The University of Burdwan

Syllabus of 3-Year Degree/4-Year Honours in Botany

Under Curriculum and Credit Framework for Undergraduate Programme (CCFUP) as per National Education Policy 2020

With effect from 2023-24

Course Introduction

The new curriculum of B.Sc. Botany offers holistic knowledge and technical skills to study plants. Exposure will be given to all areas of plant science using a unique combination of core, elective and vocational papers with significant inter-disciplinary components. Students would be exposed to both conceptual ideas and cutting-edge technologies that are presently used in the study of diverse plant life forms, processes, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social, economic, and environmental significance of plants and their relevance to the national economy. B.Sc. Botany Programme covers academic activities within the classroom sessions along with practical concepts. Candidates will develop strong philia in plants kingdom, ecosystem, life processes, their application in making technology, exploring exotic places which might help them to work as researchers or professions like Botanist, Conservationist, Ecologist, Geneticist, Biochemists, Biotechnologist etc.

Programme outcomes (POs):

Transformed curriculum shall develop educated outcome-oriented candidature, fostered with discovery- learning, equipped with practice & skills to deal practical problems and versed with recent pedagogical trends in education including e-learning, flipped class and hybrid learning to develop into responsible citizen for nation-building and transforming the country towards the future with their knowledge gained in the field of plant science.

- Shall produce competent plant biologists who can employ and implement their gained knowledge in basic and applied aspects that will profoundly influence the prevailing paradigm of agriculture, industry, healthcare and environment to providesustainable development.

- Will increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, enhance communication skill, social interaction, and increase awareness in judicious use ofplant resources by recognizing the ethical value system.

- The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET.

Programme specific objectives (PSOs): B.Sc. 1st Year Course in Botany

- This course will provide knowledge on various fields of basic Botany as well as knowhow of basic cell biology and biomolecules.
- Students will be given exposure to evolutionary trend in plant kingdom
- Syllabus is prepared to enable students for competitive exams in frontier areas of plant sciences.

Course Outcomes of Paper I (CO)

- Develop understanding about the classification and diversity of different microbes including Bacteria, Viruses, Fungi, etc. and other diverse plant groups like, Algae, Fungi & Lichens, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.
- Gain knowledge about developing commercial enterprise of microbial products.
- Understand the structure and reproduction of certain selected bacteria, algae, fungi and lichens
- Develop critical understanding on morphology, anatomy and reproduction of Microbes, Algae, fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.
- Understand the instruments, techniques, lab etiquettes and practices for working in a microbiology laboratory.
- Develop skills for identifying microbes and using them for Industrial, Agriculture and Environmental purposes.

Course Outcome - Paper II (CO)

1. Develop understanding on the basic chemistry of biomolecules, their involvement in cellular life processes.
2. Develop knowledge on plant cell architecture, their functioning in transducing life processes.
3. Develop practical knowledge on biomolecule identification and basic cellular processes.

SEMESTER WISE & COURSE WISE CREDIT DISTRIBUTION STRUCTURE UNDER CCFUP as per NEP, 2020

Semester	Course Type	Course Code	Name of the Course	Credit	Lect.	Tuto.	Pract./Viva	Full Marks	Distribution of Marks		
									Theory	Pract. / Tuto./ Viva-voce	Internal Assessment
I	Major/DSE Course (Core)	BOTN1011	Major: Plant Diversity and Evolution	4	3		1	75	40	20	15
	Minor Course	BOTN1021	Minor: Plant Diversity and Evolution	4	3		1	75	40	20	15
	Multi/inter disciplinary	BOTN1031	Biodiversity and its conservation	3	2	1	0	50	40	0	10
	Ability Enhancement Course (AEC) [L1-1 MIL]	1041	Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu or Equvlnt. Course from SWAYAM	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC)	BOTN1051	SEC: Biofertilizer	3	2	1	0	50	40	0	10
	Value Added (VA) Course	CVA1061	Environmental Science/ Education	4	3	0	1	100	60	20	20
	Total			**20**				**400**			

Semester	Course Type	Course Code	Name of the Course	Credit	Lect.	Tuto.	Pract. /Viva	Full Marks	Distribution of Marks		
									Theory	Pract. / Tuto./ Viva-voce	Internal Assessment
II	Major/DSE Course (Core)	BOTN 2011	Major: Biomolecules and Cell Biology	4	3	0	1	75	40	20	15
	Minor Course	BOTN 2021	Minor: Biomolecules and Cell Biology	4	3	0	1	75	40	20	15
	Multi/inter disciplinary	BOTN 2031	Medicinal Plants and Phytochemistry	3	2	1		50	40	0	10
	Ability Enhancement Course [L_2-1]	ENGL 2041	Functional English or Equivalent. Course from SWAYAM	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC)	BOTN 2051	SEC: Organic cultivation and Protected Agriculture	3	2	1	0	50	40	0	10
	Value Added (VA) Course	CVA 2061	Understanding India/digital and technological solution/health and wellness, yoga education, sports and fitness.	4	3/3	1/0	0/1	100	80/60	0/20	20
Skill based vocational course (addl. 4 Cr) during summer term for 8 weeks, who will exit the programme after securing 40 cr.											
For UG Certificate 40 cr + Additional 4 cr (work based vocational course) = 44 cr. Students are allowed to re-enter within 3 years within the stipulated max. period of 7 years											
	Total			**20**				**400**			

SEMESTER I

Major: (BOTN1011)- Plant Diversity and Evolution

Credit -3 **Marks - 40**

Unit 1: Origin of life **Hours: 3**

Chemical basis of origin of life, concepts of evolution, Tree and classification of life, and classification (up to six kingdoms).

Unit 2: Bacteria **Hours: 5**

Characteristic features, cell structure and genetic element, asexual reproduction and modes of gene transfer (conjugation, transformation and transduction), brief introduction to Archaea. Role of bacteria in agriculture, medicine and industry.

Unit 3: Viruses **Hours: 3**

Characteristic features, replication, RNA virus (structure of TMV), DNA virus (structure of T_2-phage), Lytic and Lysogenic life cycle (Lambda phage).

Unit 4: Algae **Hours: 4**

Characteristic features, cell structure, range of thallus, methods of reproduction and evolutionary classification of Lee (2015) up to orders. A brief account of *Nostoc*, *Spirogyra, Sargassum*, *Polysiphonia;* economic significance (brief account)

Unit 5: Fungi **Hours: 5**

Characteristics features, affinities with plants and animals, structural features, reproduction and life cycle pattern. Outline classification of Ainsworth (1973) up to orders. Myxomycetes- characteristics and their similarities with fungi. General characteristics and life cycles of *Mucor, Saccharomyces, Ascobolus, Neurospora*, *Agaricus Helminthosporium* (= *Cochiliobolus*) and *Fusarium*. Fungal symbiosis- lichen and mycorrhizae (characteristics and significance), economic importance of fungi.

Unit 6: Bryophytes **Hours: 5**

Characteristic features and reproduction, adaptation to land habit, outline classification of Schuster (1958) up to orders, evolutionary trends in Bryophytes. Brief account of *Marchantia, Anthoceros* and *Funaria*. Ecological significance.

Unit 7: Pteridophytes **Hours: 5**

Characteristic features and reproduction, Outline classification of Gifford & Foster (1989) up to order, evolutionary trends in Pteridophytes, affinities with Bryophytes. Brief account of *Psilotum, Selaginella, Equisetum, Pteris* and *Marsilea.*

Unit 8: Gymnosperms **Hours: 5**

Characteristic features and reproduction, Outline classification of Bhatnagar & Moitra (1996) up to orders, evolutionary trends in Gymnosperm, affinities with Pteridophytes. Brief account of *Cycas, Ginkgo* and *Gnetum*. Economic significance.

Unit 9: Angiosperms **Hours: 5**

Gross morphology and reproduction, Basic idea of natural, artificial and phylogenetic system of classification.

Practical

Credit 1 **Marks-20**

1. To study different strains of *Bacillus* and *E. coli* (Gram staining). (01 hr)

2. To study structure of TMV and T_2 Bacteriophage (electronmicrographs/models). (01 hr)

3. To study morphology of *Nostoc*, *Spirogyra*, *Sargassum*, *Polysiphonia etc.* from permanent slides. (02 hr)

4. To study *Mucor*, *Saccharomyces*, *Ascobolus*, *Agaricus* and *Fusarium* from permanent slides, dry preserved specimens or museum specimen. Lichens from dry or preserved specimens. (02 hr)

5. To study *Marchantia*, *Anthoceros* and *Funaria* (vegetative and reproductive morphology from permanent slides). (03 hr)

6. To study the vegetative and reproductive morphology of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* from permanent slides. (02 hr)

7. To study the vegetative and reproductive morphology of *Cycas*, *Ginkgo* and *Gnetum* from permanent slides. (02 hr)

8. To study morphology of angiosperm leaf, stem, flower, inflorescence and fruits from locally available plant species. (05 hr)

9. Temporary anatomical slide preparation of *Pteris* leaflet and *Cycas* leaflet. (02 hr)

Tutorial: Nil

Minor: (BOTN1021) Plant Diversity and Evolution

Credit: 3 **Marks: 40**

Unit 1: Origin of life **Hours: 3**

Chemical basis of origin of life, concepts of evolution, Tree and classification of life, and classification (up to six kingdoms).

Unit 2: Bacteria **Hours: 5**

Characteristic features, cell structure and genetic element, asexual reproduction and modes of gene transfer (conjugation, transformation and transduction), brief introduction to Archaea. Role of bacteria in agriculture, medicine and industry.

Unit 3: Viruses **Hours: 3**

Characteristic features, replication, RNA virus (structure of TMV), DNA virus (structure of T_2-phage), Lytic and Lysogenic life cycle (Lambda phage).

Unit 4: Algae **Hours: 4**

Characteristic features, cell structure, range of thallus, methods of reproduction and evolutionary classification of Lee (2015) up to orders. A brief account of *Nostoc, Spirogyra, Sargassum*, *Polysiphonia;* economic significance (brief account)

Unit 5: Fungi **Hours: 5**

Characteristics features, affinities with plants and animals, structural features, reproduction and life cycle pattern. Outline classification of Ainsworth (1973) up to orders. Myxomycetes- characteristics and their similarities with fungi. General characteristics and life cycles of *Mucor*, *Saccharomyces*, *Ascobolus*, *Neorospora*, *Agaricus* *Helminthosporium* (= *Cochiliobolus*), *Fusarium.* Fungal symbiosis- lichen and mycorrhizae (characteristics and significance), economic importance of fungi.

Unit 6: Bryophytes **Hours: 5**

Characteristic features and reproduction, adaptation to land habit, outline classification of Schuster (1958) up to orders, evolutionary trends in Bryophytes. Brief account of *Marchantia, Anthoceros* and *Funaria*. Ecological significance.

Unit 7: Pteridophytes **Hours: 5**

Characteristic features and reproduction, Outline classification of Gifford & Foster (1989) up to order, evolutionary trends in Pteridophytes, affinities with Bryophytes. Brief account of *Psilotum, Selaginella, Equisetum, Pteris* and *Marsilea.*

Unit 8: Gymnosperms **Hours: 5**

Characteristic features and reproduction, Outline classification of Bhatnagar & Moitra (1996) up to orders, evolutionary trends in Gymnosperm, affinities with Pteridophytes. Brief account of *Cycas, Ginkgo* and *Gnetum.* Economic significance.

Unit 9: Angiosperms **Hours: 5**

Gross morphology and reproduction, Basic idea of natural, artificial and phylogenetic system of classification.

Practical

Credit: 01 **Marks:20**

1. To study different strains of *Bacillus* and *E. coli* (Gram staining). (01 hr)

2. To study structure of TMV and Bacteriophage (electronmicrographs/models). (01 hr)

3. To study morphology of *Nostoc*, *Spirogyra, Sargassum, Polysiphonia etc.* from permanent slides. (02 hr)

4. To study *Mucor, Saccharomyces, Ascobolus, Agaricus* and *Fusarium* from permanent slides, dry preserved specimens or museum specimen. Lichens from dry or preserved specimens. (02 hr)

5. To study *Marchantia, Anthoceros* and *Funaria* (vegetative and reproductive morphology from permanent slides). (03 hr)

6. To study the vegetative and reproductive morphology of *Psilotum, Selaginella, Equisetum* and *Pteris* from permanent slides. (02 hr)

7. To study the vegetative and reproductive morphology of *Cycas, Ginkgo* and *Gnetum* from permanent slides. (02 hr)

8. To study morphology of angiosperm leaf, stem, flower, inflorescence and fruits from locally available plant species. (06 hr)

9. Temporary anatomical slide preparation of *Pteris* leaflet and *Cycas* leaflet. (02 hr)

Tutorial: Nil

Multi/inter disciplinary: (BOTN1031)-Biodiversity and its conservation

Credit: 3 **Marks: 50**

Unit I: Biodiversity: Definition and types; Habitat diversity, species diversity and genetic diversity, SDG's in biodiversity conservation. **Hours: 12**

Unit 2: Significance and threats to Biodiversity: Economic and aesthetic value, Medicinal and timber yielding plants. NTFP, threats to biodiversity. **Hours: 22**

Biodiversity Hotspots, Biodiversity hot spots of India.

Endemism and endemic species.

ICUN Red listed categories with special reference to plants of Indian hotspots.

Unit 3: Biodiversity Conservation- Indian forest conservation act, Biodiversity bill (2002) **Hours: 16**

Conservation methods – *In-situ* and *ex-situ* methods.

Biosphere reserves, National parks, Sanctuaries, Sacred grooves, Botanical gardens, Seed banks, Gene banks, Pollen banks, Culture – collections, Cryopreservation.

SEC: (BOTN1051)- Biofertilizer
Credit-3 **Marks: 50**

Hours:12

Unit 1: Introduction to microbial inoculants or biofertilizers, Plant nutrition, advantages of using biofertilizers over chemical fertilizers; Methods and steps in mass production of biofertilizers: stock culture, broth culture, growth medium, fermentation, blending with the carrier, packaging, quality check, longevity, ISI standard specification for biofertilizers; scope of biofertilizers in India.

Hours:08

Unit 2: Microinnoculants: Study of important microbial inoculants: *Rhizobium*, *Azospirillum*, *Azotobacter* and PGPR. Actinorhizae; Characteristics, and crop response.

Hours:08

Unit 3: Role of Cyanobacteria: Cyanobacteria (blue-green algae) in Agriculture: Cyanobacteria in rice cultivation; *Azolla* and *Anabaena* association, nitrogen fixation, and factors affecting growth.

Hours:12

Unit 4: Mycorrhizal association : Types of mycorrhizal association, occurrence and distribution; Role of Arbuscular mycorrhizal fungi in phosphorus nutrition, growth and yield of crop plants; VAM and AMF – methods in isolation (wet sieving and decanting), identification (morphological and molecular methods)

Hours:10

Unit 5: Biofertilizer and Organic farming: Introduction to organic farming, recycling of biodegradable

municipal (domestic), agricultural and industrial waste; green manuring, bio-composting, vermicomposting and the infield application.

SEMESTER II

Major: (BOTN2011)- Biomolecules & Cell Biology

Credit: 3 **Marks: 40**

Unit 1: Biomolecules **Hours: 07**

Chemical Bond types and characteristics, Non-covalent bonds and their biological significance. Basic chemical structure and roles of bio molecules- carbohydrates, lipids, proteins and nucleic acids. ATP as energy rich molecule. Basic Enzyme chemistry, Organic chemical principles in life processes, Basic concept of signalling molecules.

Unit 2: Cell architecture **Hours: 04**

Prokaryotic and eukaryotic cells; Origin of eukaryotic cell (endosymbiotic theory).

Unit 3: Cell Wall and Plasma Membrane **Hours: 06**

Chemistry, structure and function of Plant Cell Wall. Singer and Nicolson's fluid mosaic model of cell membrane. Membrane transporters.

Unit 4: Cell Organelles: Structure and function of the following Organelles

Nucleus: Nuclear envelope, nuclear pore complex, nuclear lamina; types of chromatins; nucleolus. **Hours: 05**

Chloroplast and Mitochondria: Structural organization; Function; chloroplast and mitochondrial genomes. **Hours: 04**

Endomembrane system: RER and SER, folding of protein in ER, export of proteins and lipids; Golgi Apparatus organization, protein sorting and export from Golgi Apparatus. PTM (Post Translational Modifications). **Hours: 05**

Cytoskeleton: Role and structure of microtubules, microfilaments, intermediary filament and motor proteins. **Hours: 04**

Unit 5: Cell division **Hours: 05**

Cell cycle; mitosis and meiosis.

Practical

Credit:01 **Marks: 20**

1. Microchemical tests for proteins, reducing and non reducing carbohydrates, starch and lipid. (09 hr)

2. Separation of chloroplast pigments by paper chromatography. (02 hr)

3. Study the effect of organic solvent and temperature on membrane permeability. (02 hr)

4. Study of cell and its organelles with the help of electron micrographs and other digital resources. (02 hr)

5. Study of plant cell structure with the help of epidermal peel mount of *Allium/Rhoeo* (02 hr)

6. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf. (01 hr)

7. Demonstration of the phenomenon of plasmolysis and deplasmolysis. (01 hr)

8. Demonstration of separation of biomolecules by dialysis. 01 hr)

Tutorial: Nil

Minor (BOTN2021): Biomolecules & Cell Biology

Credit:4 **Marks:40**

Unit 1: Biomolecules **Hours: 07**

Chemical Bond types and characteristics, Non-covalent bonds and their biological significance. Basic chemical structure and roles of bio molecules- carbohydrates, lipids, proteins and nucleic acids. ATP as energy rich molecule. Basic Enzyme chemistry, Organic chemical principles in life processes, Basic concept of signalling molecules.

Unit 2: Cell architecture **Hours: 04**

Prokaryotic and eukaryotic cells; Origin of eukaryotic cell (endosymbiotic theory).

Unit 3: Cell Wall and Plasma Membrane **Hours: 06**

Chemistry, structure and function of Plant Cell Wall. Singer and Nicolson's fluid mosaic model of cell membrane. Membrane transporters.

Unit 4: Cell Organelles: Structure and function of the following Organelles Hours: 18

Nucleus: Nuclear envelope, nuclear pore complex, nuclear lamina; types of chromatins; nucleolus. **Hours: 05**

Chloroplast and Mitochondria: Structural organization; Function; chloroplast and mitochondrial genomes. **Hours: 04**

Endomembrane system: RER and SER, folding of protein in ER, export of proteins and lipids; Golgi Apparatus organization, protein sorting and export from Golgi Apparatus. PTM (Post Translational Modifications). **Hours: 05**

Cytoskeleton: Role and structure of microtubules, microfilaments, intermediary filament and motor proteins. **Hours: 04**

Unit 5: Cell division **Hours: 05**

Cell cycle; mitosis and meiosis.

Practical

Credit:01 **Marks:20**

1. Microchemical tests for proteins, reducing and non reducing carbohydrates, starch and lipid. (09 hr)

2. Separation of chloroplast pigments by paper chromatography. (02 hr)

3. Study the effect of organic solvent and temperature on membrane permeability. (02 hr)

4. Study of cell and its organelles with the help of electron micrographs and other digital resources. (02 hr)

5. Study of plant cell structure with the help of epidermal peel mount of *Allium/Rhoeo* (02 hr)

6. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf. (01 hr)

7. Demonstration of the phenomenon of plasmolysis and deplasmolysis. (01 hr)

8. Demonstration of separation of biomolecules by dialysis. (01 hr)

Tutorial: Nil

Multi/inter disciplinary (BOTN2031: Medicinal Plants and Phytochemistry

Credit:3 **Marks:40**

Unit 1: History, Scope and Importance of Medicinal Plants, indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations. **Hours:12**

Unit 2: Conservation of endangered and endemic medicinal plants, endemic and endangered medicinal plants, Red list criteria; *In situ* conservation: Biosphere reserves, sacred groves, National Parks; *Ex situ* conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. **Hours:12**

Unit 3: Ethnobotany and Folk medicines: Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, medicines of ethno-botany.

Hours:06

Unit 4: Phytochemistry: active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendrum phlomides* (anti-rheumatic) and *Centella asiatica* (memory booster). **Hours:10**

SEC: (BOTN2051)- Organic Cultivation And Protected Agriculture

Credit-3 **Marks: 40**

Unit 1: Organic farming and its management: Organic farming and its significance, management practices (nutritional requirements, pest, diseases, weeds); Use of biofertilizers, biopesticides, bioherbicides, biocontrol agents (plant growth promoting rhizobacteria (PGPR), pheromone trapping, *Trichoderma*, *Pseudomonas*, neem oil, garlic etc.) in management.

Hours:12

Unit 2: Marketing and Policies: Marketing of the produce and government institutes and policies related to protected farming (hydroponics and organic farming).

Hours:06

Unit 3: Protected Agriculture: Protected Agriculture types (hydroponics, aquaponics and organic farming), definition, history, terminology, importance and advantages over traditional agriculture, limitations and challenges. **Hours:08**

Unit 4: Plant Growth Requirements and Media formulations: Physical parameters- Light (quality and quantity), light balancers; pH, conductivity, salinity (Dissolved Oxygen-DO, Total Dissolved Solid - TDS) and temperature; Chemical parameters-mineral nutrient requirements, deficiencies, heavy metal toxicities, growth regulators (auxins, gibberellins, cytokinins and abscisic acids); Growth media-types, properties, uses, nutrient formulae, preparation of solutions, solid Media and nutrient film. **Hours:14**

Suggested readings:

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
2. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
3. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco
5. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
6. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
7. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
8. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
9. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
10. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.
11. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.
12. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers
13. Colton C.M. 1997. Ethnobotany - Principles and applications. John Wiley and sons - Chichester
14. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
15. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
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17. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
18. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
19. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
20. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy*. Cambridge University Press, Cambridge.
21. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.

22. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
23. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
24. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6*edition.
25. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
26. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
27. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices.
28. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
29. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
30. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
31. Lone et al,. Palaeoethnobotany
32. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
33. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
34. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
35. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
36. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
37. Pelczar, M.J. (2001). Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
38. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.
39. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
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43. Renaissance of Traditional Herbal Medicine -INA -SHREE Publishers, Jaipur-1996
44. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
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58. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
59. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad
60. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
61. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
62. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
63. Wiley JM, Sherwood LM and Woolverton CJ. (2013). Prescott's Microbiology. 9th Edition. McGraw Hill International.

SEMESTER WISE & COURSE WISE CREDIT DISTRIBUTION STRUCTURE UNDER CCFUP as per NEP, 2020 for 3 year degree and 4-year honours programme

Semester	Course Type	Paper Code	Name of the Course	Credit	Lect.	Tuto.	Pract. /Viva	Full Marks	Distribution of Marks		
									Theory	Pract. /Tuto. /Vivavoce	Internal Assessment
III	Major/DS Course (Core)	BOTN3011	Microbiology	5	4		1	75	40	20	15
		BOTN3012	Archegoniate	5	4		1	75	40	20	15
	Minor Course (Voc. Edn. &Trng.)	3021		4				75			15
	Multi/inter disciplinary	BOTN3031	Plant Biotechnology	3	2	1		50	40	0	10
	AEC(MIL) L1-2	 3041	Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu or Equvlnt Course from SWAYAM	2				50	40		10
	Skill Enhancement Course (SEC)	BOTN3051	Medicinal Botany	3	2	1		50	40	0	10
	Total			**22**				**375**			
IV	Major/DS Course (Core)	BOTN4011	Phycology	5	4		1	75	40	20	15
		BOTN4012	Mycology	5	4		1	75	40	20	15
		BOTN4013	Plant Pathology	5	4		1	75	40	20	15
	Minor Course	BOTN4021	Plant Physiology and Metabolism	4	3		1	75	40	20	15
	Minor Course (other than Botany)	 4021		4				75			15
	AEC(Eng.) L2-2	ENGL 4041	Language and Creativity or Equivalent course from SWAYAM	2				50	40		10
	Total			**25**				**425**			

SEMESTER-III

Major: (BOTN 3011) Microbiology

Credit:5 **Marks-40**

Course Objective:

To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms (Virus & Bacteria) and basic concept of Immunology.

Course Outcomes: Students will learn the structure, function of microbial cell and acquire knowledge about the microbial growth, nutrition, classification and their economic importance. They will also know the structural organization of virus, viroid, prion. Students will know the basic concept of Immunology.

Theory

Unit 1: Viruses

Discovery, physiochemical and biological characteristics; organization and structure of capsid, viral genome- type and structure; classification of virus (Baltimore, 1975); viroids and prions.

(9 lectures)

Unit 2: Ultrastructure of prokaryotic cell:- Cell wall and cell membrane of bacteria and archaea; glycocalyx, pili, and flagella. Bacterial chromosome, plasmid types and episome. Reserve material and other cytoplasmic inclusions; Endospore – structure, formation and germination. **(9 lectures)**

Unit 3: Bacterial taxonomy: Classical Taxonomy and Molecular Taxonomy, Modern concept of bacterial taxonomy specifically 16 S rDNA-based sequence homology and its importance in bacterial taxonomy. Bergey's Manual of Systemic Bacteriology; 2nd Ed. Characteristic features of Archaea and Bacteria

(9 lectures)

Unit 4: Bacterial growth and nutrition: - Growth curve, growth factor, growth Kinetics; batch and continuous culture; Microbial growth control by disinfectant, antiseptic and chemotherapeutic agents – a brief account of their types and mode of action. Brief idea about Autotrophy and heterotrophy. **(9 lectures)**

Unit 5: Microbes in N_2Cycle:-Nitrification, Denitrification, Mechanism of biological N_2 fixation. **(8 lectures)**

Unit 6: Applied Microbiology: Application of microbes in agriculture (biofertilizer, biocontroling agents), Industry (fermentation and Food), environment bioremediation) and medicine (sources of antibiotics) **(8 lectures)**

Unit 7: Basic immunology: Innate and acquired immunity; T-cell, B-cell; Antigen (Ag), hapten, and Antibody (Ab); Cell mediated and Humoral Immunity, vaccine. **(8 lectures)**

Practical (20 marks)

1. Aseptic method

a) Sterilization technique by Autoclaving, Hot air oven and surface sterilization.

b) Preparation of standard bacteriological medium (Nutrient agar, Nutrient broth and Glucose - peptone medium).

c) Preparation of slant and plates.

d) Subculturing of pure bacteriological culture.

e) Pure culture technique: dilution streak method.

2. Simple staining; differential staining: Gram staining.

3. Microscopic examination of bacteria from natural habitats: curd and root nodules of leguminous plants.

Suggested Readings

1.Pelczar, M. J., Reid, R. D. & Chan, E. C. (1993). *Microbiology*, 5th ed. Macmillan. London.

2. Pinehuk, G. (2003). *Schaum's outline Series: Theory and Problems of Immunology*. McGrawHill.

3.Presscott, L. M., Harley, J. P. & Klein, D. A. (1999). *Microbiology*, McGrawHill, New York.

4.Schlegel, H. G. (1993). *General Microbiology* .7th ed. Cambridge University Press.

5.Slonczeweski, J.L. & Foster, J.W. *Microbiology- An Evolving Science*.Norton.

6.Stanier, R. Y., Adelberg, E. A. & Ingraham, J. L. (1986).*General Microbiology*.5th ed. Macmillan.

7.Talaro, K. &Talaro, A. (1999). *Foundations in Microbiology*. Dubuque, McGraw Hill.

8.Tortora, G. J., Funke, B. R., & Case. C. L. *Microbiology.An Introduction*. 6th ed. Benjamin/Cummings Publishing. Menlo Park Calif.

9.Atlas, R. M. (1984). *Microbiology, Fundamentals and Applications*. Macmillan.

10.Black, J. G. (2001). *Microbiology: Principles and Explorations, 5th ed*. John Wiley & Sons,

New York.

11.Khan F. H. (2009) *The Elements of Immunology.* Pearson.

12.Kindt, T., Goldsby, R. Osborne, B. (2007).*Kuby Immunology*.6th ed. W.H. Freeman & Co.

13. A.K.Banerjee and N Banerjee (2006) Fundamentals of Microbiology and Immunology

Major: (BOTN 3012) Archegoniate

Credit:5 **Marks-40**

Course Objective:

This course aims at making a familiarity with special groups of plants joined together by a common feature of sexual reproduction involving Archegonia. Creating an understanding by observation and table study of representative members of phylogenetically important groups should be able to make students learn the process of evolution in a broad sense. Study of morphology, anatomy, reproduction and developmental changes therein through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants.

Course Outcomes:

The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity. to my knowledge students should create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case, they are able to find some rare structure or phenomenon related to these plant

Theory

Unit 1: Introduction

Unifying features of Archegoniate; Transition and adaptation to land habit; Alternation of generations. **(4 lectures)**

Unit 2: Bryophytes

General characteristics & Classification [up toclass] of Stotler and Stotler (2000); Adaptations to land habit, Diversification of gametophytes and sporophytes. **(6 lectures)**

Unit 3: Type Studies- Bryophytes

Origin and evolution of Bryophytes, Morphology, anatomy, reproduction and evolutionary trends in *Riccia, Pellia*, *Porella*, *Sphagnum*, *Pogonatum* (developmental stages not included). Economic importance of bryophytes (a brief account). **(12 lectures)**

Unit 4: Pteridophytes

General characteristics & Classification [up toclass] of Smith (2006) Origin and evolution of Pteridophytes; Telome theory; General characteristics; early land plants (*Cooksonia*, *Rhynia*, *Lepidodendron*, *Lepidocarpon*). **(6 lectures)**

Unit 5: Type Studies- Pteridophytes

Morphology, anatomy and reproduction of *Lycopodium*, *Adiantum*, *Azolla*(Developmental details not to be included). Apogamy, and apospory, heterospory and seed habit; stelar evolution; Ecological and economic importance. **(14 lectures)**

Unit 6: Gymnosperms

General characteristics, Origin and evolution of Gymnosperms; classification Stewart and Rothwell, 1985(up to class),Brief idea about Progymnospermopsida. **(08 lectures)**

Unit 7: Type Studies-Gymnosperms

Morphology, anatomy and reproduction of *Lyginopteris*, *Pinus*, and *Ephedra* (Developmental details not to be included); Ecological importance.**(10 lectures)**

Practical: (20 marks)

1. *Riccia, Marchantia, Anthoceros*-Anatomical study of sporophyte.

2. Morpho-anatomical study of *Lycopodium, Adiantum*.

3. Morpho-anatomical study of *Pinus*, *Ephedra.*

4. Study of fossil slides of *Lepidodendron, Lyginopterisoldhamia.*

Suggested readings

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.

4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

5. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University

Multi/Interdisciplinary course: (BOTN 3031) Plant Biotechnology

Credit:3 Marks-40

Course Objective: The objective of the course is to give students new knowledge on plant biotechnology processes, including tissue culture. To make students understand about basic biotechnological processes such as recombinant DNA technology and their applications.

Learning Outcomes: The successful students will be able to: Learn the basic concepts, principles and processes in plant biotechnology. Have the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological applications.

Theory

Unit 1: Plant Tissue Culture: Historical perspective, Composition of MS medium; Plasticity and Totipotency; Organogenesis, Embryogenesis.**(12 lectures)**

Unit 2: Protoplast culture; application of plant tissue culture (micropropagation, virus elimination, secondary metabolite production, cybrids; Cryopreservation; Germplasm Conservation). **(14 lectures)**

Unit 3: Recombinant DNA technology: Basic concepts of tools of recombinant DNA technology, Restriction Endonucleases, Cloning Vectors. Ti plasmid, BAC, Eukaryotic Vectors (YAC).

(12 lectures)

Unit 4: Gene cloning: Basic concept of gene Cloning; Gene Construct; Methods of gene transfer-(*Agrobacterium*-mediated), **(12 lectures)**

Unit 5: Transgenics: Basic concept and Examples.**(7 lectures)**

Unit 6: Applications of Biotechnology: Short account. **(03 lectures)**

Suggested Readings.

1. Introduction to Plant Biotechnology- (2002) H.S. Chawla. Oxford and IBH Publication.
2. Plant Biotechnology – A Text Book. (2022) S.N. Paul Khurana and Narendra Kumar. Scientific Publisher.
3. Plant Biotechnology (2010)– P.K.Gupta. Rastogi Publication.

Skill Enhancement Course: (BOTN 3051) Medicinal Botany

Credit:3 **Marks-40**

Course Objective

To impart knowledge on plant chemical resources that may be explored in complementary herbal and alternative medicine. Also to provide an opportunity to explore uses of plants as medicine based on traditional indigenous knowledge and their application in modern pharmaceutical industries.

Course Outcomes:

The course will help in skill development related to the contribution of medicinal plants to traditional and modern medicine. The importance of holistic mode of treatment of the Indian traditional systems of medicine will be easier. It will also help in developing entrepreneurship skills to establish value addition products, botanical.

Theory:

Unit 1: Medicinal plants in the traditional systems of medicine and modern medicine. Concept on the Indian traditional systems of medicine. (**8lectures)**

Unit 2:Ayurveda & its fundamental doctrine, Important plants used in the Ayurveda system of medicine. Brief idea of Rasayanadrugs.**(7lectures)**

Unit 3:Siddha & its concepts, therapeutic and pharmaceutical uses of important plants used in Siddha system of medicine; **(7 lectures)**

Unit 4:Unani: Concept of Umoor-e-Tabiya(Fundamentals of Physique), therapeutic and pharmaceutical uses of plants used in Unani system of medicine. (**8 lectures)**

Unit 5: Nutraceuticals and polyherbal formulations. Plants used for the treatment of hepatic disorders, cardiac diseases,infertility, diabetes, blood pressure, cancer and skin diseases.**(8 lectures)**

Unit 6:Role of AYUSH, NMPB in the promotion of medicinal plants. **(4 lectures)**

Unit 7:Fundamentals of Pharmacognosy. Organoleptic, microscopic and phytochemical evaluation of plant drugs. **(8 lectures)**

Unit 8:Conservation of Endangered and Endemic Medicinal plants. Brief idea oncategories of Red Listed plants. *In situ* and *ex situ* Conservation. **(6 lectures)**

Suggested Readings.

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. - Agrobios, India

SEMESTER-IV

Major: (BOTN 4011) Phycology

Credit:5 **Marks-40**

Course Objective:

To gain knowledge of diversity, life forms, life cycles, morphology and importance of algae

Course Outcomes: Students would have understood the classification, characteristic features, cell structure and growth and reproduction in various groups of marine and fresh water algae and their ecological and economic importance

Theory

Unit 1: Algae

Definition and position of algae in plant kingdom, Basic criteria of classification of algae, Range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; Life cycle patterns, methods of reproduction; general concept of endosymbiosis, classification of Lee (2015); contributions of F.E. Fritsch & M.O.P. Iyengar; Role of algae in the environment, agriculture, biotechnology, food and industry.

(6 lectures)

Unit 2: Cyanophyta and Xanthophyta

Ecology and occurrence; Cell structure; Heterocyst structure & function; Reproduction, Genetic recombination (in Cyanophyta); Morphology and life-cycle of *Oscillatoria*, *Anabaena, Scytonema*, *Vaucheria*.

(6 lectures)

Unit 3: Chlorophyta and Charophyta

General characteristics; Occurrence; Cell structure. Life-cycles of *Volvox*, *Oedogonium*, *Coleochaete* and *Chara*.

Bacillariophyceae- Cell structure, Reproduction with special emphasis on auxospore formation, ecology and economic significance.**(8 lectures)**

Unit 4: Phaeophyta

General characteristics and occurrence; thallus structure and tissue organization, Cell structure; Reproduction, life-cycles of *Ectocarpus* and *Fucus*; economic and ecological significance.

(5 lectures)

Unit 5: Rhodophyta:

Characteristic; Cell structure, reproduction including post-fertilization changes, ecology and economic significance: Lifecycle pattern of *Batrachospermum*.

(5 lectures)

Practical (20 marks)

1. Workout and identification of vegetative and reproductive structures of *Oscillatoria, Scytonema, Rivularia, Gloeotrichia, Zygnema, Oedogonium, Cladophora, Chara, Vaucheria,Ectocarpus* and *Batrachospermum.*

2. Identification of all the genera included in the theoretical syllabus from Permanent slides (vegetative and reproductive structures).

Suggested Readings.

1. Phycology by Robert Edward Lee, 5th Edition
2. Algae by James E. Graham, Linda E. Graham, Lee W. Wilcox, M.E. Cook, 3rd Edition
3. Freshwater Algae: Identification, Enumeration and Use as Bioindicators by Edward G. Bellinger, David C. Sigee, 2nd Edition
4. Algae: Anatomy, Biochemistry, and Biotechnology, By Laura Barsanti, Paolo Gualtieri, 2nd Edition.
5. The Algae World, by Dinabandhu Sahoo and Joseph Seckbach.

6. A beginner's guide to freshwater algae, by Hilary Belcher, Erica Swale.
7. Freshwater Algae of North America, by John Wehr Robert Sheath, J. Patrick Kociolek, 2nd Edition.
8. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
9. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
10. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.

Major: (BOTN 4012) Mycology

Credit:5 **Marks-40**

Course Objective: To introduce students with various fungal groups, their ecology, classification, characteristics, reproduction and economic Importance 2. To introduce students with the phytopathology, its concepts and principles 3. To acquaint with various plant diseases, causal organisms and their control

Course Outcomes: Upon completion of this course, the students will be able to: 1. Understand the world of fungi, lichens and pathogens of plants 2. Understand the characteristics of the fungi and lichens 3. Understand the ecological and economic significance of lichen 4. Understand the significance and applications of mycology in various fields of live hood. 6. Identification of common plant diseases and their control measures

Theory

Unit 1: Introduction

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification of Alexopoulos & Mims, 1979 (up to order), symbiotic association, Lichen, Mycorrhizae-basic concept and their significance.

(6 lectures)

Unit 2: Chytridiomycota and Zygomycota

Characteristic features; Thallus organization; Life cycle of *Synchytrium*.

(5 lecture)

Unit 3: Ascomycota

General characteristics, sexual reproduction and development of ascus and ascospores, types of ascocarps; Phenomenon of heterokaryosis and parasexuality in asexual members; Life cycle of *Talaromyces, Ascobolus, Aspergillus*. **(8 lecture)**

Unit 4: Basidiomycota

General characteristics; Phenomenon of dikaryotization, development of basidia and basidiospores and basidiocarps, Life cycles of *Polyporus* sp., *Puccinia* sp., and*Ustilago*sp.; Bioluminescent fungi, Fairy Rings and Mushroom Cultivation (brief idea). **(6 lecture)**

Unit 5: Deuteromycota

General characteristics, asexual reproduction, fruiting structures, studies on the genera *Fusarium* and *Alternaria*. **(4 lecture)**

Unit 6: Allied Fungi

General characteristics; Status of Slime molds, Occurrence; Types of plasmodia. **(2 lecture)**

Unit 6: Oomycota

General characteristics; Life cycle of *Phytophthora* and *Albugo.***(3 lecture)**

Unit 8: Applied Mycology

Role of fungi in biotechnology; Application of fungi in food, flavor, and leather industry, Fermentation, Organic acids, Enzymes, Mycoproteins; Secondary metabolites, pharmaceutical preparations with reference to penicillin; Agriculture (Biofertilizers); Biological control and overview of biocontrol agents. **(10 lecture)**

Practical (20 marks)

1. Study of the following genera and their identification: *Rhizopus, Penicillium, Alterneria, Ascobolus, Agaricus* and *Polyporus.*

2. Identification of all the macroscopic and microscopic genera included in the theoretical syllabus.

Suggested Readings:

1. Introduction to Fungi- John Webster and Roland W.S. Weber
2.Introductory Mycology -Alexopoulos C.J., C.W. Mims and M. Blackwell
3.The Mycota- Esser, K. and Bennet J. W. (Eds.)
4.An Introduction to Mycology - Mehrotra, R.S. and Aneja, K.R.
5.Fundamentals of Mycology -Burnett, J. H.
6.Chemical fungal taxonomy -Frisvad, J.C. Bridge, P.D. and Arora, D.K.
7.The Filamentous Fungi - Smith, J.E.
8.Fungal Nutrition and Physiology - Garraway, M. O. and Evans, R. C.
9.Mushroom Biology - Miles, P.G. and Chang, S.T.
10.Mycorrhizae Verma - A. and Hock, B.
11.Industrial mycology -Berry, R.

Major: (BOTN 4013) Plant Pathology

Credit:5 **Marks-40**

Course Objective:

To introduce students with the phytopathology, its concepts and principles and also to acquaint with various plant diseases, causal organisms and their control measures.

Course Outcomes:

Upon completion of this course, the students will be able to understand the basic principles for identification of common plant diseases and their control measures. Also to understand the economic and pathological importance of pathogenic microorganisms.

Theory

Unit 1: Plant pathologyA brief history of plant pathology in India and losses caused by pathogens and pests; Types of pathogens, signs and symptoms, symptoms of different plant diseases. Inoculum potential, survival and longevity of inoculum, inoculum production, plant quarantine, Koch's postulates. **(12 lecture)**

Unit 2: Plant microbe interaction: molecular basis of host recognition, entry, pre-penetration, penetration and post penetration events, pathogenesis; Dissemination of pathogens: Means of dissemination (active and passive dissemination).**(12 lecture):**

Unit 3: Host parasite interaction: Concept of compatibility and specificity, gene for gene hypothesis, genetics of resistance- vertical and horizontal resistance, source of resistance. Enzymes and toxins- a brief idea on their role in pathogenesis.

(12 lecture):

Unit 4: Disease resistance: (i) Plant defense (structural and biochemical defense), with special reference to polyphenols and phytoalexins. Genetic resistance: biotechnological approaches for transfer of R- genes into susceptible plants. General idea on seed borne pathogens, market disease of fruits and vegetables. Disease control: Cultural practices, physical control, chemical control and biological control.

(12 lecture)

Unit 5: Brief account, structure, importance, disease cycle and control of the following: black rust of wheat, loose smut of wheat, white rust of *Amaranthus*, early blight and late blight of potato, brown spot of rice, powdery mildew of cucurbits.

(12 lecture):

Practical (20 marks)

1. Identification of diseases prescribed in the theoretical syllabus.

2. Workout of the following diseases: Late blight of potato, White rust of *Amaranthus*, Rust of wheat*/Justicia,* loose smut of wheat, powdery mildew of cucurbits, shot hole of *Basella*.

3. Study of herbarium and museum specimens of bacterial, fungal, and viral diseases-(Citrus Canker,bacterial blight of rice, Fusarial wilt of tomato, tikka disease of ground nut, loose and cover smut of wheat, TMV, Vein clearing of legumes.

4. Mycorrhizae-Ecto and Endo mycorrhizae (photographs only)

Suggested Readings:

1.Plant Pathology - Agrios, G.N.
2.Plant Pathology -Mehrotra, R.S.
3.Annual Review of Phytopathology - APS Press
4.Biotechnology in Plant Disease Control-Cheet,I.
5.Postinfectional defense mechanisms - Mahadevan, A.
6.Pathogenesis and host specificity in plant diseases. Vol. III.-Rudra P. Singh, Uma S. Singh
7.Keiisuke Kohmoto (eds.) 1995.
8.The nature of disease in plants - Scheffer, R.P.
9.Principles of Plant Pathology -Tarr, S.A.J .

Minor: (BOTN 4021) Plant Physiology & Metabolism

Credit:4 **Marks-40**

Course Objective: The course aims impart knowledge on how plants function and interact with environment, namely the importance of water, minerals, hormones, and light in plant growth and development; understand transport mechanisms and translocation in the phloem, and appreciate the commercial applications of plant physiology.

Course Outcomes The students will be able to correlate structure-function relationship that govern plant life processes. The chemical basis of life processes that regulate system biology of plants will also be understandable. The link between theory and practical syllabus is established, and the employability of youth would be enhanced. The youth can also begin small-scale enterprises.

Theory

Unit 1: **Photophysiology:** Basic photoprocesses; Photosynthesis & chemistry of light trapping mechanisms, Photophoshorylation; chemistry of CO_2 fixation(brief accounts of C3& C4 pathways and their significance); C_2 pathway and its significance; Basic concept of photomorphohenesis, plant photorecepts, red & blue light responsive photoprocesses- General concept.**(16 lecture):**

Unit 2:Plant-water relations: Concept of water potential, Mechanism of ascent of sap, transpiration; Phloem translocation, Composition of phloem sap, Pressure Flow Model, phloem loading and unloading. **(06 lectures)**

Unit 3: Mineral nutrition: Criteria of essentiality of elements, Role of essential elements, transport of ions across membrane, active and passive transport, carriers, channels and pumps. **(08 lecture):**

Unit 4:Respiration: Chemistry of glycolysis, anaerobic respiration, TCA cycle, ETS, oxidative phosphorylation, RQ.**(04 lecture):**

Unit 5:Enzymes: Basic structure, properties, chemical order of enzyme catalyzed reactions; Classification(IUBMB),Km (no derivation), Basic mechanism of enzyme catalysis and enzyme inhibition. **(04 lecture):**

Unit 6: Hormones & Plant growth regulators: Basic concept of PGR & hormone; Discovery, physiological roles of auxins, gibberellins, CK, ABA and ethylene.**(06 lecture):**

Unit 7: Photoperiodism & Flowering – Concept of photoperiodism, SDP, LDP, day neutral plants; Basic concept of flowering biology & chemistry of floral signal. **(10 lecture):**

References

1. Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd.

2. Kochhar, S.L., Gujral, S.K. (2017). Plant Physiology: Theory and Applications. New Delhi, Delhi: Foundation Books, imprint of Cambridge University Press India Pvt, Ltd.

3. Taiz, L., 3. Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development International, 6th edition. New York, NY: Oxford University Press,Sinauer Associates.

4. S. Bajracharya, D. (1999). Experiments in Plant Physiology: A Laboratory Manual. New Delhi, Delhi: Narosa Publishing House