Course structure for 4 years (8 semester) undergraduate program in BOTANY

Under NEP 2020

Semester I

Course code	**Course title**	**Name of the course**	**Credit of Course**	**Class hours per week**	**Evaluation**	**Internal assessment**	**Total**
BOTH-CC-T-01	Origin , life processes & diversity of plant groups	Major (Theory**)**	4	4	40	**15**	**75**
BOTH-CC-P-01	Do	Major (Practical**)**	**2**	**4**	**20**		
BOTH-GCC-T-01	Biodiversity of microbes, algae, fungi and archegoniate	Minor (Theory)	**3**	**3**	**25**	**10**	**50**
BOTH-GCC-P-01	**Do**	Minor (Practical)	**1**	**2**	**15**		
To be determined		**Multidisciplinary course**	**3**	**3**	**35**	**10**	**45**
BOTH-SEC-T-01		Skill enhancement course (Theory)	**2**	**2**	**25**	**10**	**45**
BOTH-SEC-P-01		Skill enhancement course(Practical)	**1**	**2**	**10**		
To be determined		**Value added course**	**4**	**4**	**40**	**10**	**50**
Total			**20**	**24**			**265**

Semester II

Course code	**Course title**	**Name of the course**	**Credit of Course**	**Class hours per week**	**Evaluation**	**Internal assessment**	**Total**
BOTH-CC-T-02	Biomolecules and cell biology	Major (Theory)	4	4	40	**15**	**75**
BOTH-CC-P-02	Do	Major (Practical**)**	**2**	**4**	**20**		
BOTH-GCC-T-02	Plant ecology, morphology and Taxonomy	Minor (Theory)	**3**	**3**	**25**	**10**	**50**
BOTH-GCC-P-02	Do	Minor (Practical)	**1**	**2**	**15**		
To be determined		**Multidisciplinary course**	**3**	**3**	**35**	**10**	**45**
To be determined	Communicative english	Ability enhancement course	4	4	40	10	50
BOTH-SEC-T-02		Skill enhancement course (Theory)	**2**	**2**	**25**	**10**	**45**
BOTH-SEC-P-02		Skill enhancement course(Practical)	**1**	**2**	**10**		
		Summer internship course	**4**				
Total			**24**	**24**			**265**

B.Sc Botany 4 year syllabus

Semester I : Introduction to plant groups

Semester II : Biomolecules and cell biology

Semester III : Phycology and lichen

Semester IV : Plant systematic, morphology and anatomy, bryophytes and pteridophytes

Semester V : Ecology and phytogeography

Semester VI : Plant physiology,plant metabolism, genetics, biometry and plant breeding

Semester VII : Microbiology, fungi and plant pathology, plant molecular biology and biochemistry

Semester VIII : Biodiversity and conservation, economic botany and pharmacognosy, analytical techniques in plant science, research methodology, stress biology

SEMESTER I

MAJOR

COURSE CONTENT (Theoretical)

Course: BOTH-CC-T-01(THEORY) & BOTH-CC-P-01 (PRACTICAL)

COURSE TITLE: ORIGIN, LIFE PROCESSESS AND DIVERSITY OF PLANTS GROUPS

CREDIT: 6[4(THEORY)+ 2(PRACTICAL)] FULL POINTS: 75[40(THEORY)+ 20(PRACTICAL)+ 15(INTERNAL ASSESSMENT)]

Origin, life processes and diversity of plant groups

Course objective:

After completion of the course the learners will be able to:

- Describe general characteristics of viruses, bacteria, algae, fungi and archegoniate with special reference to their classification, morphology, reproduction and ecology;
- Explain their role in environment, human welfare and in industrial applications;
- Apply this knowledge in understanding the evolutionary significance of these organisms.

Unit 1: origin of life (12)

What is life? Theories of origin of life; role of water in life process; origin of land plants

Unit 2: Microbes (6)

Viruses- Discovery, general structure; economic importance; Bacteria- Discovery, general characteristics and cell structure; economic importance

Unit 3: Algae (8)

General characteristics; salient features of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae and Bacillariophyceae; ecology and distribution of algae; economic importance of algae

Unit 4: Fungi
(7)

Introduction – general characteristics, salient features of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina ,ecology and significance of fungi, nutrition and reproduction, mycorrhiza: ectomycorrhiza and endomycorrhiza; lichens- general accout

Unit 5: Introduction to archegoniate (7)

Unifying features of archegoniates; transition to land habit; alternation of generations

Unit 6 : Bryophytes
(7)

General characteristics, salient features of Hepaticopsida, Anthocerotopsida and Bryopsida.

Adaptation to land habitat, adaptation to land habitat, Ecology and economic importance of bryophytes

Unit 7 : Pteridophyres
(7)

General characteristics, salient features of Psilophyta, Lycophyta, Sphenophyta and Filicophyta, Ecological and economical importance

Unit 8 : Gymnosperms (7)

General characteristics, salient features of Cycadophyta, Coniferophyta and Gnetophyta. Ecological and economical importance

Unit 9 : Angiosperms
(10)

General characteristics, affinity with angiosperms, herbarium, botanical garden

COURSE CONTENT (Practical): BOTH-CC-P-01

Identification of following preserved and fresh specimen

1. Bacterial forms : Coccus, Bacillus, Spirillum, Vibrio
2. Algae : *Nostoc, Lyngbya, Spirogyra, Oedogonium*
3. Fungi : *Rhizopus, Ascobolus, Agaricus, Aspergillus*
4. Bryophytes and Pteridophytes : *Riccia, Funaria, Pteris, Lycopodium*
5. Gymnosperms : Megasporophyll of *Cycas*, Female cone of *Pinus*, microspores of *Cycas* and *Pinus*
6. Angiosperms : *Polyanthes tuberosa, Crysopogon aciculatus, Tridax procumbens, Oldenlandia corymbosa, Solanum nigrum*

Suggested reading

1. Introductory Phycology by H. D. Kumar. East West Press Pvt. Ltd., New Delhi 1999.
2. General Microbiology by R.Y. Stanier. , J.L. Ingraham. , M.L. Wheelis. and P.R. Painter. International Edition(5th). 1999.
3. Introductory Mycology by C.J. Alexopoulos. , C.W. Mims. And M. Blackwell. John Wiley and Sons (Asia), Singapore. Ed. 4th. 1996.
4. An Introduction to Embryophyta by N.S. Parihar. Central Book Depot, Allahabad. Vol. I. 1991.
5. Pteridophyta by P.C. Vashishta. , A.K. Sinha. And A. Kumar. S.Chand, Delhi. 2010.
6. Gymnosperms by S. P. Bhatnagar and A. Moitra. New Age international Pvt Ltd., New Delhi, 1996
7. Angiosperm: morphology, anatomy, taxonomy, evolution by S. K. Sachdeva, Kalyani Publishers, New Delhi, 1990

SEMESTER I MINOR

Course: BOTH-GCC-T-01(THEORY) & BOTH-GCC-P-01(PRACTICAL) COURSE TITLE: BIODIVERSITY OF MICROBES, ALGAE, FUNGI AND ARCHEGONIATE; CREDIT:4[3(THEORY)1(PRACTICAL)] FULL POINTS:50[25(THEORY)+15(PRACTICAL)+ 10(INTERNAL ASSESSMENT)

Course objective:

After completion of the course the learners will be able to:

- Describe general characteristics of viruses, bacteria, algae, fungi andarchegoniate with special reference to their classification, morphology, reproduction, distribution and ecology.
- Explain their role in environment, human welfare and industrial applications.
- Apply this knowledge in understanding the evolutionary significance of these organisms.

CO URSE CONTENT (THEORY) :B O T H - G C C -T-01

1. **Unit1:Microbes (10)**

Virus–Discovery ,general structure, replication (general account), DNA virus(T-phage) ;Lytic and Lysogenic cycle, RNA virus(TMV); Economic importance; Bacteria–Discovery, General characteristics and cell structure ;Reproduction– vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

2. **Unit2:Algae (12)**

General characteristics; Ecology and distribution; Range of thallus organization and

reproduction; Classification of algae by Fritsch(1935); Morphology and life-cycles of the following : *Nostoc, Chlamydomonas ,Oedogonium, Vaucheria, Fucus, Polysiphonia*; Economic importance of algae.

3. **Unit3: Fungi (12)**

Introduction: General characteristics, ecology and significance, range of thallus organization, cell wall composition ,nutrition, reproduction and classification (Alexopoulos, Mims ,and Blackwell 1996); True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Talaromyces* (*Penicillium*: Ascomycota), *Puccinia ,Agaricus* (Basidiomycota); Symbiotic associations-Lichens: General account, reproduction and significance; Mycorrhiza : ectomycorrhiza and endomycorrhiza and their significance.

4. **Unit4: Introduction to Archegoniate (2)**

Unifying features of archegoniates ; Transition to land habit ; Alternation of generations.

5. **Unit5: Bryophytes (10)**

General characteristics ; adaptations to land habit ; range of thallus organization ; classification following Smith G.M.(1955); morphology, anatomy and reproduction of Marchantia and Funaria(developmental details not to be included) . Ecology and economic importance of bryophytes with special mention of Sphagnum.

6. **Unit 6: Pteridophytes (8)**

General characteristics; Classification of vascular plants by Gifford and Foster(1989) with diagnostic features and examples(from division Rhyniophyta to Filicophyta)· Early land plants (*Cooksonia* and *Rhynia*);Systematic position, morphology, anatomy and reproduction of *Lycopodium, Selaginella ,Equisetum* and *Pteris* (developmental details not to be included); Heterospory and seed habit, Stelar evolution; Ecological and economical importance.

7. **Unit7: Gymnosperms. (6)**

General characteristics; classification of vascular plants by Gifford and Foster(1989) with diagnostic features and examples (from division Pteridospermophyta to Gnetophyta); Systematic position, morphology, anatomy andreproduction of *Cycas* and *Pinus* (developmental details not to be included); Ecological and economical importance.

COURSECONTENT (PRACTICAL): BOTH–GCC-P-01

1. EMs/Models of viruses –T-Phage and TMV, Line drawing/Photograph of Lytic and lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining.
4. Study of vegetative and reproductive structures of *Nostoc, Oedogonium, Vaucheria, and Polysiphonia* through temporary preparations*; Chlamydomonas* and *Fucus* through permanent slides and preserved specimens.
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
7. *Agaricus*: Specimens of button stage and full-grown mushroom; Sectioning of gills of *Agaricus*.
8. Lichens: Study of growth forms of lichens (crustose ,foliose and fruticose).
9. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs).
10. *Marchantia*-morphology of thallus, whole mount(WM) of rhizoids and scales, vertical section(VS) of thallus through gemma cup, WM of gemmae(all temporary slides), VS of antheridiophore, archegoniophore ,longitudinal section(LS) of sporophyte (all permanent slides).
11. *Funaria*-morphology, WM of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, LS of capsule and protonema.
12. *Lycopodium*- morphology, transverse section (TS) of stem, WM of strobilus, (temporary slides), LS of strobilus (permanent slide).
13. *Selaginella*- morphology, WM of leaf with ligule, TS of stem, WM of strobilus, WM of microsporophyll and megasporophyll (temporary slides), LS of strobilus (permanent slide).
14. *Equisetum*- morphology, TS of internode, LS of strobilus, TS of strobilus, WM of sporangiophore, WM of spores (temporary slides); TS of rhizome (permanent slide).
15. *Pteris*– morphology, TS of rachis, VS of sporophyll, WM of sporangium, WM of spores (temporary slides), TS of rhizome, WM of prothallus with sex organs and young sporophyte (permanent slide).

SEMESTER-II MAJOR

Course: BOTH-CC-T-02 & BOTH-CC-P-02

Course title: Biomolecules and Cell Biology

Credit – 6 [4 (Theory) + 2 (Practical)]; Full Points – 75 [40(THEORY) +20 (PRACTICAL)+ 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- Describe the types, nomenclature and structures of biomolecules;
- Explain the function and structure of cells including their metabolic reactions that occur in cells;
- Elucidate the laws of thermodynamics and translate reaction mechanisms within cells into their final expressions;
- Discuss the origin of eukaryotic cell;
- Explain the process of cell division and inheritance.

COURSECONTENT (THEORY) – UG-H-BOT-CC-T-01:

Unit 1: Biomolecules (20)

A. Types and significance of chemical bonds; Structure and properties of water; pH and buffers.
B. Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and Polysaccharides.
C. Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerol structure, functions and properties; Phosphoglycerides.
D. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.
E. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A,B,Z types of DNA; Types of RNA; Structure of t RNA.

Unit 2: Bioenergetics (4)

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule.

Unit 3: Enzymes (6)

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), Michaelis – Menten equation, enzyme inhibition and factor affecting enzyme activity.

Unit 4: The cell (4)

Cell as an unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic Theory).

Unit 5: Cell wall and plasma membrane (4)

Chemistry, structure and function of plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis.

Unit 6: Cell organelles

A. Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.
B. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.
C. Chloroplast, Mitochondrion, and Peroxisome: Structural organization; Function; Semiautonomous nature of mitochondrion and chloroplast.
D. Endomembrane system: Endoplasmic Reticulum (ER) – Structure, targeting and insertion of protiens in the ER, protien folding, processing; Smooth ER and lipid synthesis, export of protiens and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosome
E. Organelle without membranes: Ribosomes – structure and function

Unit 7: Cell division

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

COURSE CONTENT (PRACTICAL) – BOTH-CC-P-02:

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of *Allium cepa/ Rhoeo/ Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in Hydrilla leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume using haemocytometer (Yeast/pollen grains).
6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique (demonstration only).
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study different stages of mitosis and meiosis.

SUGGESTED READINGS/ REFERENCES:

1. 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.
2. Berg J.M., TymoczkoJ.L. and Stryer L. (2011) Biochemistry, W.H. Freeman and Company.
3. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
4. Campbell, P.N. and Smith A.D. (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone.

5. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
7. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
8. Nelson D.L. and Cox M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company
9. Tymoczko J.L., Berg J.M. and Stryer L. (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman.

SEMESTER II MINOR
Course: BOTH-GCC-T-02 (Theory) & BOTH-GCC-P-02 (Practical)
Course Title: Plant Ecology, Morphology and Taxonomy;
Credit: 4 [3 (Theory) +1 (Practical)]; **Full Points**: 50 [25 (Theory) + 15 (Practical)+ 10 (Internal assessment)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- explain the concept of ecology and the influence of different environmental, climatic and physiographic and edaphic factors on plant life;
- comprehend the concept of phytogeography, describe botanical zones in India and explain endemism;
- describe the importance of biodiversity and relevance of conservation;
- apply morphology features in describing plants;
- discuss the essentials of plant taxonomy, explain taxonomic hierarchy and explain the classification system of Bentham and Hooker;
- explain the concepts of numerical taxonomy and cladistics.

COURSE CONTENT (THEORY): UG-BOT-G-CC-T-02

Unit 1: Introduction(2)
Concept of Ecology

Unit 2: Ecological factors **(5)**
Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature. Adaptation of hydrophytes, halophytes and xerophytes.

Unit3:Plant communities **(6)**
Characters; Ecotone and edge effect; Succession; Processes and types.

Unit4:Ecosystem **(6)**
Structure; energy flow trophic organization; Food chains and food webs, ecological Pyramids production and productivity; Ttitrophic interactions (plant defense against herbivore) with reference to Volatile Organic Compounds (VOC) and other secondary compounds, Biogeochemical cycling; Cycling of carbon, nitrogen and phosphorous.

Unit 5: Phytogeography **(4)**
Botanical zones in India (D. Chatterjee 1962); Present Status; Endemism.

Unit 6: Conservation of Biodiversity **(3)**
Level of Biodiversity: genetic, species and ecosystem diversity, Biodiversity hotspots – criteria, Indian hotspots, in-situ and ex-situ conservation, Ecological restoration
Geographic information system and Remote Sensing (brief idea).

Unit 7: Plant Morphology **(10)**

Variations in leaf morphology; phyllotaxy; types of inflorescences; morphology of flowers- types of flowers, modification of calyx, aestivation, floral formula and floral diagram, adhesion and cohesion of floral parts, placentation types; types of fruits and seeds.

Unit 8: Introduction to plant taxonomy (2)

Identification, Classification, Nomenclature.

Unit 9: Identification (4)

Functions of herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 10: Taxonomic hierarchy (2)

Ranks, categories and taxonomic groups

Unit11:Botanical nomenclature (4)

Principles and rules (ICN); rank and names; binominal system; typification; author citation; valid publication; rejection of names; principle of priority and its limitations (with examples)

Unit12:Classification (2)

Types of classifications – artificial, natural and phylogenetic. Outline of Bentham and Hooker (up to series) classifications with merits and demerits

Unit13:numerical taxonomy and cladistics (brief idea) (2)

Unit 14: salient features, Systematic position, (Bentham and Hooker), economically important plants of the following families (8)

Monocotyledons: Liliaceae, Arecaceae, Poaceae, Orchidaceae

Dicotyledons: Brassicaceae; Leguminosae (papilionoidae and Caesalpinioidae); Malvaceae; Solanaceae; Lamiaceae, Cucuebitaceae; Euphorbiaceae; Asteraceae

COURSE CONTENT (PRACTICAL): BOTH-GCC-P-02

1.Study of instruments used to measure microclimate variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.

2.Comparison of bulk density, porosity and rate of infiltration of water in soil of twohabitats.

3.Study of morphological adaptations of hydrophytes, halophytes and xerophytes (four each).

4.Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*)-illustration only, Epiphytes, Predation (Insectivorous plants)-illustration only.

5.Determination of minimal quadrat size for the for the study of herbaceous vegetation in any suitable area by species area curve method (species to be listed).

6.Quantitative analysis of herbaceous vegetation in any suitable habitat for frequency distribution and comparison with Raunkiaer's frequency distribution law.

7.Study of vegetative and floral characters of the following families of the available genera distributed locally according to Bentham and Hooker's system of classification:

a) Monocotyledon: Poaceae

b) Dicotyledon: Brassicaceae, Leguminosae (papilionoidae and Caesalpinioidae, Malvaceae; Solanaceae; Lamiaceae,Euphorbiaceae; Asteraceae

8.Spot identification (Binomial, Family) of common wild plants from families included in theory Syllabus

9.Field visits (2local) and sunmission of properly preserved herbarium specimens of at least 15

common wild plants with herbarium label, proper field record and field note book