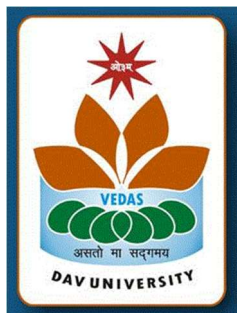


DAV UNIVERSITY JALANDHAR



**Course Scheme & Syllabus
For
B.Sc. (Hons.) Botany
(Program ID-4)**

1st TO 6th SEMESTER

Examinations 2019–2020 Session Onwards

Syllabi Applicable For Admissions in 2019

Scheme of B.Sc. (Hons.)
B.Sc. (Hons.) Botany

Semester 1

S.No	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	BOT121	Algae and Microbiology	Core	4	0	0	4
2	BOT122A	Algae and Microbiology Laboratory	Core	0	0	3	2
3	BOT123	Biomolecules and Cell Biology	Core	4	0	0	4
4	BOT124A	Biomolecules and Cell Biology Laboratory	Core	0	0	3	2
5	ENG151A	Basic Communication Skills	AECC	3	0	0	3
6	ENG152	Communication Skills Laboratory	AECC	0	0	2	1
7	Generic Elective-I		GE				6
Total							22

L: Lectures T: Tutorial P: Practical Cr: Credits
AECC: Ability Enhancement Compulsory Course

GE (Generic Elective-I) (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	ZOO154	Zoodiversity	4	0	0	4
	ZOO155	Zoodiversity Laboratory	0	0	3	2
2	MIC111	Introduction to Microbiology	4	0	0	4
	MIC112	Introduction to Microbiology Laboratory	0	0	3	2

Scheme of B.Sc. (Hons.)
B.Sc. (Hons.) Botany

Semester II

S.No	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	BOT125	Mycology and Phytopathology	Core	4	0	0	4
2	BOT126	Mycology and Phytopathology Laboratory	Core	0	0	3	2
3	BOT127	Archegoniate	Core	4	0	0	4
4	BOT128	Archegoniate Laboratory	Core	0	0	3	2
5	SGS107	Human Values and General Studies	AECC	4	0	0	4
5	EVS100	Environmental Studies	AECC	4	0	0	4
6	Generic Elective-II		GE				6
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits

GE (Generic Elective-II) (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE157	General Chemistry-I	4	0	0	4
	CHE158	General Chemistry-I- Lab	0	0	3	2
2	BTY361	Bioanalytical Tools	4	0	0	4
	BTY362	Bioanalytical Tools Laboratory	0	0	3	2

Scheme of B.Sc. (Hons.)
B.Sc. (Hons.) Botany

Semester III

S.No	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	BOT221	Morphology and Anatomy	Core	4	0	0	4
2	BOT222	Morphology and Anatomy Laboratory	Core	0	0	3	2
3	BOT223	Economic Botany	Core	4	0	0	4
4	BOT224	Economic Botany Laboratory	Core	0	0	3	2
5	BTY231	Genetics	Core	4	0	0	4
6	BTY232	Genetics Laboratory	Core	0	0	3	2
7	Generic Elective-III		GE				6
9	Skill Enhancement Course-I		SEC				2
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits
SEC: Skill Enhancement Course

SEC (Skill Enhancement Course)-I (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	BOT225	Organic Farming	2	0	0	2
2	BOT230	Herbal Technology	2	0	0	2

GE (Generic Elective-III) (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	ZOO257	Human Physiology	4	0	0	4
	ZOO258	Human Physiology Laboratory	0	0	3	2
2	MIC221	Microbial Physiology	4	0	0	4
	MIC222	Microbial Physiology Laboratory	0	0	3	2

Scheme of B.Sc. (Hons.)
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Semester IV

S.No	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	BTY241	Molecular Biology	Core	4	0	0	4
2	BTY242	Molecular Biology Laboratory	Core	0	0	3	2
3	BOT226	Plant Ecology and Phytogeography	Core	4	0	0	4
4	BOT227	Plant Ecology and Phytogeography Laboratory	Core	0	0	3	2
5	BOT228	Plant Systematics	Core	4	0	0	4
6	BOT229	Plant Systematics Laboratory	Core	0	0	3	2
7	Skill Enhancement Course-II		SEC				2
8	Generic Elective-IV		GE				6
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits
SEC (Skill Enhancement Course)-II (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	BOT231	Intellectual Property Rights	2	0	0	2
2	BOT232	Mushroom Culture Technology	2	0	0	2

GE (Generic Elective-IV) (choose one)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	CHE257	General Chemistry-II	4	0	0	4
	CHE258	General Chemistry Laboratory-II	0	0	3	2
2	BTY243	Biotechnology and Human Welfare	4	0	0	4
	BTY244	Biotechnology and Human Welfare Laboratory	0	0	3	2

Scheme of B.Sc. (Hons.)
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Semester V

S.No	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	BOT321	Reproductive Biology of Angiosperms	Core	4	0	0	4
2	BOT322	Reproductive Biology of Angiosperms Laboratory	Core	0	0	3	2
3	BOT323	Plant Physiology	Core	4	0	0	4
4	BOT324	Plant Physiology Laboratory	Core	0	0	3	2
5	Department Specific Elective-I		DSE				6
6	Department Specific Elective-II		DSE				6
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits

DSE- Discipline Specific Elective

DSE (Discipline Specific Electives-I and II) (choose two)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	BOT325	Analytical Techniques in Plant Science	4	0	0	4
	BOT326	Analytical Techniques in Plant Science Laboratory	0	0	3	2
2	BOT327	Plant Breeding	4	0	0	4
	BOT328	Plant Breeding Laboratory	0	0	3	2
3	BOT329	Stress Biology	4	0	0	4
	BOT330	Stress Biology Laboratory	0	0	3	2

Scheme of B.Sc. (Hons.)
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Semester VI

S.No	Paper Code	Course Title	Course Type	L	T	P	Cr.
1	BOT331	Plant Metabolism	Core	4	0	0	4
2	BOT332	Plant Metabolism Laboratory	Core	0	0	3	2
3	BOT333	Plant Biotechnology	Core	4	0	0	4
4	BOT334	Plant Biotechnology Laboratory	Core	0	0	3	2
5	Department Specific Elective-III		DSE				6
6	Department Specific Elective-IV		DSE				6
Total							24

L: Lectures T: Tutorial P: Practical Cr: Credits
DSE- Discipline Specific Elective

DSE (Discipline Specific Electives-III and IV) (choose two)

S.No	Paper Code	Course Title	L	T	P	Cr.
1	BOT335	Natural Resource Management	4	0	0	4
	BOT336	Natural Resource Management Laboratory	0	0	3	2
2	BOT337	Research Methodology	4	0	0	4
	BOT338	Research Methodology Laboratory	0	0	3	2
3	BOT339	Biostatistics	4	0	0	4
	BOT340	Biostatistics Laboratory	0	0	3	2

B.Sc. Botany (Hons.) Semester I
Paper: Algae and Microbiology
Course Code: BOT121

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the morphology, biology and importance of prokaryotes, eukaryotes, algal organisms, fungal organisms and lichens.

Learning Outcome

The course will enable students to know the earlier plants, their vegetative and reproductive structures and their importance.

UNIT I

Introduction to microbial world: Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine). (7 lectures)

Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). (7 lectures)

UNIT II

Bacteria: Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).

(10 lectures)

UNIT III

Algae: General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry.

(11 lectures)

UNIT IV

Cyanophyta and Xanthophyta: Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of Nostoc and Vaucheria.

(5 lectures)

Chlorophyta and Charophyta: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of Chlamydomonas, Volvox, Oedogonium, Coleochaete, Chara. Evolutionary significance of Prochloron.

(8 lectures)

Phaeophyta and Rhodophyta: Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of Ectocarpus, Fucus and Polysiphonia.

(6 lectures)

Paper: Algae and Microbiology Laboratory

Course Code: BOT122

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).

Phycology

Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia, Prochloron through electron micrographs, temporary preparations and permanent slides.

Reference Books:

1. Lee, R.E. *Phycology*. 4th ed. Cambrid: Cambridge UP, 1999. Print.
2. Willey, J. M., L.M. Sherwood, and C.J. Woolverton. *Prescott's Microbiology*. 9th ed. New York: McGraw-Hill, 2013. Print.
3. Kumar, H.D. *Introductory Phycology*. Delhi: Affiliated East-West Press, 1999. Print.
4. Sahoo, D. (2000). *Farming the ocean: seaweeds cultivation and utilization*. New Delhi: Aravali International, 2000. Print.
5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V. and Jackson R.B. *Biology*. 8th ed. USA: Pearson Benjamin Cummings, 2008. Print.
6. Pelczar, M.J. *Microbiology*. 5th ed. New Delhi: Tata McGraw-Hill Co., 2001. Print.

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B.Sc. Botany (Hons.) Semester I
Paper: Biomolecules and Cell Biology
Course Code: BOT123

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the morphology, biology and importance of prokaryotes, eukaryotes, algal organisms, fungal organisms and lichens.

Learning Outcome

The course will enable students to know the earlier plants, their vegetative and reproductive structures and their importance.

UNIT I

Biomolecules: Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Carbohydrates: Nomenclature and classification; Monosaccharides ; Disaccharides; Oligosaccharides and polysaccharides. Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins. 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 tRNA. (20 lectures)

UNIT II

Bioenergenetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule. (4 lectures)

Enzymes: 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 factors affecting enzyme activity. (6 lectures)

UNIT III

The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory). Cell wall and plasma membrane: 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. Cell organelles-Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. (12 Lectures)

UNIT IV

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes. Cell division: Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases. (14 lectures)

Paper: Biomolecules and Cell Biology Laboratory**Course Code: BOT124**

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

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 Onion/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 with the help of 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.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study the effect of organic solvent and temperature on membrane permeability.
10. Study different stages of mitosis and meiosis.

Reference Books:

1. Campbell, M.K. *Biochemistry*. 7th ed. China: Cengage Learning, 2012. Print.
2. Campbell, P. N., and A. D. Smith. *Biochemistry Illustrated: Biochemistry and Molecular Biology in the Post-genomic Era*. 4th ed. Edinburgh: Elsevier Churchill Livingstone, 2011. Print.
3. Tymoczko, J.L., Berg, J.M. and Stryer, L. *Biochemistry: A short course*. 2nd ed. New York: W.H. Freeman and Company, (2012). Print.
4. Berg, J.M., Tymoczko, J.L. and Stryer, L. *Biochemistry*. New York: W.H. Freeman and Company, 2011. Print.
5. Nelson, D.L. and Cox, M.M. *Lehninger Principles of Biochemistry*, 5th ed. New York: W.H. Freeman and Company, 2008. Print.
6. Karp, G. *Cell Biology*. 6th ed. USA: John Wiley & Sons, 2010. Print.
7. Hardin, J., Becker, G. and Skliensmith, L.J. *Becker's World of the Cell*. 8th ed. USA: Pearson Education Inc., 2012. Print.
8. Cooper, G.M. and Hausman, R.E. *The Cell: A Molecular Approach*. 5th ed. Washington, D.C: ASM Press, 2009. Print.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. *The World of the Cell*. 7th ed. San Francisco: Pearson Benjamin Cummings Publishing, 2009. Print.

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B.Sc. Botany (Hons.) Semester II
Paper: Mycology and Phytopathology
Course Code: BOT125

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the morphology, biology, harmful effects and importance of fungi to agricultural crops and humans.

Learning Outcome

The course will enable students to know the beneficial and harmful fungi and about the growth and control of the same.

UNIT 1

Introduction to true fungi: General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification (upto family).

Chytridiomycota and Zygomycota: Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Synchytrium*, *Rhizopus*.

Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces*, *Aspergillus*, *Penicillium*, *Alternaria*, *Neurospora* and *Peziza*. (14 lectures)

UNIT II

Basidiomycota: General characteristics; Habit and habitat; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Bioluminescence, Fairy Rings and Mushroom Cultivation.

Allied Fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Oomycota: General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora*, *Albugo*. (10 lectures)

UNIT III

Symbiotic associations: Lichens – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

Applied Mycology: Role of fungi in biotechnology, food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides). (14 lectures)

UNIT IV

Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers. (12 lectures)

Paper: Mycology and Phytopathology Laboratory**Course Code: BOT126**

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria*: Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ 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*, fairy rings and bioluminescent mushrooms to be shown.
8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of *Stemonitis* sporangia.
9. *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section/temporary mounts and sexual structures through permanent slides.
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

Reference Books:

1. Agrios, G.N. *Plant Pathology*. 4th ed. UK: Academic Press, 1997. Print.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. *Introductory Mycology*. 4th ed. Singapore: John Wiley & Sons, 1996. Print.
3. Webster, J. and Weber, R. *Introduction to Fungi*. 3rd ed. Cambridge: Cambridge University Press, 2007. Print.
4. Sethi, I.K. and Walia, S.K. *Text book of Fungi and Their Allies*. India: Macmillan Publishers, 2011. Print.
5. Sharma, P.D. *Plant Pathology*. India: Rastogi Publication, 2011. Print.

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B.Sc. Botany (Hons.) Semester II

Paper: Archegoniate

Course Code: BOT127

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the morphology, biology and importance of bryophytes, pteridophytes and gymnosperms.

Learning Outcome

The course will enable students to know the earlier plants, their vegetative and reproductive structures and their importance.

UNIT I

Introduction: Unifying features of archegoniate; Transition to land habit; Alternation of generations.

Bryophytes: General characteristics; Adaptations to land habit; Classification (upto family); Range of thallus organization. (10 lectures)

UNIT II

Type Studies- Bryophytes: Morphology, anatomy, reproduction and evolutionary trends of *Riccia*, *Marchantia*, *Pellia*, *Porella*, *Anthoceros*, *Sphagnum* and *Funaria* (developmental stages not included); Ecological and economic importance of bryophytes with special reference to *Sphagnum*. (14 lectures)

UNIT III

Pteridophytes: General characteristics; Classification (up to family); Early land plants (*Cooksonia* and *Rhynia*); Morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance. (12 lectures)

UNIT IV

Gymnosperms: General characteristics, classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance. (10 lectures)

Paper: Archegoniate Laboratory**Course Code: BOT128**

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. *Riccia* – Morphology of thallus.
2. *Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. *Anthoceros*- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. *Pellia, Porella*- Permanent slides.
5. *Sphagnum*- Morphology of plant, whole mount of leaf (permanent slide only).
6. *Funaria*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
7. *Psilotum*- Study of specimen, transverse section of synangium (permanent slide).
8. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
9. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
11. *Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
12. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
13. *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
14. Botanical Excursion

Reference Books:

1. Vashistha, P.C., Sinha, A.K. and Kumar, A. *Pteridophyta*. New Delhi: S. Chand, 2010. Print.
2. Bhatnagar, S.P. and Moitra, A. *Gymnosperms*. New Delhi: New Age International Pvt. Ltd. Publishers, 1996. Print.
3. Parihar, N.S. *An introduction to Embryophyta: Vol. I. Bryophyta*. Allahabad, India: Central Book Depot. 1991. Print.
4. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. *Biology*. New Delhi: Tata McGraw Hill, 2005. Print.
5. Vanderpoorten, A. and Goffinet, B. *Introduction to Bryophytes*. Cambridge: Cambridge University Press, 2009. Print.
6. Rashid, A. *An Introduction to Pteridophyta*. New Delhi: Vikas Publishers, 1999. Print.

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B.Sc. Botany (Hons.) Semester III
Paper: Morphology and Anatomy
Course Code: BOT221

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the morphology, biology and importance of angiosperms.

Learning Outcome

The course will enable students to know about the different tissue systems in angiosperms and how they function.

UNIT I

Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy.

Structure and Development of Plant Body: Internal organization of plant body: The three tissue systems, types of cells and tissues. Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development. (10 lectures)

UNIT II

Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers. (10 lectures)

UNIT III

Apical meristems: Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root. (14 lectures)

UNIT IV

Vascular Cambium and Wood: Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

Adaptive and Protective Systems: Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Anatomical adaptations of xerophytes and hydrophytes. (18 lectures)

Paper: Morphology and Anatomy Laboratory**Course Code: BOT222**

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Reference Books:

1. Dickison, W.C. *Integrative Plant Anatomy*. USA: Harcourt Academic Press, 2009. Print.
2. Fahn, A. *Plant Anatomy*. USA: Pergmon Press, 1974. Print.
3. Mauseth, J.D. *Plant Anatomy*. USA: The Benjamin/Cummings Publisher, 1988. Print.
4. Evert, R.F. *Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development*. USA: John Wiley and Sons, Inc. 2006. Print.

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B.Sc. Botany (Hons.) Semester III

Paper: Economic Botany

Course Code: BOT223

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the importance of plants in our day to day life.

Learning Outcome

The course will enable students to understand how plants are important in our life and how they influence our life.

UNIT 1

Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity. (8 lectures)

UNIT II

Cereals: Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.
Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.
Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses. (12 lectures)

UNIT III

Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper
Beverages: Tea, Coffee (morphology, processing & uses)
Sources of oils and fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses. (14 lectures)

UNIT IV

Natural Rubber: Para-rubber: tapping, processing and uses.
Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards).
Timber plants: General account with special reference to teak and pine.
Fibers: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses). (14 lectures)

Paper: Economic Botany Laboratory

Course Code: BOT224

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. **Cereals:** Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. **Legumes:** Soybean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. **Sources of sugars and starches:** Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. **Spices:** Black pepper, Fennel and Clove (habit and sections).
5. **Beverages:** Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. **Sources of oils and fats:** Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushed seeds.
7. **Essential oil-yielding plants:** Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus (specimens/photographs).
8. **Rubber:** specimen, photograph/model of tapping, samples of rubber products.
9. **Drug-yielding plants:** Specimens of Digitalis, Papaver and Cannabis.
10. **Tobacco:** specimen and products of Tobacco.
11. **Woods:** Tectona, Pinus: Specimen, Section of young stem.
12. **Fiber-yielding plants:** Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Reference Books:

1. Kochhar, S.L. *Economic Botany in Tropics*. New Delhi: MacMillan & Co., 2012. Print.
2. Wickens, G.E. *Economic Botany: Principles & Practices*. The Netherlands: Kluwer Academic Publishers, 2001. Print.
3. Chrispeels, Maarten J., and David E. Sadava. *Plants, Genes, and Agriculture*. Boston, Mass.: Jones and Bartlett, 1994. Print.
4. Swaminathan, M.S., and Kocchar, S.L., (eds.). *Plants and Society*. London: MacMillan Publications Ltd., 1989. Print.
5. Thakur, R.S., Puri, H.S. and Husain, A. *Major Medicinal Plants of India*. Lucknow: Central Institute of Medicinal and Aromatic Plants, 1989. Print.

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B.Sc. Botany (Hons.) Semester III

Paper: Organic Farming

Course Code: BOT225

L	T	P	Credits	Max. Marks	Min. Marks
2	0	0	2	50	20

Objective:

To acquaint the students about the biology and mechanism of organic farming.

Learning Outcome

The course will enable students to know importance of different living organisms in the field of agriculture.

UNIT I

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. (8 lectures)

UNIT II

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.

Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation. (12 lectures)

UNIT III

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

(13 lectures)

UNIT IV

Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (10 lectures)

Reference Books:

1. Dubey, R.C. *A Text book of Biotechnology*. New Delhi: S.Chand & Co., 2005. Print.
2. Kumaresan, V. *Biotechnology*. New Delhi: Saras Publications, 2005. Print.
3. Prakash, J.J.E. *Outlines of Plant Biotechnology*. New Delhi: Emkay Publication, 2004. Print.
4. Sathe, T.V. *Vermiculture and Organic Farming*. India: Daya publishers, 2004. Print.
5. Subha Rao, N.S. *Soil Microbiology*. New Delhi: Oxford & IBH Publishers, 2000. Print.
6. Vayas, S.C, Vayas, S. and Modi, H.A. *Bio-fertilizers and organic Farming*. India: Akta Prakashan, Nadiad. 1998. Print.

Paper: Herbal Technology**Course Code: BOT230**

L	T	P	Credits	Max. Marks	Min. Marks
2	0	0	2	50	20

Objective:

To acquaint the students about the medicines that can be obtained from the plants.

Learning Outcome

The course will enable students to know the importance of plants in medicinal world.

UNIT I

Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants. (10 Lectures)

UNIT II

Pharmacognosy - systematic position and medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. (8 Lectures)

UNIT III

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), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica* (memory booster). (12 Lectures)

UNIT IV

Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)
Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy) (12 Lectures)

Reference Books:

1. Chopra, R.N., Nayar, S.L. and Chopra, I.C. *Glossary of Indian medicinal plants*. New Delhi: C.S.I.R, 1956. Print.
2. Kanny, L, Dey and Raj B. *The indigenous drugs of India*. India: International Book - Distributors. 1984. Print.
3. Agnes, A. *Herbal plants and Drugs*. India: Mangal Deep Publications. 1999. Print.
4. Sivarajan, V.V. and Balachandra, I. *Ayurvedic drugs and their plant source*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd., 1994. Print.
5. Light, M. and Bryan, M. *Ayurveda and Aromatherapy*. New Delhi: Banarsidass, 1988. Print.
6. Green, A. *Thorsons Principles of Ayurveda*. London: Thomsons, 2000. Print.
7. Kokate, C.K. *Pharmacognosy*. India: Nirali Prakashan, 1999. Print.

B.Sc. Botany (Hons.) Semester IV
Paper: Plant Ecology and Phytogeography
Course Code: BOT226

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the interactions between the organisms and their environment.

Learning Outcome

The course will enable students to understand how environment influence the life of different organisms and vice versa.

UNIT I

Introduction: Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. (12 lecture)

UNIT II

Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

Biotic interactions: Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

Population ecology: Characteristics and dynamics. Ecological speciation (11 lecture)

UNIT III

Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids. (14 lecture)

UNIT IV

Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation. (15 lecture)

Paper: Plant Ecology and Phytogeography Laboratory**Course Code: BOT227**

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites.

Reference Books:

1. Odum, E.P. *Fundamentals of Ecology*. 5th ed. New Delhi: Cengage Learning India Pvt. Ltd., 2005. Print.
2. Singh, J.S., Singh, S.P. and Gupta, S. *Ecology Environment and Resource Conservation*. New Delhi: Anamaya Publications, 2006. Print.
3. Sharma, P.D. *Ecology and Environment*. 8th ed. India: Rastogi Publications, 2010. Print.
4. Wilkinson, D.M. *Fundamental Processes in Ecology: An Earth Systems Approach*. USA: Oxford University Press, 2007. Print.
5. Kormondy, E.J. *Concepts of Ecology*. 4th ed. India: PHI Learning Pvt. Ltd., 1996. Print.

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B.Sc. Botany (Hons.) Semester IV**Paper: Plant Systematics****Course Code: BOT228**

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the different systems of classification and how they developed.

Learning Outcome

The course will enable students to the basis of angiosperm classification and features of few basic families of flowering plants.

UNIT I

Significance of Plant systematic: Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys:Single access and Multi-access. (13 lecture)

UNIT II

Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids. (15 lecture)

UNIT III

Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification. (14 lecture)

UNIT IV

Biometrics, numerical taxonomy and cladistics: Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). (18 lecture)

Paper: Plant Systematics Laboratory

Course Code: BOT229

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae - *Ranunculus*, *Delphinium*

Brassicaceae - *Brassica*, *Alyssum* / *Iberis*

Myrtaceae - *Eucalyptus*, *Callistemon*

Umbelliferae - *Coriandrum* / *Anethum* / *Foeniculum*

Asteraceae - *Sonchus/Launaea*, *Vernonia/Ageratum*, *Eclipta/Tridax*

Solanaceae - *Solanum nigrum/Withania*

Lamiaceae - *Salvia/Ocimum*

Euphorbiaceae - *Euphorbia hirta/E.milii*, *Jatropha*

Liliaceae - *Asphodelus/Lilium/Allium*

Poaceae - *Triticum/Hordeum/Avena*

2. Field visit (local) – Subject to grant of funds from the university.

3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Reference Books:

1. Singh, G. *Plant Systematics: Theory and Practice*. 3rd ed. New Delhi: Oxford & IBH Pvt. Ltd., 2012. Print.
2. Jeffrey, C. *An Introduction to Plant Taxonomy*. Cambridge: Cambridge University Press, 1982. Print.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A. and Stevens, P.F. *Plant Systematics-A Phylogenetic Approach*. 2nd ed. USA: Sinauer Associates Inc., 2000. Print.
4. Maheshwari, J.K. *Flora of Delhi*. New Delhi: CSIR, 1963. Print.
5. Radford, A.E. *Fundamentals of Plant Systematics*. New York: Harper and Row, 1986. Print.

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B.Sc. Botany (Hons.) Semester IV
Paper: Intellectual Property Rights
Course Code: BOT231

L	T	P	Credits	Max. Marks	Min. Marks
2	0	0	2	50	20

Objective:

To acquaint the students about the different types of property rights that a person possesses.

Learning Outcome

The course will enable students to understand the different rules governing the IPRs.

UNIT I

Introduction to intellectual property right (IPR): Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Patents: Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Copyrights: Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement. (8 Lectures)

UNIT II

Trademarks: Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

Geographical Indications: Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

Protection of Traditional Knowledge: Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library. (11 Lectures)

UNIT III

Industrial Designs: Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Protection of Plant Varieties: Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001. (9 Lectures)

UNIT IV

Information Technology Related Intellectual Property Rights: Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

Biotechnology and Intellectual Property Rights.

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions. (10 Lectures)

Reference Books:

1. Gopalakrishnan, N.S. and Agitha, T.G. *Principles of Intellectual Property*. Lucknow, India: Eastern Book Company, 2009. Print.
2. Kerly, Mackenzie, D. and White, T. A. *Kerly's Law of Trade Marks and Trade Names*. 12th ed. London: Sweet & Maxwell, 1986. Print.
3. Parulekar, Ajit. *Indian Patents Law: Legal and Business Implications*. Delhi: Macmillan India, 2006. Print.
4. Wadehra, B.L. *Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications*. India: Universal law Publishing Pvt. Ltd., 2000. Print.
5. Narayanan, P. *Law of Copyright and Industrial Designs*. New Delhi: Eastern law House, 2000. Print.

Paper: Mushroom Culture Technology

Course Code: BOT232

L	T	P	Credits	Max. Marks	Min. Marks
2	0	0	2	50	20

Objective:

To acquaint the students about the mushrooms and the methodology of their production.

Learning Outcome

The course will enable students to understand the art and science underlying the mushroom production mechanisms.

UNIT I

Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*. (5 Lectures)

UNIT II

Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production. (12 Lectures)

UNIT III

Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins. (8 Lectures)

UNIT IV

Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value. (5 lectures)

Reference Books:

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R. *Oyster Mushrooms*. India: Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore. 1991. Print.
2. Swaminathan, M. *Food and Nutrition*. India: The Bangalore Printing and Publishing Co. Ltd., 1990. Print.
3. Tewari, S.C. and Kapoor, P. *Mushroom cultivation*. India: Mittal Publications, 1988. Print.
4. Bahl, N. *Hand book of Mushrooms*. 4th ed. New Delhi: Oxford Publishing Co. Pvt. Ltd, 2000. Print.

B.Sc. Botany (Hons.) Semester V
Paper: Reproductive Biology of Angiosperms
Course Code: BOT321

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the mechanism of reproduction in the angiosperms.

Learning Outcome

The course will enable students to know the vegetative and reproductive structures of angiosperms and their mechanism of action.

UNIT I

Introduction: History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.

Reproductive development: Induction of flowering; flower as a modified determinate shoot.

Flower development: genetic and molecular aspects. (10 lectures)

UNIT II

Anther and pollen biology: Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Ovule: Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female gametophyte— megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac. (15 lectures)

UNIT III

Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Self incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Pollen morphology; Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, in vitro fertilization. (12 lectures)

UNIT IV

Embryo, Endosperm and Seed: Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia. Seed structure, importance and dispersal mechanisms

Polyembryony and apomixes: Introduction; Classification; Causes and applications. (13 lectures)

Paper: Reproductive Biology of Angiosperms Laboratory

Course Code: BOT322

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
3. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test. germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs

Reference Books:

1. Bhojwani, S.S. and Bhatnagar, S.P. *The Embryology of Angiosperms*. 5th ed. New Delhi: Vikas Publishing House, 2011. Print.
2. Shivanna, K.R. *Pollen Biology and Biotechnology*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd., 2003. Print.
3. Raghavan, V. *Developmental Biology of Flowering plants*, Netherlands: Springer, 2000. Print.
4. Johri, B.M. *Embryology of Angiosperms*. Netherlands: Springer-Verlag, 1984. Print.
5. Maheshwari, P. *Recent advances in embryology*. International Soc. Plant Morphol, New York. 1963. Print.
6. Maheshwari, P. *An introduction to the embryology of Angiosperms*. McGraw Hill, New York. 1950. Print.

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B.Sc. Botany (Hons.) Semester V
Paper: Plant Physiology
Course Code: BOT323

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the various life supporting life processes in plants.

Learning Outcome

The course will enable students to know the importance of nutrients, photosynthesis and other life supportive processes in plants.

UNIT I

Plant-water relations: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. (10 Lectures)

UNIT II

Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

(12 Lectures)

UNIT III

Translocation in the phloem: Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. (14 Lectures)

UNIT IV

Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Phytochrome, cryptochromes and phototropins: Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action. (11 Lectures)

Paper: Plant Physiology Laboratory
Course Code: BOT324

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/*Avena* coleoptile bioassay (demonstration).

Reference Books:

1. Hopkins, W.G. and Huner, A. *Introduction to Plant Physiology*. 4th ed. USA: John Wiley and Sons, 2008. Print.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. *Plant Physiology and Development*. 6th ed. USA: Sinauer Associates Inc., 2014. Print.
3. Bajracharya D. *Experiments in Plant Physiology-A Laboratory Manual*. New Delhi: Narosa Publishing House, 1999. Print.
4. Buchanan, B.B., Gruissem, W. and Jones, R.L. *Biochemistry and Molecular Biology of Plants*. India: I K Internationals, 2005. Print.
5. Voet, D., and Voet, J.G. *Biochemistry*. New York: John Wiley and Sons Inc., 1995. Print.

This syllabus has been designed as per national syllabus suggested by UGC for CBCS guidelines as per requisite of honour degree.

B.Sc. Botany (Hons.) Semester V
Paper: Analytical Techniques in Plant Science
Course Code: BOT325

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the different techniques that are used in the study of plants.

UNIT I

Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

(12 lectures)

UNIT II

Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.

Spectrophotometry: Principle and its application in biological research.

(14 lectures)

UNIT III

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

(14 lectures)

UNIT IV

Biostatistics: Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

(13 lectures)

Paper: Analytical Techniques in Plant Science Laboratory

Course Code: BOT326

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

Reference Books:

1. Plummer, D.T. *An Introduction to Practical Biochemistry*. 3rd ed. New Delhi: Tata McGraw-Hill Publishing Co. Ltd., 1996. Print.
2. Ruzin, S.E. *Microtechnique and Microscopy*. New York: Oxford University Press, 1999. Print.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A. and Struhl, K. *Short Protocols in Molecular Biology*. 3rd ed. USA: John Wiley & Sons, 1995. Print.
4. Zar, J.H. *Biostatistical Analysis*. 4th ed. USA: Pearson Publication. 2012. Print.
5. Wilson, K., and Walker, J. *Principles and Techniques of Practical Biochemistry*. Cambridge: Cambridge University Press. 2000. Print.

B.Sc. Botany (Hons.) Semester V
Paper: Plant Breeding
Course Code: BOT327

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the methods and techniques of hybrid generation.

UNIT I

Plant Breeding: Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

(10 lectures)

UNIT II

Methods of crop improvement: Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants

Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

(15 lectures)

UNIT III

Quantitative inheritance: Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance.

Inbreeding depression and heterosis: History, genetic basis of inbreeding depression and heterosis; Applications.

(14 lectures)

UNIT IV

Sexual Incompatibility and Male sterility

Crop improvement and breeding: Breeding for biotic and abiotic stress resistance, Role of mutations; physical and chemical mutagens; Gamma gardens; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

(12 lectures)

Paper: Plant Breeding Laboratory
Course Code: BOT328

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Correlation of floral structure with pollination system in *Salvia*, *Pisum sativum*, *Lathyrus*, *Triticum*, *Oryza sativa*, *Zea maize*).
2. Emasculation and bagging of flowers (according to their availability).
3. Based on theory contents of each section.

Reference Books:

1. Singh, B.D. *Plant Breeding: Principles and Methods*. 7th ed. India: Kalyani Publishers, 2005. Print.
2. Chaudhari, H.K. *Elementary Principles of Plant Breeding*. 2nd ed. New Delhi: Oxford and IBH Pub., 1984. Print.
3. Acquaah, G. *Principles of Plant Genetics and Breeding*. Malden, MA: Blackwell Pub., 2007. Print.

B.Sc. Botany (Hons.) Semester V

Paper: Stress Biology

Course Code: BOT329

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the effect of various disadvantageous environmental conditions on metabolism and growth of plants.

UNIT I

Defining plant stress: Acclimation and adaptation.

Environmental factors: Water stress; Salinity stress, High light stress; Temperature stress

(12 lectures)

UNIT II

Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Stress sensing mechanisms in plants: Calcium modulation, Phospholipid signaling

(15 lectures)

UNIT III

Developmental and physiological mechanisms that protect plants against biotic stress

Developmental and physiological mechanisms that protect plants against abiotic stress

(14 lectures)

UNIT IV

Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production.

Reactive oxygen species–Production and scavenging mechanisms.

(15 lectures)

Paper: Stress Biology Laboratory

Course Code: BOT330

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
2. Superoxide activity in seedlings in the absence and presence of salt stress.
3. Zymographic analysis of peroxidase.
4. Zymographic analysis of superoxide dismutase activity.
5. Quantitative estimation and zymographic analysis of catalase.
6. Quantitative estimation and zymographic analysis of glutathione reductase.
7. Estimation of superoxide anions.

Reference Books:

1. Hopkins, W.G. and Huner, A. *Introduction to Plant Physiology*. 4th ed. USA: John Wiley and Sons, 2008. Print.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. *Plant Physiology and Development*. 6th ed. USA: Sinauer Associates Inc., 2015. Print.
3. Pareek A., Sopory S. K., Bohnert, H.J. and Govindjee. *Abiotic Stress Adaptation in Plants*. Springer, 2009. Print.
4. Ahmad P. *Oxidative Damage to Plants - Antioxidant Networks and Signaling*. Elsevier. 2015. Print.
5. Tuteja N. and Gill S.S. *Plant Acclimation to Environmental Stress*. Springer. 2015. Print.

B.Sc. Botany (Hons.) Semester VI**Paper: Plant Metabolism****Course Code: BOT331**

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the different metabolic events occurring in the plants.

Learning Outcome

The course will enable students to know about the events that help in maintenance of metabolism in plants.

UNIT I

Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

Carbon assimilation: Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO₂ reduction, photorespiration, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction.
(13 lectures)

UNIT II

Carbohydrate metabolism: Synthesis and catabolism of sucrose and starch.

Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.
(12 lectures)

UNIT III

ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Lipid metabolism: Synthesis and breakdown of triglycerides, β -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.
(15 lectures)

UNIT IV

Nitrogen metabolism: Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Mechanisms of signal transduction: Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.
(13 lectures)

Paper: Plant Metabolism Laboratory

Course Code: BOT332

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Chemical separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate reductase in germinating leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of fluorescence by isolated chlorophyll pigments.
9. Demonstration of absorption spectrum of photosynthetic pigments.

Reference Books:

1. Hopkins, W.G. and Huner, A. 4th ed. USA: John Wiley and Sons, 2008. Print.
2. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A. *Plant Physiology and Development*. 6th ed. USA: Sinauer Associates Inc.. 2015. Print.
3. Harborne, J.B. *Phytochemical Methods*. New York: John Wiley & Sons, 1973. Print.
4. Stryer, L. *Biochemistry*. 5th ed. New York: W.H. Freeman and Co., 1995. Print.
5. Voet, D., and Voet, J.G. *Biochemistry*. New York: John Wiley and Sons Inc., 1995. Print.

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B.Sc. Botany (Hons.) Semester VI**Paper: Plant Biotechnology****Course Code: BOT333**

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the application of biotechnology in plant science.

Learning Outcome

The course will enable students to know understand the application of various technological advances which has brought about change in the understanding of plant science.

UNIT I

Plant Tissue Culture: Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation). (12 lectures)

UNIT II

Recombinant DNA technology: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC). (10 lectures)

UNIT III

Gene Cloning: Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR
Methods of gene transfer: Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP). (15 lectures)

UNIT IV

Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns. (14 lectures)

Paper: Plant Biotechnology Laboratory

Course Code: BOT334

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. (a) Preparation of MS medium.
(b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Reference Books:

1. Bhojwani, S.S. and Razdan, M.K. *Plant Tissue Culture: Theory and Practice*. The Netherlands: Elsevier Science Amsterdam, 1996. Print.
2. Bhojwani, S.S. and Bhatnagar, S.P. *The Embryology of Angiosperms*. 5th ed. New Delhi: Vikas Publication House Pvt. Ltd., 2011. Print.
3. Glick, B.R. and Pasternak, J.J. *Molecular Biotechnology- Principles and Applications of recombinant DNA*. Washington: ASM Press, 2003. Print.
4. Snustad, D.P. and Simmons, M.J. *Principles of Genetics*. 5th ed. UK: John Wiley and Sons, 2010. Print.
5. Stewart, C.N. Jr. *Plant Biotechnology & Genetics: Principles, Techniques and Applications*. USA: John Wiley & Sons Inc., 2008. Print.

This syllabus has been designed as per national syllabus suggested by UGC for CBCS guidelines as per requisite of honour degree.

B.Sc. Botany (Hons.) Semester VI
Paper: Natural Resource Management
Course Code: BOT335

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the methods used in the maintenance of different natural resources.

UNIT I

Natural resources: Definition and types.

Sustainable utilization: Concept, approaches (economic, ecological and socio-cultural).

Land: Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. (10 lectures)

UNIT II

Water: Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Biological Resources: Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan). (12 lectures)

UNIT III

Forests: Definition, Cover and its significance (with special reference to India); Major and minor Forest products (wood products, wood fibers, and wood energy); Depletion; Management.

Energy: Renewable and non-renewable sources of energy (13 lectures)

UNIT IV

Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

National and international efforts in resource management and conservation (15 lectures)

Paper: Natural Resource Management Laboratory
Course Code: BOT336

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Estimation of solid waste generated by a domestic system (biodegradable and nonbiodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

Reference Books:

1. Vasudevan, N. *Essentials of Environmental Science*. New Delhi: Narosa Publishing House, 2006. Print.
2. Singh, J. S., Singh, S.P. and Gupta, S. *Ecology, Environment and Resource Conservation*. New Delhi: Anamaya Publications, 2006. Print.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. *An Introduction to Sustainable Development*. New Delhi: Prentice Hall of India Private Limited, 2008. Print.
4. Shmulsky, Rubin and P.D. Jones. *Forest Products and Wood Science, an Introduction*. 6th Ed. Blackwell publishing. 2011. Print.
5. Hoadley, R.B. *Identifying Wood, Accurate Results with Simple Tools*. Taunton Press. 1990. Print.
6. Hoadley, R.B. *Understanding Wood. A Craftsman's Guide to Wood Technology*. The Taunton Press. 1990. Print.

B.Sc. Botany (Hons.) Semester VI
Paper: Research Methodology
Course Code: BOT337

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the different methods and procedures used in botanical research.

UNIT I

Basic concepts of research: Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

General laboratory practices: Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling. (14 lectures)

UNIT II

Data collection and documentation of observations: Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Overview of Biological Problems: History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics, Transcriptional regulatory network. (16 lectures)

UNIT III

Methods to study plant cell/tissue structure: Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections. (14 lectures)

UNIT IV

Plant microtechniques: Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

The art of scientific writing and its presentation: Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism. (18 lectures)

Paper: Research Methodology Laboratory
Course Code: BOT338

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

Reference Books:

1. Dawson, C. *Practical research methods*. New Delhi: UBS Publishers, 2002. Print.
2. Stapleton, P., Yondeowei, A., Mukanyange, J. and Houten, H. *Scientific writing for agricultural research scientists – a training reference manual*. Hong Kong: West Africa Rice Development Association, 1995. Print.
3. Ruzin, S.E. *Plant microtechnique and microscopy*. New York: Oxford University Press, 1999. Print.

B.Sc. Botany (Hons.) Semester VI

Paper: Biostatistics

Course Code: BOT339

L	T	P	Credits	Max. Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the principles of statistics applied to the field of biology.

UNIT I

Biostatistics: Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

Collection of data primary and secondary: Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

(14 lectures)

UNIT II

Measures of central tendency: Mean, median, mode, geometric mean - merits & demerits.

Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

(12 lectures)

UNIT III

Correlation: Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression

(14 lectures)

UNIT IV

Statistical inference: Hypothesis - Simple and composite hypotheses, Null and alternative hypotheses; Type I and Type II errors

Level of significance p- value

Student 't' test - chi square test.

(16 lectures)

Paper: Biostatistics Laboratory

Course Code: BOT340

L	T	P	Credits	Max. Marks	Min. Marks
0	0	3	2	50	20

- 1) Calculation of mean, standard deviation and standard error
- 2) Calculation of correlation coefficient values and finding out the probability
- 3) Calculation of 'F' value and finding out the probability value for the F value.

Reference Books:

1. Danniel, W.W. *Biostatistic*. New York: John Wiley Sons, 1987. Print.
2. Sundarrao, P.S.S and Richards, J. *An introduction to Biostatistics*. 5th ed. New Delhi: PHI Learning Pvt. Ltd., 2012. Print.
3. Selvin, S. *Statistical Analysis of epidemiological data*. USA: New York University Press. 1991. Print.
4. Bishop, O.N. *Statistics for Biology*. USA: Houghton, Mifflin Co. Boston, 1966. Print.
5. Freedman, P. *The Principles of scientific research*. New York: Oxford Pergamon Press, 1960. Print.
6. Campbell, R.C. *Statistics for Biologists*. Cambridge: Cambridge University Press, 1998. Print.
7. Selvin, S. *Biostatistics – How it Works*. First Impression. New Delhi: Pearson Education Inc., 2007. Print.
8. Agarwal, B.L. *Basic Statistics*. New Delhi: New Age International, 2006. Print.

B.Sc. Botany (Hons.) Semester I
Course Title: Basic Communication Skills

Course Code: ENG151A

No. Of Lectures: 75

L	T	P	Credits	Marks
3	0	0	3	75

Course Objective:

- To enhance students' vocabulary and comprehensive skills through prescribed texts.
- To hone students' writing skills.

Learning Outcomes: Students will be able to improve their writing skills as well as will enrich their word power.

Unit – A Applied Grammar (Socio-Cultural Context)

1. Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, Interjection 5 hours
2. Tenses (Rules and Usages in Socio-cultural contexts) 6 hour
3. Modals: Can, Could, May, Might, Will, Would, Shall, Should, Must, Ought to 5hours
4. Passive/Active 5 hours
5. Reported/Reporting Speech 5 hour

Unit – B Reading (Communicative Approach to be Followed)

1. J M Synge: Riders to the Sea (One Act Play) 7 hours
2. Anton Chekhov : Joy (Short Story) 5 hours
3. Swami Vivekanand : The Secret of Work (Prose) 7 hours

Unit – C Writing

1. Essay Writing and Letter Writing 5Hours
2. Report Writing 5 hours
3. Group Discussion & Facing an Interview 5hours

References:

a. Books

1. Kumar, Sanjay and PushpLata. *Communication Skills*. India: OUP, 2012. Print.
2. Vandana, R. Singh. *The Written Word* by. New Delhi: Oxford University Press, 2008. Print.

b. Websites

1. www.youtube.com (to download videos for panel discussions). Web.
2. www.letterwritingguide.com. Web.
3. www.teach-nology.com. Web.
4. www.englishforeveryone.org. Web.
5. www.dailywritingtips.com. Web.
6. www.englishsheets.com. Web.
7. www.mindtools.com. Web.

B.Sc. Botany (Hons.) Semester I
Course Title: Basic Communication Skills Laboratory

L	T	P	Credits	Marks
0	0	2	1	25

Course Code: ENG152

No. Of Lectures: 30

Course Objective:

- To improve fluency in speaking English.
- To promote interactive skills through Group Discussions and role plays.

Learning Outcome: Students will get exposure to speaking through the above mentioned interactive exercises. In addition, they will develop a technical understanding of language learning software, which will further improve their communicative skills.

Unit – A Speaking/Listening

- | | |
|----------------------|----------|
| 1. Movie-Clippings | 10 hours |
| 2. Role Plays | 10 hours |
| 3. Group Discussions | 10 hours |

References:

Books

1. Gangal, J. K. *A Practical Course In Spoken English*. India: PHI Private Limited, 2012. Print.
2. Kumar, Sanjay and PushpLata. *Communication Skills*. India: OUP, 2012. Print.

Websites

1. www.youtube.com (to download videos for panel discussions).Web.
2. www.englishforeveryone.org.Web.
3. www.talkenglish.com.Web.
4. www.mindtools.com.Web.

B.Sc. Botany (Hons.) Semester I
GENERIC ELECTIVE COURSE

Course Title: Zoodiversity

Paper Code: ZOO154

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint students with the general characters of invertebrates and chordates emphasizing on the special characters of each group.

UNIT-A

- **Protozoa:** General characters of Protozoa; life cycle of *Plasmodium* 4 hours
- **Porifera:** General characters of Porifera; canal system in Porifera. 3 hours
- **Radiata:** General characters of Coelenterata; Polymorphism. 3 hours

UNIT-B

- **Acoelomates:** General characters of Helminthes; Life cycle of *Taenia solium* 3 hours
- **Pseudocoelomates:** General characters of Nemethehelminthes; Parasitic adaptations 3 hours

UNIT-C

- **Coelomate Protostomes:** General characters of Annelida; Metamerism 3 hours
- **Arthropoda:** General characters of Arthropoda; social life in insects 4 hours
- **Mollusca:** General characters of Mollusca; Pearl formation 3 hours
- **Coelomate Deuterostomes:** General characters of Echinodermata; Water vascular system in star fish 3 hours

UNIT-D

- **Protochordata:** Salient features 2 hours
- **Pisces:** Osoregulation. Migration of Fishes 4 hours
- **Amphibia:** General characters, Adaptations for terrestrial life, Parental care in Amphibia 4 hours
- **Reptilia:** Amniotes, origin of reptiles, terrestrial adaptations in reptiles 5 hours
- **Aves:** The origin of birds; flight adaptations 5 hours
- **Mammalia:** Early evolution of mammals; Primates; Dentition in mammals 6 hours

Reference books

1. Kotpal, R.L. *Modern Text Book of Zoology Invertebrates*. 10th ed., Meerut: Rastogi Publishers, 2012. Print.
2. Kotpal, R.L. *Minor phyla*. 5th ed. Meerut: Rastogi Publishers, 2006. Print.
3. Dhama, P.S. and Dhama, J.K. *Invertebrate Zoology*. 5th ed., New Delhi: R. Chand and Co., 2004. Print.
4. Parker, T.J. and Haswell, W.A. *Text book of Zoology, Invertebrates*. 7th ed., Vol. I (eds. A.J. Marshall & W.D. Williams), New Delhi: CBS Publishers & Distributors., 1992. Print.

5. Hyman L.H. *The Invertebrates*. Vol. I, II, III, IV and V. New York: McGraw Hill Book Company. Inc., 1959. Print.
6. Barnes, R.D. *Invertebrate Zoology*. USA: Saunders College Pub., 1992. Print.
7. Ruppert, Fox and Barnes. *Invertebrate Zoology. A functional Evolutionary Approach*. 7th ed., Cole: Thomson Books, 2006. Print.
8. Campbell and Reece. *Biology*. Singapore: Pearson Education, Pvt. Ltd., 2005. Print.
9. Kardong, K. V. *Vertebrates Comparative Anatomy. Function and Evolution*. New Delhi: Tata McGraw Hill Publishing Company, 2002. Print.
10. Raven, P. H. and Johnson, G. B. *Biology*. 6th ed. New Delhi: Tata McGraw Hill Publications, 2004. Print.

B.Sc. Botany (Hons.) Semester I

Course Title: Zoodiversity

Paper Code: ZOO155

L	T	P	Credits	Marks
0	0	3	2	50

1. Study of following specimens with the help of charts/models/e-resources;

Non Chordates: *Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias, and Antedon.*

Chordates: *Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Uraeotyphlus, Salamander, Rhacophorus, Draco, Uromastix, Naja, Viper, Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.*

2. Study of following through e-resources:

Cross section of *Sycon*, Sea anemone and *Ascaris* (male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva, Septal & pharyngeal nephridia of earthworm, Placoid, cycloid and ctenoid scales.

3. Study of the following through e-resources:

- Digestive and nervous system of Cockroach.
- Urinogenital system of Rat

B.Sc. Botany (Hons.) Semester I

Course Title: Introduction to Microbiology

Paper Code: MIC111

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint students with the general characters of microorganisms and their economical importance.

Unit I History of Development of Microbiology

No. of Hours: 15

Development of microbiology as a discipline. Spontaneous generation vs. biogenesis.

Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman

Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microbial World

No. of Hours: 40

A. Systems of classification Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

• Algae

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

• Fungi

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

• Protozoa

General characteristics with special reference to Amoeba, Paramecium, Plasmodium, Leishmania and Giardia

Unit 3 An overview of Scope of Microbiology

No. of Hours: 5

SUGGESTED READING

1. Tortora, G.J., Funke, B.R. and Case, C.L. *Microbiology: An Introduction*. 9th ed. San Francisco: Pearson Education, 2008. Print.
2. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. *Brock Biology of Microorganisms*. 14th ed. San Francisco: Pearson International Edition, 2014. Print.
3. Cappucino, J. and Sherman, N. *Microbiology: A Laboratory Manual*. 9th ed. San Francisco: Pearson Education Limited, 2010. Print.
4. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. *Prescott's Microbiology*. 9th ed. New York: McGraw Hill International, 2013. Print.
5. Atlas, R.M. *Principles of Microbiology*. 2nd ed. St. Louis: W.M.T. Brown Publishers, 1997. Print.
6. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. *Microbiology*. 5th ed. New York: McGraw Hill Book Company, 1993. Print.
7. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. *General Microbiology*. 5th ed. Basingstoke (Hants): McMillan Education, 2005. Print.

B.Sc. Botany (Hons.) Semester I

Course Title: Introduction to Microbiology Laboratory

Paper Code: MIC112

L	T	P	Credits	Marks
0	0	3	2	50

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
9. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary Mounts
10. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

B.Sc. Botany (Hons.) Semester II

Course Title: Human Values and General Studies

Course Code: SGS107

L	T	P	Cr.
4	0	0	4

Course Objectives

- To sensitize students about the role and importance of human values and ethics in personal, social and professional life.
- To enable students to understand and appreciate ethical concerns relevant to modern lives.
- To prepare a foundation for appearing in various competitive examinations
- To sensitize the students about the current issues and events of national and international importance
- To provide opportunity to the students to study inter disciplinary subjects like Geography, Science, Economy, Polity, History, International Relations etc.

Part - A

Human Values

1. Concept of Human Values: Meaning, Types and Importance of Values. 2 Hrs
2. Value Education : Basic guidelines for value education 2 Hrs
3. Value crisis and its redressal 1 Hrs

Being Good and Responsible

1. Self Exploration and Self Evaluation 2 Hrs
2. Acquiring Core Values for Self Development 2 Hrs
3. Living in Harmony with Self, Family and Society 3 Hrs
4. Values enshrined in the Constitution: Liberty, Equality 3 Hrs
5. Fraternity and Fundamental Duties.

Part - B

Value – based living

1. Vedic values of life 2 Hrs
2. *Karma Yoga* and *Jnana Yoga* 2 Hrs
3. *Ashta Marga* and *Tri-Ratna* 2 Hrs

Ethical Living:

1. Personal Ethics 2 Hrs
2. Professional Ethics 3 Hrs
3. Ethics in Education 2 Hrs

Part-C

General Geography, World Geography 3 Hrs

The Universe, The Solar System, The Earth, Atmosphere, The World we live in, Countries rich in Minerals, Wonders of the World, Biggest and Smallest.

Indian Geography 3 Hrs

Location, Area and Dimensions, Physical Presence, Indian States and Union Territories, Important sites and Monuments, Largest-Longest and Highest in India.

General History 3 Hrs

Glimpses of India History, Ancient Indian, Medieval India, Modern India, Various Phases of Indian National Movement, Prominent Personalities, Glimpses of Punjab history with special reference to period of Sikh Gurus

Glimpses of World History 3 Hrs

Important Events of World History, Revolutions and Wars of Independence, Political Philosophies like Nazism, Fascism, Communism, Capitalism, Liberalism etc.

Indian Polity: Constitution of India 3 Hrs

Important Provisions, Basic Structure, Union Government, Union Legislature and Executive, State Government: State Legislature and Executive, Indian Judiciary, The Election Commission, Panchayati Raj System, RTI etc.

General Economy 3 Hrs

The process of liberalization, privatization, globalization and Major World Issues, Indian Economy, Indian Financial System, Major Economic Issues, Economic Terminology.

Part-D

General Science 3 Hrs

General appreciation and understandings of science including the matters of everyday observation and experience, Inventions and Discoveries

Sports and Recreation 3 Hrs

The World of Sports and recreation, Who's Who is sports, Major Events, Awards and Honours. Famous personalities, Festivals, Arts and Artists

Current Affairs 3 Hrs

National and International Issues and Events in News, Governments Schemes and Policy Decisions

Miscellaneous Information

Who is who 2 Hrs

Books and Authors, Persons in News, Awards and Honours, Abbreviations and Sports

References:

1. Tripathi, A.N. *Human Values*. 3rd ed. New Delhi: New Age International Publishers, 2009. Print.
2. Subiramanian, R. *Professional Ethics*. New Delhi: Oxford University Press, 2013. Print.
3. Anand, R. and Prakashan, S. *Human Values and Professional Ethics*. New Delhi: Satya Prakashan, 2012. Print.
4. Bhalla S. *Human Values and Professional Ethics*. New Delhi: Satya Prakashan, 2012. Print.

5. Soryan, R. *Human Values and Professional Ethics*. 1st ed. New Delhi: Dhanpat Rai & Co. Pvt. Ltd., 2010. Print.
6. Jayshree, S. and Raghavan, B.S. *Human Values and Professional Ethics*. New Delhi: S Chand & Co. Ltd., 2007. Print.
7. Singh, Y. and Garg, A. *Human Values and Professional Ethics*. New Delhi: Aitbs publishers, 2011. Print.
8. Kumar, V. *Human Values and Professional Ethics*. Ludhiana: Kalyani Publishers, 2013. Print.
9. Gaur, R.R., Sangal, R. and Bagaria, G.P. *Human Values and Professional Ethics*. New Delhi: Excel Books, 2010. Print.
10. Osula, B. and Upadhyay, S. *Values and Ethics*. India: Asian Books Pvt. Ltd., 2011. Print.
11. Radhakrishnan, S. *Indian Philosophy*. New York: George Allen & Unwin Ltd. Humanities Press INC, 1929. Print.
12. Dwivedi, A.N. *Essentials of Hinduism, Jainism and Buddhism*. New Delhi: Books Today, 1979. Print.
13. Bhan, S. *Dayanand : His life and work*. New Delhi: DAVCMC, 2001. Print.
14. Dwivedi, K.D. *Esence of Vedas*. Hoshiarpur: Katyayan Vedic Sahitya Prakashan, 1990. Print.
15. Chaubey, B.B. *Vedic Concepts*. Hoshiarpur: Katyayan Vedic Sahitya Prakashan, 1990. Print.
16. Aggarwal, R.S. *Advance Objective General Knowledge*. India: S. Chand Publisher, 2013. Print.
17. Sen, S. *Concise General Knowledge Manual*. India: Unique Publishers, 2013. Print.
18. Verma, R.P. *Encyclopedia of General Knowledge and General Awareness*. India: Penguin Books Ltd., 2010. Print.
19. Thorpe, E. and Thorpe, S. *General Knowledge Manual*. Delhi: The Pearson, 2013-14. Print.
20. Mohanty, M. *General Knowledge Manual*. Delhi: Macmillan Publishers India Ltd., 2013-14. Print.
21. Government of India (Ministry of Information Broadcasting). *India 2013*, New Delhi: Publication Division, 2013. Print.
22. Methew, M. *Manorama Year Book 2013-14*. Kottayam: Malayalam Manorama Publishers, 2013. Print.
23. *Spectrum's Handbook of General Studies – 2013-14*. New Delhi: Spectrum Books Pvt. Ltd., 2013. Print.

Current Affairs

Magazines

Economic and Political Weekly, Yojna, the Week, India Today, Frontline, Spectrum.

Competition Success Review, Competition Master, Civil Services Chronicle, Current Affairs, World Atlas Book

Newspapers

The Hindu, Times of India, The Hindustan Times, The Tribune

B.Sc. Botany (Hons.) Semester II

Course Title: Environmental Studies

Paper Code: EVS100

L	T	P	Credits
4	0	0	4

Course Objective: This course aims at understanding the students in aspects of environmental problems, its potential impacts on global ecosystem and its inhabitants, solutions for these problems as well as environmental ethics which they should adopt to attain sustainable development.

Unit 1

The multidisciplinary nature of environmental studies (2 Hours)

Definition, scope and importance, Need for public awareness

Natural Resources: Renewable and non-renewable resources: (8 Hours)

Natural resources and associated problems.

(a) **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

(b) **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

(c) **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

(d) **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

(e) **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.

(f) **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Ecosystem: (4 Hours)

- Concept of an ecosystem
- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem:

a. Forest ecosystem

b. Grassland ecosystem

c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries)

Unit II

Biodiversity and its conservation

4 Hours

- Introduction – Definition: Genetic, Species and Ecosystem Diversity
- Bio-geographical classification of India
- Value of biodiversity: Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values
- Biodiversity at global, national and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity, global and national efforts.

Environmental Pollution

8Hours

- Definition, causes, effects and control measures of:
 - a. Air pollution
 - b. Water pollution
 - c. Soil pollution
 - d. Marine pollution
 - e. Noise pollution
 - f. Thermal pollution
 - g. Nuclear pollution
- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

Unit III

Social Issues and the Environment

7 Hours

- Population growth, variation among nations, Population explosion – Family Welfare Programmes.
- Environment and human health,
- From unsustainable to sustainable development
- Urban problems and related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environmental Laws: The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and control of Pollution) Act 1974; The Wildlife Protection Act, 1972; Forest Conservation Act, 1980.
- Issues involved in enforcement of environmental legislation
- Public Awareness

Unit IV

Human Population and Environment 5 Hours

- Population Growth and Variations among Nations
- Population Explosion
- Human Rights
- Value Education
- HIV / AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and Human Health
- Case Studies

Field Work

5 Hours

- Visit to a local area to document environmental assets river/ forest/ grassland/hill/mountain
- Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
- Study of common plants, insects, birds
- Study of simple ecosystems-Pond, river, hill slopes, etc (Field work equal to 5 lecture hours)

Suggested Readings:

1. Odum, E.P. *Basic Ecology*. Japan: Halt Saundurs, 1983. Print.
2. Botkin, D.B. and Kodler, E.A. *Environmental Studies: The Earth as a living planet*. New York: John Wiley and Sons Inc., 2000. Print.
3. Singh, J.S., Singh, S.P. and Gupta, S.R. *Ecology, Environment and Resource Conservation*. New Delhi: Anamaya Publishers, 2006. Print.
4. De, A.K. *Environmental Chemistry*. New Delhi: Wiley Eastern Ltd., 1990. Print.
5. Sharma, P.D. *Ecology and Environment*. Meerut: Rastogi Publications, 2004. Print.

B.Sc. Botany (Hons.) Semester II

Course Name: General Chemistry-I

Course Code: CHE157

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

L	T	P	Credits	Marks	Min. Marks
4	0	0	4	100	40

Section A: Inorganic Chemistry-1 (30 Periods)

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2 , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers n , l and m . Shapes of s , p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for $s-s$, $s-p$ and $p-p$ combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of $s-p$ mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+ . Comparison of VB and MO approaches.

Section B: Organic Chemistry-1 (30 Periods)

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates:

Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of WedgeFormula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L *cis* – *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* *cis*-addition (alk. $KMnO_4$) and *trans*-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal dihalides. *Reactions:* formation of metal acetylides, addition of bromine and alkaline $KMnO_4$ ozonolysis and oxidation with hot alk. $KMnO_4$

Reference Books:

- J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S. Print.
 - F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, USA: John Wiley. Print.
 - Douglas, McDaniel and Alexander: *Concepts and Models in Inorganic Chemistry*, USA: John Wiley. Print.
 - James E. H., Keiter, E. and Keiter, R. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication. Print.
 - Solomon, T.W.G. *Organic Chemistry*, USA: John Wiley and Sons. Print.
 - Sykes, P. *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman. Print.
 - Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill. Print.
 - Finar, I.L. *Organic Chemistry* (Vol. I & II), E. L. B. S. Print.
 - Morrison, R.T. and Boyd, R.N. *Organic Chemistry*, Prentice Hall. Print.
 - Bahl, A. and Bahl, B.S. *Advanced Organic Chemistry*, India: S. Chand. Print.
-

Course Name: General Chemistry-I-Laboratory

Course Code: CHE158

L	T	P	Credits	Marks	Min. Marks
0	0	3	2	50	20

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO_4 .
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .
4. Estimation of Fe (II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ with internal indicator.
5. Estimation of Cu (II) ions iodometrically using $\text{Na}_2\text{S}_2\text{O}_3$.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).
2. Separation of mixtures by Chromatography: Measure the R_f value in each case (combination of two compounds to be given):
 - (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
 - (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Paper: Bioanalytical Tools

Course Code: BTY361

L	T	P	Credits	Marks	Min. Marks
4	0	0	4	100	40

BIO-ANALYTICAL TOOLS

UNIT I

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

Paper: Bioanalytical Tools Laboratory

Course Code: BTY362

L	T	P	Credits	Marks	Min. Marks
0	0	3	2	50	20

PRACTICAL

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

Course Title: Principles of Genetics**Paper Code: BTY231**

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective:

This course is aimed at understanding the basic concepts of genetics at molecular level to develop analytical and quantitative skills from classical to molecular genetics.

Course Contents:**Unit I: Chromosome Theory of Inheritance (6 lectures)**

The chromosome theory of heredity, Sex chromosomes, Sex linkage, the parallel behaviour of autosomal genes and chromosomes.

Unit II: Mendelian Genetics (15 lectures)

Mendelian laws of inheritance, Monohybrid cross and the law of segregation, Dihybrid cross and law of independent assortment, Chromosome theory of inheritance, Multiple allele, lethal allele, Blood group, Rh factor, Gene interactions, Modified dihybrid ratio. Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Three point testcross, Interference, Calculating recombinant frequencies from selfed dihybrids, examples of linkage maps, The X2 test mitotic segregation in humans.

Unit III: Fine Structure of Genes and Chromosomes (14 lectures)

The concept of promoter, Coding sequence, Terminator, Induction of gene for expression. Structural organisation of chromatids, Centromeres, Telomeres, Chromatin, Nucleosome organisation; Euchromatin and heterochromatin; Special chromosomes (e.g., polytene and lampbrush chromosomes), Banding patterns in human chromosomes. Structural and numerical aberrations involving chromosomes; Hereditary defects - Klinefelter, Turner, Cri-du-Chat and Down syndromes. Mutations - spontaneous and induced, Chemical and physical mutagens.

Unit IV: Extrachromosomal inheritance and Molecular Genetics (10 lectures)

Coiling of shell in snails, Mitochondrial and chloroplast genetic systems, population genetics: Hardy-Weinberg equilibrium, Gene and genotypic frequencies.

Reference Books:

1. Strickberger, M.W. *Genetics*. 3rd ed. India: Prentice-Hall, 2008. Print.
2. Jones, S. *The Language of the Genes*. HarperCollins Publishers, 2012. Print.
3. Ridley, M. *Nature via Nurture: Genes, Experience, & What Makes Us Human*. HarperCollins Publishers, 2004. Print.
4. Aggarwal, V.K. and Verma, V.S. *Genetics*. 9th ed. India: S. Chand, 2010. Print.
5. Snustad, D.P. and Simmons, M.J. *Principles of Genetics*. 6th ed. USA: John Wiley & Sons, 2011. Print.
6. Pierce, B.A. *Genetics: A Conceptual Approach*. 4th ed. W.H. Freeman & Company, 2010. Print.

Course Title: Genetics Practical

Paper Code: BTY232

L	T	P	Credits	Marks
0	0	3	2	50

Experiments

- To make squash preparations of pre-treated metaphase chromosomes, and PMCs to view diplotene, diakinesis, metaphase I and anaphase I in *Phlox drummondii*, *Allium cepa* and (or) *Rhoeo discolor*
- Preparation of karyograms from the given photographs for karyotypic formula
- To study through photographs normal and deviant cytogenetic mechanisms
- Study of Mendel's laws, and deviations from Mendelian ratios using seed samples in the ratios of 9:7, 9:4:3, 13:3, 15:1, 12:3:1. Use Chi-Square Test for Testing the ratios
- Isolation of chloroplasts by sucrose gradient. Photographs of Restriction site variation of chloroplast DNA
- Exercises wrt determination of correct sequence and distance between the linked genes
- Induction and recovery of mutants in bacteria by UV irradiation
- Segregation demonstration in preserved material (Maize)
- Detection of Blood groups (A B O & Rh factors)
- Inheritance of other human characteristics, ability to test PTC, Thiourea
- Paternity disputes (blood groups)

B.Sc. Botany (Hons.) Semester III

Course Title: Human Physiology

Paper Code: ZOO257

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint students with the functioning of all systems of the human body.

UNIT-A

- **Nutrition:** Types of nutrition and nutrients; sources and functions of nutrients and the diseases associated with their excess or lesser intake. 2 hours
- **Digestive System:** Alimentary canal; Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and Hormonal control of Digestion 10 hours

UNIT-B

- **Respiratory System:** Ventilation; External and Internal Respiration; Transport of oxygen and carbon dioxide in blood; Factors affecting transport of gases. 6 hours
- **Circulatory System:** Composition of blood; Lymph; Blood groups; Blood coagulation; Structure of heart; co-ordination of heart beat, Cardiac cycle; ECG 10 hours
- **Excretory System:** Functional anatomy of kidney; Mechanism and regulation of urine formation. 8 hours

UNIT-C

- **Endocrine System:** Structure of pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, testes; and the diseases associated with them 7 hours
- **Reproductive System:** Spermatogenesis; Oogenesis; Physiology of male and female reproductive systems; hormonal and neuronal control 7 hours

UNIT-D

- **Nervous System:** Structure of Neuron; Propagation of nerve impulses (myelinated and non-myelinated nerve fibres); neuromuscular junctions 5 hours
- **Muscular system:** Structure of skeletal muscle, Mechanism of muscle contraction (sliding filament theory) 5 hours

Reference books

1. Guyton, A.C., Hall, J.E. *Text Book of Medical Physiology*. 12th ed. Harcourt Asia Pvt. Ltd./W.B. Saunders Company, 2011. Print.
2. Best, J.P. *Best and Taylor's physiological basis of medical practice*. 11th ed., William and Wilkins, 1985. Print.
3. Hoar, W.S. *General and comparative physiology, Adaptation and Environment*. 3rd ed. Cambridge: Cambridge University Press, 1983. Print.
4. Rhoades, R.A. and Tanner, G.A. *Medical Physiology*. 2nd ed. Lippincott Williams and Wilkins, 2003. Print.
5. Tortora, G.J. and Derrickson, B.H. *Principles of Anatomy and Physiology*. 12th ed. USA: John Wiley and Sons, Inc., 2009. Print.

Course Title: Human Physiology Laboratory

Paper Code: ZOO258

L	T	P	Credits	Marks
0	0	3	2	50

- Identification of food stuffs-starch, sucrose, glucose, proteins and fats.
- Demonstration of osmosis and diffusion.
- Demonstration of the presence of amylase enzyme in saliva. Effect of pH and temperature on enzyme action.
- Determination of coagulation and bleeding time of blood.
- Determination of blood groups of human blood samples.
- Recording of blood pressure of man.
- Enumeration of red blood corpuscles and white blood corpuscles of man.
- Estimation of haemoglobin content in blood.

B.Sc. Botany (Hons.) Semester III

Paper: Microbial Physiology

Course Code: MIC221

L	T	P	Credits	Marks	Min. Marks
4	0	0	4	100	40

Objective:

To acquaint the students about the importance of plants in our day to day life.

Learning Outcome

The course will enable students to understand how plants are important in our life and how they influence our life.

Unit I Microbial Growth and Effect of Environment on Microbial Growth Hours: 12
Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy – Autotroph/ Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Unit 2 Nutrient uptake and Transport

Hours: 10

Passive and facilitated diffusion: Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake Strengthen this unit,,add material...convert to 4 units as whole

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration

Hours: 16

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

Hours: 6

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism

Hours: 10

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Unit 6 Nitrogen Metabolism - an overview

Hours: 6

Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification

SUGGESTED READINGS

1. Madigan, M.T. and Martinko, J.M. *Brock Biology of Microorganisms*. 14th ed. Prentice Hall International Inc. 2014. Print.
2. Moat, A.G. and Foster, J.W. *Microbial Physiology*. 4th ed. USA: John Wiley & Sons, 2002. Print.
3. Reddy, S.R. and Reddy, S.M. *Microbial Physiology*. India: Scientific Publishers, 2005. Print.
4. Gottschalk, G. *Bacterial Metabolism*. 2nd ed. Springer Verlag, 1986. Print.
6. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. and Painter, P.R. *General Microbiology*. 5th ed. McMillan Press, 1987. Print.
7. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. *Prescott's Microbiology*. 9th ed. McGraw Hill Higher Education, 2013. Print.

Paper: Microbial Physiology Laboratory
Course Code: MIC222

L	T	P	Credits	Marks	Min. Marks
0	0	3	2	50	20

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

Paper: Molecular Biology**Course Code: BTY241**

L	T	P	Credits	Marks	Min. Marks
4	0	0	4	100	20

Course Objective: The aim is to extend understanding of the molecular mechanisms via which genetic information is stored, expressed and transmitted among generations.

Course Contents:**UNIT I: DNA structure and replication**

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II: DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III: Transcription and RNA processing

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation. RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV: Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation. Posttranslational modifications of proteins.

Reference Books:

1. Freshney, R. I. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*. 6th ed. Wiley-Blackwell, 2010. Print.
2. Atala, A. and Lanza, R. *Methods of Tissue Engineering*. 1st ed. Academic Press, 2001. Print.
3. Harrison, M.A. and Rae, I.F. *General Techniques of Cell Culture*. 1st ed. Cambridge: Cambridge University Press, 1997. Print.
4. Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3rd ed. Oxford University Press, 2000. Print.
5. Friefelder, D. *Molecular Biology*. 2nd ed. Narosa Book Distributors Pvt. Ltd., 2008. Print.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5th ed. Garland Science, 2007. Print.

Paper: Molecular Biology Laboratory
Course Code: BTY242

L	T	P	Credits	Marks	Min. Marks
0	0	3	2	50	20

Experiments

- Isolation of DNA from animal and plant tissue using classical methods
- Isolation of RNA from animal and plant tissue using classical methods
- Isolation of plasmid DNA from *E. coli* using boiling-prep and alkali lysis method
- Restriction fragment length polymorphism
- Agarose gel electrophoresis
- Polyacrylamide gel electrophoresis
- Elution of nucleic acids from agarose gel
- Primer Designing
- Polymerase Chain Reaction

B.Sc. Botany (Hons.) Semester IV

Course Name: General Chemistry-II

Course Code: CHE257

L	T	P	Credits	Marks	Min. Marks
4	0	0	4	100	40

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Section A: Physical Chemistry-1 (30 Lectures)

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium:

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

Ionic Equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis – calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

Section B: Organic Chemistry-2 (30 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzenesulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides *Preparation*: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 or NaNH_2 .

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and arylhalides.

Alcohols: *Preparation:* Preparation of primary, secondary and tertiary alcohols: using Grignard reagent, Esterhydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO_4 , acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts.

Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten –Baumann reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, NaHSO_3 , NH-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf Verley reduction.

Reference Books:

- T. W. Graham Solomons: *Organic Chemistry*. John Wiley and Sons. Print.
 - Sykes, P. *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman. Print.
 - Finar, I.L. *Organic Chemistry* (Vol. I & II), E. L. B. S. Print.
 - Morrison, R.T. and Boyd, R.N. *Organic Chemistry*. Prentice Hall. Print.
 - Bahl, A. and Bahl, B.S. *Advanced Organic Chemistry. India:* S. Chand. Print.
 - Barrow, G.M. *Physical Chemistry*. Tata McGraw-Hill, 2007. Print.
 - Castellan, G.W. *Physical Chemistry* 4th ed. Narosa, 2004. Print.
 - Kotz, J.C., Treichel, P.M. and Townsend, J.R. *General Chemistry*. India: Cengage Learning India Pvt. Ltd., 2009. Print.
 - Mahan, B.H. *University Chemistry*. 3rd ed. Narosa, 1998. Print.
 - Petrucci, R.H. *General Chemistry* 5th ed. New York: Macmillan Publishing Co., 1985. Print.
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Course Name: General Chemistry-II-Lab

Course Code: CHE258

L	T	P	Credits	Marks	Min. Marks
0	0	3	2	50	20

Section A: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3 , NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH .

Ionic equilibria

pH measurements

- a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
- b) Preparation of buffer solutions:
 - (i) Sodium acetate-acetic acid
 - (ii) Ammonium chloride-ammonium hydroxideMeasurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done.
 - (a) Bromination of Phenol/Aniline
 - (b) Benzoylation of amines/phenols
 - (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books

- Vogel, A.I. *Textbook of Practical Organic Chemistry*. 5th ed. Prentice-Hall. Print.
- Mann, F.G. and Saunders, B.C. *Practical Organic Chemistry*. Orient Longman, 1960. Print.
- Khosla, B.D. *Senior Practical Physical Chemistry*. R. Chand & Co. Print.

Paper: Biotechnology and Human Welfare

Course Code: BTY243

L	T	P	Credits	Marks	Min. Marks
4	0	0	4	100	40

UNIT I

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II

Agriculture: N₂ fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

Paper: Biotechnology and Human Welfare Laboratory

Course Code: BTY244

L	T	P	Credits	Marks	Min. Marks
0	0	3	2	50	40

PRACTICALS

1. Perform of ethanolic fermentaion using Baker's yeast
2. Study of a plant part infected with a microbe
3. To perform quantitative estimation of residual chlorine in water samples
4. Isolation and analysis of DNA from minimal available biological samples
5. Case studies on Bioethics (any two)