



YBN UNIVERSITY

Established by the Act of Government of Jharkhand Act 15, 2017

Gazette Notification No. 505, Dated 17th July 2017

As per Section 2(f) of UGC Act. 1956

DEPARTMENT OF BOTANY

Syllabus for Three Years Bachelor Course

BOTANY (Hons.)

(To be implemented from the Academic Year 2020 onwards)

CHOICE BASED CREDIT SYSTEM



APPROVED BY
THE BOARD OF STUDIES
UNIVERSITY DEPARTMENT OF BOTANY
YBN UNIVERSITY, RANCHI (JHARKHAND)

YBN UNIVERSITY

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VISION

- To become a preferred center of academic excellence in the field of business management according to new educational policy.
- To provide value based, research oriented education and facilitate holistic development of future performers, who will contribute in sustainable socio-economic growth of the nation.
- To provide opportunities for students to realize their full potential and thus shape them into national assets.
- To be an institute of academic excellence with total commitment to quality education in commerce and related fields, with a holistic concern for better life, environment and society.
- Doing good for the society by providing quality education and creating responsible citizens for the future.

MISSION

- To provide research based learning with analytical approach.
- To produce future performers as managers & entrepreneurs who will be responsible for the economic and social development of the nation.
- To impart up-to-date knowledge, skills and hands on training through academia-industry linkages.
- Developing social consciousness among students.
- Grooming youth to become a truly global personality well equipped to deal with the modern world and its challenges.

BOTANY PROGRAMME AIMS, OBJECTIVE AND OUTCOME

AIMS:

- 1) To transform curriculum into outcome-oriented scenario.
- 2) To develop the curriculum for fostering discovery-learning.
- 3) To equip the students in solving the practical problems pertinent to India.
- 4) To adopt recent pedagogical trends in education including e-learning, flipped class, hybrid learning and MOOCs.
- 5) To mold responsible citizen for nation-building and transforming the country towards the future.

PROGRAMME OUTCOMES (POs):

PO-1: Critical Thinking: Apply the knowledge of biology to make scientific queries and enhance the comprehension potential.

PO-2: Effective Communication: Successful transfer of scientific knowledge both orally and in writing.

PO-3: Social Interaction: Function as an individual, as a member or a leader to perform a task in class room situation or during field study.

PO-4: Effective Citizenship: Responsible for learning, develop honesty in work and respect for self and others.

PO-5: Ethics: Convey and practice social, environmental and biological ethics.

PO-6: Environment and Sustainability: Insist the significance of conserving a clean environment for perpetuation and sustainable development.

PO-7: Self-directed and Life-long Learning: study incessantly by self to cope with growing competition for higher studies and employment.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO-1: Educate students in and around Jharkhand, a prime area of Tribal belt, about plant science.

PSO-2: Inculcate strong fundamentals on modern and classical aspects of Botany.

PSO-3: Build life skills in Edible & medicinal mushroom cultivation, Bio-fertilizer production, Greenhouse maintenance and Seed technology through value-added courses.

PSO-4: Create platform for higher studies in Botany.

PSO-5: Facilitate students to take-up successful career in Botany.

NATURE AND EXTENT OF THE B.Sc. BOTANY PROGRAMME:

Botany, as traditionally delimited epistemologically, is the broad discipline encompassing various subjects involved with the study of plants. Emphasis has been shifted to modern science at the cost of traditional botany. This shift is discussed at various forums. There is need to balance the traditional botany and upcoming modern computational and applied approach. In view of above, adequate balance of topics is proposed displaying latest APG IV based phylogenetic systematics of plants covering higher plants, lower plants, aquatic (fresh and marine water) plants, nature/ field study, functional aspects of various cellular processes of plants, molecular genetics and modern tools i.e. tissue culture, genetic engineering and computational studies are required to be introduced at undergraduate level.

This modified syllabus has been drafted to enable the students to equip for national level competitive exams that they may attempt in future. To ensure implementation of a holistic pedagogical model, several allied disciplines are covered/introduced in this framework, including Chemistry, Mathematics and a number of generic, and ability enhancement electives. In addition, employability of B.Sc. Botany graduate is given due importance such that their core competency in the subject matter, both theoretical and practical, is ensured. To expand the employability of graduates, a number of skill development courses are also introduced in this framework.

PROGRAMME OBJECTIVES:

The curriculum for the B.Sc. Botany (Hons.) Programme has been designed with an aim of encouraging the broad instructional goals and to support the growing demands and challenging trends in the educational scenario. It targets at providing an environment that encourages, promotes and stimulates the intellectual, professional and personal development of the student. The curriculum caters to the all-round development of the student, rolling out globally ready individuals into the fast pacing world. The specific objectives of the B.Sc. Botany program are as follows:

- Know the importance and scope of the discipline
- Inculcate interest in and love of nature with its myriad living forms
- Develop the ability to work hard and make students fit for society
- Develop skill in practical work, experiments, equipments and laboratory use along with collection and interpretation of biological materials and data
- Make them aware of natural resources and environment and the importance of conserving it.
- Develop the ability for the application of acquired knowledge in various fields of life so as to make our country self-sufficient.
- Appreciate and apply ethical principles to biological science research and studies

TEACHING LEARNING OUTCOMES

The learning outcomes based course curriculum framework of botany is designed to persuade the subject specific knowledge as well as relevant understanding of the course. The academic and professional skills required for botany-based professions and jobs are also offered by same course in an extraordinary way. In addition, the learning experiences gained from this course should be designed and implemented for cognitive development in every student. The practical associated with this course helps to develop an important aspect of the teaching-learning process. Various types of teaching and learning processes will need to be adopted to achieve the same. The important relevant teaching and learning processes involved in this course are:

- Class lectures

- Seminars
- Tutorials
- Group discussions and Workshops
- Peer teaching and learning
- Question preparation
- Subjective type
- Long answer
- Short answer
- Objective type
- Multiple choice questions
- One answer/two answer type questions
- Assertion and reasoning
- Practicum, and project-based learning
- Field-based learning
- Substantial laboratory-based practical component and experiments
- Open-ended project work,
- Games
- Technology-enabled learning
- Internship in industry, and research establishments.

The effective teaching strategies will also need to be adopted to develop problem-solving skills, higher-order skills of reasoning and analysis. The designed course also encourages fostering the social values/responsibility for maintaining and protecting the surrounding environment for improved living conditions. A learner centric and active participatory pedagogy shall be introduced in this framework.

QUALIFICATION DESCRIPTORS (B.Sc. Botany (Honours):

The qualification descriptors for a Bachelor's degree in Botany (Honours) may include following:

- 1) To demonstrate a systematic, extensive and coherent knowledge and understanding of academic fields of study as a whole and its applications and links to disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of Botany;
- 2) To demonstrate procedural knowledge that creates different types of professionals in the field of Botany like in research and development, teaching government and public services e.g. conservationist, plant explorer, ecologist, horticulturist, plant biochemist, genetics, nursery manager, molecular biologist, plant pathologist, taxonomist, farming consultant and environmental consultant. Further application of knowledge can enhance productivity of several economically important product/botanicals. Knowledge of Botany is also necessary for the development and management of forests, parks, wastelands and sea wealth;

- 3) Developing skills and ability to use knowledge efficiently in areas related to specializations and current updates in the subject;
- 4) Demonstrate comprehensive knowledge about plants, current research, scholarly and professional literature of advanced learning areas of Botany;
- 5) Use knowledge understanding and skills for critical assessment of wide range of ideas and problems in the field of Botany;
- 6) Communicate the results of studies in the academic field of Botany using main concepts, constructs and techniques;
- 7) Apply one's knowledge and understanding of Botany to new/unfamiliar contexts and to identify problems and solutions in daily life;
- 8) To think any apply understanding of the subject of plant sciences in identifying the problems which can be solved through the use of plants;
- 9) To think of the adopting expertise in plant structure, functions and solve the problems of environment, ecology, sustainable development, hunger;

DISTRIBUTION OF DIFFERENT TYPES OF COURSES WITH THEIR CREDITS FOR B.Sc. BOTANY (Honors):

Semester	Core Courses (CC) Note: 12 CC are available. All courses are compulsory Practical=12 4 credits each	Ability Enhancement Electives (AEC) (2x2=04) Note: 10 AEC are available. Choose any 2 2 credits each	Skill Enhancement Electives (SEC) (2x2=04) Note: 10 SEC are available. Choose any 2 2 credits each	Discipline Specific Elective (DSE) (4x4=16) Note: 10 DSE are available. Choose any 4 Practical= 4 4 credits each	Generic Elective (GEC) (4x4=16) Note: 10 GEC are available. Choose any 4 4 credits each	Seminar/ Project/ group discussion 1-credit each	Credit hour load
1	CC-I CC-II	AEC			GEC		25
2	CC-III CC-IV	AEC			GEC		25
3	CC-V CC-VI		SEC		GEC		25
4	CC-VII CC-VIII		SEC		GEC		25
5	CC-X CC-X			DSE		SMR	24
6	CC-XI CC-XII			DSE		SMR	24
Credits	48 + 24 (P)= 72	04	04	16+08(P)= 24	16	02	122
% Courses	48.68						

YBN UNIVERSITY, RANCHI (JHARKHAND)
UNIVERSITY DEPARTMENT OF BOTANY

COURSE STRUCTURE OF B.Sc. BOTANY HONS. FIRST SEMESTER													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject-wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3BOT101	Ability Enhancement Compulsory Course	English Communications-I/Environmental Science-I	100	50	17	20	07	30	10	2	-	-	2
1Y3BOT102	Core Course-I	Phycology and Microbiology	70	50	17	-	-	20	07	4	-	-	4
1Y3BOT102P	Core Course-I Practical	Phycology and Microbiology Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3BOT103	Core Course-II	Biomolecules and Cell Biology	70	50	17	-	-	20	07	4	-	-	4
1Y3BOT103P	Core Course-II Practical	Biomolecules and Cell Biology-Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3BOT104	Generic Elective-I	Generic Elective-I	70	50	17	-	-	20	07	4	-	-	4
1Y3BOT104P	Generic Elective-I Practical	Generic Elective-I Lab	30	30	10	-	-	-	-	-	-	2	2
	Grand Total		400										20

COURSE STRUCTURE OF B.Sc. BOTANY HONS. SECOND SEMESTER													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject-wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3 BOT 201	Ability Enhancement Compulsory Course	English Communications-II/Environmental Science-II	100	50	17	20	07	30	-	2	-	-	2
1Y3 BOT 202	Core Course-III	Mycology and Plant Pathology	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 202P	Core Course-III Practical	Mycology and Plant Pathology Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 203	Core Course-IV	Gymnosperms & Palaeobotany	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 203P	Core Course-IV Practical	Gymnosperms & Palaeobotany Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT	Generic Elective-II	Generic Elective-II	70	50	17	-	-	20	07	4	-	-	4

1Y3BOT204P	Generic Elective-II Practical	Generic Elective-II Lab	30	30	10	-	-	-	-	-	-	2	2
	Grand Total		400										20

COURSE STRUCTURE OF B.Sc. BOTANY HONS. THIRD SEMESTER

Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject-wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3 BOT 301	Core Course-V	Plant Systematics	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 301P	Core Course-V Practical	Plant Systematics - Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 302	Core Course-VI	Economic Botany	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 302P	Core Course-VI Practical	Economic Botany- Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 303	Core Course-VII	Genetics	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 303P	Core Course-VII Practical	Genetics-Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 304	Skill Enhancement Course-1	Skill Enhancement Course-1	70	50	17	-	-	20	-	1	-	-	1
1Y3 BOT 304P	Skill Enhancement Course-1 Practical	Skill Enhancement Course-1 Lab	30	30	10	-	-	-	-	-	-	1	1
1Y3 BOT 305	Generic Elective-III	Generic Elective-III	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 305P	Generic Elective-III Practical	Generic Elective-III- Lab	30	30	10	-	-	20	07	-	-	2	2
	Grand Total		500										26

COURSE STRUCTURE OF B.Sc. BOTANY HONS.FOURTH SEMESTER

Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject-wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3 BOT 401	Core Course-VIII	Molecular Biology	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 401P	Core Course-VIII Practical	Molecular Biology-Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 402	Core Course-IX	Plant Ecology & Phytogeography	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 402P	Core Course-IX Practical	Plant Ecology & Phytogeography - Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 403	Core Course-X	Plant Embryology	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 403P	Core Course-X Practical	Plant Embryology-Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 404	Skill	Skill Enhancement	70	50	17	-	-	20	-	1	-	-	1

	Enhancement Course-2	Course-2												
1Y3 BOT 404P	Skill Enhancement Course-2 Practical	Skill Enhancement Course-2 Practical	30	30	10	-	-	-	-	-	-	-	1	1
1Y3 BOT 405	Generic Elective-IV	Generic Elective-IV	70	50	17	-	-	20	07	4	-	-	4	
1Y3 BOT 405P	Generic Elective-IV Practical	Generic Elective-IV-P	30	30	10	-	-	20	07	-	-	-	2	2
	Grand Total		500											26

COURSE STRUCTURE OF B.Sc. BOTANY HONS.FIFTH SEMESTER

Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject-wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3 BOT 501	Core Course-XI	Plant Anatomy	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 501P	Core Course-XI Practical	Plant Anatomy-Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 502	Core Course-XII	Plant Physiology & Biochemistry	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 502P	Core Course-XII Practical	Plant Physiology & Biochemistry-Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 503	Discipline Specific Elective-1	DSE-I	70	50	17	-	-	20	07	4	-	-	4
1Y3 BOT 503P	Discipline Specific Elective-1 Practical	DSE-I Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 BOT 504	Discipline Specific Elective-2	DSE-II	70	50	17	-	-	20	-	4	-	-	4
1Y3 BOT 504P	Discipline Specific Elective-2 Practical	DSE-II Lab	30	30	10	-	-	-	-	-	-	2	2
	Grand Total		400										24

COURSE STRUCTURE OF B.Sc. BOTANY HONS. SIXTH SEMESTER

Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject-wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y3 BOT 601	Core Course-XIII	Plant Biotechnology	70	50	17	-	-	20	07	4	-	-	4

1Y3 601P	BOT	Core Course-XIII Practical	Plant Biotechnology-Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 602	BOT	Core Course-XIV	Plant Breeding & Melissopalynology	70	50	17	-	-	20	07	4	-	-	4
1Y3 602P	BOT	Core Course-XIV Practical	Plant Breeding & Melissopalynology- Lab	30	30	10	-	-	-	-	-	-	2	2
1Y3 603	BOT	Discipline Specific Elective-3	DSE-III	70	50	17	-	-	20	07	4	-	-	4
1Y3 603P	BOT	Discipline Specific Elective-3 Practical	DSE-III Practical	30	30	10	-	-	-	-	-	-	2	2
1Y3 604	BOT	Discipline Specific Elective-4	DSE-IV	70	50	17	-	-	20	-	4	-	-	4
1Y3 604P	BOT	Discipline Specific Elective-4 Practical	DSE-IV Practical	30	30	10	-	-	-	-	-	-	2	2
		Grand Total		400										24

Minimum Passing Marks are equivalent to Grade D

Lectures T- Tutorials P- Practical, Major- Term End Theory Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

Discipline Specific Elective Papers: (Credits: 06 each) (4 papers to be selected) DSE 1 -4

- 1) Horticultural Practices and Post-Harvest Technology (4)+ Lab (2)
- 2) Analytical Techniques in Plant Sciences (4) + Lab(2)
- 3) Research Methodology (4) + Lab (2)
- 4) Bioinformatics (4) + Lab (2)
- 5) Plant Breeding (4) + Lab (2)
- 6) Stress Biology (4) + Lab (2)
- 7) Natural Resource Management (4) + Lab (2)

YBN UNIVERSITY- RANCHI (JHARKHAND)

**CHOICE BASED CREDIT SYSTEM
B.Sc. BOTANY HONOURS**

Semester-I

Core Course I: Phycology and Microbiology (Credits: Theory-4, Practical-2)

THEORY (Lectures: 60)

Unit 1: Introduction to microbial world

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

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). (7 lectures)

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). (7 lectures)

Unit 4: Algae

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar). Role of algae in the environment, agriculture, biotechnology and industry. (11 lectures)

Unit 5: Cyanophyta and Xanthophyta

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria*. (8 lectures)

Unit 6: Chlorophyta and Charophyta

General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction.

Morphology and life-cycles of *Chlamydomonas*, *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*. Evolutionary significance of *Prochloron*. (8 lectures)

Unit 7: Phaeophyta and Rhodophyta

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia*. (12 lectures)

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*, *Prochloron* 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 R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. 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: 60

Unit 1: Biomolecules (20 lectures)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers. **Carbohydrates:** Nomenclature and classification; Monosaccharides ; Disaccharides; Oligosaccharides and polysaccharides.

Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.

Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

Unit 2: Bioenergetics (4 lectures)

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

Unit 3: Enzymes (6 lectures)

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

Unit 4: The cell (4 lectures)

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

Unit 5: Cell wall and plasma membrane (4 lectures)

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

Unit 6: Cell organelles (16 lectures)

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 and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

Unit 7: Cell division (6 lectures)

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. Cytochemical staining of : DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study the effect of organic solvent and temperature on membrane permeability.
10. Study different stages of mitosis and meiosis.

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.17
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: 60

Unit 1: Introduction to true fungi (6 lectures)

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.

Unit 2: Chytridiomycota and Zygomycota (5 lecture)

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

Unit 4: Ascomycota (10 lectures)

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 5: Basidiomycota (8 lectures)

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 6: Allied Fungi (3 lectures)

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

Unit 7: Oomycota (4 lectures)

General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora*, *Albugo*.

Unit 8: Symbiotic associations (4 lectures)

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

Unit 8: Applied Mycology (10 Lectures)

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

Unit 9: Phytopathology (10 lectures)

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.

Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

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 Sexualstage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria*: Specimens/photographs and temporary mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust o f 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 endo mycorrhiza (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: 60

Unit 1: Introduction (4 lectures)

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

Unit 2: Bryophytes (6 lectures)

General characteristics; Adaptations to land habit; Classification; Range of thallus organization.

Unit 3: Type Studies- Bryophytes (12 lectures)

Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Marchantia*, *Pellia*, *Porella*, *Anthoceros*, *Sphagnum* and *Funaria*; Reproduction and evolutionary trends in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria* (developmental stages not included). Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit 4: Pteridophytes (6 lectures)

General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

Unit 5: Type Studies- Pteridophytes (14 lectures)

Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance.

Unit 6: Gymnosperms (18 lectures)

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

Practical

1. *Riccia* – Morphology of thallus.
2. *Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. *Anthoceros*- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. *Pellia*, *Porella*- Permanent slides.
5. *Sphagnum*- Morphology of plant, whole mount of leaf (permanent slide only).

6. *Funaria*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
7. *Psilotum*- Study of specimen, transverse section of synangium (permanent slide).
8. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
9. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
11. *Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
12. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
13. *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
14. **Botanical excursion.**

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: 60

Unit 1: Introduction and scope of Plant Anatomy (4 Lectures)

Applications in systematics, forensics and pharmacognosy.

Unit 2: Structure and Development of Plant Body (6 Lectures)

Internal organization of plant body: The three tissue systems, types of cells and tissues.

Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Unit 3: Tissues (12 Lectures)

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

Unit 4: Apical meristems (15 Lectures)

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

Unit 4: Vascular Cambium and Wood (15 Lectures)

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

Unit 5: Adaptive and Protective Systems (8 Lectures)

Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni- and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; 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. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non- glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

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.

Core Course VI: Economic Botany

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Origin of Cultivated Plants (6 lectures)

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 (6 lectures)

Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

Unit 3: Legumes (6 lectures)

Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Unit 4: Sources of sugars and starches (4 lectures)

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 5: Spices (6 lectures)

Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper

Unit 6: Beverages (4 lectures)

Tea, Coffee (morphology, processing & uses)

Unit 7: Sources of oils and fats (10 lectures)

General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

Unit 8: Natural Rubber (3 lectures)

Para-rubber: tapping, processing and uses.

Unit 9: Drug-yielding plants (8 lectures)

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

Unit 10: Timber plants (3 Lectures)

General account with special reference to teak and pine.

Unit 11: Fibers (4 lectures)

Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).

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. **Fibe r-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: 60

Unit 1: Mendelian genetics and its extension (16 lectures)

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

Unit 2: Extrachromosomal Inheritance (6 lectures)

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 (12 lectures)

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: Variation in chromosome number and structure (8 lectures)

Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Unit 5: Gene mutations (6 lectures)

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms.

Unit 6: Fine structure of gene (6 lectures)

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

Unit 6. Population and Evolutionary Genetics (6 lectures)

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

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)

Lectures: 60

Unit 1: Nucleic acids : Carriers of genetic information (4 lectures)

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment).

Unit 2. The Structures of DNA and RNA / Genetic Material (10 lectures)

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. The Nucleosome_Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit 3: The replication of DNA (10 lectures)

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative 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 4: Central dogma and genetic code (2 lectures)

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

Unit 5: Transcription (18 lectures)

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

Unit 6: Processing and modification of RNA (8 lectures)

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' polyA tail); Ribozymes; RNA editing and mRNA transport.

Unit 6: Translation (8 lectures)

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.

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: 60

Unit 1: Introduction (4 lectures)

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

Unit 2: Soil (8 lectures)

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

Unit 3: Water (4 lectures)

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

Unit 4: Light, temperature, wind and fire (6 lectures)

Variations; adaptations of plants to their variation.

Unit 5: Biotic interactions (2 lectures)

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

Unit 6: Population ecology (4 lectures)

Characteristics and Dynamics .Ecological Speciation

Unit 7: Plant communities (8 lectures)

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

Unit 8: Ecosystems (4 lectures)

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Unit 9: Functional aspects of ecosystem (8 lectures)

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

Unit 10: Phytogeography (12 lectures)

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.

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

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: 60

Unit 1: Significance of Plant systematics (12 lectures)

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

Unit 2: Taxonomic hierarchy (6 lectures)

Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Unit 3: Botanical nomenclature (10 lectures)

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 4: Systems of classification (12 lectures)

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

Unit 5: Biometrics, numerical taxonomy and cladistics (10 lectures)

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

Unit 6: Phylogeny of Angiosperms (12 lectures)

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* 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: 60

Unit 1: Introduction (4 lectures)

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.

Unit 2: Reproductive development (6 lectures)

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

Unit 3: Anther and pollen biology (10 lectures)

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 4: Ovule (10 lectures)

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.

Unit 5: Pollination and fertilization (6 lectures)

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

Unit 6: Self incompatibility (10 lectures)

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 7: Embryo, Endosperm and Seed (10 lectures)

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

Units 8: Polyembryony and apomixis (6 lectures)

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. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

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

THEORY

Lectures: 60

Unit 1: Plant-water relations (10 lectures)

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 (8 lectures)

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.

Unit 3: Nutrient Uptake (8 lectures)

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

Unit 4: Translocation in the phloem (8 lectures)

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

Unit 5: Plant growth regulators (14 lectures)

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

Unit 6: Physiology of flowering (6 lectures)

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Unit 7: Phytochrome , cryptochromes and phototropins (6 lectures)

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* coleoptile 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: 60

Unit 1: Concept of metabolism (6 lectures)

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

Unit 2: Carbon assimilation (14 lectures)

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

Unit 3: Carbohydrate metabolism (2 lectures)

Synthesis and catabolism of sucrose and starch.

Unit 4: Carbon Oxidation (10 lectures)

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.

Unit 5: ATP-Synthesis (8 lectures)

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.

Unit 6: Lipid metabolism (8 lectures)

Synthesis and breakdown of triglycerides, β -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

Unit 7: Nitrogen metabolism (8 lectures)

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

Unit 8: Mechanisms of signal transduction (4 lectures) Receptor- ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

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: 60

Unit 1: Plant Tissue Culture (16 lectures)

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 (12 lectures)

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 (10 lectures)

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 (8 lectures)

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 (14 lectures)

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.

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

Analytical Techniques in Plant Sciences

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Imaging and related techniques (15 lectures)

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

Unit 2: Cell fractionation (8 lectures)

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

Unit 3: Radioisotopes (4 lectures)

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

Unit 4: Spectrophotometry (4 lectures) Principle and its application in biological research.

Unit 5: Chromatography (8 lectures)

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

Unit 6: Characterization of proteins and nucleic acids (6 lectures)

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

Unit 7: Biostatistics (15 lectures)

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

Practical

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.

9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

Suggested Readings

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
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.

Bioinformatics

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1. Introduction to Bioinformatics (5 Lectures)

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2. Databases in Bioinformatics (5 Lectures)

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3. Biological Sequence Databases (25 Lectures)

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database

Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.

EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.

DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

Unit 4. Sequence Alignments (10 Lectures)

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5. Molecular Phylogeny (8 Lectures)

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 6. Applications of Bioinformatics (7 Lectures)

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

Practical

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Horticultural Practices and Post-Harvest Technology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Introduction (4 lectures)

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

Unit 2: Ornamental plants (4 lectures)

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coraltree).

Unit 3: Fruit and vegetable crops (4 lectures)

Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

Unit 4: Horticultural techniques (8 lectures)

Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

Unit 5: Landscaping and garden design (6 lectures)

Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

Unit 6: Floriculture (6 lectures)

Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.

Unit 7: Post-harvest technology (10 lectures)

Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.

Unit 8: Disease control and management (8 lectures)

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices; Identification of common diseases and pests of ornamentals, fruits and vegetable crops.

Unit 9: Horticultural crops - conservation and management (10 lectures)

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

Unit 10: Field trip

Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at suitable locations.

Suggested Readings

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

Research Methodology

Credit: Theory 4; Practical 2

Lectures: 60

Theory

Unit 1: Basic concepts of research (10 lectures)

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

Unit 2: General laboratory practices (12 lectures)

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

Unit 3: Data collection and documentation of observations (6 lectures)

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photo graphy.

Unit 4: Overview of Biological Problems (6 lectures)

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

Unit 5: Methods to study plant cell/tissue structure (6 lectures)

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

Unit 6: Plant microtechniques (12 lectures)

Staining procedures, classification and chemistry of stains. Staining equipment. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags).

Cytogenetic techniques with squashed plant materials.

Unit 7: The art of scientific writing and its presentation (8 lectures)

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practical

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

Suggested Readings

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

Discipline Specific Elective

Stress Biology

Credits: Theory 4, Practical 2

Lectures:60

Theory

Unit 1: Defining plant stress (2 lectures)

Acclimation and adaptation.

Unit 2: Environmental factors (20 lectures)

Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Unit 3: Stress sensing mechanisms in plants (20 lectures)

Calcium modulation, Phospholipid signaling

Unit 2: Developmental and physiological mechanisms that protect plants against environmental stress (12 lectures)

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

Unit 3: Reactive oxygen species–Production and scavenging mechanisms. (6 lectures) Practical

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

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.

Discipline Specific Elective
Plant Breeding
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Plant Breeding (10 lectures)

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 (20 lectures)

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 (10 lectures)

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 (10 lectures)

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

Unit 5: Crop improvement and breeding (10 lectures)

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

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. Acquah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

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

THEORY

Lectures: 60

Unit 1: Natural resources (2 lectures)

Definition and types.

Unit 2: Sustainable utilization (8 lectures)

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

Unit 3: Land (8 lectures)

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4: Water (8 lectures)

Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands;

Threats and management strategies.

Unit 5: Biological Resources (12 lectures)

Biodiversity-definition and types; Significance; Threats; Management strategies;

Bioprospecting;

IPR; CBD; National Biodiversity Action Plan).

Unit 6: Forests (6 lectures)

Definition, Cover and its significance (with special reference to India); Major and minor forestproducts; Depletion; Management.

Unit 7: Energy (6 lectures)

Renewable and non-renewable sources of energy

Unit 8: Contemporary practices in resource management (8 lectures)

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

Unit 9: National and international efforts in resource management and conservation (4 lectures)

Practical

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

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.

Generic Elective

Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Microbes (10 lectures)

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 (12 lectures)

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

Unit 3: Fungi (12 lectures)

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 (2 lectures)

Unifying features of archegoniate, Transition to land habit, Alternation of generations.

Unit 5: Bryophytes (10 lectures)

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 6: Pteridophytes (8 lectures)

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

Unit 7: Gymnosperms (6 lectures)

General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included). Ecological and economical importance.

Practical

5. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
6. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
7. Gram staining
8. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus** and *Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)
9. *Rhizopus* and *Penicillium* : Asexual stage from temporary mounts and sexual structures through permanent slides.
10. *Alternaria*: Specimens/photographs and tease mounts.
11. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
12. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
13. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
14. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
15. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
16. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
17. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
18. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry) (temporary slides); t.s. rhizome (permanent slide).
19. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
20. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
21. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

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.

Plant Ecology and Taxonomy

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Introduction (2 lectures)

Unit 2: Ecological factors (10 lectures)

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

Unit 3: Plant communities (6 lectures)

Characters; Ecotone and edge effect; Succession; Processes and types

Unit 4: Ecosystem (8 lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5: Phytogeography (4 lectures)

Principle biogeographical zones; Endemism

Unit 6 Introduction to plant taxonomy (2 lectures)

Identification, Classification, Nomenclature.

Unit 7 Identification (4 lectures)

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

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. (6 lectures)

Unit 9 Taxonomic hierarchy (2 lectures)

Ranks, categories and taxonomic groups

Unit 10 Botanical nomenclature (6 lectures)

Principles and rules (ICN); ranks and names; binominal system, typification, author citation,

valid publication, rejection of names, principle of priority and its limitations.

Unit 11 Classification (6 lectures)

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Unit 12 Biometrics, numerical taxonomy and cladistics (4 lectures)

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

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, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. 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): Brassicaceae - *Brassica*, *Alyssum* / *Iberis*; Asteraceae - *Sonchus*/*Launaea*, *Vernonia*/*Ageratum*, *Eclipta*/*Tridax*; Solanaceae - *Solanum nigrum*, *Withania*; Lamiaceae - *Salvia*, *Ocimum*; Liliaceae - *Asphodelus* / *Lilium* / *Allium*.
8. 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. 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.

Plant Anatomy and Embryology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Meristematic and permanent tissues (8 lectures) Root and shoot apical meristems; Simple and complex tissues

Unit 2: Organs (4 lectures)
Structure of dicot and monocot root stem and leaf.

Unit 3: Secondary Growth (8 lectures)
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)

Unit 4: Adaptive and protective systems (8 lectures)
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5: Structural organization of flower (8 lectures)
Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 6: Pollination and fertilization (8 lectures)
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7: Embryo and endosperm (8 lectures)
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship

Unit 8: Apomixis and polyembryony (8 lectures)
Definition, types and Practical applications

Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circumscissile, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.

11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

1. Bhojwani, S. S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Plant Physiology and Metabolism

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Plant-water relations (8 lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2: Mineral nutrition (8 lectures)

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Translocation in phloem. (6 lectures)

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

Unit 4: Photosynthesis (12 lectures)

Photosynthetic pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C₃, C₄ and CAM pathways of carbon fixation; Photorespiration.

Unit 5: Respiration (6 lectures)

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6: Enzymes (4 lectures)

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Nitrogen metabolism (4 lectures)

Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8: Plant growth regulators (6 lectures)

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Unit 9: Plant response to light and temperature (6 lectures)

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

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Practical

1. Determination of osmotic potential of plant cell sap by plasmolytic method.

2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings

3. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

1. Hopkins, W. G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

2. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Economic Botany and Plant Biotechnology

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Unit 1: Origin of Cultivated Plants (4 lectures)

Concept of centres of origin, their importance with reference to Vavilov's work.

Unit 2: Cereals (4 lectures)

Wheat -Origin, morphology, uses

Unit 3: Legumes (6 lectures)

General account with special reference to Gram and soybean

Unit 4: Spices (6 lectures)

General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

Unit 5: Beverages (4 lectures)

Tea (morphology, processing, uses)

Unit 6: Oils and Fats (4 lectures)

General description with special reference to groundnut

Unit 7: Fibre Yielding Plants (4 lectures)

General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 8: Introduction to biotechnology (2 lecture)

Unit 9: Plant tissue culture (8 lectures)

Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications

Unit 10: Recombinant DNA Techniques (18 lectures)

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP , SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Practical

1. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Suggested Readings

1. Kochhar, S. L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd. , New Delhi. 4th edition.
2. Bhojwani, S. S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R. , Pasternak, J.J. (2003). Molecular Biotechnology - Principles and Applications of recombinant DNA. ASM Press, Washington.

Skill Enhancement Course

Biofertilizers

(Credits 2)

Lectures: 30

Unit 1: General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis. **(4 lectures)**

Unit 2: *Azospirillum*: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication. **(8 lectures)**

Unit 3: Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation. **(4 lectures)**

Unit 4: Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants. **(8 lectures)**

Unit 5: Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. **(6 lectures)**

Suggested Readings

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

Mushroom Culture Technology

(Credits 2)

Lectures: 30_

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*. (5 Lectures)

Unit 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. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production. (12 Lectures)

Unit 3: Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins. (8 Lectures)

Unit 4: Food Preparation_ :Types of foods prepared from mushroom. Research Centres - National level and Regional level._ Cost benefit ratio - Marketing in India and abroad, Export Value. (5 lectures)

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.