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]		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	English or Equvlnt. 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 Suvendu Pal, Tapan Kumar Bera **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 Subhasis Mandal **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 Suvendu Pal **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 Subhasis Mandal , Barnali Mukherjee **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 Suvendu Pal, Saikat Mondal **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**
Saikat Mondal

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 Saikat Mondal, Tapan Kumar Bera **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 Debdut Ghosh **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 Barnali Mukherjee **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). Subhasis Mandal (01 hr)

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

Suvendu Pal

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

Subhasis Mandal, Suvendu Pal

(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) Suvendu Pal, Subhasis Mandal

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

Saikat Mondal

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

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

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

Barnali Mukherjee

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

Debdut Ghosh

Tutorial: Nil

Minor: (BOTN1021) Plant Diversity and Evolution

Credit: 3 **Marks: 40**

Unit 1: Origin of life Suvendu Pal, Tapan Kumar Bera **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 Subhasis Mandal **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 Suvendu Pal **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 Subhasis Mandal, Barnali Mukherjee **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 Suvendu Pal, Saikat Mondal **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 Saikat Mondal **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 Saikat Mondal, Tapan Kumar Bera **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 Debdut Ghosh **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 Barnali Mukherjee **Hours: 5**

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

Practical

Credit: 01 Minor practical all taken by Jaharlal Mazumdar **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. Subhasis Mandal **Hours: 12**

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

Saikat Mondal

Biodiversity Hotspots, Biodiversity hot spots of India.

Subhasis Mandal, Suvendu Pal

Endemism and endemic species. Subhasis Mandal

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

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

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

Subhasis Mandal, Saikat Mondal

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

Saikat Mondal, Subhasis Mandal

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. Debdut Ghosh

Hours:08

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

Subhasis Mandal **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. Saikat Mondal

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)

Saikat Mondal, Subhasis Mandal **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.

Debdut Ghosh, Suvendu Pal

SEMESTER II

Major: (BOTN2011)- Biomolecules & Cell Biology

Credit: 3 **Marks: 40**

Unit 1: Biomolecules Saikat Mondal **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 Tapan Kumar Bera **Hours: 04**

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

Unit 3: Cell Wall and Plasma Membrane Saikat Mondal **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. Suvendu Pal **Hours: 05**

Chloroplast and Mitochondria: Structural organization; Function; chloroplast and mitochondrial genomes. Subhasis Mandal **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). Debdut Ghosh **Hours: 05**

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

Unit 5: Cell division Suvendu Pal **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)

Saikat Mondal

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

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

Subhasis Mandal

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)

Subhasis Mandal

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

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

Subhasis Mandal

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**

Saikat Mondal

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**

Tapan Kumar Bera

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

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

Saikat Mondal

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**

Suvendu Pal

Chloroplast and Mitochondria: Structural organization; Function; chloroplast and mitochondrial genomes. Subhasis Mandal **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). Debdut Ghosh **Hours: 05**

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

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

Cell cycle; mitosis and meiosis. Suvendu Pal

Practical

Minor all practical taken by Jaharlal Mazumdar

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 Suvendu Pal Tapan Kumar Bera **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**

Subhasis Mandal, Saikat Mondal

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

Suvendu Pal, Tapan Kumar Bera **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**

Tapan Kumar Bera, Barnali Mukherjee

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.

Debdut Ghosh, Subhasis Mandal **Hours:12**

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

Debdut Ghosh , Suvendu Pal **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. Debdut Ghosh , Saikat Mondal **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**

Debdut Ghosh, Barnali Mukherjee

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.
16. Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd.
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
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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.
40. Radford, A.E. (1986). Fundamentals of *Plant Systematics.* Harper and Row, New York.
41. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah. 8) Rajiv K. Sinha - Ethnobotany The
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