Dictyostele. Detailed account of Soral evolution – soral types, soral characters and phylogeny of ferns. Teleome theory, Heterospory and seed habit. Economic importance of Pteridophytes.

Unit II

Comparative morphology, anatomy, reproductive biology and evolutionary studies of the following groups: Psilopsida, Lycopsidea, Sphenopsida, Filicopsida. Coenopteridales, Ophioglossales, Marattiales, Osmundales and filicales;; Monographic study of *Isoetes*, *Psilotum*, *Ophioglossum*, *Osmunda*, *Lygodium*, *Cyathea*, *Gleichenia*, *Adiantum*, *Pteris*, *Christella* and aquatic ferns.

Unit III

Classification of gymnosperms upto the rank of orders. General account of the following groups with special reference to the genera indicated in brackets: Pteridospermales (*Calymmatotheca*, *Hoeninghausi*), Glossopteridales (*Glossopteris*), Caytoniales (*Caytonia*), Bennettitales (*Williamsonia* sp.), Pentoxylales, Corditales (*Cordaites* sp.)

Unit IV

A general account, distribution and Economic importance of Gymnosperms. Morphology, anatomy, reproduction, phylogeny and relationship of the following orders with special reference to the genera mentioned against each order.

Cycadopsida : *Cycas*, *Zamia*

Coniferopsida: *Pinus*, *Cupressus*, *Podocarpus*, *Araucaria*

Gnetopsida : *Gnetum*, *Ephedra*, *Welwetschia*.

General characteristics of Cycadales, Ginkgoales, Coniferales and Gnetales (Comparative study only).

UNIT V

Geological time Scale; Radiocarbon dating; Contribution of Birbal Sahni to Paleaobotany. Study of fossils in understanding evolution. Fossilization and fossil types. Economic importance of fossils – fossil fuels and industrial raw materials and uses.

Detailed study of the following fossil forms –

Fossil Pteridohytes : *Rhynia*, *Lepidodendron*, *Lepidocarpon*, *Sphenophyllum* and *Calamites*.

Fossile Gymnosperms: *Lyginopteris*, *Heterangium*, *Cordaites*.

Outcome of the course

After successfully completing this course, the student will be able to recognize morphological, anatomical and reproductive characteristics of extinct and extant Pteridophytes, Gymnosperms and Palaeobotany. The student will understand the evolutionary history of plant kingdom.

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Suggested Laboratory exercises

1. Comparative study of the anatomy of vegetative and reproductive parts of Pteridophytes: *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Gleichenia*, *Pteris*, *Ophioglossum* and *Isoetes*.
2. Study of Morphology, Anatomy and reproductive structures of Pteridophytes from prepared slides and specimens.
3. Preparation of models (Plasticine/ thermocol) to demonstrate stealer evolution.
4. Comparative study of the anatomy of vegetative and reproductive parts of *Cycas*, *Ginkgo*, *Cedrus*, *Abies*, *Picea*, *Cupressus*, *Araucaria*, *Cyptomeria*, *Taxodium*, *Pinus*, *Biota*, *Podocarpus*, *Agathis*, *Taxus*, *Ephedra* and *Gnetum*.
5. Study of the important reproductive stages through specimens and permanent slides.
6. Study of important fossil gymnosperms and living gymnosperms from prepared slides and specimens.

Suggested reading:

1. Vashishta. P.C., A.K. Sinha and Adarsh Kumar. 2008. Botany for Degree students - Pteritophyta. S. Chand and Company Ltd., New Delhi.
2. Shripad, N.A. 1998. Paleobotany, Oxford and IBH Publishing Co. Pvt Ltd., New Delhi.
3. Vashishta, P.C. 1991. Gymnosperms. S. Chand & Company Ltd., Ram Nagar, New Delhi.
4. Gifford, E.M and Foster, E.S., 1984. Morphology and evolution of vascular plants. 3rd edition, W.E. Freeman and Co, New York.
5. Sporne, K.R. 1962. The morphology of Pteridophytes. Hutchinson Univ. Library, London.
6. Sporne, K.R. 1965. The morphology of Gymnosperms. Hutchinson Univ. Library, London.
7. Banks, H.P, 1970. Evolution and Plants of the past. Wadsworth publishing Co, Belmont.
8. Beck, C.B, 1988. Origin and evolution of Gymnosperms. Columbia University press, New Delhi.
9. Bhatnagar, S.P. and Alok Moitre, 2003. Gymnosperms, New Age International, New Delhi.
10. Bierhorst, D.W, 1971. Morphology of vascular Plants. Macmillan publishing Co, New York.
11. Biswas, c., B.M. Johri, 1999. The Gymnosperms, Narosa Publishing House, Chennai.
12. Gensel, P.G and Andrews, H.N., 1984. Plant life in the Devonian. Preger publications, New York.
13. Graham, L.E., 1993. Origin of land plants. John Wiley & Sons, New York.
14. Mukta Bhargava, 2003. The latest portfolio of theory and practice of Gymnosperms. Dominant Publishers and Distributors, New Delhi.
15. Parihar, N.S., 2005. An introduction to Embryophyta- Pteridophytes - Central Book Depot, Allahabad.
16. Pandey, S.N., S.P. Misra and P.S. Trivedi. 2002. A Textbook of Botany Volume II. Vikas Publishing House Pvt Ltd, New Delhi.

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SEMESTER II CORE COURSE

CORE COURSE: PLANT PHYSIOLOGY AND BIOCHEMISTRY

COURSE CODE : BOT 2002-C CREDITS: 4 MARKS: (EA.75+IA.25=100)

Objective:

- To give students a greater appreciation of the world we depend on and to stimulate student learning to basing concept of physiology and biological sciences.
- An introduction to basic principles of plant functions , primarily covering physical process in plants in metabolism , secondary products, cell physiology and introducing principles of growth and developments.

Unit I

Water potential, transport of water and solutes: uptake transport and translocation of water, ions, and solutes from soil, through xylem and phloem, mechanism of loading and unloading of photo-assimilates. Transpiration: types, factors affecting and significance of stomata, structure and function, mechanism of opening and closing of stomata.

Photochemistry and Photosynthesis: Photosynthetic pigments and light harvesting complexes, photo-oxidation of water, mechanism of electron and proton transport, carbon assimilation; regulation of Calvin cycle; photorespiration and its significance, the C3, C4 plants and CAM pathways, emerson effect. PS-I and PS-II.

Unit II

Respiration: Glycolysis, TCA cycle, electron transport in plant mitochondria and ATP synthesis, Pentose Phosphate pathway, Glyoxylate cycle. Sensory Photobiology: History, photochemical and biochemical properties. Photophysiology of light induced responses by the photoreceptors: phytochromes, cryptochromes, phototropins and zeatins (ZTL). hydroponics. Stress physiology: response of plants to biotic (pathogen & insects) and abiotic (water, temperature and salt) stress

Unit III

Plant Growth Regulators: Structure, biosynthesis, storage, break down and transport. Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinin, ethylene, abscisic acid, brassinosteroids, jasmonates, salicylic acid and strigolactones. Hormone receptors, signal transduction and gene expression.

Physiology of Floral Induction: photoperiodism and its significance, CO, FT and Hd1 proteins, homeotic genes, quartet (ABCE) model of flowering. Secondary metabolites- biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

Unit IV

Bioenergetics: Law of thermodynamics, concept of enthalpy and entropy and their significance in biological systems, Water biochemistry, high energy molecules, redox potential; Amino acids and proteins: Structure and physicochemical properties of amino acids; Proteins: Primary, secondary, tertiary and quaternary structure of proteins and significance. Enzymes: Classification, types, physicochemical nature, enzyme kinetics, mechanism of action and regulation.

Unit V

Carbohydrates: Structure and physico-chemical properties of carbohydrates, biological significance, important glycoprotein, Lipids: Classification, structure and properties of lipids, biological significance of glycolipids, fatty acid biosynthesis and storage lipids and their catabolism. Chromatography: Basic concept, Paper, TLC, HPLC, GC, Size-exclusion chromatography, Ion-exchange chromatography, Hydrophobic Interaction chromatography and Affinity chromatography; Labeling Techniques: Radiolabeling and Fluorescent labeling of biomolecules and their detection, Safety guidelines

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Outcome of Course:

Students will be able to understand the various physiological life processes in plants. They will also gain about the various uptake and transport mechanisms in plants and are able to coordinate the various processes. They understand the role of various hormones, signalling compounds, thermodynamics and enzyme kinetics. During the course students will gain knowledge about various mechanisms such as channel or transport proteins involved in nutrient uptake in plants.

Suggested Practical Exercises:

1. Preparation of standard curve of glucose and determination of glucose content in given plant material.
2. Extraction and estimation of starch from plant material.
3. Study of absorption spectra for chlorophyll-a and chlorophyll-b and calculate the ratio of chlorophyll-a and chlorophyll-b.
4. Determination of osmotic potential of vacuolar sap by plasmolytic method.
5. Separation of chlorophyll pigment by paper and column chromatography.
6. To determine the rate of photosynthesis under different light qualities.
7. To determine the rate of photosynthesis under CO₂ effect.
8. Bioassay of auxins and cytokinins using appropriate plant material.
9. To determine the rate of transpiration under different environmental condition.
10. To study water and salt stress in herbaceous plant growth.

Suggested Readings:

1. Buchanan, B. B., W. Gruissem and R. L. Jones. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland.
2. Salisbury, F. B. and C. W. Ross. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California. Taiz, L., Zeiger, E., 2010. Plant Physiology, Fifth edition, Sinauer Associates, Massachusetts, USA.
3. Lincoln Taiz, Eduardo Zeiger, Ian Max Møller, Angus Murphy. 2018. Fundamental of Plant Physiology, Oxford University Press, 2018; ISBN: 1605357901, 9781605357904.
4. Jain, V.K. 2017 (19th Edition) Fundamentals of Plant Physiology. S. Chant&co, New Delhi.
1. Nelson DL and Cox MM. (2004) Leininger Principles of Biochemistry, 4th Edition, W.H. Freeman and Company, New York, USA.
2. Davies P J. (2004) Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
3. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant metabolism. Longman Essex, England.
4. S.K. 2006 A text book of Plant Physiology S. Chant&co, New Delhi.
5. Panda, S.K, 2005. Advances in Stress Physiology of plants, Scientific publishers India, Jodhpur.
6. Devlin, R.M. and Baker, N.R. 1973. Photosynthesis, Reinhold Affiliated East West Press Pvt. Ltd, New Delhi.
7. Hewitt, E.J. and Cutting, C.V. 1979. Nitrogen metabolism of plants, Academic Press, London.
8. Roberts, E.A. 1987. Plant growth regulators. Kluwer Academic publishers, London.

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SEMESTER – II CORE COURSE
CORE COURSE: GENETICS, CYTOGENETICS AND BIOSTATISTICS
COURSE CODE : BOT2003-C CREDITS: 4 MARKS : (EA.75+IA.25=100)

Objective

- To acquire a knowledge on features of sexual reproduction and understand the basic principles of genetics applied to plant breeding procedures.
- To provide students advanced knowledge on microbial and plant genetics and its applications.
- To familiarize students on the various types of genetical techniques and procedures.
- Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc
- To highlight the breeding developing upon production breeding, quality breeding, adaptive breeding and protection breeding regardless of breeding system.
- Evolutionary biology is to teach past history & origin of living organisms.

Unit I

Gene concept; allele concept, multiple alleles, isoalleles, Pseudoalleles, Inheritance Genetics: Principles of Mendelian Inheritance and interaction of genes. Apoptosis and programmed cell death in plant.

Unit II

Cytoplasmic inheritance involving chloroplast and mitochondria, interaction between nuclear and cytoplasmic genes, Sex determination in plants, Cytogenetics and Induced Variations: Linkage and recombination: Concept of Linkage, evolution of linkage, cis and trans arrangement of linked gene, kinds of linkage, germinal and somatic crossing over, detection of crossing over, kinds of crossing-over

Unit III

Spontaneous and induced mutations, point mutation, transitions, transversions, physical and chemical mutagens, molecular basis of mutations. Numerical alterations in chromosomes: Euploidy, haploid, tetraploid, polyploidy, aneuploidy and its significance Structural changes in chromosomes: Deficiency, duplication, inversion, translocation. Quantitative inheritance, population genetics, Hardy-Weinberg equilibrium, genetic drift, speciation and adaptive radiation.

Unit IV

History and objectives of plant breeding; germplasm collection, merits and demerits. Selection and hybridization, type and methodology, merits and demerits, their application. Selection in self and cross pollinated crops, heterosis and hybrid vigor

Unit V

General concepts and terminology, sampling methods, Measures of location, scale and shape, contingency tables test of significance and chi-square test, comparison of means: t-test, multiple range tests, Simple experimental design, analysis of variance, correlation and regression analysis, Introduction to multivariate methods, relevance of biostatistics to biological interpretative, elementary idea of probability, combination and permutations, continuous and discontinuous variables; Measures of central tendency: Mean, Median and Mode; Measures of dispersion: Standard deviation, Standard error, Mean deviation. Difference between parametric and non-parametric statistics; confidence interval, basic introduction to multivariate statistics, Types of statistical software and their application in analysis of data.

Outcome of course

Students will know the principle of genetics value and the importance on improving the molecular genetics. On the successful completion of the course, the student will be able to: Comprehensive, detailed understanding of the basis of heredity. Understanding the role of genetic mechanisms in evolution. The ability to evaluate conclusions that are based on genetic data. Understanding the role of genetic technologies in industries related

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to biotechnology, pharmaceuticals, energy, and other fields.

Suggested Laboratory exercises

1. Determination of probability of tossing for one coin.
2. Determination of probability for the throw of dice.
3. Determination of probability for tossing of two coins.
4. X² test as applied to the result of above three experiments.
5. Determination of size of the leaves on a specific size of two population of a species and calculation of standard deviation and standard error.
6. Permutation and combination.
7. Correlation analysis.
8. Determination of genotype from the data provided.
9. Determination of linkage values from the data provided and preparation of chromosome map.
10. Determination of various Mendelian ratio by checker board as well as by binomial equation.

Suggested reading:

1. Clark, M.S. and Wall, W.J. 1996, Chromosomes: The Complex Code. Chapman & Hall, London.
2. Stebbins, G.L. 1950, Variation and Evolution in Plants. Columbia Univ. Press, New York.
3. Swanson, C. P., Mertz, T.F. and Young, W.J. Cytogenetics : The Chromosomes in Division, Inheritance and Evolution (2nd Edn). Englewood Cliff, Prentice-Hall, New Jersey.
4. Sharma, A.K. and Sharma, Archana. 1985. Advances in Chromosome and Cell Genetics. Oxford & IBH Publishing Co., Calcutta.
5. Schnedl, W.. Banding patterns in chromosomes. In: International Review of Cytology (Suppl. 4).
6. Lewine, Benjamin, Jones and Bartlet, Genes X, Sudbury, Masschusetts
7. Gupta, P.K., Cytogenetics, Rastogi Publication, Meerut
8. Peter, D, Snustand and Simmons, M.J., John Wiley and Sons Inc.

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SEMESTER II CORE COURSE

CORE COURSE: MORPHOLOGY, ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

COURSE CODE: BOT2004-C CREDITS: 4 MARKS: (EX. 75+ IA. 25=100)

Objective:

- To understand and provide an insight into the internal structure and reproduction of the most evolved group of plants, the Angiosperms.
- To understand the origin, structure, growth, development and reproduction of angiosperms through anatomy and embryology.
- To get an insight into the histochemistry with special reference to various stains and staining procedures

UNIT I

Introduction of morphology and anatomy including brief evolution and historical account; External and internal organization of higher plants. General morphology of floral parts and their modification. Formation of floral organ and their development. Genetics of floral organ differentiation. Accessory floral organ: epicalyx, involucre, carpel, corona, nectaries and epigyny.

UNIT II

Xylem and phloem and their elements, differentiation of secondary xylem and phloem. Characteristics of phloem components, phylogenetic trends and specialization of xylem and phloem. Periderm: structure and development of protective tissue in monocots. Wound healing and grafting, tyloses and lenticels. Structure of wood in relation to its weight, strength and durability, growth rings, Heart and sap wood, porous and non-porous wood.

UNIT III

Organization of shoot/root apical meristem (SAM) and (RAM). Cytological and molecular analysis of SAM and RAM. Secretory and laticifers, fates and lineage vascular tissue differentiation, lateral root, root hairs, root-microbes interaction. Differentiation of epidermis with reference to stomata and trichomes, tracheary elements etc. Development of organs, organ identity, key regulatory mechanism in development of size and shape of specific organs such as leaf, stem shoot etc.

UNIT IV

Seed germination, types, factors affecting, and hormonal control of seedlings growth. Importance and types of dormancy, seed dormancy, overcoming seed dormancy, Bud dormancy. Cork cambium and its derivatives, function of cork and abscission layers. Anomalies of stem anomalous secondary growth in dicots and monocots.

UNIT V

Development of male and female gametophyte, microsporogenesis and megasporogenesis. Domains of pollen wall, pollen tube growth and guidance, Fertilization, double fertilization, self incompatibility mechanism, development of endosperm, embryo and its culture. Somatic embryogenesis, apomixis, polyembryony and its induction, induced parthenocarpy. In vitro pollen germination, pollen sterility and fertility. Pollen pistil interaction, control of fertilization and current concept of fertilization, barriers of fertilization, heterospermy, polyspermy, and heterofertilization, endosperm, types and classification, Embryogeny, development of dicot and monocot embryo, nutrition of embryogeny.

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Outcome of the Course

The students will be able to recognize the anatomical differences between monocotyledons and dicotyledons of roots, stems, leaves, bark and wood. In addition, they will clearly understand the seed-to-seed developmental aspects of angiosperms.

Suggested Field/Laboratory Exercises:

Suggested Field / Laboratory Exercises corresponding to theory courses, covering all units. As per the prescribed syllabus in above units. Morphological studies may also be supported with field studies.

1. Examination of Root and Shoot apices. 2. Maceration, clearing and peeling techniques. 3. Cambial variant in Bougainvillea, Boerhaavia, Nyctanthes, Bignonia, Aristolochia, Strychnos sps and Dracaena. 4. Nodal Anatomy – Different types of nodes. 5. Different types of stomata. 6. Calculation of stomatal index and frequency. Embryology : 1. Slides showing stages of anther, embryo sac, endosperm and embryo development. 2. Types of ovules. 3. Pollen germination and viability test. 4. Dissection of embryo – Tridax, Crotalaria and Cleome. 5. Endosperm and endosperm haustoria – Cucurbitaceae members.

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.P. 1981. Embryology of angiosperms. Vikas Publication Pvt.Ltd. New Delhi.
2. Eames, A.J and Mac Daniel, 1975. An introduction to Plant Anatomy. TMH edition, TataMacGraw Hill, New Delhi.
3. Pandey, S.N. and Ajanta Chandha. 2006. Plant Anatomy and Embryology. Vikas Publishing House Pvt.Ltd, New Delhi.
1. Esau, K. 1989. Anatomy of seed plants. John Wiley & Sons, New York
4. Maheshwari, P. 1963. An Introduction to embryology of Angiosperms. Tata McGraw Hill. New York.
5. Pandey, P.B. 2000. Plant Anatomy. S.Chand & Co.,
6. Esau, K. 1972. Plant anatomy. John Wiley & Sons, New York.
7. Shivanna, K.R. 2003. Pollen biology and biotechnology. Oxford IBH, New Delhi
8. Singh, V., P.C. Pandey and D.K. Jain. 2003. Embryology of Angiosperms. Rastogi Publications. Meerut.

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SEMESTER III CORE COURSE
CORE COURSE: TAXONOMY OF ANGIOSPERMS AND BIOSYSTEMATICS
COURSE CODE- BOT 3001-C CREDITS: 4 MARKS: (EA.75+IA.25=100)

Objective: - To impart the knowledge of

- Basic principles of Taxonomy, classification and Nomenclature of Plants.
- Taxonomic tools and use of Computers & GIS in identification of plants
- Awareness of Plant Biodiversity
- Structure –External and Internal, Types and functions of Plant parts.

Unit I

General Taxonomy: Introduction, aims, objectives, classical and modern history of taxonomy. The species concept, taxonomic hierarchy- species, genus, family and other categories. Principles used in assessing relationship, delimitation of taxa and attribution of rank. Salient features of International Code of Botanical Nomenclature. Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit II

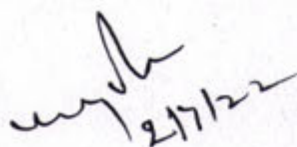
Taxonomic Evidences and Tools: Taxonomic evidences: Morphology, Plant anatomy, Palynology, Embryology, Cytology, Phytochemistry, Genome analysis and DNA hybridization technique in relation to taxonomy, sero-taxonomy. Taxonomic tools – Herbarium Definition, Steps involved in development of an herbarium, Maintenance of Herbarium, General account of Herbaria in India. Role of BSI in Herbaria, Private herbaria, Herbarium of KEW, Utility and importance of Herbaria in Taxonomy, Botanical gardens-origin, type, development and role in taxonomic studies of major gardens of India and world; Virtual herbarium; Flora and e-flora; Histological, Cytological, Phytochemical, Serological, Biochemical and Molecular techniques. Taxonomic literature: Flora, Monographs, Journals; Keys: Single access and Multi-access types and use of keys in plant identification, computers, GPS and GIS.

Unit III

Plant Bio-Systematics: Systematics - an inter disciplinary science, steps in bio system, biosystematics, category and importance of bio systematic studies Phenetic versus Phylogenetic system, Modern phenetic methods(Taximetrics) – Concepts, Characters and attributes, OTU's, cluster analysis, advantage over conventional taxonomy and calculation of affinity, Modern Phylogenetic methods i.e. Cladistic in Taxonomy (Monophyletic, polyphyletic and paraphyletic groups; Pleiomorphic and apomorphy etc.), System of angiosperm classification proposed by Linnaeus, Bentham and Hooker, Hutchinson, Engler and Prantl, Thakhatjan, basic knowledge of phylocode and Angiosperm Phylogeny Group (APG) IV, Comparative accounts, merits and demerits of major system of classification.

Unit IV

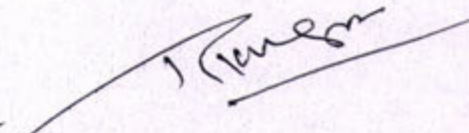
Concept of phytogeography, Endemism, Hotspots, Hottest Hotspots, Plant Explorations, Invasions and Introductions. Local plant diversity with its socio-economic importance. Taxonomy and sustainable utilization


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of bioresources. DNA barcoding and its practical implications. Application of DNA markers in taxonomy. Present status and future scope of Taxonomy in India.

Unit V

Taxonomic features, systematic phylogeny and economic importance of families: Dicotyledons: Ranunculaceae, Magnoliaceae, Capparidaceae, Brassicaceae, Malvaceae, Caryophyllaceae, Asteraceae, Cucurbitaceae, Apocynaceae, Apiaceae, Rosaceae, Rutaceae, Fabaceae, Myrtaceae, Combretaceae, Oleaceae, Asclepiadaceae, Convolvulaceae, Boraginaceae, Scrophluriceae, Acanthaceae, Verbaenaceae, Solanaceae, Lamiaceae, Polygonaceae, Euphorbiaceae, Moraceae

Monocotyledons: Orchidaceae, Amaryllidaceae, Araceae and Arecaceae, Zingiberaceae, Cyperaceae, Poaceae and major families of angiosperms of your locality.

Outcomes: - On the completion of the course, the students will be able to understand-

- All bout of Taxonomy, classification-Major Systems & their merits & demerits and Nomenclature-ICBN of Plants.
- About species concept and principles used in assessing relationships.
- Taxonomic tools like- Herbarium preparation, use of Flora, other methods like Phytochemical, Serological, Biochemical as well as modern technique like Computers and GIS.
- Awareness about Plant Biodiversity and its loss- Hot spots of different region etc.
- Detail knowledge Internal and External Structures, types, modifications and functional of All plant parts like- Root, Stem, Leaf, wood, Flower & its parts and Seeds.
- To develop observational skills and field experience.
- To identify a taxonomically diverse array of native plants.
- To recognize common and major plant families.
- Comprehend the concepts of plant taxonomy and classification of Angiosperms.

Suggested laboratory work:

1. To study the range of taxonomic features of angiosperm plants.
2. To study and work out the differences in dicot and monocot flower
3. To study the variation in stamens and carpels.
4. To study placentation types in various taxa.
5. To study the floral adaptations for pollination.
6. To prepare a cladogram on the basis of various morphological features of the species belonging to a genus.
7. To study the Taxonomic features systematic phylogeny and economic importance of families of angiosperms of the syllabus as on availability.
8. To study of specimens from representative families from your locality.
9. Description of various species of a genus, location of key characters and preparation keys at generic level, family level.
10. Training in using floras, herbaria for identification of specimens described in the class.
11. Field trips within and around the campus; compilation of field notes and preparation herbarium sheets of such plants, wild or cultivated as are abundant.
12. Botanical Excursion: AS FUNDS MAY PERMIT

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Suggested Readings:

1. Banson, L. B. 1957: Plant Classification, Heath & Co. Boston.
2. Davis P.R. & Heywood V.H. 1973: Principles of Angiosperms and Taxonomy. Robert E. Kreiger Pub. Co. New York, USA.
3. Eames, A. J. 1961: Morphology of Angiosperms, Mc-Graw Hill, New York.
4. Heywood & Moore, D. M. 1984: CW Tent concept in Plant taxonomy Academic Press.
5. Jeffery, C. 1968: An Introduction to Plant Taxonomy. J. & H. Churchill Limited · Lawrence, G.H.M. 1951: Taxonomy of Vascular Plants. Macmillan, New York.
6. Massey J.R. and Ben. C.R. 1974. Vol-II. Pant Systematics, Harper & Row, New York
7. Naik, V. N. 1992: Taxonomy of Angiosperms. Tata Mc-Graw Hill Pub. Co.Ltd. New Delhi
8. Singh, V.P. & Khare, V.S. 1996 Flora of Ujjain district. PEBA Publishers New Delhi
9. Singh, V.P. 2014 Flora of Madhya Pradesh (Western Part) Scientific Publishers Jodhpur
10. Sivarajan, V.V. 1984. Introduction to Principles of Plant Taxonomy. Oxford & IBH Pub. Co. New Delhi
11. Sporne, K. R. 1974. The Morphology of Angiosperms. Hutchinson University Library, London
12. Verma, D.M., Balkrishnan, N.P. & Dixit, R.D. 1993 Flora of M.P. 5 volumes. B.S.I., Calcutta
13. Saxena, N.B., Saxena Samindra 2014 Plant Taxonomy, Pragati Prakashan, Meerut
14. Sambamurty, A.V. S. S. 2005. Taxonomy of Angiosperms. I. K. International Pvt. Ltd., New Delhi.
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16. Bhattacharyya, B. and B. M. Johri. 1998. Flowering Plants - Taxonomy and Phylogeny. Narosa Publishing House, New Delhi.
17. Heywood, V. H. and Moore, D. M. 1984. Current Concepts in Plant Taxonomy. Oxford University Press. 5. Duthie, J. F. "Flora of upper gangetic plain and of the adjacent siwalik & sub-himalayan tracts," Calcutta, Vol. 3, No. 1, 1915.
18. Sharma, O. P. 1993. Plant Taxonomy. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
19. Stace, C. A. 1989. Plant Taxonomy and Biosystematics. University Park Place, Baltimore (2nd edn.)
20. Takhtajan A. 2009. Diversity and classification of flowering plants, 2nd edn. Berlin: Springer.
21. Verma, B. K. 2010. An introduction to Taxonomy of Angiosperms. PHI Learning Pvt. Ltd. New Delhi.
22. Jones, SB Jr. and Luchsinger, AE. 1986. Plant Systematics (2nd edition). McGraw Hill Book Co., New York

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SEMESTER – III CORE COURSE

CORE COURSE: PLANT BIODIVERSITY RESOURCES AND CONSERVATION

COURSE CODE- BOT 3002-C CREDITS: 4 MARKS: (EX.75+IA. 25=100)

Objective:

- to impart the knowledge of conservation of biodiversity in the students and people
- great potential in services in governmental nongovernmental and NGO services
- multifaceted opportunities in academic and commercial ventures.
- Potential in various bio conservation projects and in national parks biosphere reserves etc.

Unit - I

Biodiversity: Definition; factors responsible for determination of Biodiversity; Global concern over climate change, Levels of Biodiversity: Genetic, Species, Ecological, Evolutionary and Agrobiodiversity, Diversity Measures: (Diversity Indices)- Alpha(α), Beta (β), Gamma(γ) Diversity. Principles of conservation; extinctions; environmental status of plants based on International Union for Conservation of Nature. Origin of Agriculture: Meaning of Agriculture, Development of Agriculture, Origin of cultivated plants, Indo-Burmese Centre of Origin, Contribution of Vavilov, Domestication of crop plants, Plant introduction

Unit - II

Biodiversity Conservation Initiatives. 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 for conservation of wild biodiversity. 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) - IGFRI, CAFRI, IARI, CRRI, IISR; Council of Scientific & Industrial Research (CSIR) – CDRI, CIMAP, NBRI, IMTECH, CCMB and the Department of Biotechnology (DBT) for conservation, non-formal conservation efforts

Unit – III

Plant resources, Concept, Status and Concern, Local plant diversity and its economic importance, Origin, evolution, , cultivation and uses of (1) Food, forage and fodder crops, (2) Fiber crops (3) Medicinal and aromatic plants, and (4) Vegetable oil-yielding crops.

Unit-IV

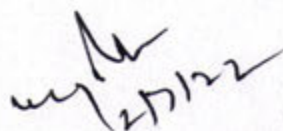
A general account Important fire - wood, timber yielding plants and non-wood forest products (NWFPs) such as bamboos, rattans, raw materials for paper-making, gums, tannins, dyes, resins, beverages, and fruits. Intellectual Property Rights (IPR)- Brief history, types - patent, trademark, trade secret, GI, copyright and others ethical issues of patenting, WIPO and patent organization

Unit-V

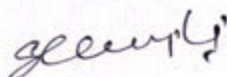
Plants as Avenue trees and aesthetics: Selection of avenues and avenue trees, planting schemes. Plants as Pollution control agents: Tolerance of plants to different pollutants. Bioenergy (biofuels) of plant origin- A general account of fuel wood, energy Plantations, organic waste materials for energy, petroleum plants. Alcohol Fuel and Biogas. Green revolution: Benefits and adverse consequences, beyond green revolution

Outcomes of Course:

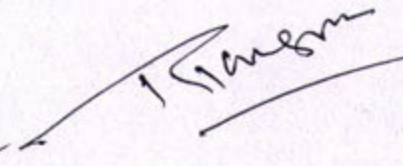
After completion of the Course the student will Learn about the therapeutic applications of plants, and important cash crops and plantation crops. Various biodiversity conservation practices in situ as well as ex situ. Great potential of employment opportunity in various bsr, national parks, sanctuaries and in NGOs.











Suggested laboratory work:

- Cereals: Rice (habit sketch, study of paddy and grain, starch grains).
- Legumes: Soya bean/moong bean/black gram, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
- Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, starch grains, micro-chemical tests).
- Spice and Beverages: clove, black pepper, Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
- Oils & Fats: Groundnut, Mustard—plant specimen, seeds; tests for fats in crushed seeds.
- Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis.
Woods: Tectona, Pinus/Sal: Specimen, Section of young stem.
- Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

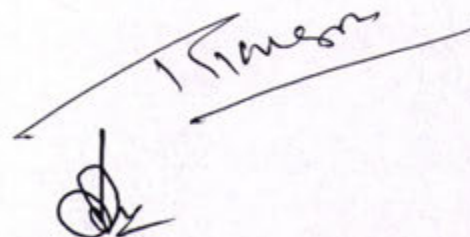
Suggested Readings:

1. Heywood, V. H. and Watson, R. T. 1995. Global Biodiversity Assessment. Paroda, R. S. and Arora, R. K. 1991. Plant genetic resources Conservation and Management.
2. Frankel, O. H.; Brown, A. D. H. and Burdon, J. J. 1995. The conservation of Plant Diversity.
3. Technical guidelines for the safe movement of Germplasm by FAO/IBPGR.
4. B. P. Pandey (2017) Economic Botany. S. Chand Publication, New Delhi.
5. Ahmedullah, M. and M.P. Nayar, 1986. Endemic plants of the Indian region. Vol 1. Botanical Survey of India.
6. Krishnamurthy K V 20014. An advanced text book of Biodiversity, Principles and Practice. Oxford and IBH Publishing Co. Pvt. Ltd.
7. Negi S S 1933. Biodiversity and its conservation in India. Indus Publishing Company, New Delhi
8. Primack, Richard B 2006. Essentials of conservation biology, 4th edition, Senaceer Associates, Sunderland, Mass.
9. Rao R R 1994. Biodiversity in India (floristic aspects). Bishen Singh Mahendra Pal Singh, Dehradun.
10. Ravikumar K and D K Ved 2000. Illustrated field guide to 100 red listed medicinal plants of conservation concern in Southern India
11. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
12. Samba Murty and Subrahmanyam (2011). Text Book of Modern Economic Botany, CBS Publishers and Distributors, New Delhi.
13. Hill, Albert F. Economic Botany, Tata Mc Grow Hill Publishing Company, Ltd. New Delhi.
14. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
15. Singh, Pandey and Jain (2017). Economic Botany, Rastogi Publication, Meerut.
16. B. Baruah (2017). Economic Botany, Kalyani Publishers, New Delhi

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SEMESTER- III ELECTIVE COURSE - 1

ELECTIVE COURSE: INDUSTRIAL MICROBIOLOGY

COURSE CODE: BOT3003-E1.1 CREDITS: 4 MARKS: EX.75+IA.25=100

Objectives:

- To make the students to understand the basic concepts of the **Industrial Microbiology** microorganisms and its mechanism of action in host cells.
- To learn the microbiological techniques used for the classification of microorganisms.
- To understand the microbe-host interaction and their metabolic activities.

UNIT-I:

Development and scope of Industrial Microbiology. Use of Fermentation equipment: Design and construction of fermenters, Batch and Continuous fermenters. Computer control of fermentation process. Characteristics of fermentation media, Raw materials (substrates).

UNIT-II:

Use of microorganisms in industries through ages.
Strategies for isolation and screening of industrially important microorganism.
Strategies for improvement of industrially important microbial strains.

UNIT-III:

Industrial product of vinegar and acetic acid.
Industrial product of citric acid.
Industrial product of antibiotics; penicillin and streptomycin.
Industrial product of amino acids; glutamic acid and lysine.

UNIT-V:

Biopesticides: bacterial, fungal and viral control of insect pests.
Bio fertilizer: production and method of application.
Bioremediation.

Outcome of Course:

1. The course provides knowledge about the scope of industrial microbiology and fermentation technology.
2. Isolation and development of different industrially important microorganisms and a practical idea about their applications for human welfare.
3. Students will have opportunities to know about production of important products by the help of microorganisms such as antibiotics, enzymes, vitamins, SCPs, Bio-fertilizers
4. Students will get a vision of latest microbial applications in production of fermented foods and dairy products.
5. It will help students to understand the use of microbes in bioremediation and pesticide development.

Suggested Laboratories exercise

1. Isolation and identification of bacteria, yeast and fungi from bakeries and fermenters of distilleries.
2. Inoculation of fungi and bacteria on sterilized glucose and sucrose solutions and identification of the different types of amino acids and organic acids in filtrate during different incubation periods. (Chromatography)
3. Isolation and identification of different types of fungi and bacteria from curd, rotten fruits and vegetables.

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4. Collection of different types of mushrooms from local area/ region: inventory and analysis of their amino acid contents. (Chromatography)
5. Preparation of spawn for cultivation of edible mushrooms.
6. Observation of the antagonism of three antibiotics against common plant pathogens in Petri plates (disc methods).
7. Demonstration of fermentation by using yeast.
8. Isolation of industrially important microorganisms from different environment .

Suggested Readings:

1. Anke, T. 1997. Fungal biotechnology. Chapman and Hall. London.
2. Bullock, J. and Kristiansen, B. 1987. Basic Biotechnology. Academic Press, New York.
3. Casida, Jr. L.E. 1968. Industrial Microbiology. New Age International (P) Ltd Publishers, New Delhi.
4. Crueger, W. and Crueger, A 2000. Biotechnology: A Text Book of Industrial Microbiology. Panima Publishing Corporation, New Delhi.
5. Peppler, H.J. 1997. Microbial Technology. Robert E. Krieger Publishing Company. New York.
6. Prescott, C.S and Duim. G.C. 1959. Industrial Microbiology. McGraw-Hill Book Company, New York.
7. Reed, G. 1987 Prescott and Dunn's Industrial Microbiology. CBS Publishers and Distributors, New Delhi.
8. Riviere. J. 1975. Industrial Applications of Microbiology. John Wile & sons, New York
9. Smith, J.E., Berry, D.R., and Kristiansen, B. 1983. Filamentous Fungi Vol. IV, Fungal Technology, Edward Arnold, London.
10. Stanbury, P.F., Whitaker, A. and Hall, S.J. 1995. Principles of Fermentation Technology, Pregemen Press, Oxford.

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SEMESTER – III ELECTIVE COUSE-2

ELECTIVE COURSE: CROP GENETICS AND PLANT BREEDING.

COURSE CODE: BOT3003E1.2 CREDIT: 4 MARKS: (EA. 25+ IA. 75= 100)

Objective:

- To acquire a knowledge on features of sexual reproduction and understand the basic principles of genetics applied to plant breeding procedures.
- To provide students advanced knowledge on microbial and plant genetics and its applications.
- To familiarize students on the various types of genetical techniques and procedures.
- Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc
- To highlight the breeding developing upon production breeding, quality breeding, adaptive breeding and protection breeding regardless of breeding system.
- Evolutionary biology is to teach past history & origin of living organisms

UNIT - I

Genetic principles: Origin & development of crop genetics, Mendelian principles of inheritance, Interaction of Genes, Multiple allelism, Lethality Atavism, Pleiotropy, Qualitative and Quantitative Inheritance, Extra chromosomal inheritance, Evolution of crop plants such as wheat Rice Cotton, Sugarcane, Gram & Mustard. Apomixis, Incompatibility and male sterility systems & their uses in plant breeding.

Role of plant breeding in Agriculture: History & Objectives of plant breeding, early plant breeders and their accomplishments.

UNIT - II

Plant Breeding Methods: Basic schemes, Pure lines and Inbred lines, Breeding methods for improvement of self-pollinated plants, cross pollinated plants and asexually propagated plants. Back crossing; Single seed decent method, Development of synthetics & composites. Role of Mutation & polyploidy in plant Breeding.

UNIT – II

Breeding for Biotic & Abiotic Stresses: Mechanism for disease and insect resistance. Breeding for quality traits and for resistance to heat, frost & drought, Release, Seed Production and Distribution of cultivars, Hybrid seed production Identification and release of varieties, Seed Certification, Organization for crop improvement in India.

UNIT - IV

Statistical Methods and Field Plot Techniques: Data collection and interpretation Source of Variation Design, of experiments, Correlation & Regression; Measure of control tendencies, Test of significance (t & Chi square, Mean, Mode, Median, Standard deviation standard error, Coefficient of variability, Inbreeding depression & heterosis)

UNIT- V

Bioethics, bioprospecting, Future of plant breeding through modern biotechnological techniques.

Intellectual Property Rights- history, type, applications in plant breeding, patents, copyright, trademarks, geographical indications etc and relevance in future research.

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Outcome of course:

Students will know the principle of genetics value and the importance on improving the molecular genetics. On the successful completion of the course, the student will be able to: Comprehensive, detailed understanding of the basis of heredity. Understanding the role of genetic mechanisms in evolution. The ability to evaluate conclusions that are based on genetic data. Understanding the role of genetic technologies in industries related to biotechnology, pharmaceuticals, energy, and other fields.

Suggested Practical Exercises:

- Collaborative studies with agriculture institutions as desired
- Field and laboratory studies
- Visit of instructions etc.
- Practical as per the requirement of syllabus.

Suggested Readings:

1. Burnham, C.R. (1962). Discussions in Cytogenetics: Burgers, Minneapolis.
2. Fukui K and Nakayama S (eds.) (1996). Plant Chromosomes-Laboratory Methods. CRC Press, London
3. Gupta, P.K. (1999). Cytogenetics. Rastogi & Co., Meerut.
4. Gupta, P.K. and Tsuchiya, T. 1991. Chromosome Engineering in Plants: Parts A & B, Elsevier Publishers, the Netherlands.
5. Gupta PK, Singh SP, Balyan HS, Sharma PC and Ramesh B (1998). Genetics and Biotechnology in Crop Improvement. Rastogi Publications, Meerut
6. Hawes C and Satiat-Jennemaitre (eds.). (2001). Plant Cell Biology 2nd Ed. Oxford University Press, New York
7. Khush GS (1973). Cytogenetics of Aneuploids. Academic Press, New York
8. Singh RJ (2003). Plant Cytogenetics (Second Edition). CRC Press, Taylor & Frances group.
9. Singh RJ and Prem P. Jauhar (Eds.) (2005). Genetic Resources, Chromosome Engineering, and Crop Improvement: Grain Legumes, Volume I. CRC Press, Taylor & Frances group
10. Swaminathan, M.S., Gupta, P.K. and Sinha, U. (1983). Cytogenetics of Crop Plants. Macmillan India, New Delhi.
11. Swanson, C.P., Merz, T. and Young, W.J. (1982). Cytogenetics. Prentice-Hall of India (Pvt.) Ltd., New Delhi.
12. Sybenga, J. (1972). General Cytogenetics. North-Holland publishing Co. Amsterdam
13. Sybenga, J. (1992). Cytogenetics in Plant Breeding. Springer-verlag, Berlin.
14. Allard, R.W. (1960). Principles of Plant Breeding. John Wiley, New York
15. Chopra, V.L. (2000). Plant Breeding: Theory and Practice 2nd Ed. Oxford & IBH, New Delhi.
16. Frey, K. J. (1966). Plant Breeding. The Iowa State University Press, Ames.
17. Frey, K. J. (1982). Plant Breeding II. Kalyani Publishers, New Delhi.
18. Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, New York.
19. Poehlman, J.M. (1987). Breeding Field Crops, 3rd Ed. AVI Publishing Co. Inc., Westport, Connecticut
20. Poehlman J. M. and Sleper D. A. (1995). Breeding Field Crops, 4th Ed. Panima Publishing Corporation, New Delhi
21. Roy D. Analysis and Exploitation of Variation. Narosa Publishing, New Delhi
22. Simmonds, N.W. (1979). Principles of Crop Improvement. Longman Groups Ltd. London.
23. Singh B. D. (2007). Plant Breeding. Kalyani Publishers. Ludhiana.

SEMESTER III ELECTIVE COUSE-3

ELECTIVE COURSE: PHARMACOGNOSY

COURSE CODE: BOT3003E1.3 CREDIT: 4 MARKS: EA. 25+ IA. 75= 100

Objectives

To understand and involves the fundamentals of Pharmacognosy like scope,

- classification of crude drugs, their identification and evaluation,
- To find out the phytochemicals in the modern extraction techniques.
- Characterization and identification of the herbal drugs and their applications.
- To reveal the range of herbal products and their novel usage in human life

UNIT- I

Introduction Definition. History and scope of Pharmacognosy. Indigenous system of medicine: Ayurveda, Homeopathy, Unani, traditional Chinese Medicine, Naturopathy, Yoga and Siddha. Classification of drug of natural origin. Adulteration/Substitution and drug evaluation. Significance of Pharmacopeial standards.

UNIT - II

Plant constituents Occurrence, distribution, classification, isolation, identification test and pharmaceutical applications: plant metabolites, carbohydrate lipids, protein and amino acids, nucleic acids, glycosides, terpenoids, volatile oil / essential oil / resin and tannins.

UNIT - III

Therapeutic Uses of Plants and Drugs Occurrence, distribution, organoleptic evaluation, chemical constituents including tests wherever applicable and therapeutic efficacy of following categories of drugs. Laxatives: Aloes. Rhubarb. Castor Oil. Ispaghula. (b) Cardiotonic - Digitalis Arjuna. (c) Carminatives and G.I. regulators. Umbelliferous fruits, Coriander, Cardamom, Ginger, Black pepper, Asafoetida, Nutmeg and Clove. (d) Astringents: Catechu (e) Drugs acting on nervous systems - Belladonna, Aconite, Withania somnifera, Ephedra and Opium. (f) Anti diabetics- Pterocarpus, Gymnema sylvestre.

UNIT -IV

Industrial uses of Medicinal Plants, Perfumes and flavourings agents- peppermint oil, Lemon oil, orange oil, Lemon grass oil and Sandal wood. Pharmaceutical aids- honey. Arachis oil, Starch, Kaolin, Pectin, Olive oil, Lanolin, Bees wax, Acacia, Sodium alginate, Agar, Guar gum and Gelatin. Miscellaneous- liquorice, Garlic, Picrorhiza, Dioscorea, Linseed, Shatavari, Shankhapushpi, Pyrethrum and Tobacco.

UNIT- V

Crude Plant Drugs Collection and preparation of crude drug for the market as exemplified by ergot, Opium, Rauwolfia, Digitalis and senna. Gross anatomical studies of Senna, Datura, Cinnamon, Cinchona, Fennel, Clove, Ginger, Nuxvomica and Ipecacuanha.

Outcome of the Course

The students are able to identify drug from natural origin and their supply, cultivation, collection, storage along with their special conditions and also define drugs from natural origin. identify the cultivation and collection conditions. identify the storage of drugs. Recall the knowledge about modern concept and scope of Pharmacognosy. To learn the fundamental principles on cultivation, collection processing and evaluation of medicinal plants. Discuss the phyto-chemical screening techniques and able to identify the Phyto-constitutes of plants.

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Suggested Field/Laboratory Exercises:

Suggested Field / Laboratory Exercises corresponding to theory courses, covering all units.

Suggested Readings:

1. Trease. G.E. and Evans W.C. 2009. Pharmacognosy. 16th Edn. Elsevier
2. Wallis T. E. 2005. Textbook of Pharmacognosy, 5th Edn. CBS publishers.
3. S. B. Gokhale. 2008. Pharmacognosy, Pragati Books Pvt. Ltd.
4. C. K. Kokate 2008. Pharmacognosy 53rd Edn. Nirali publisher.
5. Mohammed Ali. 2019. Textbook of Pharmacognosy 2Edn. CBS Publisher.
6. Horborne. J.B. 1983. Phyto chemical methods. Chapman and Hall. London.
7. Biren Shah and A.k. Seth 2010. Textbook of pharamcognosy and Phytochemistry.8th Edn. Reed Elsevier India Pvt. Ltd.
8. Pharmacopoeia of India. Govt. of India. Ministry of health 1955 and 1966.

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SEMESTER III ELECTIVE COURSE-4.1

CORE COURSE: PLANT PATHOLOGY

C. CODE: BOT3004-E1.1

CREDITS: 4

MARKS: EA. 75 +IA.25=100

Objectives

- To understand the economic value of cereal crops.
- The objectives of the Plant Pathology are the study on: the living entities that cause diseases in plants; the non-living entities and the environmental conditions that cause disorders in plants; the mechanisms by which the disease causing agents produce diseases; the interactions

UNIT - I

The concept of disease in plants. Importance of plant disease. Historical and developmental aspects of plant pathology, diseases caused by bacteria, viruses, fungi, and parasitic organisms. Mode of infection and role of enzymes and toxins in plant disease. Epidemiology, plant disease forecasting.

UNIT -II

Defense mechanisms of plants against infection; preexisting structural and chemical defense, induced and chemical defence, hypersensitive reactions, role of phytoalexins and other phenolic compounds, management of plant disease, cultural, chemical, biological, biopesticides, fungicides, chemotherapy breeding for resistance varieties, plant quarantine, Integrated pest management.

UNIT-III

Molecular aspect of host pathogens interaction, PR protein, degradation of phytoalexin. Application of molecular biology to plant disease control. transgenic approach for crop protection.

UNIT-IV

Study of symptomatology (etiology), disease cycle. Importance and control of plant disease caused by fungi: Rots disease, Damping off seedlings of crops, Downy mildews of cucurbits, Rust of wheat and barley, Loose smut of wheat, Blunt of rice, Powdery mildew of pea, covered smut of barley., Wilt of sugarcane, leaf spot of turmeric, leaf blight of wheat, Blast of rice and mango anthracnose, Stem gall of coriander, Leaf curl of peach, early and late blight of potato. Wilt of arhar, Red rot of sugarcane. Tikka disease of ground nut, Ergot of Bajra, Smut of sugarcane, Karnal bunt of wheat, Linseed rust, Wart disease, blight of calocasia, Die back and fruit rot of chilly, Rhizome rot of ginger,

UNIT-V

Study of symptomatology, disease cycle, importance and control of plant diseases caused by bacteria, viruses, mycoplasma and nematodes: Citrus canker, Tundu disease of wheat, Mosaic of bhindi, Sugarcane, tobacco, papaya, potato, Bunchy top of banana, Bacterial blast of rice, Panama disease of banana, Potato spindle tuber mosaic, Ear cockles of wheat, Grassy shoot of sugarcane, Tungro of rice, root knot in vegetable.

Outcomes of Course:

Students will understand the pathology of plants and will help in plant protection management. This will provide unlimited job protentional in government as well as private services and also commercial ventures.

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Suggested laboratory exercise:

1. Study of plant diseases, namely wart of potato, blight of colocassia, downy mildew of cucurbits, wart of sesame, stem gall on coriander, ergot of bajra, smut of sugarcane, linseed rust, tikka disease of groundnut, red rot of sugarcane, bacterial blight of rice, yellow vein mosaic of bhindi, mosaic of sugarcane, grassy shoot of sugarcane and other local diseases on crops
2. Preparation of media and slants for isolation
3. To Study antagonism between fungi in culture medium
4. Quantitative estimation of mycotoxins secreted by toxigenic strains of fungi
5. Estimation of rotting on fruits inoculated by fungi

Suggested Readings

1. Agrios GN (2005) Plant Pathology, Academic Press, Burlington.
2. John AL (1998) Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press, Boca Raton, USA
3. Dickinson CM (2003) Molecular Plant Pathology, Bios Scientific Publisher, Oxford.
4. Robert N, Trigiano, Windham MT, Windham AS (2003) Plant Pathology: Concepts and Laboratory Exercises, CRC Press, Boca Raton, USA.
5. Bridge PD, Clarkson JM (1998) Molecular Variability of Fungal Pathogens, CAB International, Oxfordshire.
6. Singh RS (2008) Plant Diseases, Oxford and IBH Publishing Co Pvt Ltd, New Delhi.
7. Singh RS (2008) Principles of Plant Pathology, Oxford and IBH Publishing Co Pvt Ltd, New Delhi.
8. Dhingra OD, James B, Sinclair (1995) Basic Plant Pathology Methods, CRC Publication, Boca Raton, USA.

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SEMESTER III ELECTIVE COURSE-4.2
CORE COURSE: BIOLOGICAL INVASIONS

C.CODE: BOT3004E1.2

CREDITS: 4

MARKS: EA. 75 +IA.25=100

Objectives

- To understand the nature and ability of invasive plant species, their impact on native biodiversity, case studies on terrestrial and aquatic invasive plants and control measures of biological invasions.

UNIT - I

Biological Invasions Biological invasions: Introduction- attributes of invasive plant species, Reproductive capacity allelopathy effects – Phenotypic plasticity- plant fitness to the new environment. Hypotheses related to invasive species – natural enemy and empty niche hypotheses. World's worst 100 invasive species- Databases for biological invasions.

UNIT - II

Terrestrial Ecosystem Plant invasion in terrestrial ecosystem – Examples and case studies of invasive plant species – biology, ecology of the following species and impact of invasion on native biodiversity – *Lantana camara*, *Parthenium hysterophorus*, *Chromolaena odorata* and *Mikania micrantha*.

UNIT - III

Freshwater Environment Freshwater environment water hyacinth invasion – biology and ecology of *Eichhornia crassipes* its invasiveness and impact on freshwater biodiversity and problems on environment and wiser management. Marine bio invasions: Introduction- Natural and climate change mediated invasions- vectors of marine invasions- Biofouling- Ballast water management – establishment of marine invasive species examples and case study of the sea weed *Kappaphycus alvarezii* in coastal marine ecosystem.

UNIT - IV

Management of Invasion Management of Invasions: Impacts of exotics on plant productivity; Biological control of invasive plant species- Mechanical, chemical and biological control measures- Positive resource use - Quarantine and EIA assessments.

UNIT - V

Global Climate Changes and Bio invasions Global climate change and bio-invasions – Economic loss caused by invasive species; Case study of one terrestrial and aquatic invasive plant species from the local environment and preparation of report for submission with a review of literature on these two selected species. Outcome of Course Students will acquire knowledge on plant invasiveness, attributes and impact of invasive species on biodiversity and productivity of native ecosystem and control measures of plant invasions.

Course Learning Outcomes

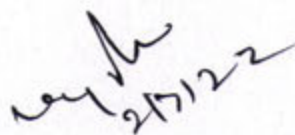
On successful completion of this course students should be able to:

1. Apply ecological theory to explain the entry, establishment, spread and impact of populations, particularly non-indigenous organisms that threaten plant health.
2. Evaluate the potential threats posed by non-indigenous organisms that attack or compete with plants.
3. Design generic surveillance and monitoring programs for invertebrates, weeds and plant pathogens.
4. Communicate technical and scientific information and concepts in written and graphical forms.
5. Explain the impact of invasive species on ecosystems.

Suggested Laboratory Exercises:

As per the units in the syllabus.

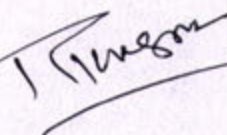
Field surveys and exercises for practical studies.


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Suggested Readings:

1. Singh, J.S., Singh, S.P & Gupta, S.R. 2017. Ecology, Environmental Science and Conservation. S. Chand (G/L) & Company Ltd.
2. Kohli, R. K., Batish, D. R., Singh, J. S., Singh, H. P., Bhatt, J. R. 2012. Invasive alien plants: an ecological appraisal for the Indian subcontinent. CAB International. Reference books 1. GISP – Global Invasive Species Programme <https://www.gisp.org/>
3. E., Russel, L., Zern, J., Aquino, T. and Tsomondo, T. 2001. Economic and environmental threats of alien plants, animal, and microbe invasions. Agriculture, Ecosystems and Environment, 84: 1-20.
4. Rilov, G. and Crooks. (2009). Biological invasions in marine ecosystemsecological, Managemant and Geographic Perspectives. Springer-Verlag, Berlin Heideberg.
5. Singh, S.P., Biological Suppression of Weeds. Biological Control Centre, Bangalore, 1989.
Williamson, M. 1996. Biological Invasion, Chapman & Hall, London

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SEMESTER III ELECTIVE COURSE-4.1

CORE COURSE: MUSHROOM CULTIVATION TECHNOLOGY

C. CODE: BOT3004E1.3

CREDITS: 4

MARKS: EA. 75 +IA.25=100

Objectives

- To create awareness about the Mushroom among the people.
- To strengthen the promotion of mushroom cultivation by establishing a well-equipped laboratory and offices.
- To know and explore the cultivation in Tamil Nadu
- To understand and provide the Unit with appropriately trained personnel for the promotion of mushroom production in the country.
- To increase the production and consumption of mushrooms.
- To develop new products for food, and assist in managing biological resources
- To make our economy strongly by exporting Mushroom product

UNIT-I

Introduction Mushroom – introduction, Life cycle of Mushrooms. Types and identification – edible and poisonous Mushrooms - external factors for growth. Economic importance of Mushrooms as food.

UNIT-II

Mushroom Cultivation Methods History and scope of mushroom cultivation-early cultivation- domesticated mushrooms today- other domesticated fungi. - selection - 'starter' - preparation of spawn - preparation of Compost (outdoor and indoor beds) - incubation - Harvesting and marketing

UNIT-III

Spawn preparation, Spawn production - grain, powder and granular spawn - mother spawn - planting spawn - spawn preparation-spawning techniques-environmental conditions for spawn run preparation of culture (Tissue culture and spore culture), preservation and storage of culture - various media (PDA, malt extract, Wheat extract, compost extract)

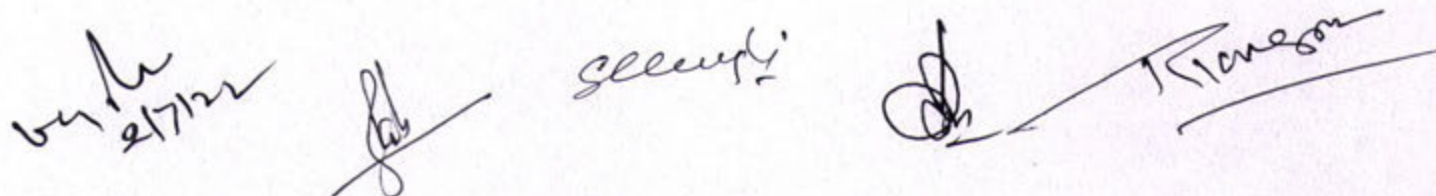
UNIT-IV

Different types of Mushrooms, Cultivation of white Button Mushrooms (*Agaricus bisporus*) and Oyster Mushrooms (*Pleurotus spp*) – materials – sterilization – spawning and fruiting – house design for *Pleurotus* – preservation, canning drying, Cultivation of paddy straw Mushrooms – Preparation, Spawn making – Methods of Cultivation. Mushrooms are different types in Uttar Pradesh: a) Button Mushroom b) Oyster Mushroom c) Milky Mushroom about 70% of its population living in the rural areas and their main income source is agriculture. Primary data was collected through questionnaires and secondary data from online.

UNIT-V

Mushroom harvesting technology, Mushroom technology – nutritive value of edible Mushrooms Protein, carbohydrate, fat, mineral, and vitamin - Medicinal value of Mushrooms, Advantages of Mushrooms Cultivation – Harvesting & Marketing (Local, National and International level).

Outcome of the Course:



Great potential for self-employment as well as commercial venture. Great potential for value added preparations. Multiple areas of services and also will cater the rural development needs. A great source of employment generation for both skilled as well as unskilled labour.

The students are able to specify in the Marketing aspects-make profit with consumer satisfaction, financial aspects-arrange the financial support, and Socio-economic aspects make people aware about good or bad products with reasonable price.

Suggested Laboratory Exercises: As per the syllabus from five units as above.

Suggested Readings:

1. Shubhrata R.Mishra,2014. Techniques of Mushroom Cultivation. Discovery Publuishing House Pvt. Ltd.New Delhi.
2. Kannaiyan.S and Ramasamy, K, 1980. A Handbook of Edible Mushroom. Today andTomorrows. Printers and Publishers, New Delhi,
3. Tewari,S.C.and Pankaj Kapoor,2018, Mushroom Cultivation Mittal Publication New Delhi.
4. Pathak V.N, Nagendra Yadav and Maneesha Gaur. 1998.
5. Mushroom Production and Processing Technology. Agrobios (India) Jodhpur, 179p.
6. Suman, B.C. and Sharma, V.P.2007, Mushroom cultivation in India. Daya Publishing House New Delhi.
7. Chauhan, M., Gajre.K. and Prajapati.P.2013, Scientific Cultivation of Mushroom. Biotech Books New Delhi

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SEMESTER IV CORE COURSE

CORE COURSE - PLANT BIOTECHNOLOGY AND BIOINFORMETICS

COURSE CODE- BOT 4001-C

CREDITS: 4

MARKS: (EA.75+2IA. 5=100)

Objective

- This course provides the clear understanding of biotechnology, sterilization techniques, various tissue culture techniques and its applications.
- Various IPR issues
- Provides insights in the various biotransformation processes and development of useful strains.
- This course will help the students to acquire a vast knowledge of recombinant technology and its use in production of transgenic plants.
- This course provides a deep knowledge about cloning vehicles, phages, restriction endonucleases and blotting techniques.

Unit I

A brief introduction to Biotechnology; Recombinant DNA technology: Restriction endonucleases, DNA Modifying enzymes, DNA polymerases; Vectors, Markers and reporter genes, Cloning, Screening of recombinant clone; Polymerase chain reaction: Principle, method, variants and practical applications; cDNA. Electrophoresis: polyacrlamide gel electrophoresis (PAGE), agrose gel electrophoresis (AGE), native page-PAGE, SDS-PAGE

Unit II

Techniques of tissue culture, cell culture and organ culture. Sterilization techniques and culture media used in tissue culture. cellular totipotency and differentiation, general technique and stages, methods of micropropagation and its applications, Production of haploids: anther culture and pollen culture. Somatic embryogenesis, somaclonal variation. Protoplast culture: isolation, culture and fusion of protoplast.

Unit III

Gene cloning and identification: Genomic and cDNA library, blotting: principal, Hybridization techniques: Southern, northern and western hybridization; FISH; Molecular markers: RFLP, RAPD, AFLP, SSR, SNP; Functional genomics: Quantitative Real Time PCR, Microarray, RNA interference, Mutagenesis and Genome editing, Protein Production strategies in Expression System; Metagenomics

Unit IV

Methods of gene transfer, Agrobacterium mediated genetic transformation of plants, Regeneration methodologies and Screening of transformants; Genetic engineering and its applications in Agriculture: Genetic manipulation of pest resistance, Molecular farming; Transformation of chloroplast genome and its advantage; Biosafety concerns in Plant Biotechnology.

Unit V

Bioinformatics: Introduction, Databases (Genomic and Protein Database), Similarity Searching: BLAST and FASTA; Tools for DNA, RNA and Protein sequence analysis, ExPASy-PROSITE, Sequence Retrieval Methods, Primer Designing tools, Gene Prediction, Restriction Site Annotation, ORF Finder, Sequence Alignment; Molecular evolution and analysis methods

Course Outcome:

State of art technology of present and future with unlimited scope and potential for a great future.

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Suggested Laboratory exercises

1. Selection of salt tolerance / amino acid analogue resistance through cell culture.
2. Isolation and culture of protoplast.
3. Isolation and screening of industrially important microorganism.
4. Isolation of plant DNA, plasmid DNA, bacteriophage DNA.
5. Genetics colonization and tumour induction Agrobacterium Ti plasmid.
6. Restriction analysis and molecular weight DNA.
7. Sequencing and polymerase Chain Reaction.
8. Demonstration of Agarose gel electrophoresis.
9. Preparation of genomic DNA from bacteria.

Suggested readings:

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine & R. Losick Molecular Biology of the Gene, Cold Spring Harbor Laboratory
2. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and application of recombinant DNA ASM Press, Washington, D.C
3. T. A. Brown, Genomes - Garland Science (Taylor & Francis Group), New York & London
4. Alberts Bruce, Johnson Alexander, Lewis Julian, Raff Martin, Roberts Keith and Walter Peter Molecular Biology of the Cell - Garland Science
5. Lodish, Harvey, Berk Arnold, et. al.,-Molecular Cell Biology.
6. Introduction to plant biotechnology by H S Chawla
7. Elements of biotechnology by P K Gupta
8. S H Mantell, et. al. by Principles of Plant Biotechnology: An introduction to genetic engineering in plants
9. Plant Biotechnology by B. D. Singh, Kalyani Publications

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SEMESTER IV CORE COURSE

CORE COURSE- PLANT ECOLOGY AND ENVIRONMENT

COURSE CODE- BOT 4002-C

CREDITS: 4

MARKS (EA. 75+IA. 25=100)

Objectives

- The course focuses on the concept of vegetation, and different life forms, energy dynamics and seasonal expectation.
- The course also focuses on various biogeochemical cycles and to develop an understanding of production and productivity at global level.
- The course also relates to various theories of different geological time scale and thus develops a holistic understanding of nature.
- The students are well prepared to understand the dynamic components of nature, so that they can be better planners for sustainable future.
- Students get equipped with ecological concepts which can be applied to various developmental projects.

Unit I

Introduction to ecology, and environmental terminology, population dynamics, vegetation organization and development: population characteristics, population growth forms, density dependent and density independent controls, population structure (distribution, aggregation, isolation territoriality) energy partitioning, r - and k-selection, Species interaction: types of interaction, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Unit II

Concepts of community and continuum, analysis of communities (analytical and synthetic characters), community coefficients, competition, ecological niche, ecades, ecotype, key stone & dominant species, succession, mechanism of ecological succession (relay floristic and initial floristic composition facilitation, tolerance and inhibition models), concept of climax

Unit III

Ecosystem organization, structure and function: primary production (methods of measurement), energy dynamics (tropic organization, energy flow pathway, energy quality, ecological efficiencies), biogeochemical cycles. Structure and function of some Indian ecosystems. Soil: origin, development and formation. Soil profile, factor of soil formation. Soil type of India and its physical chemical and biological characteristics, edaphic factors.

Unit IV

Pollution and climate change: kinds, sources and effects of pollution, heavy metals (Pb, Cd, Hg), green house gases (CO₂, CH₄, N₂O, CFCs), Green-house effect and global warming, ozone layer depletion and ozone hole, acid rain

Unit V

Environmental impact assessment, threatened and endangered plant species, role of diversity in ecosystem stability, general account of remote sensing and its application, sustainable development. Major terrestrial biomes, theory of island biogeography, biogeographical area of India, major vegetations.

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Outcome of Course:

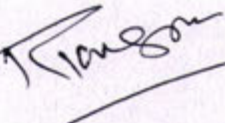
A great potential area from ancient time till date. A subject of unlimited scope and potential for a great future. A mandatory part of existence for the planet. Great scope in competitive studies. Mandatory part declared by honourable supreme court for all graduate students and for everyone.

Suggested Laboratories and field exercise:

1. Determination of minimum size of quadrat by species area curve method.
2. Determination of minimum number of quadrat by species area curve method.
3. Determination of frequency of various species by quadrat method and preparation of frequency diagram.
4. Determination of density of quadrat method.
5. Determination of abundance of species by quadrat method.
6. Determination of relative frequency by quadrat method.
7. Determination of relative density by quadrat method.
8. Determination of basal area by quadrat method.
9. Determination of relative dominance by quadrat method.
10. Determination of IVI by quadrat method.
11. Determination of community coefficient of two sites by quadrat method.
12. Preparation of biological spectrum of a locality.
13. Study of physical and chemical characteristics of soil by rapid field test.
14. Determination of moisture constant of soil.
15. Determination of pH of water.
16. Determination of dissolved oxygen in water
17. Determination of soil profile.
18. Determination of soil texture, colour, consistence.
19. Determination of height of the tree.

Suggested Readings:

1. Odum, E. P. and Barret G.W. 2005. Fundamentals of Ecology. Cengage publication
2. Odum, E.P., 1983. Basic Ecology., Saunders College Publishing
3. Singh, J.S., Singh S.P. and Gupta S.R. 2006. Ecology Environment and Resource Conservation. Anamaya Publishers
4. Andrews, W.R., Jackson & Julie, M. Jackson. 1996. Environmental Science- The Natural Environment and Human Impact. Addison Wesley Longman Ltd.
5. Barbour, M.G., Burk, J.H. and Pitts, W.O. 1987. Terrestrial Plant Ecology. Cummings Pub. Co., California.
6. Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science. Cambridge. U.K.
7. Brady, N. C. 1990. The Nature and Properties of Soils. MacMillan.

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8. Chapman, J.L. and Reiss, M.J. 1988. Ecology- Principles and Applications. Cambridge University Press, Cambridge, U.K.
9. Heywood, V.H. and Watson, R. T. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U.K.
10. Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press, Cambridge, U.K.
11. Kohli, R., Arya, K. S., Singh, P. H. and Dillon, H. S. 1994. Tree Directory of Chandigarh. Lovedale Educational, New Delhi.
12. Kormondy, E. J. 1996. Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
13. Kothari, A. 1997. Understanding biodiversity- Life sustainability and Equity. Orient Longman.
14. Ludwig, J. and Renold, J.F. 1988. Statistical Ecology. John Wiley & Sons., New York.
15. Mason, C. F. 1991. Biology of Freshwater Pollution. Orient Longman.
16. Moldan, B. and Billharz, S. 1997. Sustainability Indicators. John Wiley & Sons., New York.
17. Muller- Dombols, D. and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology. Willey, New York.
18. Nair, M. N. B. et al. (Eds.). 1998. Sustainable Management of Non-wood Forest Products. Faculty of Forestry. Universiti Putra, Malaysia.-434004, P.M. Serdang, Selangor, Malaysia.
19. Odum, E.P. 1971. Fundamentals of Ecology. Saunders, Philadelphia.
20. Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia.
21. Odum, E.P. and Barrett, G.W. 2005. Fundamentals of Ecology. Thomson Brooks/ Cole, EWP Pvt. Ltd., New Delhi.
22. Santra, S.C. 2008. Environmental Science. New Central book Agency Pvt. Ltd., Kolkota .
23. Sharma, P.D. 2000. Ecology and Environment. Rastogi Publications, Meeruth.
24. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publisher, New Delhi.
25. Smith, R.L. 1996. Ecology and Field biology. Harper Collins, New York.
26. Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.
27. Wilson, E.O. 1988. Biodiversity. National Academic Press, Washington, D.C.

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SEMESTER IV ELECTIVE COURSE
ELECTIVE COURSE- FOREST BIOLOGY

COURSE CODE: BOT 4003-E1.1 CREDITS: 4 MARKS: EA. 75+IA. 25=100

Objective: To implant the knowledge of

- Significance and importance of forest for humanity and life forms
- Various forestry system of India and world
- MFP for tribals and related dependent peoples
- Forests in Cultural, Folklore and traditional life systems
- Role of forest in environmental management.

UNIT- I

Introductory Forestry - Indian Forest through Ages. forest area and cover, Factors of locality: climatic (Light, temperature & Frost). Topographic (Effect of Altitude, Aspect & Exposure. Forest Influences and Classification of forest, Community, Forest Utilization: Bio-resources derived from the forests - wood resources, properties of wood, its Seasoning & preservation; Non wood resources – gums, resin, oleoresin, tannin & dyes, nuts, rubber, canes, bamboo, medicinal plants, charcoal, lac, katha, bidi leaves, Pulp & paper, fibre.

UNIT- II

Forest ecology & environment: Ecosystem, forest community concepts, vegetation concepts, primary productivity; General Silviculture: Definition scope and objective of Silviculture various systems; Regeneration of forests, nursery and planting techniques, maintenance, management, Plantation manure and compost, Types of green house, and mist chambers, shade houses.

UNIT- III

Silviculture detail studies of some species - *Azadirachta indica*, *Albizia Lebbeck*, *Buchanania Lanza*, *Casuarina equisetifolia*, *Acacia speices*, *Lagerstroemia parviflora*, *Eucalyptus sp.*, *Shorea robusta*, *Tectona grandis*, *Terminalia arjuna*, *Dalbergia sissoo*, *Anogeissus pendula* *Butea monosperma* and mythological, climate change support trees of Bundelkhand Region.

UNIT- IV

Forest Management System: a. Principles of Forest Management - Forest Policy of 1894, National Forest Policy – 1952 and 1988; Social forestry; Farm Forestry; Joint Forest Management; Agroforestry - Agroforestry systems and plantations, multipurpose tree species for Agroforestry systems in different region of India. b. Wild life management: common game animals and birds of India and their distribution, wildlife Protection Act, 1972 and project tiger

UNIT- V

Forest protection: General factors for forest destruction - shifting cultivation, Insect pest and disease Gazing and lopping, forest fires and Protection Measures
Conservation forestry: Soil properties & classification, Indian soil Types, soil Erosion and its control. VAM; Protected areas; Wastelands; Afforestation on different types of lands- Hot desert and shifting dunes, saline & alkaline areas Ravine lands, cold desert, Wet land, Mined areas, denuded hill slopes, and lateritic soils.

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Outcomes: this course will facilitate the opportunities and provide ample scope for

- Competitive examinations like UPSC, NET, IFS etc
- Agroforestry development and support to farmers
- Forest related products commercialisation.
- Multiple forest and silvicultural activities.

Suggested Practical Exercises :

Practical will include all the exercises as given by respective subject teacher covering all the topics from the theory papers. Some are as under -

1. To observe the horizontal distribution of species in a field of the given data.
2. To calculate the relative frequency, relative density, relative abundance and IVI of the given data by quadrat method and by developing artificial vegetation plots.
2. To determine the leaf area of the given leaves.
3. To determine the percent leaf injury of the given leaves.
4. Study of Biological spectrum at a site
5. To calculate the dry matter of different plant components by using provided data
6. Measurement of Biodiversity Indices (Simpson's Biodiversity Index/ Shannon's index/
7. To develop population structure diagram
8. To calculate net primary productivity of a area by given data
9. To Study the soil pH and soil moisture content.
10. Comment on modern equipment and tools used in nursery.
11. Testing of seeds mainly for, moisture, viability, germination.
12. Application of various pre-sowing seed treatments for germination
13. Calculation of germination percentage of seeds.
14. To observe the VAM .
15. Non wood forest produce: description as to the part of the plant and use.
16. Biostatistics A. To calculate the mean, median and mode by analysing the given data
17. To calculate the standard error and deviation To calculate the correlation coefficient

Suggested Readings:

1. Fundamentals of Ecology - Odum, Saunders, Philadelphia
2. Basic Concepts of Ecology - Kermondy, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Modern Concepts of Ecology - H.D. Kumar, Vikas Publishing House.
4. Aims and Methods of Vegetation Ecology-Muller Dombois and Ellenberg.
5. Economic Botany- Hill, Mac Graw Hill Book Comp.
6. A Handbook of forestry- Dr. S.S. Negi .
7. Dwivedi AP. 1993. Forestry in India. Surya Publication
8. Kumar V. 1999. Nursery and Plantation Practices in Forestry. Scientific Publ.
9. Tideman, E.M. Wasteland management guideline for Indian condition.
10. Fundamentals of Ecology - Odum, Saunders, Philadelphia
11. Aims and Methods of Vegetation Ecology-Muller Dombois and Ellenberg.
12. Economic Botany- Pandey, S. Chand and Com., New Delhi.
13. Bakshi BK. 1976. Forest Pathology. Controller of Publications, GOI.
14. Manion PD. 1991. Tree Diseases Concept. Prentice Hall. Stebbings EP.
15. Tiwari KM. 1988. Social Forestry and Rural Development. International Book Distr.

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SEMESTER IV ELECTIVE COURSE

ELECTIVE COURSE- LIMNOLOGY

COURSE CODE: BOT 4003E1.2 CREDITS: 4 MARKS: EA. 75+IA. 25=100

Objectives:

This course has been designed to target the potential of water without which lifeforms could not exist on this planet. This caters the studies of water bodies and their relation ship with flora and fauna at various level of depts and their interactions which help in maintaining the ecology and ecosystem of life and environment their in.

Unit I

Introduction to Limnology, Properties of water, Lake ontogeny, morphometry, Physical factors: Light Temperature, Heat, and Stratification. Chemical factors: DIC, Oxygen in lakes, profiles, seasonal effects, primary production, effect of DOC and BOD

Unit II

Redox reactions in the water column and sediment, Size spectrum of planktonic organisms, Size efficiency hypothesis, Food webs: benthic-pelagic coupling, paleolimnology, Human impact on lack ecosystem

Unit III

Chemical properties: Hydrogen-ion concentration, Dissolved gases in freshwater- Nitrogen and Phosphorus cycles in freshwater lakes. Ecological classification of freshwater organisms: Nature and distribution of Phytoplankton, Macrophytes and Zooplankton communities. Concept of Productivity: Seasonal variation, Primary productivity in freshwater lakes, Estimation of Primary Productivity.

Unit IV

Food Chains, Food webs, Trophic levels and Energy flow and community structure in freshwater ecosystems. Eutrophication: Causes, mechanism and significance and impact, Management of freshwater bodies.

Outcome of Course:

- To impart study of fresh water studies and ecosystem studies their in.
- Potential in various environment related services and competitions.
- To get services in various recreational water sports and Ramsar water bodies conservations.
- Potential in save water save life area NGOs.

Suggested Laboratory Exercises:

1. Construction of morphometric maps of aquatic systems.
2. Measurement of transparency and temperature.
3. Analysis of different dissolved gases : Dissolved oxygen and Carbon dioxide.
4. Analysis of lake water for bicarbonates, carbonates, total alkalinity, chlorides etc.
5. Sampling of phytoplankton and their qualitative and quantitative analysis.
6. Sampling of periphytes and macrophytes, and their qualitative and quantitative analysis.
7. Sampling of Zooplankton and their qualitative and quantitative analysis.
8. Primary production: Experiment-in-situ by light and dark bottle method.
9. Short term productivity experiments for the understanding of diel variation in aquatic ecosystems.
10. Analysis of sediments for benthic fauna and flora.

Essential Readings

1. Welch, P.S. (1952) Limnology. 2nd ed. McGraw Hill Co., New York.
2. Wetzel, R.G. (1975) Limnology. W.B. Saunders Co., Philadelphia.

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3. Ruttner, F. (1963) Fundamentals of Limnology. 3rd ed. University of Toronto Press, Canada.
4. Cole, G.A. (1979) Textbook of Limnology. 2nd ed. C.V. Mosby Co. Toronto.

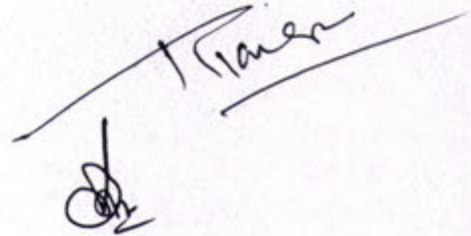
Additional Readings

1. Goldman, C.R. and A.J. Horne (1983) Limnology. McGraw Hill, Inc. Tokyo.
2. Golterman, H.L. (1975) Physiological Limnology. Elsevier Scientific Pub. Oxford.
3. Moss, B. (1980) Ecology of Fresh Waters. Blackwell Scientific Pub., Oxford.
4. Barne, A.K. and K.H. Mann (1980) Fundamentals of Aquatic Ecosystems. Blackwell Scientific Pub., Oxford.
5. Hutchinson, G.E. (1957) A Treatise on Limnology. Vol. I-II. John Wiley & Sons, New York.
6. Robinson, (2014). Ecological Principles of wastewater microbes. Auris.
7. Dey, (2014). Ecology of Aquatic Systems. Medtech Publishers.

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SEMESTER IV ELECTIVE COURSE
ELECTIVE COURSE- HERBAL SCIENCE

COURSE CODE- BOT 4003-E1.3 CREDITS: 4 MARKS: EA. 75+IA. 25=100

Objectives:

- To study the importance of herbal medicine in India
- To identify the herbal medicine uses plant
- To cultivation medicinal plants
- To understand the morphological characters of medicinal plants

UNIT - I

Introduction of Herbal Sciences, Role of plants in naturopathy- A historical perspective of medicinal plants in India. Importance and relevance of medicinal drugs in India. Indian system of medicine viz, Siddha, Ayurveda, Allopathy, Unani and Homeopathy. Study of Phytochemicals—reserve materials, secretory materials and excretory materials. Indian Systems of Medicine (Ayurveda, Siddha, Unani, Tibetan, Yoga and Naturopathy) Ayurveda: Historical perspective, Swasthavritta (measures to be adopted for maintaining the health of healthy person in a positive way through prevention, promotion and correction).

UNIT - II

Medicinal Plants Therapeutic Compounds, Chemical constituents. Therapeutic and other pharmaceutical uses of Root – *Withania somnifera*, *Hemidesmus indicus*. Stem – *Tinospora cordifolia*, *Ephedra gerardiana*. Underground stem – *Zingiber officinale*, *Curcuma longa*, Wood - *Santalum album*, Bark - *Saracaasoca*, *Terminalia arjuna*. Leaves- *Ocimum santum*, *Adathoda vasica*. Flower- *Syzygium aromaticum*, *Crocus sativus*. Fruit *Terminalia bellirica*, *Embllica officinalis*. Seeds- *Strychnos nuxvomica*. Whole plants *Phyllanthus amarus*.

UNIT - III

Gardening Medicinal Plants, Medicinal gardening – garden in the hills and plains, house gardens, important plants for gardening. Poisonous plants of India—Types of Plant poison- active plant poison treatment for plant poisons, Some important poisonous plants, their toxicity and action. Adulteration of crude drugs and its detection—methods of adulteration, types of adulteration. Medicinal plants of export values. Rejuvenating herbs—role of non flowering plants in the field of medicine.

UNIT - IV

Cultivation of Medicinal Plants Cultivation of medicinal plants in India. Breeding methods applied to medicinal plants. Herbal medicine preparation: Decoction, infusion, syrup, tincture and poultice. Food: herbal salad, chutney, soup and Tea. Exports values of medicinal plants- Bark - Cinchona, Leaves – Adathoda and Eucalyptus, Flower - Clove. Fruits and seed - Wood apple, Gooseberry and Poppy seed, Underground stem - Ginger, Unorganized drugs. Gum - Acacia, Resin - Turpentine, Fixed oil - Castor oil

UNIT - V

Conservation of Medicinal Plants, Study of some common plants of medicinal value Binomial, common name, part of uses, active principles and medicinal uses. *Azadirachta indica*, *Acalypha indica*, *Achyranthes aspera*, *Aloe vera*, *Alternanthera sessilis*, *Cinnamomum zeylanicum*, *Centella asiatica*, *Digitalis purpurea*,

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Emblica officinalis, *Ocimum sanctum*, *Phyllanthus amarus*, *Solanum trilobatum*, *Syzygium cumini*. The endemic medicinal plants of India. Conservation of existing and endangered medicinal plants.

Outcomes of the Course

The students are able to learn the major use of herbal medicines is for health promotion and therapy for chronic, as opposed to life-threatening, conditions. However, usage of traditional remedies increases when conventional medicine is ineffective in the treatment of disease, such as in advanced cancer and in the face of new infectious diseases.

Suggested Field/Laboratory Exercises:

Suggested Field / Laboratory Exercises corresponding to theory courses, covering all units.

Suggested Readings:

1. Agarwal, O.P, 1985. Vol-II. Chemistry of organic – natural products.
2. Chopra, R.N., Chopra, I.C., Handa, K.L., and Kapur, L.D. 1994. Indigenous drugs of India.
3. Tilgner, Sharol Marie . 2018. Herbal ABC's: The Foundation of Herbal Medicine.
4. Bhagwan Das—Fundamentals of Ayurveda.
5. Kandasamy Pillai, 1972. History of Siddha medicine. Govt. of Tamilnadu.
6. Krup, P.V. Handbook of medicinal plants Vol I & II, CCRIMH, New Delhi.
7. Nadkarni, K.M., 1976. Indian Materia Medica Vol I & II, Popular Prakashan Pvt. Ltd.
8. Wallis, T.E., 1967. Text book of Pharmacognosy, J.A. Churchill Ltd.
9. C.K. Kokale, C.K. Kokate & Purohit – Pharmacognosy, Nirali Prakashan, New Delhi.
10. E. Edwin Jerald & Sheeja Edwin Jerald – Text Book of Pharmacognosy and Phytochemistry, CBS Publishers & Dist., New Delhi.

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SEMESTER IV ELECTIVE COURSE
ELECTIVE COURSE- ETHNOBOTANY AND IPR
COURSE CODE- BOT 4004-E1.1 CREDITS: 4 MARKS: EA. 75+IA. 25=100

Objective: To impart the knowledge of

- Basic idea about all fundamental and interdisciplinary aspects of Ethnobotany
- conservation of Genetic diversity,
- Traditional and tribal systems of medicines,
- plant in the folklore and mythology,
- wild life protection in tribes and
- Traditional and tribal system of medicine for therapeutic and treatment of ailments and diseases.

UNIT- I:

Ethnobotany: Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context;

Ethnic groups of India: Major and minor tribes with special reference to Bundelkhand region, life styles of ethnic tribes,

Ethnic groups of India and Ethnobotany: Major and minor ethnic groups or Tribals of India with special reference to Bundelkhand Region and their life styles and conservation practices. Forest Vs. ethnic groups; Plants in Tribal life with reference to Magico-religious rituals and social customs. Sacred groves.

UNIT - II

Plants in mythology, Taboos and Totems in relation to plants, folklore and folktales. Wild life protection in tribal, Plant domestication by the tribal, Plants in similes in metaphors.

Methodology of Ethnobotanical studies: Field work documenting the information- questionnaire survey; Herbarium Ancient Literature; Archaeological findings; Temples and sacred places Protocols.

World centers of ethnobotany with special reference to India.

UNIT - III

History and principles of Ayurveda, Unani and Siddha systems of medicines; Preservation of genetic diversity, plants used in various system of medicine- Ayurvedic, Unani and siddha system and TKDL- Traditional Knowledge Digital Library.

UNIT - IV

Ethnobotany and legal aspects. Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Ethnobotany as a source (recent) of already known drugs:

- a) Withania as an antioxidant and relaxant b) Sarpagandha in brain ailments
c) Becopa and Centella in epilepsy and memory development in children d) Phyllanthus fraternus in diabetic and viral jaundice e) Artemisia as a powerful cerebral antimalarial agent and its possible use in tuberculosis.

Ethnomedicinal significance and potential studies of – *Allium cepa*, *Allium sativum*, *Aloe vera*, *Azadiricta indica*, *Butea monosperma*, *Cassia fistula*, *Cannabis sativa*, *Embalica officinalis*, *Euginea jambolana*, *Lawsonia inermis*, *Mantha arvensis*, *Ocimum sanctum*, *Ricinus communis*, *Santalum album*, *Terminalia*

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bellerica, Terminalea chebula, Terminalea arjuna, Boerhaavia diffusa, Tribulus terrestris, Eclipta alba, Euphorbia hirta.

UNIT - V

Role of ethnobotany in national priority, health care and development of cottage industries in India. Role of ethnobotany in modern Medicine with special examples; Medico-ethnobotanical sources in India with special reference to Bundelkhand Region; Bioethics, Bioprospecting and Biopiracy,

Intellectual Property Rights: History, Types, Forms of protection, Patents, Trademarks, Trade secrets, Designs, Geographical indication, Plant variety protection, procedure of patenting

Course Outcomes: On the completion of the course, the students will be able to understand-

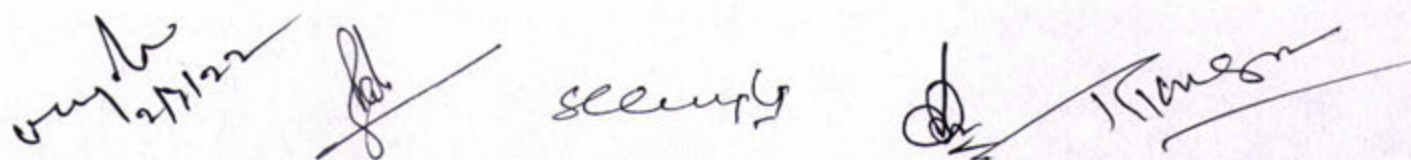
- Ethnobotany- Definition and scope of Ethnobotany and interdisciplinary approaches of ethnobotany.
- Preservation of genetic diversity, plants used in Ayurvedic, Unani and homeopathic system & Allopathic medicine system and Role of Ethnobotany in the development of society.
- Plants in mythology, Taboos, Totems in relation to plants, folklore, folktales and Wild life protection in tribal.
- Ethnobotanical importance of major plants in tribal life styles and traditional system of medicine.

Suggested Practical:

1. Collection and study of germplasm (seeds) and prepare a seed-bank medicinal & ethnobotanically important plants.
2. Preparation of a herbarium, medicinal parts of plants. (Leaf, stem, bark, root-powder, decoction, Bark powder etc.)
3. Detailed study of certain diseases and collect plants which are used in treating common local ailments
4. Collection of locally available plants their parts which are credible to medicinal purposes.
5. Rest exercises as per syllabus.

Suggested Readings:

1. Cotton, C.M. 1996. Ethnobotany- Principles and applications, John Wiley & Sons, NY.
2. Jain, S. K. & Mudgal V. 1999. A hand book of Ethnobotany. Bishan Singh & Mahendra pal Singh, Dehradun.
3. Jain, S. K. & Rao R. R. 1976. Field and Herbarium methods. Today's & tomorrow Pub., New Delhi.
4. Jain, S. K. & Shrivastava S. 1999. Dictionary of Ethnobotany- Veterinary Plants of India Deep Pub, New Delhi.
5. Jain, S. K. 1987. Manual of Ethnobotany. Scientific Pub, Jodhpur.
6. Jain, S. K. 1991. Dictionary of Indian Folk Medicine and Ethnobotany. Deep Pub, New Delhi.
7. Jain, S. K. 1997. Contribution to Indian Ethnobotany -III Ed. Scientific Pub, Jodhpur.
8. Jain, S. K. 2001. Bibliography of Indian Ethnobotany. Scientific Pub, Jodhpur.
9. Jain, S. K. 1989. Methods and approaches in Ethnobotany. Society of Ethnobotany, Lucknow.
10. Martin J. 1995. Ethnobotany. Chapman & Hall, London.
11. Sakalani A. & Jain S. K. 1994. Cross Cultural Ethnobotany of N-E India. Deep Pub, New Delhi.
12. Vargese E. 1996. Applied Ethnobotany- A case study of among the Kharia of Central India. Deep Pub, New Delhi.



SEMESTER IV ELECTIVE COURSE

ELECTIVE COURSE: HORTICULTURE AND LANDSCAPING

COURSE CODE- BOT 4004E1.2

CREDITS: 4

MARKS: EA. 75+IA. 25=100

Objectives:

To understand horticulturists, apply their knowledge, and technologies used to

- grow intensively produced plants for human food and non-food uses and for
- personal or social needs.
- To real their work involves plant propagation and cultivation with the aim of
- improving yields, diseases, plant growth, nutritional value, quality, and resistance
- to insects, and environmental stresses.
- To the students also work as gardeners, therapists, designers, growers, and
- technical advisors in the food and non-food sectors of horticulture.

Unit - I

Introductions Garden Design and Landscaping Garden and Garden design. Knowledge of plants – Soils- Irrigation – Transplanting Potting- Soil less culture. Lawn – Rock Garden – Rosary – water garden – terrace garden – Kitchen Garden –Landscaping Fences for utility and beauty – Archers and pergolas – Green house and glasshouse – summer house.

Unit - II

Propagation Methods: Propagation techniques – Vegetative Propagation, Sexual propagation – Seed Germination techniques– Seed dormancy – Seedling raisings – Vegetative cuttings – Layering – grafting – Budding – Stocks – Scion relationships – micro propagation.

Unit - III

Nutrition and Diseases Management Nutrition and Diseases Manures and Manuring – Training and pruning – Irrigation techniques. Classification of Irrigation, Methods of Irrigation. Applications and use of plant growth regulators in horticulture – Some important diseases of Horticultural plants and its plant protection.

Unit - IV

Floriculture and Pomology: Floriculture and Pomology Culture of Economically important flowers: Jasmine – Rose – Cut flowers. Fruit culture: Mango – Guava – Banana - Papaya.

Unit - V

Post-Harvest Techniques, Post-harvest technology Flower arrangements and decorations- harvesting – Marketing - post harvest Storage of fruits and vegetables – Preservation of fruits and vegetables.

Outcome of the Course

The students will be able to recognize the major areas of Horticulture and Landscape horticulture includes the production, marketing and maintenance of landscape plants. Olericulture includes the production and marketing of vegetables. Pomology includes the production and marketing of fruits. The career in the field of horticulture is the best career choice for students. Horticultural crops i.e. fruit and vegetable acquire a place of important as protective food. They provide much needed health supporting vitamins, minerals. Besides, their value in human consumption, horticultural crops play an important role in commerce, particularly in export trade and processing industry.

Suggested Field/Laboratory Exercises:

Suggested Field/Laboratory Exercises corresponding to theory courses, covering all units.

Suggested Readings:

1. Bose T.K. 1990. Fruits of India. Tropical and subtropical, Naya Prakash, Calcutta.
2. A.K. Tiwari., 2012. Fundamentals of Ornamentals Horticulture and Landscape Gardening. Publisher: Nipa (2012) ISBN-10: 9381450072; ISBN-13: 978-9381450079.
3. Bose.T.K. Som. M.G. and Katrir. J. 1993. Vegetable Crops, Naya Prakash, Calcutta.
3. Bose .T.K. and D.Mukherjee. 1987. Gardening in India, Naya Prakash, Calcutta.
4. Bose .T.K.. and C.P. Yadav. 1989. Commercial flowers, Naya Prakash, Calcutta.
1. Edman, J.B. T.L. Senn, F.S. Andrews and R.G. Halfacre, 1988. Fundamentals of Horticulture, Tata McGraw Hill Publishing house company, New Delhi.
2. Hartman. H.T. and Kester D.E . 1986. Plant propagation principles and practices Prentices Hall of India Ltd., New Delhi.
3. Janick. J.W.H. 1988. Horticulture Science. Freeman and Co., Sanfrancisco.
4. Nambisan .K.M.P. 1992. Design Elements of Landscape Gardening- Oxford and IBH Publications.
5. Prasad, S and Kumar, 1999. Principles of Horticulture. Agrobotanica, Bikaner
6. Shanmugavelu K.G. 1989. Production Technology of vegetable Crops. Oxford India. Publication, New Delhi.

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SEMESTER IV ELECTIVE COURSE

ELECTIVE COURSE: TECHNIQUES IN BOTANY

COURSE CODE- BOT 4004E1.3

CREDITS: 4

MARKS: EA. 75+IA. 25=100

Objectives:

- To understand and familiar with modern instruments used in plant science field.
- To Understand Principle, working, ray diagram and application of advance microscopes
- The students are able to stain the bacteria with differential staining techniques.
- To understand bio-analytical methods used in various molecular biology.

UNIT I

Microscopy Structure, working principle and applications of Light, Dark field, Bright Field, Phase Contrast, Confocal, Fluorescence, Scanning and Transmission Electron microscopy, Material preparation for Electron microscopy. Microscopic measurements: Micrometers – Ocular and Stage; Haemo-cytometer and Camera Lucida.

UNIT II

Micro-techniques and Culture Techniques Sectioning of Biological specimens - Free hand, staining of the sections, Mounting and mountants, Fixing coverslips and ringing. Collection and Preservation of plant material. Cryopreservation. Culture Technique: Principles, types (Bacteria, Fungi, Algae, Plant) media preparation, sterilization, inoculation, Equipment – Laminar air flow, thermobath, shaker, stirrer, hot air Oven.

UNIT III

Histochemical and Spectroscopic techniques Introduction to Histochemical techniques – staining of Proteins, Carbohydrates, and Lipids. Microslide preparation—Whole mounts, Smears and Squashes. Maceration technique. Colorimetry, UV-Visible and Atomic Absorption Spectrophotometry, IR, M.Sc., Botany: Syllabus (CBCS) NMR and Mass Spectrophotometry and X-Ray Diffraction analysis. Flow Cytometry, Autoradiography: Isotopes used in Biology

UNIT IV

Molecular and separation Techniques Blotting techniques- Southern, Northern and Western; ELISA; RIA and PCR (Thermocycler and Real Time PCR). DNA finger printing; RFLP; RAPD, MALDI and FISH techniques. Electrophoresis – General principles – Electrophoresis- Agarose gel; SDS –PAGE. Chromatography – Principles and applications of Paper, Thin layer, Column, Ion exchange, affinity, Gel permeation, Adsorption and Partition chromatography. HPLC and FPLC. HPTLC and GC. Centrifugation: Basic principles of Sedimentation; Preparative Ultracentrifugation.

UNIT V

Tissue culture techniques Introduction - tissue culture techniques - laboratory organization – preparation of nutrient media. Methods of sterilization – Chemical and Physical methods. Preparation of explants – callus initiation, subculture and hardening. Concepts of totipotency and redifferentiation. Cell suspension culture – callus culture, Anther and pollen culture – haploids and their significances. Embryo culture - Meristem culture for virus-free clones.

Suggested Laboratory Exercises:

As per the requirement of all five units of syllabus with relevant institutional visits. If institution permits then could do industrial and research internships.

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Suggested Reading:

1. Ananta Swargiary. 2017. Biological tools and Techniques. Kalyani Publishers, New Delhi.
2. Prasad and Prasad, 2000. Outlines of Micro technique. Emkaypubl, New Delhi.
3. Practical Biochemistry: Principles and Techniques. Ed. E. Wilson and J. Walker (2000) Cambridge Publ.
4. Chawla, H.S. 2000. Introduction to biotechnology. Oxford and IBH publishing Co., New Delhi.
4. Johansson DA. 1975. Plant Microtechnique. McGraw Hill. Reference Books
5. Nagarajan, P. and Senthilkumar, N. 2001. Molecular biology principles and methods a practical approach, SreeNarmatha Printers, Coimbatore. M.Sc., Botany: Syllabus (CBCS)
6. Sharma, R.K. and S.P.S. Sangha. 2009. Basic Techniques in Biochemistry and Molecular Biology. I.K. International Pvt. Ltd, New Delhi.
7. Keith Wilson and John Walker. 2010. Principles and Techniques of Biochemistry and Molecular biology. Cambridge University Press, New York.
8. Palanichamy, S. and M. Shunmugavelu. 1997. Research methods in Biological Sciences. Palani Paramount Publications, Palani.
9. P.R. Yadav and Rajiv tyagi, 2006. Biological Techniques, Discovery Publishing House, New Delhi.
10. Susan carson, Heather B. Miller and D. Scott, 2012. Molecular biology techniques, Elsevier.
11. Bajpai P.K. 2006. Biological instrumentation and Methodology. S Chand Publishers, New Delhi.
12. Sabari Ghosal and Srivastava A. K. 2009. Fundamentals of Biological Techniques and Instrumentation. PHI Learning Private Ltd. New Delhi.

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