



**JIWAJI UNIVERSITY, GWALIOR (M.P.)**

**SYLLABUS**

**FOR**

**School of Studies in Botany**

**B. Sc. Honors (Botany)**

**SESSION**

**2022 – 2026**

*12/2/22  
25/7/2022*

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25/7/22*

**JIWAJI UNIVERSITY GWALIOR**

**B.Sc. Honors Botany syllabus CHOICE BASED CREDIT SYSTEM  
Structure for Undergraduate Program SESSION 2022-26**

**B.Sc. (Hons) Botany 2022-2026 CBCS**

Sem	Subject		Minor Theory (4-Credits)	Any other Faculty Generic Elective (GE) Theory (4-Credits)	Vocational (SEC) Theory (4-Credits)	Ability Enhancement (AEC) (4-Credits)	Subject		Field Project/ Internship (6/10 Credits)	Credits
	Major Core Course Theory (4-Credits)	Major DSE Theory (4-Credits)					Lab-I (2-Credits)	Lab-II (2-Credits)		
I	101	Microbiology and Phyycology	102	GE-1	103	104	105	106	--	20
	201	Mycology and Phytopathology	--	GE-2	203	204	205	206	--	20
III	301	Anatomy of Angiosperms	302	GE-3	303	--	304	305	--	20
	401	Molecular Biology	--	GE-4	403	--	404	405	--	20
V	501	Plant Ecology and Phytoecography	502	--	503	Nursery and Gardening	504	505	FP-1 (6-credits)	20
	601	Plant Systematics	602	603	--	--	604	605	FP-2 (6-credits)	20
VII	701	Plant Biotechnology	702	703	--	704	705	FP/ RP (6-credits)	20	
	801	Plant Physiology	802	803	--	804	805	FP/ RP (10-credits)	20	
Total	32	16	24	12	16	8	16	8	28	160

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**Jiwaji University, Gwalior**  
**B.Sc. (Hons) Botany 2022-26**

**Course Structure and Scheme of Examination**

**FIRST SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>101- T</b> <b>(Major Course)</b>	Microbiology and Phycology (Theory)	100	4	60	21	40	14
<b>102- T</b> <b>(Minor Course)</b>	Biomolecules and Cell Biology (Theory)	100	4	60	21	40	14
<b>105- Lab</b> <b>(Major Course)</b>	Microbiology and Phycology -Lab	100	2	60	21	40	14
<b>106- Lab</b> <b>(Minor Course)</b>	Biomolecules and Cell Biology -Lab	100	2	60	21	40	14
<b>GE-1-T</b>	Animal Diversity, Animal form & function	100	4	60	21	40	14
<b>AEC-I-104-T</b>	English Communication (Theory)	100	4	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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**Jiwaji University, Gwalior**  
**B.Sc. (Hons) Botany 2022-26**

**Course Structure and Scheme of Examination**

**SECOND SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>201-T</b> (Major Course)	Mycology and Phytopathology (Theory)	100	4	60	21	40	14
<b>202-T</b> (Minor Course)	Archegoniate (Theory)	100	4	60	21	40	14
<b>205- Lab</b> (Major Course)	Mycology and Phytopathology -Lab	100	2	60	21	40	14
<b>206- Lab</b> (Minor Course)	Archegoniate -Lab	100	2	60	21	40	14
<b>GE-II-T</b>	Animal evolution, development Physiology, Behaving & wild life	100	4	60	21	40	14
<b>AEC-II-204-T</b>	Environmental Science (Theory)	100	4	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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**B.Sc. (Hons) Botany 2022-26**

**Course Structure and Scheme of Examination**

**THIRD SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>301-T</b> (Major Course)	Anatomy of Angiosperms (Theory)	100	4	60	21	40	14
<b>302-T</b> (Minor Course)	Economic Botany (Theory)	100	4	60	21	40	14
<b>304- Lab</b> (Major Course)	Anatomy of Angiosperms -Lab	100	2	60	21	40	14
<b>305- Lab</b> (Minor Course)	Economic Botany -Lab	100	2	60	21	40	14
<b>GE-III-T</b>	Chemistry Atomic str, bonding general organic chemistry & aliphatic hydrocarbons	100	4	60	21	40	14
<b>SEC-I-303-T</b>	Ethnobotany (Theory)	100	4	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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**Course Structure and Scheme of Examination**

**FOURTH SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>401-T</b> (Major Course)	Molecular Biology (Theory)	100	4	60	21	40	14
<b>402-T</b> (Minor Course)	Genetics & Plant Breeding (Theory)	100	4	60	21	40	14
<b>404- Lab</b> (Major Course)	Molecular Biology -Lab	100	2	60	21	40	14
<b>405- Lab</b> (Minor Course)	Genetics & Plant Breeding -Lab	100	2	60	21	40	14
<b>GE-IV-T</b>	Chemistry Chemical energetic (Theory)	100	4	60	21	40	14
<b>SEC-II-403-T</b>	Mushroom Culture Technology (Theory)	100	4	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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**B.Sc. (Hons) Botany 2022-26**

**Course Structure and Scheme of Examination**

**FIFTH SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>501-T</b> (Major Course)	Plant Ecology and Phytogeography (Theory)	100	4	60	21	40	14
<b>DSE- 502-T</b>	Natural Resource Management (Theory)	100	4	60	21	40	14
<b>504- Lab</b> (Major Course)	Plant Ecology and Phytogeography -Lab	100	2	60	21	40	14
<b>FP-1- 505</b>	Field Project/ Internship	100	6	60	21	40	14
<b>SEC-III-503-T</b>	Nursery and Gardening (Theory)	100	4	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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**B.Sc. (Hons) Botany 2022-26**

**Course Structure and Scheme of Examination**

**SIXTH SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>601-T</b> (Major Course)	Plant Systematics (Theory)	100	4	60	21	40	14
<b>DSE-2- 602-T</b>	Advances in Plant Sciences (Theory)	100	4	60	21	40	14
<b>DSE-3- 603-T</b>	Reproductive Biology of Angiosperms (Theory)	100	4	60	21	40	14
<b>604- Lab</b> (Major Course)	Plant Systematics -Lab	100	2	60	21	40	14
<b>FP-2- 605</b>	Field Project/ Internship	100	6	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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**Course Structure and Scheme of Examination**

**SEVENTH SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>701-T</b> (Major Course)	Plant Biotechnology (Theory)	100	4	60	21	40	14
<b>DSE-3- 702-T</b>	Industrial and Environmental Microbiology (Theory)	100	4	60	21	40	14
<b>703-T</b> (Minor Course)	Research Methodology (Theory)	100	4	60	21	40	14
<b>704-Lab</b> (Major Course)	Plant Biotechnology - Lab	100	2	60	21	40	14
<b>FP/RP- 705</b>	Field Project/ Internship	100	6	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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**Jiwaji University, Gwalior**  
**B.Sc. (Hons) Botany 2022-26**

**Course Structure and Scheme of Examination**

**EIGHTH SEMESTER**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>801-T</b> (Major Course)	Plant Physiology (Theory)	100	4	60	21	40	14
<b>802-T</b> (Minor Course)	Plant Metabolism (Theory)	100	4	60	21	40	14
<b>803-Lab</b> (Minor Course)	Plant Physiology (Lab)	100	2	60	21	40	14
<b>FP/RP- 804</b>	Field Project/ Internship	100	10	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

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## Semester-I

### 101: 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-archaeobacteria, 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*.

### 105: Microbiology Practical

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).

### 105: 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.

### Suggested Readings

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4<sup>th</sup> edition.
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9<sup>th</sup> 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. 8<sup>th</sup> edition.  
Pelczar, M.J. (2001) Microbiology, 5<sup>th</sup> edition, Tata McGraw-Hill Co, New Delhi

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## 102: 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 quaternary 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: Bioenergetics 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 theory), enzyme inhibition and factors affecting enzyme activity.

#### Unit 3: 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.

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**106: Biomolecules and Cell Biology****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. 6<sup>th</sup> 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

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**GE-1: Animal Diversity, Animal Form and Function**  
(Course will be offered by School of Studies in Zoology)

Total Hours : 48

CREDITS: 4

**Unit- I: Criteria for classification of multicellular animals**

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

**Unit-II: Non-Chordates**

General characters and classification of the following upto classes with examples showing distinctive features

1. Protozoa
2. Porifera
3. Cnidaria
4. Ctenophora
5. Platyhelminthes
6. Nematoda
7. Annelida
8. Arthropoda
9. Mollusca
10. Echinodermata

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

**Unit-III: Chordates**

General characters and classification of the following up to Sub-classes/ orders with examples showing distinctive/adaptive features

1. Protochordates: Urochordates, Cephalochordates
2. Cyclostomes
3. Pisces
4. Amphibians
5. Reptiles
6. Aves
7. Mammals

**Unit-IV Introduction to Invertebrate Physiology**

**Mode of Feeding and Digestion**

1. Feeding mechanisms: suspension, deposit, cropping, sucking (herbivorous) and raptorial (carnivorous).
2. Intracellular and extracellular digestion: food vacuole and gastro vascular cavity.

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**Respiratory Organs and Pattern of Circulation**

1. Structure and function of gills, trachea, and book lungs.
2. Pattern of circulation in invertebrates.

**Types of excretion and Mode of Excretion**

1. Open tubular: metanephridia
2. Closed saccular: protonephridia and Malpighian tubules.

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**Unit-V**

**Nervous system in invertebrates**

1. Patterns of nervous system in invertebrates
2. Organization of nervous system in invertebrates

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**Receptors and sense organs in invertebrates**

1. Mechanoreceptors and Chemoreceptors in insects
2. Photoreception in insects

**Reproduction**

1. Types of asexual reproduction: fission, regeneration and parthenogenesis
2. Sexual reproduction: primary and accessory sex organs and their functions

**Suggested Books**

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

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**AEC-1 (104): 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

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## Semester-II

### 201: 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.

Study!

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## 205: Mycology and Phytopathology

### 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. 4<sup>th</sup> edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3<sup>rd</sup> 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.

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**202: 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 propagation 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*). Stellar 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, , Fossilization, Fossil Gymnosperm (*Williamsonia seawardiana*), economic importance of Gymnosperms.

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

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**206: Archegoniate  
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 temporary 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 and Ephedra.
6. Study the male and female cones in Cycas, Pinus and Ephedra.
7. Study of fossil 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.

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**GE-2 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**

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**

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

**Unit-III: Vertebrate (Mammalian) Physiology**

**Respiration**

1. Mechanism and regulation of breathing.
2. Transport of oxygen and carbon dioxide.

**Circulation :**

1. Blood Properties and Circulation.
2. Introduction to Structure and function of Heart, Cardiac cycle and ECG.

**Nervous System**

1. Structure and Types of neuron.
2. Physiology of nerve impulse conduction.

**Reproductive System**

1. General plan of gonads and urino-genital ducts.
2. Types of uterus.

**Unit IV: Fundamentals of Endocrinology**

1. Distribution, Structure and Types of endocrine glands in mammals.
2. Neuroendocrine system: Hormones of Hypothalamus and Pituitary gland.
3. Regulation of neuroendocrine system.
4. Insect hormones

**Unit V: Animal Behaviour & Wild Life**

1. Concepts and patterns of Behavior.
2. Reproductive and social behavior.
3. Biological rhythms.
4. Migration: orientation and Navigation
5. Wild life conservation: National parks and sanctuaries, Community reserves; Tiger conservation in India.

*Unit I*

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**Suggested Books:**

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

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**AEC- 204: 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. Bioremediation, 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

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### Semester-III

#### **301: 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.

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**304: Anatomy of Angiosperms**  
**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 Benjamin/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.

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**302: 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. Legumes; 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*, *Belladonna*, *Withania*, *Tinospora*, *Cannabis* and Tobacco (Morphology, processing, uses and health hazards).

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**305: Economic Botany  
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.

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**GE-3: Chemistry-I**

**Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons (Theory)**  
 [Course will be Offered by School of Studies in Chemistry]  
 (Theory)

Total Hours : 48

CREDITS: 4

**UNIT-I Atomic Structure & Elementary Quantum Mechanics:**

- 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.
- 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.
- Molecular orbital theory, basic ideas:** Criteria for forming M.O, construction M.O's by LCAO-H<sub>2</sub><sup>+</sup> ion calculation of energy levels from wave functions, concept of  $\sigma$ ,  $\sigma^*$ ,  $\pi$ ,  $\pi^*$  & n orbitals and their characteristics.
- Hybrid orbitals – (sp, sp<sup>2</sup>, sp<sup>3</sup>), calculation of co-efficient of A.O.'s used in these hybrid orbitals. Schrödinger wave equation, Significance of  $\psi$  and  $\psi^2$ .

**UNIT-II Periodic Properties & Bonding**

- Atomic and ionic radii, ionization energy, electron affinity and electro negativity definition, methods of determination
- Trends in periodic table and applications in predicting and explaining the chemical behaviour.
- 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<sub>3</sub>, H<sub>3</sub>O<sup>+</sup> and H<sub>2</sub>O. 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.
- 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.
- Weak Interactions –: Hydrogen bonding, Vander Waals forces.

**UNIT-III Basics of Organic Chemistry and Stereochemistry**

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

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**UNIT-IV Aliphatic Hydrocarbons**

1. Chemistry of alkanes: Formation of alkanes, Wurtz Reaction
2. Carbon-Carbon bonds: 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. Sulphonation 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. & Snyder, 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.

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**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) *Azadirachta 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 serpentina*, *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

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## Semester-IV

### 401: 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,  $\theta$  (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.

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**404: Molecular Biology  
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. 6<sup>th</sup> edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5<sup>th</sup> edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9<sup>th</sup> edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3<sup>rd</sup> 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. 10<sup>th</sup> edition.

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**402: Genetics and Plant breeding  
(Credits: Theory-4)**

**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. Infective heredity- Kappa particles in *Paramecium*.

**Unit 2: 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 3: Chromosomal Alteration and Gene mutation**

Structural changes in chromosome- Deletion, Duplication, Translocation and Inversion. Numerical changes in chromosome- Euploidy, Aneuploidy. Significance of Polyploidy in plants. Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical.

**Unit 4: Plant Breeding and methods of crop improvement:**

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding. Centres of origin and domestication of crop plants, plant genetic resources;

**Unit 5: Crop improvement and breeding**

Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations. Role of biotechnology in crop improvement.

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**405: Genetics and Plant Breeding  
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. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
6. 1. Effect of Mutagens Chemical and Radiation
7. 2. Vegetative propagating method in Plants.
8. 3. Budding - 'T' Budding and Patch Budding.
9. 4. Layering - Pot Layering trench Layering and Goottee Layering.
10. 5. Grafting - Simple Grafting, Single Grafting, double Grafting and Whip Grafting

**Suggested Readings**

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8<sup>th</sup> edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5<sup>th</sup> edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9<sup>th</sup> 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. 10<sup>th</sup> edition.
5. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7<sup>th</sup> edition.
6. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2<sup>nd</sup> edition.
7. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

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

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  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle.
2. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  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 ( $SN_1$ ,  $SN_2$  and  $SN_i$ ) 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.

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**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:  $KNH_2/NH_3$  (or  $NaNH_2/NH_3$ ).
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.  $KMnO_4$ , acidic dichromate, conc.  $HNO_3$ ).
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): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) Preparation: from acid chlorides and from nitriles. Reactions – Reaction with HCN, ROH,  $NaHSO_3$ ,  $NH_2-G$  derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation.

**SUGGESTED READINGS**

1. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988)
4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S. • Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
5. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010. • Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
6. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
7. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009). • Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
8. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

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**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, pickles, 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.

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**Semester-V**

**501: 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); hydrological 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 of India; Local Vegetation.

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**504: Plant Ecology and Phytogeography  
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. 5<sup>th</sup> 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. 8<sup>th</sup> 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. 4<sup>th</sup> edition.

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**Discipline Specific Elective: DSE -1 (502)**

**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.

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## Skill Enhancement Course (SEC-3)

### 503: Nursery and Gardening

Lectures: 48

(Credits 4)

**Unit 1:** Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

**Unit 2:** Seed: Structure and types and dispersal - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing, certification, seed dispersal strategies and Plant Quarantine.

**Unit 3:** Vegetative propagation: Grafting, Budding, Layering their types and methods, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber, shed root, shade house and glass house.

**Unit 4:** Gardening: definition, objectives and scope - different types of gardening - landscape, Bonsai preparation, Vermicomposting and home gardening - parks and its components - plant materials and design - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

**Unit 5:** Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

#### Suggested Readings:

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

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**VI Semester**

**601: 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). Binomial Botanical Nomenclature Principles and rules (ICN); Typification.

**Unit 3: Systems of classification**

Major contributions of Theophrastus, Bauhin, Linnaeus, Adanson, de Candolle and Bessey, Classification systems of Bentham and Hooker, Hutchinson and Engler and Prantle (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

**Unit 4: Biometrics, numerical taxonomy and Phylogeny of Angiosperms**

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences). Brassicaceae, Solanaceae, Asclepiadaceae, Apocynaceae. Origin and evolution of angiosperms.

**Unit 5: Angiospermic Families (Description of Plants)**

Brassicaceae, Solanaceae, Asclepiadaceae, Apocynaceae, Fabaceae, Labiatae, Asteraceae and Poaceae.

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### 603: Plant Systematics 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	-	<i>Ranunculus, Delphinium</i>
Brassicaceae	-	<i>Brassica, Alyssum / Iberis</i>
Myrtaceae	-	<i>Eucalyptus, Callistemon</i>
Umbelliferae	-	<i>Coriandrum /Anethum / Foeniculum</i>
Asclepiadaceae	-	<i>Calotropis procera</i>
Asteraceae	-	<i>Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax</i>
Solanaceae	-	<i>Solanum nigrum/Withania</i>
Lamiaceae	-	<i>Salvia/Ocimum</i>
Euphorbiaceae	-	<i>Euphorbia hirta/ E.milii, Jatropha</i>
Liliaceae	-	<i>Asphodelus/Lilium/Allium</i>
Poaceae	-	<i>Triticum/Hordeum/Avena</i>

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. 3<sup>rd</sup> 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. 2<sup>nd</sup> 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.

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**Discipline Specific Elective: DSE-2-**

**602: 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.

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**Discipline Specific Elective: DSE-3-  
603: 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.

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## VII Semester

### 701: 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); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

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**704: Plant Biotechnology  
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. 5<sup>th</sup> edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5<sup>th</sup> edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

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**Discipline Specific Elective: DSE-4**

**702: 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.

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**703: Research Methodology**  
**(Credits: Theory-4)**  
**THEORY**

**Lectures: 48**

**Unit 1:**

Introduction to research:  
What is research?  
Significance of research  
Research and scientific methods.

**Unit 2:**

Definition of a research problem:  
What is a research problem? How to select and define a research problem?  
Research design:  
Meaning, need, features and types of a research design  
Basic principles of research design  
Hypothesis:  
What is a hypothesis?  
Basic concepts related to testing a hypothesis

**Unit 3:**

Basic statistics:  
Methods of data collection  
Collection of primary and secondary data  
Measure of central tendency  
Measures of dispersion  
Measures of asymmetry  
Measures of relationship  
Simple regression analysis  
Multiple correlation and regression

**Unit 4:**

Scientific writing:  
Introduction to types of scientific documentation  
Abstract, research paper, review, commentary, project report and thesis  
Mechanics of scientific report writing  
The language of science

**Unit 5:**

Presentation:  
Document layout and editing  
Excel: Tabulation and graphical presentation  
PowerPoint  
Computers in research: Introduction

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VIII Semester  
801: 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 Cryptochromes**

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.

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## 803: Plant Physiology

### 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. 4<sup>th</sup> edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

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## 802: Plant Metabolism

(Credits: Theory-4)

### 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<sub>2</sub> reduction, photorespiration, C<sub>4</sub> pathways; Crassulacean acid metabolism; Factors affecting CO<sub>2</sub> 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,  $\beta$ -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination,  $\alpha$  oxidation. Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

*1/2/21*  
*PK*