JIWAJI UNIVERSITY, GWALIOR (M.P.)

SYLLABUS

FOR

School of Studies in Botany

B. Sc. Honors (Botany)

SESSION

2020 – 2023

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN

B. Sc. Honors-2020-2023

	CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	C 1- **Microbiology and Phycology** C 2- **Biomolecules and Cell Biology**	English Communication			GE-1- **Plant Ecology and Taxonomy/ for Zoology (H) Animal Diversity, Animal form & function for Botany (H)**
II	C 3- **Mycology and Phytopathology** C 4- **Archegoniate**	Environmental Science			GE-2- **Biodiversity (Microbes, Algae, Fungi and Archegoniate/ for Zoology (H) Animal evolution, development Physiology, Behaving & wild life for Botany (H)**
III	C 5- **Anatomy of Angiosperms** C 6- **Economic Botany** C 7- **Genetics**		SEC -1- **Ethnobotany**		GE-3- **Chemistry Atomic str, bonding general organic chemistry & Aliphatic hydrocarbons.**
IV	C 8- **Molecular Biology** C 9- **Plant Ecology and Phytogeography** C 10- **Plant Systematics**		SEC -2- **Mushroom Culture Technology**		GE-4- **Chemistry Chemical energetic,**
V	C 11- **Reproductive Biology of Angiosperms** C 12- **Plant Physiology**			DSE-1- **Plant Breeding** DSE -2- **Advances in Plant Sciences**	
VI	C 13- **Plant Metabolism** C 14- **Plant Biotechnology**			DSE -3- **Natural Resource Management** DSE -4- **Industrial and Environmental Microbiology**	

B.Sc. (Hons) Botany students will opt GE papers from Zoology during I and II semester and GE papers from Chemistry during III and IV semesters. Students of B. Sc. (Hons) Zoology, Biochemistry and Chemistry can opt GE papers from Botany during I and II semesters

Scheme of Examination (B. Sc. Honors, Botany Course)

First Semester

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
CC-I	Theory	100	4	60	21	40	14
CC-II	Theory	100	4	60	21	40	14
GE-I	Theory	100	4	60	21	40	14
CC-I	CC-I Lab-I	100	2	60	21	40	14
CC-II	CC-II Lab-II	100	2	60	21	40	14
AECC-I	English Communication	100	4	60	21	40	14
	Grand Total		**20**				

Second Semester

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
CC-III	Theory	100	4	60	21	40	14
CC-IV	Theory	100	4	60	21	40	14
GE-II	Theory	100	4	60	21	40	14
CC-III	CC-III Lab-I	100	2	60	21	40	14
CC-IV	CC-IV Lab-II	100	2	60	21	40	14
AECC-II	Environmental Science	100	4	60	21	40	14
	Grand Total		**20**				

CC: Core Course, GE-: General Electiv, AECC: Ability Enhancement Compulsory Course.

Third Semester

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
CC-V	Theory	100	4	60	21	40	14
CC-VI	Theory	100	4	60	21	40	14
CC-VII	Theory	100	4	60	21	40	14
GE-III	Theory	100	4	60	21	40	14
CC-V	CC-V Lab	100	2	60	21	40	14
CC-VI	CC-VI Lab	100	2	60	21	40	14
CC-VII	CC-VII Lab	100	2	60	21	40	14
SEC-I	Skill Enhancement Course-I	100	4	60	21	40	14
	Grand Total		**26**				

Fourth Semester

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
CC-VIII	Theory	100	4	60	21	40	14
CC-IX	Theory	100	4	60	21	40	14
CC-X	Theory	100	4	60	21	40	14
GE-IV	Theory	100	4	60	21	40	14
CC-VIII	CC-VIII Lab	100	2	60	21	40	14
CC-IX	CC-IX Lab	100	2	60	21	40	14
CC-X	CC-X Lab	100	2	60	21	40	14
SEC-II	Skill Enhancement Course-II	100	4	60	21	40	14
	Grand Total		**26**				

CC: Core Course, GE-: General Elective, SEC: Skill Enhancement Course.

Fifth Semester

Course Code	Course Name	Total	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
CC-XI	Theory	100	4	60	21	40	14
CC-XII	Theory	100	4	60	21	40	14
DSE-I	Theory	100	4	60	21	40	14
DSE-II	Theory	100	4	60	21	40	14
CC-XI	CC-XI Lab	100	2	60	21	40	14
CC-XII	CC-XII Lab	100	2	60	21	40	14
DSE-I	DSE-I Lab	100	2	60	21	40	14
DSE-II	DSE-II Lab	100	2	60	21	40	14
	Grand Total		**24**				

Sixth Semester

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
CC-XIII	Theory	100	4	60	21	40	14
CC-XIV	Theory	100	4	60	21	40	14
DSE-III	Theory	100	4	60	21	40	14
DSE-IV	Theory	100	4	60	21	40	14
CC-XIII	CC-XIII Lab	100	2	60	21	40	14
CC-XIV	CC-XIV Lab	100	2	60	21	40	14
DSE-III	DSE-III Lab	100	2	60	21	40	14
DSE-IV	DSE-IV Lab	100	2	60	21	40	14
	Grand Total		**24**				

Total Credits: # 140

CC: Core Course, DSE: Discipline Specific Elective.

Semester-I

Core Course I: Microbiology and Phycology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Introduction to microbial world

Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, Medicine and diagnostics. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Unit 2: 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). Transmission methods in viruses

Unit 3: 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). Economic importance of Bacteria.

Unit 4: Algae: General, Phaeophyta and Rhodophyta

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, Significant contributions of important phycologists. Role of algae in the environment, agriculture, biotechnology and industry.

Unit 5: Cyanophyta, Chlorophyta, Charophyta, Xanthophyta, Phaeophyta and Rhodophyta

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc, Volvox, Oedogonium, Chara, Vaucheria, Ectocarpus, Polysiphonia.*

Practical

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,Procholoron* through electron micrographs, temporary preparations and permanent slides.

Suggested Readings

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

Core Course II: Biomolecules and Cell Biology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: 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; Phosphoglycerides.
Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary 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.

Unit 2: Bioenergenetics and Enzymes

Laws of thermodynamics, concept of free energy. Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Nomenclature and Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theroy), enzyme inhibition and factors affecting enzyme activity.

Unit3: The cell

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

Unit 4: 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.

Unit 5: Cell organelles and Cell division

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.
Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.
Chloroplast, Mitochondria, Endoplasmic Reticulum, Golgi Complex and Peroxisomes:

Structural organization and Function, Semiautonomous nature of mitochondria and chloroplast. Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

Practical

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

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
9. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Semester-II

Core Course III: Mycology and Phytopathology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Introduction to true fungi
General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification, Economic importance of Fungi.

Unit 2: Chytridiomycota and Zygomycota
Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Synchytrium, Rhizopus* and *Mucor.*

Unit 3: 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.*

Unit 4: Basidiomycota and Oomycota
General characteristics; Ecology; 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.

Unit 5: 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, Loose smut of Wheat, White rust of crucifers.

Practical

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.

Suggested Readings

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

Core Course IV: Archegoniate
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: General account of Archegoniate and Bryophytes

Unifying features of archegoniates; Transition to land habit; Alternation of generations. General characteristics of Bacteria, Adaptations to land habit; Classification; Range of thallus organization. Vegetative propogation in Bryophytes, Heterospory and origin of seed habit, Economic importance of Bryophytes.

Unit 2: Type Studies- Bryophytes

Classification (up to family), morphology, anatomy and reproduction of *Riccia, Marchantia, Anthoceros and Funaria*; Reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros* and *Funaria* (developmental stages not included).

Unit 3: Pteridophytes

General characteristics; Classification; Early land plants (*Rhynia* and *Harneophyton*). Stelar organization in ferns , Telome theory and Economic importance of Pteridophytes.

Unit 4: Type Studies- Pteridophytes

Classification (up to family), morphology, anatomy and reproduction of Lycopodium, *Selaginella* and *Equisetum* (Developmental details not to be included).Apogamy, Apospory and Parthenogenesis.

Unit 5: Gymnosperms

General features and Classification, Geological time scale, , Fosslization, Fossil Gymnosperm (*Williamsonia sewardiana*), economic importance of Gymnosperms.

Morphology, anatomy, reproduction and Life cycle of Pinus, Cycus and Ephedra.

Practical

1. Study of Morphology and anatomy of Riccia, Marchantia and Anthoceros by preparing temporary mounting..
2. Study the different kind of sporophyte Riccia, Marchantia and Anthoceros.
3. To make the temparary and double staining of Lycopodium, Selaginella and Equisetum.
4. To study the different types of steles in ferns.
5. Study the morphology and anatomy of different vegetative parts in Cycas, Pinus amd Ephedra.
6. Study the male and female cones in Cycas, Pinus amd Ephedra.
7. Study of fosil Pteridophytes and Gymnosperms

Suggested Readings

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

Semester-III

Core Course V: Anatomy of Angiosperms

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Introduction and scope of Plant Anatomy

Applications in systematics, forensics and pharmacognosy. the three tissue systems, types of Plant cells and tissues.

Unit 2: Tissues

Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Hydathodes, cavities, lithocysts and laticifers.

Unit 3: Apical meristems

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, Types of vascular bundles; Structure of dicot and monocot stem. Origin, development, arrangement; Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap.

Unit 4: Vascular Cambium and Wood

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Abnormal secondary growth. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Tylosis, Annual rings Periderm and its significance.

Unit 5: Adaptive and Protective Systems

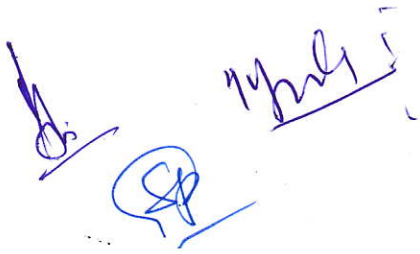
Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and non glandular, two examples of each), stomata , Adcrustation and incrustation; Mechanism of stomatal opening closing. Anatomical adaptations of xerophytes and hydrophytes.

Practical

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. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
4. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
5. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
6. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
7. Root: monocot, dicot, secondary growth.
8. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.

Suggested Readings

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.



Core Course VI: Economic Botany
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

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.

Unit 2: Cereals and Legumes

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets. Legunes; Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes.

Unit 3: Sources of sugars, Starches and Spices

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses and Listing of important spices, their family and part used.

Unit 4: Sources of oils, fats, Timber and Fibers plants

General description, classification, extraction, their uses and health implications groundnut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses). General account with special reference to teak and pine

Unit 5: Drug-yielding plants

Therapeutic and habit-forming drugs with special reference to *Cinchona, Digitalis, Papaver, Belladona, Withania, Tinospora ,Cannabis* and Tobacco (Morphology, processing, uses and health hazards).

Practical

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).

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.

Core Course VII: Genetics
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Mendelian genetics and its extension

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Polygenic inheritance.

Unit 2: Extra chromosomal Inheritance

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast;Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

Unit 3: Linkage, crossing over and chromosome mapping

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

Unit 4: Chromosomal Alteration

Structural changes in chromosome- Deletion , Duplication, Translocation and Inversion.

Numerical changes in chromosome- Euploidy, Aneuploidy. Significance of Polyploidy in plants

Unit 5: Gene mutations

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents);

Practical

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Semester-IV

Core Course VIII: Molecular Biology

THEORY (Credit :4, Practical-2)

Lectures: 48

Unit 1: Nucleic acids : History and Structure of DNA and RNA

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel- Conrat's experiment. DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA -- mitochondria and chloroplast DNA. Nucleosome model.

Unit 2:The replication of DNA

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

Unit 3: Central dogma and genetic code and Transcription

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features) Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli.* Eukaryotes: transcription factors, Gene silencing.

Unit 4: Translation

Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

Unit 5: Processing an modification of RNA

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' poly A tail); Ribozymes; RNA editing and mRNA transport.

Practical

1. Preparation of LB medium and raising *E.Coli.*
2. Isolation of genomic DNA from *E.Coli.*
3. DNA isolation from cauliflower head.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Suggested Readings

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Core Course IX: Plant Ecology and Phytogeography
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Introduction Soil, Water and Climatic factors

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment. Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development. Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); ydrological Cycle; Water in soil. Variations; adaptations of plants to their variation

Unit 2: Biotic interactions Ecosystems

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. Structure; Processes; Food chains and Food webs; Ecological pyramids.

Unit 3: Population ecology and Plant communities

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

Unit 4: Functional aspects of ecosystem

Principles and models of energy flow; Production and productivity; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Unit 5: Phytogeography

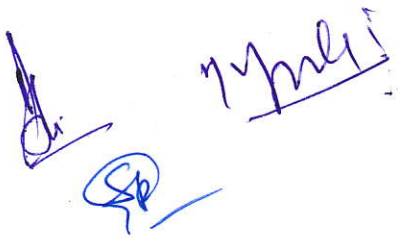
Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division ofIndia; Local Vegetation.

Practical

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. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
4. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
8. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

Suggested Readings

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



Core Course X: Plant Systematics
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Significance of Plant Systematics

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.

Unit 2: Taxonomic hierarchy and Botanical Nomenclature

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

Unit 3: 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 Prantle (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit 4: Biometrics, numerical taxonomy and cladistics

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

E-flora; Documentation: Flora, Monographs, Journals; Keys:Single access and Multi-access.

Unit 5: 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).

Practical

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*
Ascleipiadaceae	-	*Calotropis procera*
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).

Suggested Readings

1. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Jeffrey, C. (1982). An Introduction to *Plant Taxonomy.* Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.

Semester-V

Core Course XI: Reproductive Biology of Angiosperms

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: 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. Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

Unit 2: 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.

Unit 3: Ovule, Pollination and fertilization

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

Unit 4: Self incompatibility

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); 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.

Unit 5: Embryo, Endosperm Seed, Polyembryony and apomixis

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. Introduction; Classification; Causes and applications.

Practical

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, psuedomonads, 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.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Core Course XII: Plant Physiology
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: 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.

Unit 2: Mineral nutrition and Nutrient Uptake

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. Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, Uniport, co-transport, symport, antiport.

Unit 3: 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.

Unit 4: Plant growth regulators

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid and Ethylene.

Unit 6: Physiology of flowering, Phytochrome and Crytochromes

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Practical

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* coleptile bioassay (demonstration).

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Semester-VI

Core Course XIII: Plant Metabolism

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Concept of metabolism

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

Unit 2: 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, CO_2 reduction, photorespiration, C_4pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit 3: 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. Synthesis and catabolism of sucrose and starch.

Unit 4: ATP-Synthesis and Mechanism of Signal Transduction

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.

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

Unit 5: Lipid and Nitrogen Metabolism

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation. Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Practical

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.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

Core Course XIV: Plant Biotechnology
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: 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).

Unit 2: 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).

Unit 3: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

Unit 4: 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).

Unit 5: 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); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Practical

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.

Suggested Readings

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

Discipline specific Elective: DSE-1

Plant Breeding

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Plant Breeding

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

Unit 2: 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.

Unit 3: Quantitative inheritance

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

Unit 4: Inbreeding depression and heterosis

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

Unit 5: Crop improvement and breeding

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical

1. Effect of Mutagens Chemical and Radiation
2. Vegetative propagating method in Plants.
3. Budding - 'T' Budding and Patch Budding.
4. Layering - Pot Layering trench Layering and Goottee Layering.
5. Grafting - Simple Grafting, Single Grafting, double Grafting and Whip Grafting

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Discipline Specific Elective: DSE-2

Advances in Plant Sciences

(Credits: Theory- 4 Practical-2)

THEORY

Lectures: 48

Unit 1: Imaging and related techniques:
Principles of microscopy; Light microscopy; Dark field and bright field microscopy. Fluorescence microscopy; Phase contrast microscopy and its applications. Electron Microscopy; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation:
Principle and applications; Paper chromatography; Column chromatography, TLC, HPLC, Ion-exchange chromatography. Centrifugation: analytical centrifugation, ultracentrifugation. Spectrophotometry: types, Principle and its application in biological research.

Unit 3: Biostatistics and Bioinformatics:
Basic idea about 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; Bioinformatics: Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 4: Tissue culture
Collection, Handling and Instrumentation of Tissue Culture, Media preparation, Sterilization, Ex plane preparation, Aseptic inoculation callus and direct stock induction. Callus culture, Anther culture, Ovary culture, Embryo culture and Totipotency.

Unit 5: Herbarium techniques:
Introduction and objectives, Collection process, field note, pressing and drying of specimen, Mounting and labeling of specimen, storing of herbarium sheets. Herbaria in India.

Practical

1. To separate Pigments by paper chromatography.
2. To separate sugars by thin layer chromatography.
3. Study of microphotographs by Electron Microscopy.
4. Study and slide preparation by using Bright field, Dark field, phase contrast microscopy.
5. To estimate protein concentration through Lowry's methods.
6. Preparation of permanent slides (double staining).
7. Herbarium techniques.
8. Preparation of media and sterilization techniques used in Tissue culture.

Suggested Books

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.
5. Arthur M Lesk (2003) Introduction to Bioinformatics. Oxford University Press.

Discipline Specific Elective: DSE-3

Natural Resource Management (Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Natural resources and Sustainable utilization

Definition and types of Natural resources Concept, approaches (economic, ecological and socio-cultural).

Unit 2: Land and Water

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Metlands; Threats and management strategies.

Unit 3: Biological Resources

Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 4: Forests and Sources of energy

Definition, Cover and its significance (with special reference to India); Major and minor forestproducts; Depletion; Management. Renewable and non-renewable sources of energy and National and International effects.

Unit 5: Contemporary practices in resource management and conservation

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management. Methods of conservation.

Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) 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.

Suggested Readings

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Discipline Specific Elective: DSE-4

Industrial and Environmental Microbiology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 48

Unit 1: Scope of microbes in industry and environment, Bioreactors/Fermenters and fermentation processes

Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots. Role of *Rizobium, Mycorhiza (VAM),* and *Blue Green Algae* in industru and environment Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory, pilotscale and production fermenters; types of fermenter.

A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations (If facilities available in the surroundings and University permit)

Unit2:Microbial production of industrial products

Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin).

Unit 3: Microbial enzymes of industrial interest and enzyme immobilization

Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

Unit 4: Microbes and quality of environment.

Distribution of microbes in air, water and soil ; Isolation and enumeration of microorganisms from soil, air and water.

Unit 5: Microbial flora of water.

Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples.

Practical

1. Principles and functioning of instruments in microbiology laboratory
2. Hands on sterilization techniques and preparation of culture media.
3. Isolation of Micro organism from air.
4. Isolation of Microbes from water and soil.

Suggested Readings

1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition.

Generic Elective: GE-1
Plant Ecology and Taxonomy
(Credits: Theory-4)
THEORY
Lectures: 48

Unit 1: Introduction, Ecological factors and Plant communities
History and introduction and Ecology Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes. Characteristic feature plant communities, Ecotone and edge effect; Succession; Processes and types.

Unit 2: Ecosystem, Biogeochemical cycle and Phytogeography
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous, Principle biogeographical zones; Endemism

U nit 3: Introduction to plant taxonomy, Herbarium and taxonomic evidences
Identification, Classification, Nomenclature. Functions of Herbarium, technique of preparation of Herbarium important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access. Taxonomy in relation to cytology, Phytochemistry and Palynology.

Unit 4 : Botanical nomenclature and Typification
Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 5: Types of Classification
Types of classification-artificial, natural and phylogenetic. Bentham and Hooker, Engler and Prantl and Hutchinson (upto series)..

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition. 68

Generic Elective GE-2
Biodiversity (Microbes, Algae, Fungi and Archegoniate)

(Credits: Theory-4)

THEORY

Lectures: 48

Unit 1: Microbes- History and their types

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

Unit 2: Algae

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Volvox*, *Chlamydomonas, Oedogonium*, *Vaucheria* and *Polysiphonia*. Economic importance of algae.

Unit 3: Fungi

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

Unit 4: Introduction to Archegoniate and Bryophytes

Unifying features of archegoniates, Transition to land habit, Alternation of generations. General characteristics of Bryophytes adaptations to land habit, Classification, Range of thallus organization.Classification (up to family), morphology, anatomy and reproduction of *Marchantia* (Developmental details not to be included).Ecology and economic importance of bryophytes

U nit 5: Pteridophytes and Gymnosperms

General characteristics, classification of Pteridophytes and Gymnosperms Early land plants (*Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella* and *Equisetum*.(Developmental details not to be included).Heterospory and seed habit, stelar evolution.Ecological and economical importance of Pteridophytes. Morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad. 66

Skill Enhancement Course: SEC-1
Ethnobotany
(Credits 4)
Lectures: 48

Unit 1: Ethnobotany - An overview
Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science.The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2: Methodology of Ethnobotanical studies
a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3: Studies of some Ethno medicinal plants in India
Medico-ethnobotanical sources in India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

Unit 4: Role of Ethnobotany in modern Medicine
Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania*. Role of ethnic groups in conservation of plant genetic resources.Endangered taxa and forest management (participatory forest management).

Unit 5: Ethnobotany and legal aspects
Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings

1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3) Lone et al,. Palaeoethnobotany
4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, _Lucknow, India.
5) S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.
6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – _Chichester
7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah._8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996_9) Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd. 84

Skill Enhancement Course: SEC-2
Mushroom Culture Technology

(Credits 4)

Lectures: 48

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus florida, Agaricus bisporus* and *Genoderma sp.* Life cycle of edible fungi and structure of fruiting body.

Unit 2: 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.

Unit 3: Factors affecting the mushroom bed preparation. Low cost technology, Composting technology in mushroom production.

Unit 4: Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

Unit 5: 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.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

B.Sc. [Honors] Botany [CBCS Structure]

Ability Enhancement Compulsory Courses [AECC]

Courses Offered

1. **AECC1: English Communication**
2. **AECC2: Environmental Science**

Semester-I
AECC1: English Communication

Total Hours:48 **Credits: 4**

The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions.

Unit – I

Introduction:
Theory of Communication
Types and modes of Communication

Unit – II

Language of Communication:
Verbal and Non-verbal (Spoken and Written),
Personal, Social and Business
Barriers and Strategies
Intra-personal, Inter-personal and Group communication

Unit – III

Speaking Skills:
Monologue
Dialogue
Group Discussion
Effective Communication/ Mis- Communication
Interview
Public Speech

Unit – IV

Reading and Understanding:
Close Reading
Comprehension
Summary Paraphrasing
Analysis and Interpretation
Translation (from Indian language to English and vice-versa)
Literary/Knowledge Texts

Unit – V

Writing Skills:
Documenting
Report Writing
Making notes
Letter writing

Text Books:

1. *Fluency in English* - Part II, Oxford University Press, 2006.
2. *Business English*, Pearson, 2008.
3. *Language, Literature and Creativity*, Orient Blackswan, 2013.
4. *Language through Literature* (forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjana Kaul, Dr. Brati Biswas

SEMESTER-II

AECC1: Environmental Science

Total Hours : 48 **Credits: 4**

UNIT-I

1. Basic concepts and issues, global environmental problems - ozone depletion, UV-B,
2. Greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management.
3. Environmental pollution - types of pollution, sources of pollution, measurement of pollution
4. Methods of measurement of pollution, fate of pollutants in the environment,

UNIT-II Environmental Pollution and Population

1. Air, water, noise, heat and nuclear pollution- definition, causes, effect and prevention of pollution
2. Population growth, disparities between countries
3. Population explosion, family welfare program
4. Environment and human health
5. Cleanliness and disposal of domestic waste

UNIT-III Resources and conservation

1. Natural resources, problems and conservation
2. Water resources
3. Forest resources
4. Land resources

UNIT-IV Resources and Disaster Management

1. Food resources
2. Energy resources
3. Disaster Management and Environmental laws
4. Disaster Management- Food, earthquake, cyclones and landslides

UNIT-IV Laws for conservation and Protection of Environment

1. Conservation of laws for air pollution
2. Conservation of laws for water pollution
3. Wildlife conservation laws
4. Role of information technology in protecting environment and health

SUGGESTED READINGS

1. Waste water engineering - treatment, disposal and reuse, Metcalf and Eddy Inc., Tata McGraw Hill, New Delhi.
2. Environmental Chemistry, AK. De, Wiley Eastern Ltd, New Delhi.
3. Bioremidation, Baaker, KH and Herson D.S., 1994. Mc.GrawHillInc, NewYork.
4. Environmental Molecular Biology, Paul. A, Rochelle, 2001.Horizon Press.
5. Environmental Protection and Laws by Jadhav and Bhosale, V.M.Himalaya publ. House 13. Biodiversity Assessment and Conservation by PC Trivedi, Agrobios publ.
6. Air Pollution and Health by J. G. Ayres,Editors- J. G. Ayres, Robert L. Maynard, R. Richards
7. Environmental Pollution: Management and Control for Sustainable Development by R.K.Khitoliya, S. Chand

GE-I: B.Sc Hons.SEM-I Zoology

BOB 101: Animal Diversity, Animal Form & Function

(Course will be offered by School of Studies in Zoology)

Total Hours : 48 **CREDITS: 4**

Unit- I:Criteria for classification of multicellular animals 6

1. Symmetry
2. Early development: spiral and radial cleavage Protostomes and Deuterostomes
3. Body cavities: acoelomates, pseudocoelomates, coelomates (schizo andenterocoelomates)
4. Homology and analogy

Unit-II:Non-Chordates

5. General characters and classification of the following upto classes with examples showing distinctive features **12**
   - 5.1 Protozoa
   - 5.2 Porifera
   - 5.3 Cnidaria
   - 5.4 Ctenophora
   - 5.5 Platyhelminthes
   - 5.6 Nematoda
   - 5.7Annelida
   - 5.8 Arthropoda
   - 5.9 Mollusca
   - 5.10 Echinodermata

6. Hemichordates: General characters and classification up to sub-classes 1

Unit-III: Chordates

7. General characters and classification of the following up toSub-classes/ orders with examples showing distinctive/adaptive features 12

- 7.1Protochordates: Urochordates, Cephalochordates
- 7.2 Cyclostomes
- 7.3 Pisces
- 7.4 Amphibians
- 7.5 Reptiles
- 7.6 Aves
- 7.7 Mammals

Unit-IV Introduction to Invertebrate Physiology10

8. Mode of Feeding and Digestion

8.1 Feeding mechanisms: suspension, deposit, cropping, sucking (herbivorous) and raptorial (carnivorous).

8.2 I

ntracellular and extracellular digestion: food vacuole and gastro vascular cavity.

9. Respiratory Organs and Pattern of Circulation

9.1 Structure and function of gills, trachea, and book lungs.

9.2 Pattern of circulation in invertebrates.

10. Types of excretion and Mode of Excretion **3**

10.1 Open tubular: metanephridia

10.2 Closed saccular: protonephridia and Malpighian tubules.

Unit-V

11. Nervous system in invertebrates **11**

11.1 Patterns of nervous system in invertebrates

11.2 Organization of nervous system in invertebrates

12. Receptors and sense organs in invertebrates

12.1 Mechanoreceptors and Chemoreceptors in insects

12.2 Photoreception in insects

13.Reproduction

13.1 Types of asexual reproduction: fission, regeneration and parthenogenesis

13.2 Sexual reproduction: primary and accessory sex organs and their functions

Suggested Books

1. Miller & Harley: Zoology (6th ed. 2005,Brown)
2. Purves et al: Life-the Science of Biology, (7th ed. 2004,Sinauer)
3. Campbell & Reece: Biology (7th ed. 2005,Pearson)
4. Dorit, Walker & Barnes: Zoology (1991,Saunders)
5. Taylor,.Green& Stout : Biological Sciences (3rd ed. 2005,Cambridge)
6. Mader: Biology (9th ed. 2007,Brown)
7. Kotpal: Modern text book of Zoology: Invertebrates (11th ed. 2016Rastogi)
8. Kotpal: Modern text book of Zoology: Vertebrates (4th ed. 2016Rastogi)
9. Jordan & Verma: Invertebrate Zoology (Reprint 2014, S.Chand)
10. Jordan & Verma: Chordate Zoology (Reprint 2014, S.Chand)
11. Nigam: Biology of Non-chordates (1997, SChand) 12 Nigam: Biology of Chordates (1997, SChand)

GE-II: BOB: Sem II Zoology

Animal Evolution, Development,Physiology,Behaviour and Wildlife

(Course will be offered by School of Studies in Zoology)

Total Hours : 48 **CREDITS: 4**

Unit-I: Developmental Biology **8**

1. Gametogenesis: Spermatogenesis and oogenesis.
2. Mode of Fertilization: Sea Urchin and Mammals.
3. Conceptual Idea of development of Chick
4. Regeneration (Liver, *Hydra*, *Planaria*)

Unit-II: Evolutionary Biology **10**

5. Concept and theories of organic evolution:Lamarckism, Darwinism, Neo-Darwinism.
6. Hardy-Weinberg theory of natural population, allele/gene and genotype frequency, Factors affecting allele frequency.
7. Zoo-geological time scale.
8. Genetic polymorphism and ecological adaptation/speciation.
9. Isolating mechanisms.

Unit-III: Vertebrate (Mammalian) Physiology

10. Respiration **15**
    - 10.1 Mechanism and regulation of breathing.
    - 10.2 Transport of oxygen and carbon dioxide.
11. Circulation :
    - 11.1 Blood Propertiesand Circulation.
    - 11.2 Introduction to Structure and function of Heart, Cardiac cycle and ECG.
12. Nervous System
    - 12.1 Structure and Types of neuron.
    - 12.2 Physiology of nerve impulse conduction.
13. Reproductive System
    - 13.1 General plan of gonads and urino-genital ducts.
    - 13.2 Types of uterus.

Unit IV: Fundamentals ofEndocrinology

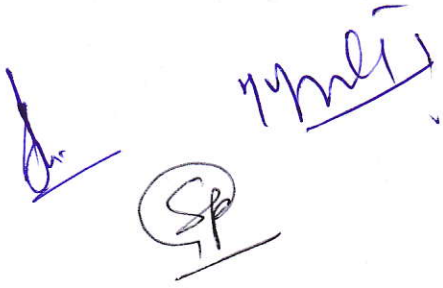
15. Distribution, Structure and Types of endocrine glands in mammals. **7**
16. Neuroendocrine system: Hormones of Hypothalamus and Pituitary gland.
17. Regulation of neuroendocrine system.
18. Insect hormones

Unit V: Animal Behaviour& Wild Life8

19. Concepts and patterns of Behavior.
20. Reproductive and social behavior.
21. Biological rhythms.
22. Migration: orientation and Navigation7
23. Wild life conservation: National parks and sanctuaries, Community reserves; Tiger conservation in India.

Suggested Books:

1. Rastogi: Organic Evolution (2007, Kedarnath& Ramnath).
2. Futuyma: Evolutionary Biology (2005,Sinauer).
3. Hall and Hallgrimsson: Strickberger's Evolution (2008, Jones andBartlet).
4. Ganong: Review of Medical Physiology (22nd ed. 2005, LangeMedical).
5. Guyton and Hall: A text book of Medical Physiology (11th ed. 2006,Saunders).
6. Keele& Neil: Samson Wright's Applied Physiology (13th ed. 1989,Oxford).
7. Hadley: Endocrinology (5th ed. 2000, PrenticeHall).
8. Norris: Vertebrate Endocrinology, Fourth Edition, 2007, AcademicPress.
9. Alcock: Animal Behaviour: An Evolutionary Approach (10th ed 2015,Sinauer).
10. Drickamer, Vessey& Jakob: Animal Behaviour – Mechanisms, Ecology, Evolution (5th ed 2002, McGraw-Hill).
11. Dugatkin: Principles of animal behavior (3rd ed 2014, Norton &Company).
12. Manning & Dawkins (1998): An Introduction to Animal Behaviour (5th ed 1998,Cambridge).
13. Balinsky: An Introduction to Embryology (1981,CBS).
14. Gilbert: Developmental Biology (8th ed., 2006,Sinauer).
15. Wolpert: Principles of Development (3rd ed. 2007,Oxford.
16. Chanda S.K (1992).Conserving wild life in India.



Generic Elective-3: Chemistry-I
Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons (Theory)
[Course will be Offered by School of Studies in Chemistry]

SEMESTER – III

Total Hours : 48 **CREDITS: 4**

UNIT-I Atomic Structure & Elementary Quantum Mechanics:

1. **Quantum Numbers Shapes of s, p, d, f orbitals**. Aufbau principle and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge.
2. Dual nature of Electron, Photo Electric Effect, Compton effect, Idea of the de-Broglie matter waves, Heisenberg Uncertainty principle, Bohr's Model of Hydrogen atom (no derivation) and its defects.
3. **Molecular orbital theory, basic ideas**: Criteria for forming M.O, construction M.O's by LCAO-$H2^+$ ion calculation of energy levels from wave functions, concept of σ, σ *, π, π* & n orbitals and their characteristics.
4. Hybrid orbitals – (sp, sp^2, sp^3), calculation of co-efficient of A.O.'s used in these hybrid orbitals. Schrödinger wave equation, Significance of ψ and ψ2.

UNIT-II Periodic Properties & Bonding

1. Atomic and ionic radii, ionization energy, electron affinity and electro negativity definition, methods of determination
2. Trends in periodic table and applications in predicting and explaining the chemical behaviour.
3. Covalent Bond: Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH_3, H_3O^+ and H_2O. MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electro negativity difference.
4. Ionic Solids: Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, Lattice defects, Semiconductors, Lattice energy and Born-Haber cycle, Solvation energy and Solubility of Ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond: free electron, valence bond and bond theories.
5. Weak Interactions –: Hydrogen bonding, Vander Waals forces.

UNIT-III Basics of Organic Chemistry and Stereochemistry

1. Basics of Organic Chemistry: *Organic Compounds:* Classification, Hybridization, Shapes of molecules.
2. Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and hyperconjugation. Homolytic and Heterolytic fission with suitable examples.Electrophiles and Nucleophiles.
3. Stereochemistry: Fischer Projection and Newmann Projection formulae Geometrical isomerism: cis–trans and, syn-anti isomerism.
4. Optical Isomerism*: Criteria for* Optical Activity, Enantiomers and Distereoisomers, meso structures, Threo and Erythro isomers.

UNIT-IV Aliphatic Hydrocarbons

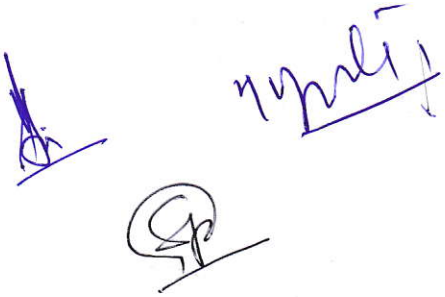
1. Chemistry of alkanes: Formation of alkanes, Wurtz Reaction
2. Carbon-Carbon pibonds:Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions.
3. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition) and Diels-Alder reaction.
4. Reactions of alkynes: Electrophilic and Nucleophilic additions.

UNIT-V Cycloalkanes

1. Types of cycloalkanes and their relative stability
2. Conformation analysis of alkanes: Chair, Boat and Twist boat forms; Relative stability
3. Aromatic hydrocarbons:Electrophilic aromatic substitution: halogenation, nitration
4. Ssulphonation and Friedel-Craft's alkylation/acylation with their mechanism.

SUGGESTED READINGS:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. &Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
9. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
11. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
12. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
13. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009
14. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
15. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.



Generic Elective-4: CHEMISTRY-II (Theory)
Chemical Energetics, Equilibria& Functional Organic Chemistry
[Course will be offered by School of Studies in Chemistry]

SEMESTER – IV

Total Hours : 48 **CREDITS: 4**

UNIT-I Chemical Energetics

1. Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry.
2. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution.
3. 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.
4. Chemical Equilibrium: Free energy change in a chemical reaction.

UNIT-II Chemical and Ionic Equilibrium

1. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o , Le Chatelier's principle.
2. Relationships between Kp, Kc and Kx for reactions involving ideal gases. (8 Lectures)
3. Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization
4. Ionization constant and ionic product of water.

UNIT-III Acid, Base, Buffers and Aromatic hydrocarbons

1. 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.
2. Buffer solutions.Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

3. Functional group approach for the following reactions to be studied in context to their structure. Aromatic hydrocarbons Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

UNIT-IV Chemical Reactions, Alkyl and Aryl Halides

1. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation.
2. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).
3. Alkyl and Aryl Halides Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. Preparation: from alkenes and alcohols.
4. 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.

UNIT-V Reactions of alcohols, phenol, aldehydes and ketones

1. Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).
2. Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
3. Alcohols, Phenols and Ethers (Upto 5 Carbons) Alcohols: Preparation: Preparation of 1o , 2o and 3o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. KMnO4, acidic dichromate, conc. HNO3).
4. Phenols: (Phenol case) Preparation: Cumenehydroperoxide 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.
5. Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH, NaHSO3, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation.

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