Rajiv Gandhi University

Course Curriculum for

B.Sc. (Honours) in Botany

Three Year Undergraduate Degree Course

(Effective from Academic Session 2021-22 onwards)

(Framed as per Learning Outcomes based Curriculum with Choice Based Credit System)

05/7/2021
संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

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Preamble

The higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects learning outcome based curriculum in order to maximize the benefits of the newly designed curriculum. The Learning Outcome Based Curriculum in general and in Botany in particular will definitely help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. It is pertinent to mention here that the purpose of education is to develop an integrated personality of the individual and the educational system provides all knowledge and skills to the learner for this.

The syllabus developed for B. Sc. (H) in Botany has the provision of ensuring the integrated personality of the students in terms of providing opportunity for exposure to the students towards Core Courses, Discipline Specific Courses, Generic Elective Courses, Ability Enhancement Courses and Skill Enhancement Courses with special focus on technical, communication and subject specific skills through practical and other innovative transactional modes to develop their employability skills.

The syllabus is based on Learning Outcome Based Curriculum and has categorically mentioned very well defined expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness and so on along with very specific learning course outcomes at the starting of each course.

Choice based credit system (CBCS) in B.Sc. (Honours) Botany

Under the credit-based semester system, the requirement for awarding and conferring a degree is prescribed in terms of number of credits to be completed by the students. The CBCS provides choice for students to select courses from a pool of Elective and Ability enhancement courses offered in other subjects. The learning outcome-based curriculum framework (LOCF) offers a flexibility and innovation in design of the programme, its assessment, and expects graduate attributes demonstrating the level of learning outcome. It is further expected to provide effective teaching-learning strategies including periodic review of the programme and its academic standard. The LOCF based programme will ensure that students get a clear purpose to focus their learning efforts and enable them to make a well-judged choice regarding the course they wish to study. This will enable the students to build a strong foundation in the subject and gain in-depth knowledge that suit the present day needs of students in terms of securing their paths towards higher studies or employment. It would also ensure equal academic standards across the country and broader picture of their competencies.

Nature and extent of the B.Sc. (Hons.) in Botany Programme

Botany is a broad discipline encompassing various subjects involved with the study of plants. B.Sc. (Hons.) in Botany programme is designed to provide students with a sound theoretical background and practical training in all aspects of botany and help them develop an appreciation of the importance of botany in different contexts. To ensure implementation of a holistic pedagogical model, a number of choices for Generic electives from allied disciplines like Chemistry, Zoology, Geology, have been included in this framework In addition, considering the employability aspect of B.Sc. Botany graduates, due importance has been given towards their core competency in the subject matter, both theoretical and practical. To expand the employability of graduates, certain Ability enhancement electives to develop language proficiency and many Skill bases elective courses from

relevant disciplines like Chemistry, Zoology, Geology, Mathematics and Computer Science have been introduced. The syllabus will also enable the students to equip for national level competitive exams that they may attempt in future.

Aims of B.Sc. (Hons.) in Botany Programme

The broad aims of bachelor's degree programme in Botany are:

- To provide an environment that ensures cognitive development of students in a holistic manner. A dialogue about plants and its significance is fostered in this framework, rather than didactic monologues on mere theoretical aspects.
- To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A botany graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
- To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.
- To enable the graduate prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

Program Learning Outcomes

The student graduating with the Degree B.Sc. (Honours) Botany should be able to acquire:

- Core competency: Students will acquire core competency in the subject Botany, and in allied subject areas.
- The student will be able to identify major groups of plants and compare the characteristics of lower (e.g. algae and fungi) and higher (angiosperms and gymnosperms) plants.
- Students will be able to use the evidence based comparative botany approach to explain the evolution of organism and understand the genetic diversity on the earth.
- The students will be able to explain various plant processes and functions, metabolism, concepts of gene, genome and how organism's function is influenced at the cell, tissue and organ level.
- Students will be able to understand adaptation, development and behaviour of different forms of life.
- The understanding of networked life on earth and tracing the energy pyramids through nutrient flow is expected from the students.
- Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Botany.
- Analytical ability: The students will be able to demonstrate the knowledge in understanding research and addressing practical problems.
- Application of various scientific methods to address different questions by formulating the hypothesis, data collection and critically analyse the data to decipher the degree to which their scientific work supports their hypothesis.
- Critical Thinking and problem solving ability: An increased understanding of fundamental concepts and their applications of scientific principles is expected at the end of this course. Students will become critical thinker and acquire problem solving capabilities.

- Digitally equipped: Students will acquire digital skills and integrate the fundamental concepts with modern tools.
- Ethical and Psychological strengthening: Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses.
- Team Player: Students will learn team workmanship in order to serve efficiently institutions, industry and society.
- Independent Learner: Apart from the subject specific skills, generic skills, especially in Botany, the program outcome would lead to gain knowledge and skills for further higher studies, competitive examinations and employment.

Duration of Programme: Six semesters (Three years).

Programme Structure

1. The syllabi for B.Sc. (Honours) in Botany is drafted as per the UGC guidelines for Learning Outcomes based Curriculum Framework (LOCF) based approach with an aim to equip the students with knowledge, skill, values and attitude.
2. Usually a course refers to a 'paper' and is a component of an academic programme.
3. The programmes includes:
   (A) *Core Courses*: A core course is a compulsory paper to be studied by all the students to complete the requirements for the undergraduate degree.
   (B) *Elective Courses*: Elective course is a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.
   (a) Discipline Specific Elective (DSE) Courses: It shall be supportive to the discipline of study, providing an expanded scope, enabling an exposure to some other discipline/domain, and nurturing student's proficiency/skill.
   (b) Generic Elective (GE) Course: An elective course chosen generally from other discipline(s)/subject(s), with an intention to seek exposure is called a Generic Elective.
   (c) *Ability Enhancement Courses*: The Ability Enhancement Courses may be of two kinds:
      (i) *Ability Enhancement Compulsory (AEC) Courses*: The courses which lead to knowledge enhancement. These courses are mandatory.
      (ii) *Skill Enhancement Courses (SEC)*: These courses are skill-based and/or value-based and aimed at providing hands-on-training, competencies, skills, etc. These courses are mandatory and shall be chosen from a pool of such courses prescribed in the syllabi of various Science and Technology related disciplines/Subjects available in the College/University.
4. To acquire a B.Sc. (H.) Botany degree, a student shall have to study 14 (fourteen) Core Courses, 4 (four) Discipline Specific Elective (DSE) courses, 4 (four) Generic Elective (GE) courses, 4 (four) Skill Enhancement Courses (SEC) along with 2 (two) Ability Enhancement Compulsory (AEC) Courses (Refer to the Table 1).

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Table 1: Course structure for B.Sc. (Hons.) in Botany

Semester	Core Courses (CC)	Elective Courses				Semester wise credits
		DSE	GE	AEC	SEC	
I	CC 1, CC 2	-	GE 1	AEC 1	SEC 1	24
II	CC 3, CC 4	-	GE 2	AEC 2	SEC 2	24
III	CC 5, CC 6, CC 7	-	GE 3	-	SEC 3	26
IV	CC 8, CC 9, CC 10	-	GE 4	-	SEC 4	26
V	CC 11, CC 12	DSE 1 DSE 2	-	-	-	24
VI	CC 13, CC 14	DSE 3 DSE 4	-	-	-	24
Total Minimum Credits	**84**	**24**	**24**	**8**	**8**	**148**

5. The minimum and the maximum credit requirements for the B.Sc. (H.) Botany degree shall be 148 and 160 respectively. Students may pursue courses for additional 12 credits on their own (Refer to "RAJIV GANDHI UNIVERSITY REGULATIONS FOR CHOICE BASED CREDIT SYSTEM FOR UNDER-GRADUATE COURSES, 2021").

6. Semester-wise distribution of courses for B.SC. (Hons.) in Botany programme under CBCS and the Credit Distribution shall be as follows:

Semester	Course Code	Course Name	Credits			
			L	T	P	Total
I	BOT-CC-111	Phycology and Microbiology	4	0	2	6
	BOT-CC-112	Biomolecules and Cell Biology	4	0	2	6
	XXX-AE-111	Ability Enhancement Compulsory Course (AEC)-1 (ENG-AE-111 OR HIN-AE-111)	4	0	0	4
	XXX-SE-xxx	Skill Enhancement Course (SEC)-1	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-1)	-	-	-	6
II	BOT-CC-121	Mycology and Phytopathology	4	0	2	6
	BOT-CC-122	Archegoniate: Bryophytes, Pteridophytes, Gymnosperms	4	0	2	6
	EVS-AE-121	Ability Enhancement Compulsory Course (AEC)-2	4	0	0	4
	XXX-SE-xxx	Skill Enhancement Course (SEC)-2	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-2)	-	-	-	6
III	BOT-CC-231	Anatomy of Angiosperm	4	0	2	6
	BOT-CC-232	Economic Botany and Plant Resource Utilization	4	0	2	6
	BOT-CC-233	Genetics and Cytogenetics	4	0	2	6
	XXX-SE-xxx	Skill Enhancement Course (SEC-3)	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-3)	-	-	-	6
IV	BOT-CC-241	Molecular Biology	4	0	2	6
	BOT-CC-242	Plant Ecology and Phytogeography	4	0	2	6
	BOT-CC-243	Plant Systematics	4	0	2	6
	XXX-SE-xxx	Skill Enhancement Course (SEC-4)	-	-	-	2
	XXX-GE-xxx	Generic Elective (GE-4)	-	-	-	6

V	BOT-CC-351	Plant Physiology	4	0	2	6
	BOT-CC-352	Reproductive Biology of Angiosperms	4	0	2	6
	BOT-DE-35X	Discipline Specific Elective (DSE-1)	4	0	2	6
	BOT-DE-35Y	Discipline Specific Elective (DSE-2)	4	0	2	6
VI	BOT-CC-361	Plant Metabolism	4	0	2	6
	BOT-CC-362	Plant Biotechnology and Genetic Engineering	4	0	2	6
	BOT-DE-36X	Discipline Specific Elective (DSE-3)	4	0	2	6
	BOT-DE-36Y	Discipline Specific Elective/Project Work (Dissertation) (DSE-4)	4	0	2	6

Note: The number of credits is given above is in the form L:T:P, where L, T and P indicate Lecture, Tutorial and Practical laboratory credits respectively. Each lecture credit corresponds to one lecture hour per week, each tutorial credit corresponds to one tutorial hour per week while each laboratory credit corresponds to two laboratory hours per week. For example, 4:0:2 credits indicate that the course has 4 lectures, no tutorial session and two laboratory hours each week.

7. Selection of the following Elective courses shall be governed by "RAJIV GANDHI UNIVERSITY REGULATIONS FOR CHOICE BASED CREDIT SYSTEM FOR UNDER-GRADUATE COURSES, 2021" and students should refer to the provisions mentioned therein.

Discipline Specific Electives (DSE)

Semester	Course Code	Course Name	Credits			
			L	T	P	Total
V (DSE-1 & DSE-2)	BOT-DE-351	Research Methodology	4	0	2	6
	BOT-DE-352	Biostatistics	4	0	2	6
	BOT-DE-353	Forest Ecology	4	0	2	6
	BOT-DE-354	Spices and Culinary Herbs	4	0	2	6
	BOT-DE-355	Horticultural Practices	4	0	2	6
	BOT-DE-356	Horticultural Post-Harvest Practices	4	0	2	6
VI (DSE-3 & DSE-4)	BOT-DE-361	Pomology	4	0	2	6
	BOT-DE-362	Applied Microbiology	4	0	2	6
	BOT-DE-363	Plant Pathology	4	0	2	6
	BOT-DE-364	Bioanalytical Techniques	4	0	2	6
	BOT-DE-369	Project Work (Dissertation)	0	0	6	6
The students shall select 2 DSE each in V and VI semester. Student may opt for Project Work (Dissertation) in lieu of a DSE paper in VI semester (Refer to the above mentioned regulation).						

Ability Enhancement Compulsory Courses (AEC)

Semester	Course Code	Course Name	Credits			
			L	T	P	Total
I (Any One)	ENG-AE-111	Communicative English	3	1	0	4
	HIN-AE-111	**हिंदी शिक्षण**	3	1	0	4
II	EVS-AE-121	Environmental Studies	4	0	0	4

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Skill Enhancement Courses (SEC)

Semesters	Course Code	Course Name	Credits			
			L	T	P	Total
I & III	BOT-SE-001	Organic Farming	2	0	0	2
	BOT-SE-003	Botanical Gardening & Landscaping	1	0	1	2
II & IV	BOT-SE-002	Mushroom Cultivation	1	0	1	2
	BOT-SE-004	Nursery and Gardening	1	0	1	2
A student shall select at least 2 SEC of total 4 credits from his/her concerned discipline. For remaining 4 credits, he/she may select course(s) either from his/her own discipline or other under-graduate disciplines of Science and Technology in the College/University (Refer to the above mentioned regulation).						

Generic Electives (GE)

Semester	Course Code	Course Name	Credits			
			L	T	P	Total
I	BOT-GE001	Microbes and Cryptogams	4	0	2	6
II	BOT-GE-002	Phanerogams and Palaeobotany	4	0	2	6
III	BOT-GE001	Microbes and Cryptogams	4	0	2	6
	BOT-GE-003	Economic Botany and Plant Resource Utilization	4	0	2	6
IV	BOT-GE-002	Phanerogams and Palaeobotany	4	0	2	6
	BOT-GE-004	Biodiversity and Conservation	4	0	2	6
GEs given above are for the students of subsidiary disciplines/subjects (Refer to the above mentioned regulation). They shall select one GE in each semester from 1st to 4th semester, either exclusively from one subsidiary discipline or 2 courses each from two subsidiary disciplines. Students of Botany (Hons.) shall likewise choose 4 GEs from the available subsidiary disciplines (Chemistry, Zoology and Geology).						

Teaching Learning Process

These courses shall be delivered through classroom, laboratory work, projects, case studies and field work in a challenging, engaging, and inclusive manner that accommodates a variety of learning styles and tools (PowerPoint presentations, audio visual resources, e-resources, seminars, workshops, models, software). The laboratory training complements the theoretical principles learned in the classroom, hands-on experience with modern instruments, Lab based and field based experimentation and studies.

Assessment Methods, Conduct of Examinations, Eligibility Conditions, and Declaration of results

Academic performance in various courses i.e. core, discipline electives, generic electives and skill enhancement courses are to be considered as parameters for assessing the achievement of students. All students shall be subjected to the process of continuous evaluation and assessment. A number of appropriate assessment methods will be used to determine the extent to which students demonstrate desired learning outcomes.

Marks allocation for Internal Assessment and End Semester Examinations, Question paper pattern, Duration of examination for various courses, Attendance and other eligibility conditions for appearing in the examination, and Declaration of results shall be in accordance with the relevant provisions as stipulated in the above cited regulation and also the Ordinance(s) of the University.

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CORE COURSES

BOT-CC-111: PHYCOLOGY AND MICROBIOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students gain knowledge about the diverse life forms, life cycles, morphology and importance of microorganisms (Viruses, Bacteria and Algae).

Learning outcomes

On completion of this course, the students will be able to:

- Develop understanding on the concept of microbial nutrition.
- Classify viruses based on their characteristics and structures.
- Develop critical understanding of plant diseases and their remediation.
- Examine the general characteristics of bacteria and their cell reproduction/ recombination.
- Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance.
- Conduct experiments using skills appropriate to subdivisions.

Key Words: Eubacteria, Archaebacteria, Viruses, Algae, Economic importance.

Unit I: Introduction to microbial world **15 Lectures**

Microbial nutrition, nutritional types, 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).

Unit II: Viruses and Bacteria **15 Lectures**

General characteristics; classification (Baltimore), structure and replication of DNA virus (T4 and λ), lytic and lysogenic cycle; RNA virus (TMV), viroides and prions. General characteristics; Archaebacteria, Eubacteria, wall-less forms (mycoplasmas); Cell structure; Reproduction and recombination (conjugation, transformation and transduction). Binary fission and endospore.

Unit III: Algae, Cyanophyta and Xanthophyta **15 Lectures**

Algae: Life histories of algae, commonly found algae of India, Algal cell structure, Classification (by Fritsch), Phylogeny and evolution of algae, Algal cultivation methods. Algal bioprospecting. Cyanophyta: Range of thallus organization; Cell structure; Reproduction, of *Spirulina* and *Nostoc.* Xanthophyta: Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Vaucheria.*

Unit IV: Chlorophyta and Phaeophyta and Rhodophyta **15 Lectures**

Chlorophyta: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas*, *Volvox, Oedogonium, Cladophora, Ulva,* and *Chara.* Red tides and other algal adaptations. Commercial cultivation and economic importance of green algae.

Phaeophyta and Rhodophyta: General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus*, *Porphyra* and *Polysiphonia.* Commercial cultivation and economic importance of brown and red algae.

Practical **60 Hours**

Microbiology

1. Electron micrographs/Models of viruses – T4 and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs. Water bloom. Electron micrographs or charts of bacteria, binary fission, endospore, conjugation.
3. Gram-staining of root nodule and curd.
4. Micrometry and counting of cells by Haemocytometer

Phycology

1. Study of phototactic isolation of zoids of *Ulva* through chart.

2. Microscopic observation of vegetative and reproductive structures of *Nostoc, Chlamydomonas*, *Volvox*, *Oedogonium, Coleochaete, Chara, Vaucheria, Sargassum/ Ectocarpus, Fucus and Polysiphonia, Procholoron* through temporary preparations and permanent slides.

Suggested Readings

Singh, R.P. 2018. Microbiology. Kalyani Publishers.

Dubey, R.C. and Maheswari, D.K. 2005. A Text Book of Microbiology. S. Chand & Company.

Pelczar, M.J. (2001). Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

Wiley, J.M, Sherwood, L.M. and Woolverton, C.J. (2013). Prescott's Microbiology. 9th Ed. McGraw Hill International.

Awasthi, A. K. (2015). Textbook of Algae. Vikas Publishing House Pvt. Ltd.

Sharma, O.P. (2011), A Text Book of Algae. Tata-McGraw Hill Co., New Delhi.

Sambamurty, AVVS. (2005). A Textbook of Algae. Wiley India.

Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th Ed.

Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.

BOT-CC-112: BIOMOLECULES AND CELL BIOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students gain knowledge on Bioenergetics, Biomolecules (Protein, Carbohydrate, Lipid and Nucleic acids), Enzymes (Classification, structure & functions), Cell Biology (cell organelles) and Signal transduction in cells.

Learning outcomes

On completion of this course, the students will be able to:

- Develop understanding on chemical bonding among molecules.
- Identify the concept that explains chemical composition and structure of cell wall and membrane.
- Classify the enzymes and explain mechanism of action and structure.
- Compare the structure and function of cells & explain the development of cells.
- Describe the relationship between the structure and function of biomolecules.

Key Words: Nucleic Acids, Amino Acids, Proteins, Lipids, Fatty Acids, Signal Transduction

Unit I: Bioenergetics **5 Lectures**

Bioenergetics: Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule. Types and significance of chemical bonds; Structure and properties of water; significance of pH and buffers.

Unit II: Biomolecules **15 Lectures**

Carbohydrates: Nomenclature and classification and isomeric form; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacylglycerols 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 III: Enzymes **10 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, Lineweaver–Burk equation, enzyme inhibition and factors affecting enzyme activity.

Unit IV: Cell Biology and Signal transduction **30 Lectures**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Plant and animal cells; Origin of eukaryotic cell (Endosymbiotic theory). 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. Nucleus: Structure, nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament; Intracellular trafficking. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Lysosomes and Vacuoles. Endomembrane system: Endoplasmic Reticulum – Types and Structure. Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle - checkpoints and regulation; role of protein kinases. Signal Transduction: Receptors and primary and secondary signal transduction.

Practical **60 Hours**

Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.

1. Study of plant cell structure with the help of epidermal peel mount of Onion/ *Rhoeo*/*Crinum*.
2. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
3. Measurement of cell size by the technique of micrometry.
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollengrains).
5. Study of cell and its organelles with the help of electron micrographs.
1. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
2. Study the phenomenon of plasmolysis and deplasmolysis.
3. Study the effect of organic solvent and temperature on membrane permeability.
4. Study different stages of mitosis and meiosis.
5. Acid/ Alkaline phosphatase or amylase: Enzyme characteristics: pH/temperature/ kinetics
6. Immobilization of whole cell and isolated oraganelle.
7. Separation of protein by SDS-PAGE (only demonstration to class by the instructor).

Suggested Readings

Gupta, P.K. Biomolecules and Cell Biology, Rastogi Publication, Merruth, UP.
Gupta, P.K. Cell Biology, Rastogi Publication, Merruth, UP.
Gupta, P.K. Cell Biology and Genetics. Rastogi Publication, Merruth, UP.
Sahu A.C. 2019. Biomolecules & Cell Biology. Kalyani Publishers.
Devasena, T. 2012. Cell Biology. Oxford University Press.
Gupta, S.N. Concepts of Biochemistry, Rastogi Publication, Meerut.
Gupta, S.N. A Text Book of Biochemistry. Rastogi Publication, Meerut.
Cooper, G.M. (2018). The cell: A Molecular Approach. 8th Edition. Oxford University Press.
Karp, G., Iwasa, J. and Marshall, W. Cell and Molecular Biology: Concepts and Experiments, 8th Edition. John Wiley & Sons, USA
Stryer, L., Berg, J.M et al. (2019) Biochemistry. 9th Ed. W.H. Freeman and Company.
Campbell, M.K. (2018) Biochemistry, 9th ed., Cengage Learning.
Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biochemistry, 8th Edition., Macmillan.
Vodopich Darrell and Moore Randy. 2020. Biology Laboratory Manual. 12th Edition. McGraw Hill.

05/7/2021

BOT-CC-121: MYCOLOGY AND PHYTOPATHOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to introduce students with various fungal groups, lichens and their classification characteristics, reproduction and economic Importance, about the various phytopathology, the causal organisms and their controls.

Learning outcomes

On completion of this course, the students will be able to:

- Identify true fungi and demonstrate the principles and application of plant pathology in the control of plant disease.
- Demonstrate skills in laboratory, field and glasshouse work related to mycology and plant pathology.
- Develop an understanding of microbes, fungi and lichens and appreciate their adaptive strategies
- Identify the common plant diseases according to geographical locations and device their control measures

Key Words: Chytridiomycota, Oomycota, Zygomycota, Ascomycota, Basidiomycota, Economic importance, Plant pathology.

Unit I: Introduction to fungi and classification **15 Lectures**

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

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

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

Unit II: Basidiomycota, Allied fungi and Oomycota **15 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.

Allied fungi: General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies. Oomycota: General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora, Albugo*.

Unit III: Symbiotic associations and Applied Mycology **15 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.

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 IV: Phytopathology **15 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 **60 Hours**

Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).

1. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.
2. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
3. *Peziza*: sectioning through ascocarp.
4. *Alternaria:* Specimens/photographs and temporary mounts.
5. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
6. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
7. Study of phaneroplasmodium from actual specimens and /or photograph. Study of *Stemonitis* sporangia.
8. *Phytophthora and Albugo:* Study of symptoms of infected plants; asexual phase study through section/temporary mounts and sexual structures through permanent slides.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs).
10. 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

Sharma, P.D. (2017). Mycology and Phytopathology. Rastogi Publications, Merruth, UP.

Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.

Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

Dube, H.C. (2013). An Introduction to Fungi. Scientific Publication

Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology. 4th edition. John Wiley & Sons (Asia) Singapore.

Webster, J. and Weber, R. (2007). Introduction to Fungi. 3rd edition. Cambridge University Press, Cambridge.

Agrios, G.N. (1997). Plant Pathology, 4th edition, Academic Press, UK.

BOT-CC-122: ARCHEGONIATAE: BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

This course aims at making students gain knowledge on Archegoniates and about Bryophytes, Pteridophytes, Gymnosperms and their Ecological and economic importance; and about their fossils.

Learning outcomes

On completion of this course, the students will be able to:

- Demonstrate an understanding of archegoniatae, Bryophytes, Pteridophytes and Gymnosperms
- Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
- Understanding of plant evolution and their transition to land habitat.
- Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms

Key Words: Moss, Hornworts, Liverworts, Fern, Pine

Unit I: Introduction **5 Lectures**

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

Unit II: Bryophytes **15 Lectures**

General characteristics; Classification (up to family); Adaptations to land habit; Range of thallus organization. Morphology, anatomy, reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros, Sphagnum* and *Funaria* (excluding developmental details); Common mosses of India, ecological and economic importance of bryophytes with special reference to *Sphagnum.*

Unit III: Pteridophytes **15 Lectures**

General characteristics; Classification (up to family); General account of early land plants. Morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Marsilea* (excluding developmental details). Apogamy and apospory, heterospory and seed habit; telome theory, stellar evolution; ecological and economic importance of pteridophytes.

Unit IV: Palaeobotany and Gymnosperms **25 Lectures**

Concept of palaeobotany, Process of fossilization, Fossil types; study of following fossil types: *Rhynia*, *Lyginopteris*, *Williamsonia, Pentoxylon.*

General characteristics of Gymnosperms; Classification (up to family); Morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum* (excluding developmental details); *Cycas* and *Pinus* of India, Ecological and economic importance.

Practical **60 Hours**

1. *Riccia* – Morphology of thallus.
2. *Marchantia*- Morphology of thallus, whole mount of rhizoids and Scales, vertical section of thallus through Gemma cup (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. *Sphagnum*- Morphology of plant, whole mount of leaf (permanent slide only).
5. *Funaria*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule; whole mount of protonema.
6. *Psilotum*- Study of specimen, transverse section of synangium (permanent slide).
7. *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).
8. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, whole mount of sporangiophore, whole mount of spores (temporary slide), transverse section of rhizome (permanent slide).
9. *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).
10. *Cycas*- Morphology (coralloid roots, 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).
11. *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 and radial longitudinal sections stem (permanent slide).
12. *Gnetum*- Morphology (stem, male and female cones), transverse section of stem, vertical section of ovule (permanent slide)
13. Botanical excursion.

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Suggested Readings

Rashid, A. (2016). An Introduction to Archegoniate Plants. Vikas Publishing House Pvt. Ltd.

Sambamurty, AVVS. (2006). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany. IK International Publishers.

Pandey, B.P. (2006). A Text Book of Bryophyta, Pteridophyta and Gymnosperms, IK International Publishing House Pvt. Ltd

Chopra, R.N. and Kumar, P.K. Biology of Bryophyta. Wiley Eastern.

Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot, Allahabad.

Vanderpoorten, A. and Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press, Cambridge.

Parihar, N.S. (1966). The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.

Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International Publishers, New Delhi, India.

Biswas, C. and B. M. Johri. 1997. Gymnosoperms. Narosa Publishing House. New Delhi.

Shukla.A.C. and Mistra, S.P. Essentials of Palaeobotany. Vikas Publishing House Pvt. Ltd., New Delhi.

BOT-CC-231: ANATOMY OF ANGIOSPERMS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students understand about adaptive and protective systems in plants; anatomy; structural organization and functions of different plant parts; as well as the developmental and functional aspects of their vascular systems.

Learning outcomes

On completion of this course, the students will be able to:

- Develop an understanding of concepts and fundamentals of plant anatomy.
- Examine the internal anatomy of plant systems and organs.
- Develop critical understanding on the evolution of concept of organization of shoot and root apex.
- Analyze the composition of different parts of plants and their relationships.
- Evaluate the adaptive and protective systems of plants/

Keywords: Tissue, Tunica Corpus, Cambium, Secondary Growth, Korper-Kappe, Quiescent, Endodermis

Unit I: Adaptive and Protective Systems **15 Lectures**

Introduction to Epidermal tissue system, cuticle, trichomes, stomata (structure, function and classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes, mesophytes and hydrophytes. Applications in systematics, forensics and pharmacognosy.

Unit II: Introduction to plant anatomy and plant body **15 Lectures**

Internal organization of plant body: tissue system, types of cells and tissues. Classification of tissues; Simple and complex tissues, cyto-differentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Unit III: Apical meristems **15 Lectures**

Evolution of concept and organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cyto-histological zonation); Types of vascular bundles; Structure of dicot and monocot stem. 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 IV: Vascular Cambium and Wood **15 Lectures**

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Anomalous secondary growth; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

Practical **60 Hours**

Study of anatomical details through permanent slides/temporary stain mounts/macerations/museum specimens with the help of suitable examples or experimentally

1. Study of stomata through peal method and replica method.
2. Simple microtomy – hand sections and / or using microtome- handheld or rotary microtome
3. Staining techniques
4. Apical meristem of root, shoot and vascular cambium.
5. Distribution and types of parenchyma, collenchyma and sclerenchyma.
6. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
7. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
8. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
9. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
10. Root: monocot, dicot, secondary growth.
11. Stem: monocot, dicot - primary and secondary growth; anomalous secondary growth in *Achyranthes*, *Boerhaavia* and *Dracaena;* periderm; lenticels.
12. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
13. Adaptive Anatomy: xerophytes, hydrophytes.
14. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings

Pandey, B.P (2012): Plant Anatomy. S. Chand Publishing Co., New Delhi.
Pandey, S. N. and Chadha, A. Plant Anatomy and Embryology. Vikas Pub. House Pvt. Ltd.
Pandey B.P (2001): Text Book of Botany: Angiosperm. S. Chand Publishing Co
Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant
Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.

BOT-CC-232: ECONOMIC BOTANY AND PLANT RESOURCE UTILIZATION

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students understand about the Origin, evolution, conservation and uses of certain cultivated crops such as cereals, pulses, Medicinal & Aromatic plants, Spice & Condiments, Fibres, Sugar yielding plants, Fat and oil yielding plants.

Learning outcomes

On completion of this course, the students will be able to:

- Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems
- Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership
- Develop a basic knowledge of taxonomic diversity and important families of useful plants
- Increase the awareness and appreciation of plants & plant products encountered in everyday life
- Appreciate the diversity of plants and the plant products in human use

Keywords: Quarantine, germplasm, Cryopreservation, Transgenics, Timber, Aromatic Plants, cereals

Unit I: Origin and conservation of Cultivated Plants **14 Lectures**

Origin, Importance and domestication: Origin of Agriculture and ancient economic botany, Vavilov's Centres of Origin and diversity of crop plants, domestication, evaluation, bioprospection, Major plant introductions; Crop domestication and loss of genetic diversity.

Germplasm augmentation and conservation: History and importance of germplasm collection; Overview of: Ecogeographical distribution of diversity, General account of : Biotechnology in plant germplasm acquisition, plant tissue culture in disease elimination, in vitro conservation and exchange, cryopreservation, transgenics – exchange and biosafety issues.

Plant Quarantine: Principles, objectives and relevance.

Unit II: Cereals and Millets, Pulses and Legumes, Sources of Sugars and Starches

14 Lectures

Origin, evolution and uses of following crops

Cereals: Wheat, Rice, maize, millets. Pulses: Chickpea, Black gram, Cowpea, Soyabean, Pea, Lentil), and Legumes (lab-lab bean, ricebean, French bean). Sugarcane: processing, products and by-products. Propagation & uses of Sugarbeet and sweet sorghum. Sweet Potato, Yam, Taro and Tapioca.

Unit III: Spices, Beverages, Oil seeds, fats and Essential oils **16 Lectures**

Listing of important spices (Saffron, Cloves, Cardamom, Cinnamon, Tejpat, Nutmeg and Mace, Anise, Cumin, Celery, Tamarind, Vanilla, Asafoetida, Dill, Fenugreek, Fennel), their botanical name, family and part used. Origin, distribution, ecology, botany, cultivation practices, processing of economic plant part/ product, main chemical constituents, and economic importance of following major spices: Turmeric, Ginger, Capsicum, Black Pepper, Coriander.

Beverages (Tea and Coffee): History, origin, growing countries, Botany, cultivation practices, common diseases and pests, major chemical constituents, processing and quality control of economic product.

Oil seeds and fats: General description, classification, extraction and uses of groundnut, coconut, linseed, soybean, mustard.

Essential Oils: General descriptions, uses extraction / distillation of essential oil, chemical constituents of major essential oil yielding aromatic plants, namely Geranium, Lemongrass, Menthol mint, Basil, Eucalyptus, Clove.

Unit IV: Aromatic, Drug-yielding, Medicinal, Timber, Rubber and Fibre yielding plants

16 Lectures

Drug-yielding and Medicinal plants: Fumitories and Masticatories : Processing, therapeutic uses, and health hazards of habit-forming drugs, Botany and cultivation / regulatory practices of such drug yielding plants with special reference to *Papaver, Cannabis* and Tobacco.

Major Medicinal Plants: Botany, Uses, Cultivation and Processing of major medicinal plants, namely: Ashwagandha, Kalmegh, Ghrit Kumari (*Aloe vera*), Amla (*Phyllanthus*), Stevia, Sarpagandha, Digitalis.

Natural Rubber: Pararubber: tapping, processing and uses.

Timber plants and Fibres: General account and Botany of the Tree, wood structure and quality characteristics, and timber processing with special reference to, Saal (*Shorea robusta*), Teak and Pine.

General account of the Fibre yielding plants, Classification based on the origin of fibers, Extraction, processing, morphology and uses of fibers, with special reference to Cotton, Coir, Jute.

Practical **60 Hours**

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, Curcuma and Clove (habit and sections).
5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).

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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 *Cymbopogon* spp., Mint, Basil, *Eucalyptus* (specimens/photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of Ashwagandha, Artemisia, Kalmegh, Phyllanthuds, Satavar, Gilloi, *Digitalis, Papaver* and *Cannabis.*
10. Tobacco: specimen and products of Tobacco.
11. Woods: *Tectona, Pinus*: Specimen, Section of young stem.
12. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Suggested Readings

Alam, Afroz. 2020. A Textbook of Economic Botany and Ethnobotany. IK International Publishing House.

Purohit and Vyas. 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd Ed. Agrobios, India.

Atal, C.K. and Kapur, B.M. (1982). Cultivation and Utilization of Medicinal Plants. CSIR-RRL, Jammu.

Farooqi, A.A. and Sriram, A.H. (2000). Cultivation Practices for Medicinal and Aromatic Crops. Orient Longman Pub.

Sambamurty, AVSS and Subrahmanyam, N.S. (2008). A Textbook of Modern Economic Botany. CBS Publishers & Distributors Pvt. Ltd.

Bhutya, R.K. (2021). Medicinal Plants of India Vol. I & II. Scientific Publishers.

Kumar, N. Spices, Plantation Crop, Medicinal & Aromatic Plants. Medtech Publishers, India.

Bhutya, R.K. (2021). Medicinal Plants of India Vol. I & II. Scientific Publishers.

Patil, D.A. and Dhale, D.A. (2013) Spices and Condiments: Origin, History and Applications. Daya Publishing House, Delhi.

Pandey, B.P. (1999): Economic Botany. S. Chand & Co., New Delhi.

Sarma. O.P . 1996: Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd.

CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow (2016). Aush Gyanya : Handbook of Medicinal and Aromatic Plant Cultivation.

Hajra, P.K.; Verma, D.M. & Giri, G.S. 1996. Materials for the Flora of Arunachal Pradesh. Vol.I. Botanical Survey of India, Calcutta.

Giri, G.S.; Pramanik, A. & Chowdhery, H.J. 2008. Materials for the Flora of Arunachal Pradesh. Vol. II. Botanical Survey of India, Kolkata.

Chowdhery, H.J.; Giri, G.S. & Pramanik, A. 2009. Materials for the Flora of Arunachal Pradesh. Vol. III. Botanical Survey of India, Calcutta.

Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.

Kochhar, S.L. (2016). Economic Botany: A Comprehensive Study. 5th Edition. Cambridge

Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

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BOT-CC-233: GENETICS AND CYTOGENETICS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students understand the Principles of Genetics, Chromosome biology and the structure and function of genes.

Learning outcomes

On completion of this course, the students will be able to:

- Have conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
- Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders.
- Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
- Analyze the effect of mutations on gene functions and dosage.
- Examine the structure, function and replication of DNA.

Keywords: Mendelism, Linkage, gene mapping, Crossing over, Ploidy, Hardy-Weinberg, Genetic Drift, Natural Selection

Unit I: Principles of genetics and Biology of Inheritance **15 Lectures**

Mendelism: History; Mendel's Laws of inheritance; Chromosome theory of inheritance and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Mendellian segregation and gene interaction: Numericals; Polygenic inheritance.

Unit II: Extra-nuclear Inheritance, Linkage, crossing over and chromosome mapping **15 Lectures**

Determining non-Mendelian Inheritance; Maternal effects and cytoplasmic inheritance; Chloroplast mutation: Variegation in Four O'clock plant; Linkage and crossing over; Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Linkage and Gene mapping, and numericals based on gene mapping.

Unit III: Variation in Chromosome Number and Structure, Mutations **15 Lectures**

Chromosome morphology and Karyotype concept; Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Position effect; Euploidy, Aneuploidy and Amphiploidy and their implications, FISH and GISH in chromosome and genome identification. Types of mutations; Molecular basis of Mutations; Induction of mutations and Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms.

Unit IV: Gene Concept, Gene Interaction, Population and Evolutionary Genetics **15 Lectures**

Evolution of Gene Concept - Classical vs molecular concepts of gene (One gene one character; One gene-one enzyme, one gene-one polypeptide hypothesis and beyond); Cis-trans complementation test for functional allelism and gene as unit of function, mutation and recombination, non-coding RNA. Concept of sex determination and Sex chromosomes; Sex-linked, Sex-limited and sex-influenced characters; Dosage compensation. Allele frequencies, Genotype frequencies, Hardy-Weinberg Law. Role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Practical **60 Hours**

1. Mitosis, and study of chromosome morphology through squash preparation, including effect of chemicals on mitosis.
2. Meiosis and study of chiasma frequency through temporary squash preparation.
3. Laws through seed ratios. Laboratory exercises in probability and chi-square.
4. Chromosome mapping using point test cross data.
5. Pedigree analysis for dominant and recessive autosomal and sex linked traits.

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6. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
7. Blood Typing: ABO groups & Rh factor.
8. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
9. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
10. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Color blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached earlobe.
11. To test PTC tasting ability in a random sample and calculate gene frequencies for the taster and non–taster alleles.
12. Identification of inactivated X chromosome as Barr body and drumstick.

Suggested Readings

Gupta, P.K. Concepts of Genetics (Abridged Edn.), Rastogi Publications, Meerut.
Gupta, P.K. (2018) Genetics. 5th Edition, Rastogi Publications, Meerut.
Jain, H.K. (1999). Genetics: Principles, Concepts and Implications. Oxford & IBH Publishing Company.
Hartl, D.L. (2014). Essential Genetics, 6th Edition, Jones and Barlett Publishers, Boston.
Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. 12th edition. Pearson, USA.
Snustad, D.P. and Simmons, M.J. (2015). Principles of Genetics. 7th edition. Wiley.
Russell, P. J. (2012). i-Genetics- A Molecular Approach, 3rd edition. Benjamin Cummings, U.S.A.

BOT-CC-241: MOLECULAR BIOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students gain the knowledge of structure and functions of DNA and RNA.

Learning outcomes

On completion of this course, the students will be able to;

- Analyse the structures and chemical properties of DNA and RNA through various
- historic experiments.
- Differentiate the main types of prokaryotes through their grouping abilities and their
- characteristic
- Evaluate the experiments establishing central dogma and genetic code.
- Gain an understanding of various steps in transcription, protein synthesis and protein modification.

Keywords: Central Dogma, DNA Replication, Post translational modification, Wobble hypothesis, Exons, Cistrons

Unit I: Nucleic Acids **15 Lectures**

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

Unit II: Central dogma and The replication of DNA **15 Lectures**

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

replication of the 5'end of linear chromosome; Enzymes involved in DNA replication. DNA proofreading. Key experiments establishing - The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Central Dogma Reverse (RNA viruses etc.),

Unit III: Genetic code and transcription **15 Lectures**

Genetic code (deciphering & salient features) and wobble hypothesis. Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Concept of operon Prokaryotes: lac operon. Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

Unit IV: Processing and modification of RNA and translation **15 Lectures**

Split genes-concept of introns and exons, removal of introns, spliceosome machinery and eukaryotic mRNA processing; Ribozymes; RNA editing and mRNA transport. Translation: Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins, Protein targeting.

Practical **60 Hours**

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; mRNA processing.

Suggested Readings

Verma, P. S. and Agarwal, V. K. 2020. Molecular Biology. S. Chand Publishing.

Gupta, P.K. Biomolecules and Cell Biology, Rastogi Publication, Merruth, UP.

Sahu A.C. 2019. Biomolecules & Cell Biology. Kalyani Publishers.

Gupta, S.N. A Text Book of Biochemistry. Rastogi Publication, Meerut.

Cooper, G.M. (2018). The cell: A Molecular Approach. 8th Edition. Oxford University Press.

Karp, G., Iwasa, J. and Marshall, W. Cell and Molecular Biology: Concepts and Experiments, 8th Edition. John Wiley & Sons, USA

Stryer, L., Berg, J.M et al. (2019) Biochemistry. 9th Ed. W.H. Freeman and Company.

Campbell, M.K. (2018) Biochemistry, 9th ed., Cengage Learning.

Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biochemistry, 8th Edition., Macmillan.

Russell, P. J. (2012). i-Genetics- A Molecular Approach, 3rd edition. Benjamin Cummings, U.S.A.

Hartl, D.L. (2014). Essential Genetics, 6th Edition, Jones and Barlett Publishers, Boston.

Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. 12th edition. Pearson, USA.

Snustad, D.P. and Simmons, M.J. (2015). Principles of Genetics. 7th edition. Wiley.

05/7/2021

संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

BOT-CC-242: PLANT ECOLOGY AND PHYTOGEOGRAPHY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students understand the ecosystem and community concepts, succession, ecological adaptations, population ecology and speciation, Functional Aspects of Ecosystem and Phytogeography.

Learning outcomes

On completion of this course, the students will be able to:

- Understand core concepts of biotic and abiotic
- Classify the soils on the basis of physical, chemical and biological components
- Analysis the phytogeography or phytogeographical division of India
- Evaluate energy sources of ecological system
- Assess the adaptation of plants in relation to light, temperature, water, wind and fire.
- Conduct experiments using skills appropriate to subdivisions

Keywords: Soil, Community, Ecotone, Succession, Competition, r and k selection, ecological pyramids, Climax community

Unit I: Ecosystem and its components **15 Lectures**

Ecosystem: Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids. Ecosystems of India. Abiotic and biotic Components and their interrelationships and dynamism, homeostasis. Soil: Origin; Types and Formation; Composition (Physical, Chemical and Biological components); Soil profile. Types of soils in India. Water: States of water in the environment; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle.

Unit II: Ecological adaptations and Population ecology **15 Lectures**

Variations in adaptation of plants in relation to light, temperature, water, wind and fire. Biotic interactions: Competition (Inter- and intraspecific); Ammensalism, mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation. Population ecology: Characteristics and population growth, population regulation, life history strategies; *r* and *k* selection. Ecological Speciation.

Unit III: Plant Communities and Ecosystem **15 Lectures**

Community characteristics: analytical and synthetic; Concept of ecological amplitude; Habitat and niche; Ecotone and edge effect. Succession: processes, types; climax concept. Primary vs Secondary succession.

Unit IV: Functional Aspects of Ecosystem and Phytogeography **15 Lectures**

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles of carbon, nitrogen and phosphorus. Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phyto-geographical division of India; Vegetation of Northeast India.

Practical **60 Hours**

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 (with pH meter, universal indicator/Lovibond comparator and/or pH paper strip)
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. Study of morphological adaptations of hydrophytes and xerophytes (four each).
8. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
9. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
10. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
11. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
12. Field visit to familiarise students with ecology of different sites.

Suggested Readings

Ambasht, R. S. and Ambasht, N.K. 2017. A textbook of Plant Ecology. 15th Ed. CBS Publishers and Distributors, New Delhi.

Ambasht, R. S. and Ambasht, P.K. 2017. Environment and Pollution an Ecological Approach 5th Ed. CBS Publisher and Distributors.

Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

Bhatia, A.L. Textbook of Environmental Biology. Wiley India.

Gupta Meetu. Fundamentals of Environmental Biology. Wiley India.

Kormondy, E.J. (1996). Concepts of Ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

Odum, E.P. (2005). Fundamentals of Ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.

Bowman, W. D., Hacker, S. D. and Cain, M. L. 2018. Ecology. Oxford University Press.

Gurevitch, J., Scheiner, S. M. and Fox, G. A. 2021. The Ecology of Plants, 3rd Edition. Oxford University Press.

BOT-CC-243: PLANT SYSTEMATICS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students gain knowledge on the taxonomy and phylogeny of plants.

Learning outcomes

On completion of this course, the students will be able to:

- Classify Plant systematics and recognize the importance of herbarium and Virtual herbarium
- Evaluate the Important herbaria and botanical gardens
- Interpret the rules of ICN in botanical nomenclature
- Assess terms and concepts related to Phylogenetic Systematics
- Generalize the characters of the families according to Bentham & Hooker's system of classification

Keywords: Monophyly, paraphyly, polyphyly, apomorphy, plesiomorphy, homoplasy

Unit I: Significance of Plant systematics and Taxonomic hierarchy 18 Lectures

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology embryology, cytology, phytochemistry and molecular data. Field inventory; Importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: intended (yolked) and bracketed keys. Phenetics vs. Cladistics, Taxonomic Hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concepts (biological, morphological, evolutionary). Modes of speciation. Problems with species concepts. Rankless system of phylogenetic systematics

Unit II: Botanical Nomenclature and System of Classification 15 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. System of

classification: Natural system of classification (Bentham and hooker), Takhtajan classification of Angiosperms, Principles of Angiosperm Phylogeny Group (APG IV) classification.

Unit III: Systematics, Structure and Biometrics **15 Lectures**

Systematics position and range of floral structure of: Magnoliaceae, Fabaceae, Asteraceae, Zingiberaceae, Poaceae and Orchidaceae.

Biometrics: Concepts and methods of Molecular taxonomy; Numerical Taxonomy and Cladistics: Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

Unit IV: Phylogenetic Systematics **12 Lectures**

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades, synapomorphy, symplesiomorphy, apomorphy, lineage sorting, serial homology etc). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Practical **60 Hours**

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 - *Alyssum / Iberis*
   Papaveraceae - *Argemone*
   Myrtaceae - *Eucalyptus, Callistemon*
   Umbelliferae - *Coriandrum /Anethum / Foeniculum*
   Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
   Solanaceae - *Solanumnigrum/Physalis*
   Lamiaceae - *Salvia/Ocimum*
   Euphorbiaceae - *Euphorbia hirta/ Jatropha, Croton*
   Liliaceae - *Asphodelus/Lilium/Allium*
   Poaceae - *Triticum/Hordeum/Avena*
2. Field visit (local or outside depending on situation) –
3. Mounting of a properly dried and pressed specimen of any 20 wild plant with Herbarium label (to be submitted in the record book).
4. Construction of plant phylogenetic trees using various loci (rbcL, ITS, trnLetc) with various phylogenetic methods (Neibour Joining, Maximum Likelihood etc.)

Suggested Readings

Pandey, B.P (2013): Taxonomy of Angiosperms. S. Chand & Publishing Co., New Delhi

Singh, G. (2012). Plant Systematics: Theory and Practice. 3rd edition. Oxford & IBH Pvt. Ltd., New Delhi.

Naik. V.N . Taxonomy of Angiosperms. Tata McGraw Hill. New Delhi.

Jain SK & Rao RR (1977). Field and Herbarium Methods. Oxford & IBH Pvt Ltd New Delhi.

Hajra, P.K.; Verma, D.M. and Giri, G.S. (1996). Materials for the Flora of Arunachal Pradesh. Vol.I. Botanical Survey of India, Calcutta.

Giri, G.S.; Pramanik, A. & Chowdhery, H.J. (2008). Materials for the Flora of Arunachal Pradesh. Vol. II. Botanical Survey of India, Kolkata.

Chowdhery, H.J.; Giri, G.S. & Pramanik, A. (2009). Materials for the Flora of Arunachal Pradesh. Vol. III. Botanical Survey of India, Calcutta.

Davis, P.H. and Heywood, V.H. Principles of Angiosperm Taxonomy, Oliver and Boyd, London.

Jones. S.B . Jr. and Luchsinger. A.E .: Plant Systematics. McGraw-Hili Book Co . New York.

Jeffrey, C. (1982). An Introduction to *Plant Taxonomy*. Cambridge University Press, Cambridge.

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.

Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.

BOT-CC-351: PLANT PHYSIOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students realize how plants absorb water and mineral nutrients reach to different parts; how they manufacture food (photosynthesis) and translocate to different parts (translocate) and how they generate energy (reparation); how light, pigments and hormones help in plant growth and development; and the commercial applications of plant physiology.

Learning outcomes

On completion of this course, the students will be able to;

- Understand Water relation of plants with respect to various physiological processes.
- Explain chemical properties and deficiency symptoms in plants
- Classify aerobic and anaerobic respiration
- Explain the significance of Photosynthesis and respiration
- Assess dormancy and germination in plants

Keywords: Hydroponics, Nitrogenase, Photosynthesis, Photorespiration, CAM, Phytochrome, Phytohormone

Unit I: Plant water relation and mineral nutrition **15 Lectures**

Water relation of plants; water absorption, uptake and bulk movement of water, stomatal regulation of transpiration, anti-transpirants; Inorganic nutrition (macro and micro); deficiency symptoms; mineral absorption, translocation and assimilation. Hydroponic studies.

Unit II: Nitrogen nutrition **12 Lectures**

Inorganic and organic nitrogen sources, atmospheric nitrogen fixation, Biological nitrogen fixation in microbes/legumes, nif genes and NOD factors, nitrate and ammonia assimilation, inter relationship between photosynthesis and nitrogen metabolism.

Unit III: Photosynthesis and respiration **18 Lectures**

Importance of photosynthesis for food security and environment. (a) Light reaction: Radiant energy, photosynthetic apparatus, pigments and their biosynthesis; light harvesting complex; light absorption and composition and characteristics of two photosystems, photosynthetic electron transport, (b) Dark reaction: Carbon dioxide fixation in C3, C4 and CAM plants, photorespiration and its significance, environmental factors affecting photosynthesis.

Respiration: Aerobic and anaerobic respiration; cyanide independent respiration; fermentation; cytochrome system; carbohydrate and lipid metabolism; high energy compounds and factors affecting respiration.

Unit IV: Phytochromes and phytohormones **15 Lectures**

Growth and development (a) Phytochromes and light control, role of phytochrome in tropism, flowering and fruiting. (b) Phytohormones: Auxin; cytokinin; Gibberellins; ethylene; ABA. Synthesis, distribution and physiological effects. Application of hormones in agriculture and horticulture. Polyamines, brassinosteroids and their functions. Seed dormancy and germination, senescence, circadian rhythms in plants.

Practical **60 Hours**

1. Determination of water potential of given tissue (potato tuber) by weight method.
2. Determination of osmotic potential of plant cell sap by plasmolytic method.
3. Comparison of transpiration rates of different types of leaves by Cobalt chloride method.
4. Extraction and separation of Photosynthetic Pigments by solvent partitioning method.
5. Quantitative estimation of Carbohydrates (Bendict's, Fehling's, Anthone, Iodine Test etc).
6. Qualitative determination of amino acids (Ninhydrin, Xanthoproteic, Millon's and - Lead Sulfite test etc.).
7. Qualitative estimation of protein Folin, Biuret and Millon's test.

8. Determination of a few inorganic mineral nutrients (Ca, Mg, P, S, K, Fe, Ni, Cu, Mn etc) by Flame photometer.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Avena coleptile curvature bioassay (demonstration).
3. Enzyme activity with respect to temperature, pH and substrate concentration.
4. Demonstration of aerobic/anaerobic respiration in plant material.
5. To demonstrate that light, Co2, chlorophyll pigments are essential for photosynthesis.
6. Demonstration of phototrophism, geotrophism, hydrotrophism.

Suggested Reading

Pandey, S. N. and Sinha, B. K. Plant Physiology. 4th Ed. Vikas Publishing

Srivastawa, H.S.. Plant Physiology and Biochemistry. Rastogi Publication, Meerut.

Gupta, S.N. Concepts of Biochemistry, Rastogi Publication, Meerut.

Gupta, S.N. A Text Book of Biochemistry. Rastogi Publication, Meerut.

Frank B. Salisbury and Cleon W. Ross (2010). Plant Physiology, Cengage learning (Thompson), India Edition, New Delhi

Taiz, L. Zeiger, E., Moller, I. M. and Murphy, A. 2018. Fundamentals of Plant Physiology. Oxford University Press.

Kochhar, S. L. and Gujral, S. K. 2020. Plant Physiology: Theory and Applications. 2nd Edition. Cambridge University Press.

Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. 4th edition. John Wiley and Sons. U SA.

Stryer, L., Berg, J.M et al. (2019) Biochemistry. 9th Ed. W.H. Freeman and Company.

Campbell, M.K. (2018) Biochemistry, 9th ed., Cengage Learning.

Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biochemistry, 8th Edition., Macmillan.

Vodopich Darrell and Moore Randy. 2020. Biology Laboratory Manual. 12th Edition. McGraw Hill.

BOT-CC-352: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students know the biology behind flowering, pollination, reproduction, fruiting, and ovule and seed development in plants.

Learning outcomes

On completion of this course, the students will be able to:

- Recall the history of reproductive biology of angiosperms & recognize the importance of genetic and molecular aspects of flower development
- Understand structure and functions of anther wall and pollen wall
- Evaluate the special structures of Ovule
- Solve Self-incompatibility in Pollination and fertilization & relate between Embryo, Endosperm and Seed
- Comprehend the causes of Polyembryony and apomixes with its classification

Keywords: Gametogenesis, Self-incompatibility, In vitro fertilization, Cybrids, Polyembryony, Apomixes

Unit I: Introduction to Reproductive Biology **04 Lectures**

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. Types of reproduction and regeneration in plants: Sexual, asexual / vegetative reproduction.

Unit II: Flower Formation, Male and Female Gametophyte Development **20 Lectures**

Anther: Anther wall: Structure and functions, micro-sporogenesis, callose deposition and its significance.

Pollen biology: Micro-gametogenesis; Pollen wall structure, MGU (male germ unit), NPC system; scope of Palynology (a brief account); Pollen wall proteins; Pollen viability, Unique features: Pseudomonads, polyads, massulae, pollinia.

Ovule: Types of ovules; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– mega-sporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

Unit III: Pollination, Fertilization and Self-incompatibility 16 Lectures

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

Self-incompatibility: Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); 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 IV: Embryo, Endosperm and Seed, Polyembryony and Apomixes 20 Lectures

Endosperm: Types, development, structure and functions of endosperm.

Embryo: Structure and types of embryo; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo;

Seed: Structure, importance and dispersal mechanisms (Adaptations – Autochory, Anemochory, Hydrochory, Zoochory with examples).

Polyembryony and Apomixes: Introduction; Classification (given by Bhojwani and Bhatnagar); Causes and applications.

Practical 60 Hours

1. Anther: Wall structure; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bi-celled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. 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. Demonstration of pollen germination using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/ specimens/ photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature embryo sac.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. 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

Bhojwani, S. S. Dantu, P.K. and Bhatnagar, S. P. The Embryology of Angiosperms, 6/e. Vikas Publishing House Pvt. Ltd.

Pandey, A.K. (1997). Introduction to Embryology of Angiosperms. CBS Publishers & Distributors, New Delhi.

Pullaiah, T., Lakshminarayana, K. and Hanumantha Rao, B. 2019. Plant Reproduction. 2nd Ed. Scientific Publishers.

Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.

Singh, Pande & Jain: Reproductive Biology & Angiosperms. Rastogi Publication, Meerut.

Singh, Pande & Jain: Embryology of Angiosperms. Rastogi Publication, Meerut.

Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

BOT-CC-361: PLANT METABOLISM

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students understand the Concept of cellular Metabolism, Carbon reduction and Assimilation Metabolism, Oxidation and ATP-Synthesis, Lipid and Nitrogen Metabolism, and the Mechanism of Signal Transduction.

Learning outcomes

On completion of this course, the students will be able to:

- Differentiate anabolic and catabolic pathways of metabolism
- Recognize the importance of Carbon assimilation in photorespiration
- Explain the ATP-Synthesis
- Interpret the Biological nitrogen fixation in metabolism

Keywords: Anabolism, catabolism, Pentose phosphate pathway, ATP synthesis, Electron Transport Chain, MAP kinase cascade

Unit I: Concept of Metabolism **14 Lectures**

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes). Historical background, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres.

Unit II: Carbon Assimilation, Metabolism and Oxidation **20 Lectures**

Photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction/ Carbon assimilation: C3 and C4 pathways; photorespiration; Crassulacean acid metabolism; Factors affecting CO_2 reduction. Synthesis and hydrolysis of sucrose and starch. Glycolysis and its 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 III: ATP-Synthesis **8 Lectures**

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

Unit IV: Lipid and Nitrogen Metabolism, Mechanism of Signal Transduction 18 Lectures

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α-oxidation. Biological nitrogen fixation (examples of legumes and non-legumes); Biochemistry of nitrogen fixation; Nitrate and Ammonia assimilation; Transaminase reactions. Receptor-ligand interactions; Secondary messenger concept, Calcium-calmodulin, MAP kinase cascade.

Practical **60 Hours**

1. Solvent partitioning 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

Srivastawa, H.S.. Plant Physiology and Biochemistry. Rastogi Publication, Meerut.
Gupta, S.N. Concepts of Biochemistry, Rastogi Publication, Meerut.
Gupta, S.N. A Text Book of Biochemistry. Rastogi Publication, Meerut.
Heldt, H. W. and Piechulla, B . (2019). Plant Biochemistry. 4th Edition. Paperback. Academic Press.

Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biochemistry, 8th Edition., Macmillan.
Stryer, L., Berg, J.M et al. (2019) Biochemistry. 9th Ed. W.H. Freeman and Company.
Campbell, M.K. (2018) Biochemistry, 9th ed., Cengage Learning.
Buchanan, B.B. and Gruissem, W. (2015). Biochemistry and molecular biology of plants. Willy, USA.
Vodopich Darrell and Moore Randy. 2020. Biology Laboratory Manual. 12th Edition. McGraw Hill.

BOT-CC-362: PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students understand the Concept of Plant Tissue Culture, Recombinant DNA technology, Gene Cloning and Methods of Gene Transfer and the major concerns and Applications of Transgenic Technology.

Learning outcomes

On the completion of the course the students will be able to

- Understand the core concepts and fundamentals of plant biotechnology and genetic engineering
- Develop their competency on different types of plant tissue culture
- Analyze the enzymes and vectors for genetic manipulations
- Examine gene cloning and evaluate different methods of gene transfer
- Critically analyze the major concerns and applications of transgenic technology

Keywords: Callous, Protoplast, Gene Cloning, Vectors, Transgenic technology, Embryo culture, Anther culture

Unit I: Plant Tissue Culture **12 Lectures**

Historical perspective; Formulation of nutrient media; Sterilization, role of vitamins and hormones; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Organ culture, Embryo culture, Anther and triploid culture, Callus culture, Protoplast isolation, culture and fusion; Tissue culture applications including micropropagation, androgenesis, production of virus free plants, secondary metabolite production, haploids, triploids and hybrids and germplasm conservation, Cryopreservation and usages.

Unit II: Recombinant DNA technology **12 Lectures**

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Ligases (enzymes); Cloning Vectors: Prokaryotic (pUC 18 and pUJC19, pBR322. Ti plasmid, BAC); Lambda phage, Ml3 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

Unit III: Gene Cloning and Methods of Gene Transfer **16 Lectures**

Basic concept of Gene cloning, advantages of gene cloning, Bacterial Transformation methods and selection of recombinant clones using various strategies, PCR- mediated gene cloning; Gene Construct; Plant transformation vector, T-DNA and viral vector, *Agrobacterium*-mediated Transformation protocols, molecular mechanism of T-DNA transfer, direct gene transfer method by Electroporation, Microinjection, Microprojectile bombardment ;Selection of transgenics–selectable marker and reporter genes (Luciferase, GUS, GFP), chloroplast transformation, transgene analysis.

Unit IV: Major Concerns and Applications of Transgenic Technology **20 Lectures**

Transgenic technology and sustainable agriculture, Biosafety concerns with transgenic technology, History of transgenic development across the world, Major concerns with implementation of transgenic technology in India. Applications as Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits in major crops (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug).

Practical **60 Hours**

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

Suggested Readings

Razdan, M.K. 2018 Introduction to Plant Tissue Culture. Oxford & IBH Publishing.

Pullaiah, T. Subba Rao, M.V. and Sreedevi, E.. 2017. Plant Tissue Culture : Theory and Practicals. 2nd Edition. Scientific Publishers.

Singh, B.D. 2015. Biotechnology. Kalyani Publishers.

Gupta, P.K. Elements of Biotechnology. Rastogi Publication, Merruth.

Slater, A. Scott, N.W. and Fowler, M.R. (2008). Plant Biotechnology. Second Edition. Oxford.

Stewart, C.N. Jr. (2016). Plant Biotechnology and Genetics: Principles, Techniques, and Applications, 2nd Edition. John Wiley & Sons Inc., USA.

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DISCIPLINE SPECIFIC ELECTIVE (DSE) COURSES

BOT-DE-351: RESEARCH METHODOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students to understand the Basic Concepts of Research, to make them realize the Data Collection and Documentation of Observations, Overview of Biological Problems and the Ethics and Good Practical's and Art of Scientific Writing.

Learning outcomes

At the end of the course the students will be able to,

- Understand the concept of research and different types of research in the context of biology
- Develop laboratory experiment related skills.
- Develop competence on data collection and process of scientific documentation
- Analyze the ethical aspects of research
- Evaluate the different methods of scientific writing and reporting

Keywords: Qualitative, Quantitative, Reproducibility, Scientific methodology, Plagiarism, Scientific misconduct, Ethics in Science

Unit I: Basic Concepts of Research **16 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 II: Data Collection and Documentation of Observations **16 Lectures**

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

Unit III: Overview of Biological Problems **12 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 IV: Ethics and Good Practical's and Art of Scientific Writing **16 Lectures**

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

Practical **60 Hours**

1. Application of Microsoft Excel for Data tabulation and analysis.
2. Use of Microsoft office Powerpoint for presentation.
3. Experiments based on chemical calculations.
4. Plant microtechnique experiments.
5. The art of imaging of samples through microphotography and field photography.
6. Poster presentation on defined topics.
7. Technical writing on topics assigned.
8. Identification of different type of research in day by day life
9. Testing of a formulated hypothesis with type I and type II errors
10. Curation of relevant scientific literature from Google Scholar
11. Poster presentation on defined topics
12. Demonstration for checking of plagiarism using recommended software
13. Technical writing on topics assigned.
14. More Practical may be added depending on the local habitats and available facilities

Suggested Readings

Dawson, C. (2002). Practical Research Methods. UBS Publishers and Distributors, New Delhi.

Narayana, P.S., Varalakshmi, D. and Pullaiah, T. (2016). Research Methodology in Plant Science. Scientific Publishers.
Gurumamani, N. (2011). Research Methodology: For Biological Science. MJP Publishers New Delhi
Swagiary, Ananta. Biological tools and Techniques. Kalyani Publishers.
Arumugam, N. Research Methodology for Life Sciences. Saras Pub.
Kothari, C. R., and Garg, Gaurav. (2004). Research Methodology: Methods and Techniques, 4th Ed. New Age International Publishers.
Kumar, Ranjit, (2011). Research Methodology: A step-by-step guide for beginners. SAGE Publications India Pvt. Ltd., New Delhi
Holmes, D., Moody, P., Dine, D. and Trueman, L. (2016). Research Methods for the Biosciences. Oxford University Press.
Locharoenrat, K. Research Methodologies for Biginners. CRC Press.
Leedy, P. D. (2019). Practical Research: Planning and Design. 12th Ed. Pearson.

BOT-DE-352: BIOSTATISTICS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students understand the principle and application of statistics in biological science research particularly analysis and interpretation of scientific data.

Learning outcomes

At the end of the course the students will be able to,

- Comprehend the fundamental concepts related to descriptive and inferential biostatistics.
- Develop skills in data tabulation, its treatment, analysis, interpretation and graphical representation of data.
- Analyze the implications of inferential statistics in biology.
- Develop their competence in hypothesis testing and interpretation.

Keywords: Probability, Frequency, ANOVA, t-test, P-value, Hypothesis testing, Correlation, regression

Unit I: Biostatistics **15 Lectures**

History of the field and connection with population genetics, levels of measurements, types of variables, precision vs accuracy.

Unit II: Data Summarization and Visualization **15 Lectures**

Types of variables, frequency tabulations (EFD, ERFD, ECD), various types of charts, error bars, scatterplots

Unit III: Descriptive Statistics **15 Lectures**

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

Unit IV: Correlation, Regression and Statistical inference **15 Lectures**

Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression. Hypothesis testing and P values, Confidence Intervals, Student 't' test, chi square test, ANOVA.

Practical **60 Hours**

1. Calculation of mean, standard deviation and standard error.
2. Calculation of correlation coefficient values and finding out the probability.
3. Calculation of 'F' value and finding out the probability value for the F value.
4. Student's t-test: Independent and dependent. Hand calculation and calculation using MS Excel.
5. ANOVA and Tukey's HSD: Hand calculation and calculation using MS Excel.

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Suggested Readings

Balaji, K., Raghavaiah, A.V.S. and Jayaveera, K.N. Biostatistics. Wiley India.
Rangaswamy, R. (1995). A Text Book of Agricultural Statistics. New Age Publishers.
Sundarrao, P.S.S and Richards, J. Christian. An introduction to Biostatistics, 3rd edition. Medical College, Vellore
Campbell, R.C. (1998). Statistics for Biologists, Cambridge University Press.
Zar, J.H. (2012). Biostatistical Analysis. 4th edition. Pearson Publication. U.S.A.
Danniel, W.W. (1987). Biostatistics, New York, John Wiley Sons.

BOT-DE-353: FOREST ECOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students learn about the general concepts of Forest ecology and ecosystems; nutrient cycling; sustainability of forest ecosystem and Forest laws.

Learning outcomes

At the end of the course the students will be able to:

- Comprehend the fundamental concepts related to Phytogeography, forest ecosystem and their functioning.
- Understand the importance of forest and need for their conservation and management.
- Acquaintance to Forest policies and relevant laws for conservation of forests and protection of wild life.

Keywords: Forest types and ecosystems, Ecosystem functioning, Forest Conservation, Environmental impact assessment, Forest and Wild life protection.

Unit I **10 Lectures**

Basics of forests, General concepts of forest ecology and ecosystems; Topographic, edaphic and biotic factors; Forest Types of India and North East India; Forest and tree cover.

Unit II **20 Lectures**

Ecosystems nutrient cycling; Biotic interactions; Autecology; Population and community ecology; Forest ecosystem structure and function, Phytogeography.

Ecological energetics; Forest productivity; Forests disturbance and succession, Invasive species; Biodiversity and threats; Forest fire; Major terrestrial biomes.

Unit III **20 Lectures**

Sustainability of forest ecosystem; Application of ecological information in management of forest ecosystem. Microbial ecology; Environmental pollution and forest health, Other environmental problems. Forest clearance and environmental impact assessment.

Ecological restoration: Climate change and its impacts; Global and regional strategies to combat climate change; Tools to study the climate change; Adaptation of forest trees to climate change.

Unit IV **10 Lectures**

Forest laws: History of forest legislation in India, Salient features of Indian Forest Act 1927 and Forest Conservation Act, 1980. Wildlife Protection Act 1972 and their amendments, Forest policies/ acts/rules relevant to North East India.

Practical **60 Hours**

1. Demonstration of different methods of vegetation analysis.
2. Qualitative characters of the given community.
3. Standing biomass
4. Quantitative and synthetic community characters.
5. Similarity and dissimilarity index.
6. Soil PH, texture, moisture and water holding capacity, NPK etc.
7. Field visits to selected forest ecosystems in Arunachal Pradesh

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Suggested Readings

Barman P.K.R. (2019) Fundamentals of Forestry. Kalyani Publishers.
Raj, A.J. and Lal. S.B. (2020). Forestry Principles and Applications. Scientific Publishers.
Sagwal, S.S. (2021). Forest Ecology. Kalyani Publishers.
Puri, G.S., Gupta, R.K., Meher-homji, V.M., Puri, S. (1989). Forest Ecology Vol. II Oxford and IBH Pub. Co., New Delhi.
Kimmins, J.P. (2004) Forest Ecology (2 Edn.). Prentice and Hall, New York.
Pahwa, Sunil. (2011). Forest and Wildlife Laws. Global India Publications, Guwahati/New Delhi
Singh, Gurdip. (2016). Environmental Law. Eastern Book Company, Lucknow, Edition: 2nd, 2016
Forest Act, 1927 [Amended up to Act 5 of 2018 and as of 30-12-2020] Bare Act. Eastern Book Company, Lucknow.
Singh, J.S., Singh, S.P. and Gupta, S.R. (2008) Ecology, Environment and Resource Conservation, Anamya Publication, New Delhi.
Ambasht, R.S. and Ambasht, N.K. (2006) A Text Book of Plant Ecology, CBS Publishers, New Delhi.
Odum, E.P. (2005). Fundamentals of Ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
Bowman, W. D., Hacker, S. D. and Cain, M. L. 2018. Ecology. Oxford University Press.
Gurevitch, J., Scheiner, S. M. and Fox, G. A. 2021. The Ecology of Plants, 3rd Edition. Oxford University Press.

BOT-DE-354: SPICES AND CULINARY HERBS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students aware about the cultivation, production disease management and marketing of spices and culinary herbs at the global, national and regional levels and their importance and uses.

Learning outcomes

At the end of the course the students will be able to:

- Gain knowledge on various resources of spices and culinary herbs, and their culinary therapeutic and medicinal importance.
- Know the distribution and abundance of spices and culinary herbs.
- Learn method of cultivation, crop management,, and post-harvest management.

Keywords: Spices, culinary herbs, nutritional and medicinal values, Cropping and Post-harvest management

Unit I **10 Lectures**

Spices: Definition, concept and characteristic features. Importance of spices: nutritional and medicinal values. Global and National production of spices and marketing. Prospect of Spice cultivation in Arunachal Pradesh.

Unit II **10 Lectures**

Taxonomy of Spices, Types of Spices: Commercial varieties and distribution in India and North East India. Climatic conditions and soil type requirements for cultivation. Cultivation Techniques of Spices: Site selection, layout and plotting, sowing method, time and season of sowing, irrigation, fertilization and crop management.

Unit III **20 Lectures**

Cultivation methods of popular varieties of Spices: Black Pepper (*Piper nirgum*); Turmeric (*Curcuma longa*); Green Cardamom (*Elleteria cardamomum*); Black Cardamom (*Amomum subulatum*); Mace and Nutmeg (*Myristica fragrans*); Star anise (*Illicium verum*); Cinnamon (*Cinnamomum verum*); Bay leaves (*Cinnamomum tamala*); Ginger (*Gingiber officinale*); Garlic (*Allium sativum*); Onion (*Allium cepa*); Cumin (*Cuminum cyminum*); Carom seeds (*Trachyspermum ammi*); Red chilly (*Capsicum annum*) and *Zanthoxylum armatum*. Common fungal, bacterial and insect pest diseases of spices and their management.

Unit IV **20 Lectures**

Culinary Herbs: Definition, concept and characteristic features; Importance of Culinary Herbs: nutritional and medicinal values of some ethnobotanical local herbs. Global and national production of Culinary Herbs and its marketing. Taxonomy and Cultivation: Habit, distribution, climatic conditions and soil type requirements, cultivation techniques and crop management.

Cultivation of popular varieties of Culinary Herbs: Coriander (*Coriandrum sativum*); Rosemary (*Rosmarinus officinalis*); Basil (*Ocimum basilicum*); Thyme (*Thymus vulgaris*); Spear minth (*Mentha spicata*); Lemon grasss (*Cymbopogon flexuosus*). Common fungal, bacterial and insect pest diseases of Culinary Herbs and their management.

Practical **60 Hours**

1. Crop management, fertilizer application and harvesting techniques of cultivated seed spices.
2. Crop management, fertilizer application and harvesting techniques of cultivated culinary herbs.
3. Culinary Herbs: Identification and Collection and preservation method of propagative parts.
4. Documentation of disease symptoms and Identification of common fungal and bacterial, insect pest diseases of Common fungal, bacterial and insect pest diseases of Culinary Herbs and their management.
5. Site selection, plotting and layout, Planting method of commercially important culinary herbs- Coriander (*Coriandrum sativum*); Rosemary (*Rosmarinus officinalis*); Basil (*Ocimum basilicum*); Thyme (*Thymus vulgaris*); Spear minth (*Mentha spicata*); Lemon grasss (*Cymbopogon flexuosus*).
6. Spices: Seed Identification, collection and preservation methods.
7. Spices: Site selection, plotting and layout, sowing and irrigation method of commercially important spices- Black Pepper (*Piper nirgum*), Cinnamon (*Cinnamomum verum*); (*Gingiber officinale*); Garlic (*Allium sativum*); Onion (*Allium cepa*); Cumin (*Cuminum cyminum*); Carom seeds (*Trachyspermum ammi*) and Red chilly (*Capsicum annum*).

Suggested Readings

Sarah Garland (1979). The Complete Book of Herbs & Spices: an illustrated guide to grow and using aromatic, cosmetic, culinary and medicinal plants. The Viking Press.

Jill Norman (1990). The Complete Book of Spices: A Practical Guide to Spices and Aromatic Seeds. RD Press, Montreal.

Jill Norman (2002). Herbs & Spices. Dorling Kindersley Ltd., Penguin Random House.

Purthi, J.S. (2006). Spices and Condiments. National Book Trust, New Delhi.

Kumar, N. (1995). Spices, Plantation Crop, Medicinal & Aromatic Plants. Medtech Publishers, India/Oxford & IBH, New Delhi.

Patil, D.A. and Dhale, D.A. 2013. Spices and Condiments: Origin, History and Applications. Daya Publishing House, Delhi.

Farrell, K. T. (2000). Spices, Condiments and Seasoning. 2nd Ed. Springer.

Andrew Chevallier. (1996). The Encyclopaedia of Medicinal Plants. A Practical Reference Guide to over 550 Key Herbs and their Medicinal Uses.Dorling Kindersley Ltd.

Craker, E. and Simon, James. (1986). Herbs, Spices, and medicinal Plants: Recent Advances in Botany, Horticulture & Pharmacology, Volume I. CBS Publisher Spices & Condiments Indian Spices Markets: Trends and Opportunities.

Jain, S.K. (1980): Glimpses of Indian Ethnobotany. Oxford & IBH Publication New Delhi.

Alam, Afroz. 2020. A Textbook of Economic Botany and Ethnobotany. IK International Publishing House.

Sood, S.K., Bhatnagar, A.K., Kharwal, A. and Lakhanpal, T. N. 2014. Ethnobotany Himalayan Region, 1/e. IK International Publishing House

Jain, S.K. 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur

Pandey, B.P. (1999): Economic Botany. S. Chand & Co., New Delhi.

Sarma. O.P . (1996). Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd.

Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd Ed. Agrobios, India.

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BOT-DE-355: HORTICULTURAL PRACTICES

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students gain knowledge on the cultivation, production disease management and commercialization of Horticultural crops which includes ornamental plants, fruits, vegetables, medicinal and Aromatic plants along with landscaping & Garden Designing.

Learning outcomes

At the end of the course the students will be able to:

- Understand the concept of different types of horticultural crops, their conservation and management
- Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromatic plants.
- Critically evaluate different cultivation practices and disease management
- Reflect upon different Landscaping practices and garden design

Keywords: IPR, Biofertilizers, Aromatic Plants, Japanese Gardens, Quarantine, Cultivars

Unit I: Horticultural Crops - Conservation and Management **15 Lectures**

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; urban horticulture and ecotourism. Documentation and conservation of germplasm; Role of micro-propagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues.

Unit II: Ornamental Plants, Floriculture **15 Lectures**

Propagation of plants for beauty: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [aroids, rose, marigold, carnations, orchids, poppies, tuberose, sages, cacti and succulents] Ornamental flowering trees (Gulmohar, Lagerstroemia, Cassia fistula and areca palms etc.- as are available in the area). Cut and dry flowers, bonsai and their commercial prospects (market demand and supply); Importance of flower shows and exhibitions.

Unit III: Plants for Nutrition and Health **15 Lectures**

Fruit and Vegetable Plants: Production, origin and distribution; Description of plants and their economic products; Management and marketing; Identification of some fruits and vegetable varieties (citrus, banana, chillies and cucurbits).

Medicinal and Aromatic Plants: Production, origin and distribution. Description of plants and their economic products; Cultivation, processing and marketing of products of major medicinal plants (Mints, Amla, Ginger, Turmeric, Aloe vera).

Unit IV: Cultivation & Cultural Practices, Disease Management, Landscaping & Garden Design **15 Lectures**

Application of manure, organic, chemical and Biofertilizers, micronutrients; Weed control; 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.

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Disease Management: 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.

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

Practical **60 Hours**

1. Field trips: Field visit to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at agricultural institutes / universities or other suitable locations.
2. Identification of major conditions responsible for spoilage of horticultural crops.
3. Identification of pathogenic and non-pathogenic diseases of horticultural plants.

4. More Practical to be added depending on the local habitats and available facilities.

Suggested Readings

Chadha, K.L. (2002). Hand Book of Horticulture. ICAR.

Chadha, K.L. and Pareek, O.P. (1996). (Eds.). Advances in Horticulture. Vols. IV. Malhotra Publ. House.

Rathore, N.S., Mathur, G.K. and Chasta, S.S (2018). Post-Harvest Management and Processing of Fruits and Vegetables. ICAR, New Delhi.

Singh, Jitendra. (2006) Basic Horticulture. Kalyani Publishers.

Hartmann, H.T. and Kester, D.E. (1989). Plant Propagation – Principles and Practices. Prentice Hall of India.

Kadar, A.A. (2013). Postharvest Technology of Horticultural Crops - An Overview from Farm to Fork Ethiop .J. Appl. Sci. Technol. (Special Issue No.1): 1- 8.

Kader, A. A. (2002). Postharvest technology of horticultural crops, third edition. University of California, Agriculture and Natural Resources, Publication 3311, 535p.

NIIR Board. (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research, New Delhi.

Peter, K.V. (2008). (Ed.). Basics of Horticulture . New India Publ. Agency.

Pradeepkumar, T., Suma, B., Jyothibhaskar. and Satheesan, K.N. (2007). Management of Horticultural Crops. Parts I, II. New India Publ. Agency.

Singh, H.P., Singh, G., Samuel, J.C. and Pathak, R.K. (2003). Precision Farming in Horticulture . NCPAH, DAC/PFDC, CISH, Lucknow.

Sudeer, K.P. and Indira V. (2007). Post-Harvest Technology of Horticultural Crops. New India Publication Agency, New Delhi.

Sudheer, K.P. and Indira, V. (2007). Post-Harvest Technology of Horticultural Crops. New India Publ. Agency.

Willis, R., Mc Glassen, W.B., Graham, D. and Joyce, D. (1998). Post-Harvest. An Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals. CABI.

BOT-DE-356: HORTICULTURAL POST-HARVEST PRACTICES

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to highlight the importance of Post-harvest Technology, to elaborate on Post-harvest Processing, Protection of Post-harvest Produce and Transportation of Post-harvest Processed products

Learning outcomes

At the end of the course, the students will be able to,

- Understand the concept of different types of horticultural practices for value addition
- Visualize the post-harvest problems likely to be confronted
- Know the tricks of the trade and how to increase the longevity of the produce

Keywords: Irradiation, Canning, Refrigeration, Value addition, Trimming, Chlorination, Waxing

Unit I: Post-harvest Technology **16 Lectures**

Importance and overview of post -harvest handling; Principles and methods of preservation and processing : Methods of minimizing loses during storage and transportation; Harvesting and handling of fruits, cut flowers, vegetables, herbs, storage tissues and organs; Laws related to food selling.

Unit II: Post-harvest Processing **16 Lectures**

Food processing: canning, fruit juice beverages, pickles, jam, jellies, candies, Food additives, labelling; Food irradiation and food safety; Importance and advantages of appropriate technologies; Evaluation of quality traits; Harvesting of produce and Extent of post-harvest losses;

Unit III: Protection of Post-harvest Produce **16 Lectures**

Concept of maturity, Maturity indices, Pre-harvest quality modifiers, Trimming, cleaning and drying technologies; Post-harvest physiology : Physiological disorders – Development, identification and Control; Post-harvest diseases and losses by insects: Types of diseases, Source of infection, Factors affecting disease development, Losses by insects; Prevention techniques for post -harvest losses : Storage techniques, Biorational approaches; Value addition: Standardization, improvement of quality.

Unit IV: Post-harvest Processing and Transportation **12 Lectures**

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage: ventilated, refrigerated, MAS, CA storage, Precooling, sorting & grading, packaging, transportation and marketing. Cool chain.

Practical **60 Hours**

1. Water content measurement of fruits and vegetables.
2. Cold storage techniques for fruits and vegetables
3. Visit to some nearby cold-storage facility
4. Identification of major conditions responsible for early decay of produce.
5. Identification of pathogenic and non-pathogenic reasons of produce spoilage during storage
6. Handling of post-harvest equipment : Dryers, Storage containers and vessels
7. The production process of the marketable products of *Aloe,* Herbal tea, soups etc.
8. Post-harvest processing / drying of Ginger, Turmeric, Chilli etc.
9. Extraction / hydro-distillation of essential oil of *Ocimum, Citronella* etc.
10. Post-harvest processing for transportation.
11. Packaging and transport of produce, minimization of damage during packaging of dry fruits / nuts / herbs and herbal products

Suggested Readings

Rathore, N.S., Mathur, G.K. and Chasta, S.S (2018). Post-Harvest Management and Processing of Fruits and Vegetables. ICAR, New Delhi.

Sharma, S.K. (2010) Post-Harvest Management and Processing of Fruits and Vegetables. New India Publishing Agency, New Delhi.

Verma, L.R. and Joshi, V. K. (2000). Postharvest technology of Fruits and Vegetables. Indus Publishing House, Delhi.

John, P.J. (2020). A Handbook of Post-Harvest Management of Fruits and Vegetables. Daya Publishing House, Delhi.

Chakraverty, A., Majumdar, A.S., Raghavan, G.S.V. and Ramaswamy, H.S. (2003). Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea and Spices. Marcel Dekker Inc, NY.

Ramaswamy, H. (2015). Post-harvest Technologies of Fruits and Vegetables. DEStech Publications, Inc., USA.

Wills, R and Golding, J. (2016). Postharvest : An introduction to the physiology and handling of fruits and vegetables. UNSW Press.

Wills, R.B.H., Glasson, W.B. and Mc. Graham, D. (2007). Postharvest: an introduction to the physiology and handling of fruits, vegetables and Ornamentals., CABI.

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BOT-DE-361: POMOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students learn the importance of the study of fruit production, scope and classification of fruits, cultivation, disease management, registration of new cultivars, and preservation of fruits for future use.

Learning outcomes

On completion of this course the students will be able to:

- Understand the concept of registration procedures with cultivars, vegetative and generative pomology
- Classify the cultivars according to scientific names.
- Plan the development of orchards and its management
- Explain the methods of post-harvest preservation requirements i.e. refrigeration, canning, dehydration and chemical preservation.

Keywords: Pomology, Pruning, Cultivars, Orchard, Orchard management, Canning, Nutrition

Unit I **16 Lectures**

Definition, scope and importance of pomology, pomological systems, pomological collection, role of fruits in human nutrition. Major groups of fruit crops of local climates/regions, (a) deciduous (stonefruits, pomefruits) and (b) evergreen (e.g. olive, citrus species) fruit crops (c) nut trees and small fruit crops species of subtropical and tropical origin.

Unit II **16 Lectures**

Origin-spread, botanical classification, Economic importance-applications, Specific requirements for cultivation (soil management, fertilization, pruning, thinning, irrigation), Climate and soil, Propagation (rootstocks), Pruning, Pollination, Fertilization, Fruit growth, Harvest, Cultivars, Pests, Diseases, Physiological disorders

Unit III **16 Lectures**

Registration procedure with new cultivars, vegetative and generative pomological traits, Botanical classification of cultivars and characteristics of the important traits. Planning and layout of orchards, preparation of land for orchard development, selection of planting materials and transplanting, protection of young plants, orchard management systems

Unit IV **12 Lectures**

Fruit preservation, present status, future prospecting nutritive value of fresh and processed fruits, Brief account on principles and methods of refrigeration, canning dehydration and chemical preservation.

Practical **60 Hours**

1. Lectures and field trips to local orchards to include every type of fruit tree in the area
2. Development of nursery for at least 5 types of trees with regular detailed notes
3. Study of pathological diseases and their control. Study of Physiological disorders of the fruit trees, identifying the cause and application of solution
4. Study of economics of the Fruit farming.
5. Understanding the formulations and preparation of fertilizer and pesticides solutions.
6. Learning of basic pruning and grafting techniques.

Suggested Readings

Bal, J.S. (2014). Fruit Growing. Kalyani Publishers.
Pareek, O.P. and Sharma (2017). Systematic Pomology, Vol. I & II. Scientific Publishers.
Chattopadhyay, T. K. (2014) A Text Book on Pomology – Vol I-IV. Kalyani Publishers.

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संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

BOT-DE-362: APPLIED MICROBIOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students acquire knowledge on the application of microbiology: concepts, tools and techniques on Microbial culture, Microbes and Soil fertility, Waste management and bioremediation, Food microbiology, Fermentation Technology and Industrial Microbiology.

Learning outcomes

On completion of this course the students will be able to:

- Understand concepts of applied microbiology.
- Isolate and maintain cultures of microorganisms and study their characteristic features.
- Conceptualize the importance and applications of microbes in human welfare.

Keywords: Microbes, Culture techniques, Microbes and Human welfare.

Unit I **15 Lectures**

The microbial world: Major domains and their general characteristics. Nutritional types of microorganisms. Culture media and its types, Maintenance and preservation of pure cultures.

Tools and techniques for identification of bacteria: Staining methods, culture methods, biochemical tests, other recent methods.

Microbial culture techniques: Isolation, purification and maintenance of Bacteria, Fungi, Actinomycetes.

Microbial growth: Definition, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate, Effect of environment on the microbial growth (temp. pH and others). Physical and Chemical methods of microbial control.

Unit II **12 Lectures**

Microbes and Soil fertility: Microbial decomposition of organic matter; microbial enzymes and nutrient re-cycling. Plant Growth Promoting Rhizobacteria and Fungi: Nitrogen fixing microorganisms (symbiotic, non-symbiotic and associative). Phosphate solubilizing microorganisms; Ectomycorrhiza and Arbuscular mycorrhiza. Biofertilizer and Biopesticide production.

Waste management and bioremediation: Applications of microbes in waste management and bioremediation.

Unit III **15 Lectures**

Food microbiology: Microbes as source of food, Microbial spoilage of food and food products, Principles and methods of food preservation, Major microbial enzymes and their application in food industry. Concept of food borne diseases.

Fermented foods: Definition, popular dairy based and other fermented foods in India.

Probiotic foods and supplements: Concept, Health benefits, types of microorganisms used, Consumer products available in the market.

Unit IV **18 Lectures**

Fermentation Technology: Introduction to fermentation processes, Isolation, preservation and improvement of industrially important microorganisms, Components of a typical bioreactor, Batch, Fed-batch and continuous fermentations, Solid-state and liquid-state fermentations;. Substrates for industrial fermentation. Sterilization, Development of inoculums, aeration. Steps in Down-stream processing.

Microbial production of Industrial products: Citric acid, Ethanol, Penicillin, Single Cell Protein, Enzymes (amylase, protease, lipase) and Biofuels. Biopharmaceutical products of microbial origin.

Practical **60 Hours**

1. Microbiology Good Laboratory Practices and Biosafety.
2. Principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, pH meter, light microscope).
3. Use of laminar flow autoclave, incubator, BOD incubator, hot air oven, pH meter.
4. Practice of cleaning and disinfecting of the glassware/plasticware

5. Preparation of culture media for bacterial and fungal culture.
6. Sterilization of medium using Autoclave and assessment for sterility.
7. Sterilization of glassware using Hot Air Oven and assessment for sterility.
8. Isolation and pure culturing of bacteria and fungi from rhizosphere /water samples.
9. Measurement of Microbial growth.
10. Estimation of CFU count by spread plate method.
11. Simple staining, Gram's staining, Acid fast staining (permanent slide only), Capsule staining.
12. Assessment of microbiological quality of water.
13. Visit to some nearby Fermentor, Malt or wine industry
14. Preparation of wine from grapes or beer from rice/grains

Suggested Readings

Singh, R.P. (2018). Microbiology, 4th Ed. Kalyani Publishers

Schlegel, H.G. and Zaborosch, C. (2008). General Microbiology 7th Edition, Cambridge Publications

Madigan, M.T., Martinko, J.M. and Parker, J. (2014). Brock Biology of Microorganisms. 14th Ed. Pearson/ Benjamin Cummings

Holt, John, G. (c1994). Bergey's Manual of Determinative Bacteriology 9th Edition, Baltimore: Williams and Wilkins.

Subba Rao N.S. (2000). Soil Microorganisms and Plant Growth, 4th Ed., Oxford and IBH.

Rangaswami, G. and Bagyaraj, D.J. (2006) Agricultural Microbiology. 2nd Edition, PHI Learning.

Kannaiyan, S. Kumar, K. and K. Govindarajan. 2013. Biofertilizers Technology. Scientific Publishers.

Okafor, N., Benedict, C. and Okeke. (2017). Modern Industrial Microbiology and Biotechnology. Taylor & Francis.

Sivakumaar, P.K. (2010). An Introduction to Industrial Microbiology. S. Chand publishing.

Casia, J.R.L.E (2009). Industrial Microbiology. New Age International (P) Ltd. New Delhi.

Pradipta, K. and Mohapatra, I.K. (2008). Textbook of Environmental Microbiology. I. K. International Pvt. Ltd.

Vivek Kumar. (2012). Laboratory Manual of Microbiology. Scientific Publishers.

Pareek, R.P. and Pareek, Navneet. 2019. Agricultural Microbiology. Scientific Publishers.

Dubey, R. C. and Maheshwari, D. K. 2013. A Textbook of Microbiology, 4/e. S. Chand Publishing

Arora, B. and Arora, D.R. (2007). Practical Microbiology. CBS Publishers and Distributors.

Karwa, A.S., Rai, M.K. and Singh, H. B. (2008). Handbook of Techniques in Microbiology, Scientific Publishers.

Saxena, J., Bauntiyal, M. and Ravi, I. (2012). Laboratory Manual of Microbiology, Scientific Publishers.

Cappucino, J. and Sherman, N. (2014). Microbiology: A Laboratory Manual. 10th Ed. Pearson.

BOT-DE-363: PLANT PATHOLOGY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students acquaint with various plant diseases, causal organisms and their control, Parasitism and Disease Development (Disease Symptoms, Disease cycle), Host-Pathogen Interaction and Management of Plant Diseases.

Learning outcomes

On completion of this course the students will be able to:

- Know various types of plant diseases and process of their development.
- Conceptualize the role of environment on disease development and various methods of disease management.
- Identify and manage diseases of some major crop of the region.

Keywords: Plant diseases, symptoms, disease cycle, epidemiology, disease management.

Unit I **06 Lectures**

Plant diseases: Definition, concept and characteristic features. Types of Plant Diseases: Abiotic and Biotic. Scope and Importance of Plant disease study. Pathogen and Parasite: Definition, concept and characteristic features and types.

Unit II **12 Lectures**

Parasitism and Disease Development: The Disease Triangle-Host, Pathogen and Environment.

Disease Symptoms- Concept and characteristic features; disease symptoms of: Bacterial, Fungal, Viral, Mollicutes and Mycoplasma disease.

Disease cycle: Definition, concept and characteristic features; the steps of disease cycle; Epidemiology and disease forecasting.

Unit III **15 Lectures**

Host-Pathogen Interaction: Chemical and physical factors, genetic factors. Role of enzymes and toxins of pathogen in plant diseases

Altered Physiology of Diseased Plant: Photosynthesis; Translocation; Respiration; Growth and Reproduction.

Defense Mechanism of Host: The mechanism of host defense; Structural and Chemical Defense.

Unit IV **27 Lectures**

Management of Plant Diseases: Regulatory, Cultural, Biological, Physical and Chemical Control methods.

Study of symptoms, causal organism, disease cycle and control measures of important crops of Northeast India - Rice, Maize, Potato, Cabbage, Mustard, Chilly, Tomato, Brinjal, Orange, Apple, Grapes, Kiwi, Tea and Timbers.

Practical **60 Hours**

1. Collection of diseased parts of plants and Identification of symptoms of fungal, bacterial, viral and insect diseases.
2. Study of the symptoms of important diseases and their causal organisms of the following plants: Rice, Maize, Potato, Cabbage, Mustard, Chilly, Tomato, Brinjal, Orange, Apple, Grapes, Kiwi, Tea and Timbers.
3. Understanding the formulations and preparation of pesticides solutions.

Suggested Readings

Singh R.P. (2019). Plant Pathology. 3rd Edition. Kalyani Publishers.

Singh, R.S. (2009). Plant Diseases, Oxford & IBH Publications, New Delhi.

Mehrotra, R.S. and Agrawal, A. (2006). Plant pathology. 6th Ed. Tata-McGraw Hill, New Delhi

Rangaswami, G. and Mahadevan, A. (2004). Diseases of Fruits and Vegetable Crop Plants in India. 4th Ed. Prentice Hall of India Pvt. Ltd., New Delhi.

Agrios, G. N. (2005). Plant Pathology, 5th Edition, Department of Plant Pathology, University of Florida, Elsevier Academic Press Publication,

Dickinson, M. (2003). Molecular Plant Pathology, School of Biosciences, University of Nottingham, UK, Bios Scientific Publishers, Taylor & Francis Group.

Vidhyasekaran, P. (2004). Concise Encyclopedia of Plant Pathology by The Haworth Press Inc. Press Publication

Strange, R. N. (2003). Introduction to Plant Pathology, University College London, Wiley & Sons Publication.

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Rono Hills, Doimukh (A.P.)

BOT-DE-364: BIO-ANALYTICAL TECHNIQUES

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of the course is to make students gain knowledge on various techniques and instruments used for the study of plant biology.

Learning outcomes

On completion of this course the students will be able to:

- Develop conceptual understanding of cell fractionation.
- Classify different types of chromatography techniques.
- Explain the principle and application of various microscopic techniques.
- Apply suitable strategies in data collections and disseminating research findings.

Keywords: HPLC, Fluorochrome, AGE, PAGE, FACS, SEM, TEM

Unit I: Cellular Fractionation and Separation Techniques **14 Lectures**

Good laboratory practices, Cell fractionation, Cell wall degradating enzymes, Sedimentation of cellular particles, Mobility of particles under external centrifugal forces, type of centrifugation: Differential and density gradient centrifugation, type of rotors, analytical centrifugation for estimation of mass of biological molecules, Svedberg equation, ultracentrifugation and applications.

Unit II: Characterization of Biomolecules **16 Lectures**

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography. Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE.

Unit III: Visualization Molecules in Living Cells **16 Lectures**

Principles of microscopy; Light microscopy; compound 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. Use in biological research, auto-radiography, pulse chase experiment.

Unit IV: Data Collection, Processing and Analysis **14 Lectures**

Data collection methods, 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 **60 Hours**

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

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Suggested Readings

Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. 3rd edition, John Wiley & Sons.

Kitson, F.G., Larsen, B.S., McEwen, C.N. (1996). Gas Chromatography and Mass Spectrometry: A Practical Guide. 1st Edition. Academic Press.

Lioyd R. Snyder, Joseph J. Kirkland, Joseph L. Glajch (1997). Practical HPLC Method Development. 2nd edition. Wiley-Interscience.

O David Sparkman, Zelda Penton, Fulton Kitson (2011). Gas Chromatography and Mass Spectrometry: A Practical Guide. 2nd Edition. © Academic Press.

Plummer, D.T. (1996). An Introduction to Practical Biochemistry. 3rd edition. Tata McGraw-Hill Publishing Co. Ltd. New Delhi.

Robert P. A. (2001). Identification of essential oil components by gas chromatography/ quadrupole mass spectroscopy. Carol Stream, Ill. : Allured Pub. Corp., ©2001.

Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

Zar, J.H. (2012). Biostatistical Analysis. 4th edition. Pearson Publication. U.S.A.

BOT-DE-369: PROJECT WORK (DISSERTATION)

(Credit Distribution L0:T0:P6 = 6 Credits)

Course Objective

The aim of this course is to provide an active learning experience to the students through minor projects, and nurture under the guidance of a mentor their analytical thinking and problem solving skills.

Learning Outcomes

On completion of this course the students will be able to:

- Acquire critical thinking and skills to plan and execute a minor research project.
- Properly collect and analyze data.
- Develop written and verbal presentation skills.

Students may opt for dissertation in lieu of any one DSE paper. The topic of dissertation work, either field based or lab based, shall be decided in the beginning of the VI semester by the faculty committee of the Botany department of affiliated colleges giving due consideration to the choice of the students and the facilities available in the department. The dissertation has to be submitted by the students before completion of the semester examination.

Internal assessment and Final evaluation of the dissertation shall be done as per the provisions mentioned in the regulation cited above.

The marking for the dissertation shall is as follows:

Report: 50 Marks, Presentation: 10 Marks, Viva-Voce: 20 Marks.

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Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

ABILITY ENHANCEMENT CUMPULSORY COURSES (AEC)

ENG-AE-111 Communicative English

Credit: L3:T1:P0 Lecture Hour: 40

Course Objective

The course aims to train learners to be more effective at communicating successfully in interviews, public speaking, letter writing, report writing, presentations, and inter-personal debates and conversations. The learner also imbibes the fundamentals of communication and the art of persuasive speaking and writing which depends crucially on clarity of thought and contextual understanding expressed through appropriate vocabulary.

Learning Outcomes

After completion of the course, learners will be able to master the art of persuasive speech and writing, the art of listening, reading, and analysing; spend the bulk of their time in class in practical exercises of reading and writing; develop critical thinking skills; and they will be introduced to established principles of academic reading and writing. Other specific outcomes:

- Identify deviant use of English both in written and spoken forms
- Recognize the errors of usage and correct them and write simple sentences without committing errors of spelling and grammar
- Developing own competence in using the language
- Understand and appreciate English spoken by others
- Use language for speaking with confidence in an intelligible and acceptable manner
- Understand the importance of reading for life and develop an interest for reading
- Read independently unfamiliar texts with comprehension
- Understand the importance of writing in academic life and career.

Module 01: **Poetry:** William Shakespeare – All the World is a stage; William Wordsworth – I wondered lonely as a Cloud; Ralph Waldo Emerson – The Mountain and the Squirrel; Emily Dickinson – Success is Counted Sweetest; Robert Frost - Stopping by Woods on a Snowy Evening; Rabindranath Tagore – Where the Mind is without Fear; A. K. Meherotra – Songs of the Ganga.

Module 02: **Short Stories:** R.K. Narayan – Lawly Road; Mulk Raj Anand – Barbar's Trade Union; Somerset Mangham – The Luncheon; Guy De. Maupassant – The Necklace; Anton Chekhov – The Lament; O' Henry – The Last Leaf; Manoj Das – The Submerged Valley.

Module 03: **One-Act Plays and Short Fiction:** (a) Norman Mckinnell - The Bishop's Candle Sticks; Anton Chekov – A Marriage Proposal; Eugene Lonesco – The Lesson; August Strandberg – Miss Jullie; Fritz Karinthy– Refund; (b) Harper Lee – To kill a Mocking Bird, (Or) R. K. Narayan – Vendor of Sweets.

Module 04: **Fundamentals of Grammar:** Parts of speech, Articles and Intensifiers, use of tense forms, Use of Infinitives, Conditionals, Adjectives and Adverbs, Prepositions, Making Affirmative, Negative and Interrogative, Making Question Tag.

Module 05: **Composition Practice:** (a) Comprehension, Précis Writing, Paragraph Writing (150 words), Letter writing – Personal, Official, Demi-official, Business, Public speaking, Soft Skills, Interviews, Preparing Curriculum Vitae, Report (Meetings and Academic) writing; (b) Communication Practice – Introducing yourself, Introducing people to others, Meeting People, Exchanging Greetings, Taking Leave, Answering the Telephone, Asking Someone for Some Purpose, Taking and Leaving Messages, Call for help in emergency.

Module	Weightage of Marks	Theory	Practical
Module 01	20%	✔	
Module 02	20%	✔	
Module 03	20%	✔	
Module 04	20%	✔	✔
Module 05	20%	✔	✔

Practical Exercises

The students are required to:

1. know dictionary and its types, mapping a dictionary to locate words, and multiple uses of dictionary/ies
2. know the uses of Thesaurus/Lexicon/Activator/Encyclopaedia
3. know Note making/taking
4. know information transfer exercises
5. know the usage library resources properly
6. know citing references or developing a bibliography
7. Edit a piece of self and peer writing, writing and revising the drafts and preparing the final draft
8. Understand and appreciate the principle of politeness in relation to the speaker/ listener, debating, ex-tempore speeches, and other discourses.

Suggested Readings

Crystal, David (1985) Rediscover Grammar with David Crystal. Longman.

Hewings, M. (1999) Advanced English Grammar. Cambridge University Press.

Bakshi, R. N. A course in English Grammar, Orient Longman

Krishnaswamy, N. Modern English – A Book of Grammar, Usage and Composition. MacMillan India Ltd.

Bailey, Stephen (2003). Academic Writing. London and New York, Routledge.

Grellet, F (1981). Developing Reading Skills: A Practical Guide to Reading Skills. New York, CUP

Hedge, T. (2005). Writing. London, OUP

Kumar, S and Pushp Lata (2015). Communication Skills. New Delhi, OUP

Lazar, G. (2010). Literature and Language Teaching. Cambridge, CUP

Nuttall, C (1996). Teaching Reading Skills in a Foreign Language. London, Macmillan

Raman, Meenakshi and Sangeeta Sharma (2011). Technical Communication: Principles and Practice. New Delhi, OUP

Note: Students are advised to use latest edition of text books. For reading the texts, available sources of texts and help of the Web source may be taken.

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Rono Hills, Doimukh (A.P.)

HIN-AE-111 हिंदी शिक्षण (Hindi Sikshan)

क्रेडिट (Credit): L3:T1:P0 व्याख्यान घंटे (Lecture Hours): 40

(यह पत्र प्रथम सत्र में हिन्दी कौशलाधारित पाठ्यक्रम चुनने वाले सभी विद्यार्थियों के लिये हैं। यह पत्र चार इकाइयों में विभक्त है। प्रत्येक इकाई के लिये व्याख्यानों की संख्या निर्धारित हैं)

उद्देश्य: *सामाजिक, व्यवसायिक, कार्यालयी तथा शैक्षणिक परिप्रेक्ष्य में विद्यार्थियों के भाषा-कौशल में निखार लाना। विद्यार्थियों में प्रतिस्पर्धात्मक परीक्षाओं एवं साक्षात्कार हेतु आत्मविश्वास उत्पन्न करना। विद्यार्थियों में रचनात्मक कौशल विकसित करना। भाषा-ज्ञान के माध्यम से विद्यार्थियों को रोजगारोन्मुख शिक्षा प्रदान करना।*

इकाई 1: राष्ट्रीय एवं अन्तरराष्ट्रीय परिप्रेक्ष्य में हिन्दी का महत्त्व; मानक हिन्दी और बोलचाल की हिन्दी में अन्तर; स्वागत भाषण, भाषण, विषय प्रवर्तन तथा धन्यवाद ज्ञापन। व्याख्यान – 10

इकाई 2: आलेख रचना: सम्पादक के नाम पत्र, सम्पादकीय लेखन, स्तम्भ लेखन, पत्र पत्रिकाओं के लिये आलेख रचना-; आकाशवाणी एवं दूरदर्शन हेतु वार्ता, साक्षात्कार एवं परिचर्चा तैयार करने की विधियाँ। व्याख्यान – 10

इकाई 3: व्यावहारिक लेखन: कार्यालयी पत्राचार; प्रेस विज्ञप्ति; सूचना ; ज्ञापन; कार्यसूची; कार्यवृत्त; प्रतिवेदन; सम्पादन; संक्षेपण; आत्मविवरण तथा ईमेल लेखन-, फेसबुक, ब्लॉग और ट्वीटर लेखन। व्याख्यान – 10

इकाई 4: सृजनात्मक लेखन: कविता, कहानी, नाटक तथा एकांकी, निबंध, यात्रावृत का स्वरूप विवेचन। व्याख्यान – 10

उपलब्धियां -हिंदी शिक्षण से सम्बन्धित इस पत्र में विद्यार्थी हिन्दी भाषा के व्यावहारिक स्वरूप तथा प्रयोजनमूलक हिन्दी के क्षेत्र लेखन से जुड़ी बहुविध जानकारियों से परिचित हुए। हिन्दी भाषा की बढ़ती लोकप्रियता और बढ़ते अन्तरराष्ट्रीय महत्त्व के सन्दर्भ में हिन्दी भाषा आधारित कौशल विकास से विद्यार्थियों को अवगत कराया गया। विशेषकर आलेख रचना के अतिरिक्त व्यावहारिक एवं सर्जनात्मक लेखन से जुड़ी बारीकियों को जान सके।

कार्य सम्पादन पद्धति: व्याख्यान, विचारविमर्श-, समूहचर्चा-, सामग्री-समीक्षा और प्रस्तुतीकरण आदि।

Module	Weightage of Marks	Theory	Practical / Numerical
Module 01	25%	✔	✔
Module 02	25%	✔	✔
Module 03	25%	✔	✔
Module 04	25%	✔	

सहायक ग्रन्थ

1. अच्छी हिन्दी : रामचन्द्र वर्मा
2. व्यवहारिक हिन्दी व्याकरण और रचना : हरदेव बाहरी
3. हिन्दी भाषा : डॉ भोलानाथ तिवारी
4. रेडियों लेखन : मधुकर गंगाधर
5. टेलीविजनः सिद्धान्त और टैकनिक : मथुरादत्त शर्मा
6. प्रयोजनमूलक हिन्दी : डॉ दंगल झाल्टे
7. सरकारी कार्यालयों में हिन्दी का प्रयोग : गोपीनाथ श्रीवास्तव, राजकमल, दिल्ली
8. टेलीविजन लेखन : असगर वजाहत / प्रेमरंजन; राजकमल, दिल्ली
9. रेडियो नाटक की कला : डॉ सिद्धनाथ कुमार, राजकमल, दिल्ली
10. रेडियो वार्ता शिल्प : सिद्धनाथ कुमार, राजकमल, दिल्ली

EVS-AE-121: ENVIRONMENTAL STUDIES

Credits: L4:T0:P0 = 4 Credits Lecture Hours: 60

Course Objective

The objective of this paper is to provide basic concept of on Environment, Ecology, Natural Resources, Importance of biodiversity and need for their conservation along with various environmental issues and Govt. policies, and Environmental movements.

Learning outcomes

- Learners will be able to understand environment science and its importance.
- Learners will understand the various types of pollution and hazards caused by them.
- Learners will understand ways to monitor environment and the various green technologies.
- Learners will know the various Acts enacted for the protection of the environment.

Key Words: Environment, Ecosystem, Natural Resources, Biodiversity, Environmental Issues and Policies

Unit I: Basic Concept of Environment **12 Lectures**

Environment: Definition, scope and importance; Multidisciplinary nature of environmental studies. Concept of sustainability and sustainable development.

Ecosystem – Concept, Structure and function; Energy flow in an ecosystem: food chains, food webs, ecological pyramid. Ecological succession. Ecosystem services.

Unit II: Natural Resources **12 Lectures**

Land as a resource, Land use patterns, land degradation, soil erosion and desertification.

Forest Resources, Use and over-exploitation; Deforestation - causes and impacts on environment.

Water Resources, Use and over-exploitation of surface and ground water; floods, droughts, Case studies on conflicts over water (international & inter-state).

Energy Resources, Renewable and non-renewable energy sources, growing energy needs, use of alternate energy sources.

Traditional ecological knowledge.

Unit III: Biodiversity and Conservation **12 Lectures**

Biodiversity: Definition, levels (genetic, species and ecosystem diversity) and values; Biogeographic zones of India; Biodiversity hot spots. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions.

Conservation of biodiversity: *In-situ* and *Ex-situ* conservation of biodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit IV: Environmental Issues and Policies **24 Lectures**

Environmental pollution: types, causes, effects and controls of Air, water, soil, noise, solid waste and nuclear pollution.

Global environmental issues: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

Salient features of Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Paris agreement, Nagoya Protocol.

Human Communities and the Environment: Human population growth: Impacts on environment, human health and welfare.

Disaster management: Floods, Earthquake, Cyclones and Landslides.

Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.

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Suggested readings

Bharucha, E. 2020. Textbook for Environmental Science for undergraduate students. University Grants Commission, New Delhi.

Gupta Abhik and Gupta Susmita. 2021. Environmental Studies: Principles and Practices. 344 pages, SAGE Texts.

Ahluwalia, V.K.. Environmental Studies. 2nd Ed. TERI Press.

Kaushik Anubha and Kaushik, C.P. 2018. Perspectives in Environmental Studies. 6th Ed. New Age International Pvt. Ltd.

Krishnamurthy, K. V. 2020.An advanced textbook on Biodiversity: Principles and Practice. CBS Publisher and Distributors

Ambasht, R. S. and Ambasht, P.K. 2017. Environment and Pollution an Ecological Approach 5th Ed. CBS Publisher and Distributors.

Ambasht, R. S. and Ambasht, N.K. 2017. A textbook of Plant Ecology. 15th Ed. CBS Publishers and Distributors, New Delhi.

Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

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SKILL ENHANCEMENT COURSE (SEC)

BOT-SE-001: ORGANIC FARMING

(Credit Distribution L2:T0:P0 = 2 Credits)

Course Objective

The objective of the course is to make students gain knowledge on Organic Agriculture and farming and use of eco-friendly biofertilizers like Azospirilium Azotobactor, and mycorrhizae (VAM), their identification, multiplication and recycling of the organic waste.

Learning outcomes

On completion of this course the students will be able to:

- Develop their understanding on the concept of Organic agriculture, Certification Process, Product Labeling and Regulatory Mechanisms.
- Identify the different forms of Organic Manures and biofertilizers, methods of their production and application for better crop production and their uses.

Keywords: Organic agriculture, Certification, Product Labeling, Organic Manures, Biofertilizers

Unit I: Organic Agriculture **07 Lectures**

– Concept and origin; The principles of Organic Agriculture; Comparative perspective of Organic and Conventional Agriculture; Organic Agriculture in the world and in India.

Unit II: Organic Certification **08 Lectures**

Organic Certification– Certification Process, Product Labeling; Regulatory Mechanisms for Organic Certification in India. National Standards for Organic Production.

Unit III: Organic Manures **07 Lectures**

Organic Manures– Types and advantages of organic manures, Humification. Composting– types and factors influencing composting; Vermi-composting and Benefits. Bio-compost – Preparation, application and storage using organic waste materials.

Unit IV: Biofertilizers **08 Lectures**

Types, advantages and applications, Methods of Biofertilizer production (*Azospirillum*, *Azotobacter*, VAM); Advantages and disadvantages of Biofertilizers.

(Note: *Students' visit to a local organic composting production facility and organic farming plot should be arranged by the Institution)*

Suggested Readings

Maliwal, P.L. (2021). Principles of Organic Farming: Text Book. Scientific Publishers.

Palaniappan, S.P. and Annadurai, K. (2014). Organic Farming Theory & Practice. Scientific Publishers.

Sharma, A.K. (2018). A Handbook of Organic Farming. Agrobios Publishers, India.

Veeresh, G. K. (2010). Organic Farming. Foundation Books, Cambridge University Press.

Alexander Mc Gregor, Lynn Pugh and Jerry Larson (2009). Fundamental of Organic Farming and Gardening. Georgia Organics.

Ann Larkin Hansen (2010). The Organic Farming Manual (A Comprehensive Guide to Starting and Running a Certified Organic Farm). Storey Publishing LLC.

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BOT-SE-002: MUSHROOM CULTIVATION

(Credit Distribution L1:T0:P1 = 2 Credits)

Course Objective

The objective of this paper to make aware student about the edible mushrooms (nutritional and medicinal mushrooms), mushroom growing techniques and their Post-harvest handling and marketing.

Learning outcomes

On completion of this course the students will be able to:

- Learn the importance, prospect and suitable cultivation techniques for various types and categories of mushrooms.
- Understand the role of nutritional and environmental factors in mushroom production, and management the diseases of mushrooms.
- Know the Government Schemes and Policies for mushroom cultivation

Keywords: Edible mushrooms, Cultivation techniques, Diseases, Post-harvest handling of produces, Government Policies and Funding.

Unit I **02 Lectures**

Edible mushrooms – Types, nutritional and medicinal importance; Global and National Scenario of mushroom production and marketing; Mushroom production: nutritional and environmental factors; Prospect of Mushroom Cultivation in Arunachal Pradesh.

Unit II **03 Lectures**

Basic techniques and steps in Mushroom cultivation – Starter culture, Spawn production and substrate preparation techniques. Substrate supplementation. Casing soil: preparation technique.

Unit III **06 Lectures**

Methods of commercial cultivation for Button (*Agaricus bisporus*), Oyster (*Pleurotus* sp.), Paddy straw (*Volvareriella volvacea*) and Shiitake mushrooms (*Lentinula edodes*). Common fungal and bacterial diseases of mushrooms and their management

Unit IV **04 Lectures**

Post-harvest handling and marketing of mushrooms. Farm design for Button, Oyster, Paddy straw and Shiitake mushrooms. Government Schemes and Policies for mushroom cultivation Entrepreneurships and funding agencies.

Practical **30 Hours**

1. Laboratory techniques and handling of various equipment for Starter culture, Master spawn and commercial spawn production, preservation and handling of spawn.
2. Culture Maintenance and Preservation Techniques
3. Substrate preparation, steam sterilization and chemical treatment method of paddy straw and other locally available cereal straw.
4. Method of wheat straw based Compost; Casing Soil.
5. Mushroom Cultivation of: Oyster mushrooms and Button Mushroom.
6. Identification of common fungal and bacterial diseases of Oyster/Button Mushrooms.

(Note: *Students' visit to a local Mushroom farm should be arranged by the Institution)*

Suggested Readings

Singh, M., Vijay, B., Kamal, S. and Wakchaure, G. C. (2011). Mushrooms Cultivation, Marketing and Consumption: Directorate of Mushroom Research (ICAR), Chambaghat, Solan (HP).

Tripathi, D.P. (2017). Mushroom cultivation. Oxford & IBH Publishing.

Bahl, N. (2018). Handbook of Mushrooms. 4th Ed. Oxford & IBH Publishing.

Kapoor, J.N. (1999). Mushroom cultivation. Publications and Information Division, ICAR, Krishi Anusandhan Bhavan, Pusa, New Delhi-1100012

Stamets, Paul. (2000). Growing Gourmet and Medicinal Mushrooms. 3rd Ed. Ten Speed Press. UK.

BOT-SE-003: BOTANICAL GARDEN AND LANDSCAPING

(Credit Distribution L1:T0:P1 = 2 Credits)

Course Objective

The objective of this paper is to gain knowledge of gardening, cultivation, multiplication, raising of seedlings of various types of plants.

Learning outcomes

After the completion of this course the learner will be able to:

- Apply the basic principles and components of gardening
- Conceptualize flower arrangement and bio-aesthetic planning
- Design various types of gardens according to the culture and art of bonsai
- Distinguish between public garden, formal, informal and free style gardens
- Establish and maintain special types of gardens for outdoor and indoor landscaping

Keywords: Gardening, Landscaping, Flower arrangement, Vertical gardens, Roof gardens, Computer aided designing

Unit I **03 Lectures**

Garden – definition, components, adornments, lawn making, methods of designing rockery, water garden etc.; Greenhouse & conservatories; garden walk-paths, bridges, constructed features.

Unit II **04 Lectures**

Nursery techniques on medicinal plants, timber, fruits and ornamental plants; Flower arrangement: production details and cultural operations, constraints, post-harvest practices; Herbs, shrub, climbers and tree garden. Concept of Moss garden: design, establishment, maintenance.

Unit III **04 Lectures**

Vertical gardens, roof gardens; Art of making bonsai; Parks and public gardens: Landscape designs, Styles of garden, formal, informal and free style gardens; Urban landscaping, Landscaping for government office premises, educational institution.

Unit IV **04 Lectures**

Garden: Establishment and maintenance, special types of gardens; Bio-aesthetic planning, ecotourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water-scaping, xeri-scaping, hard-scaping; Exposure to Computer Aided Designing (CAD) for outdoor and indoor-scaping.

Practical **30 Hours**

Note: Suitable practical may be conducted using available facilities. Students' visit to established gardens in Arunachal Pradesh and adjoining areas should be arranged by the Institution.

1. Methods of mass propagation and Nursery techniques on medicinal plants, ornamental and various categories of plants.
2. Identification of pathogenic and non-pathogenic diseases of garden plants and grasses.
3. Hydroponics of herbs.
4. Cultivation of ornamental aquatic plants.
5. Exposure to Computer Aided Designing (CAD) for outdoor and indoor-scaping.

Suggested Readings

Bhattacharjee, S.K. (2004) Landscape Gardening and Design with Plants. Aavishkar Publishers and Distributors, Jaipur.

Nambisan, K.M.P. (1992). Design Elements of Landscape Gardening. Oxford & IBH, New Delhi.

Iyenger, Gopalswamy. (1990). Complete Gardening in India. IBH, Bangalore.

Butts, E. and Stensson, K. (2012). Sheridan Nurseries: One hundred years of People, Plans, and Plants. Dundurn Group Ltd.

Russell, T. (2012). Nature Guide: Trees: The world in your hands (Nature Guide).

Singh Paramjit and Dash, Sudhansu S. (2017): Indian Botanic Gardens - Role in Conservation. Botanical Survey of India, Kolkata.

Nayar, M. P. (1987): Network of Botanic Gardens. Botanical Survey of India, Kolkata.

Oldfield Sara (2010): Botanic Gardens: Modern-Day Arks. MIT Press, One Rogers Street, Cambridge.
Lane Mark (2020): Royal Gardens of the World: 21 Celebrated Gardens from the Alhambra to Highgrove and Beyond. Kyle Books, UK.

BOT-SE-004: NURSERY AND GARDENING

(Credit Distribution L1:T0:P1 = 2 Credits)

Course Objective

The objective of this paper is to gain knowledge of nursery bed preparation, seed types, seed selection and seed production technology, multiplication by vegetative propagation and gardening.

Learning outcomes

On completion of this course, the students will be able to:

- Understand the concept of Nursery, process of sowing seeds in nursery
- List the various resources required for the development of nursery
- Distinguish among the different forms of sowing and growing plants
- Analyze the process of Vegetative propagation
- Understand concept of Garden & Landscaping, appreciate the diversity of plants and selection of gardening
- Examine the cultivation of different vegetables, medicinal plants and growth of plants in nursery and gardening

Keywords: Nursery, Gardening, Seed dormancy, Vegetative propagation, Seedlings, Landscape

Unit I **03 Lectures**

Nursery: definition, objectives and scope; Nursery infrastructure: planning, design and seasonal activities; Preparation of organic manure; Planting - direct seeding and transplants.

Unit II **03 Lectures**

Seed: Structure and types. Seed dormancy: causes and methods of breaking dormancy. Seed storage: Seed banks, factors affecting seed viability, genetic erosion. Seed production technology, seed testing and certification.

Unit III **03 Lectures**

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings; Hardening of plants in green house, mist chamber, shed roof, shade house and glasshouse.

Unit IV **06 Lectures**

Gardening: definition, objectives and scope; Garden Landscaping; different types of gardening; Sowing, raising of seeds and seedlings; Transplanting of seedlings.

Cultivation of different economic crops: ornamental (Rose, Anthurium, Aroids, Orchids), timber (Hollock), medicinal (Turmeric, Garlic, Kalmegh, Tulsi), fruits (Jackfruit), vegetables (Tomato & Cabbage). Storage of produced and marketing.

Practical **24 hour**

Note: Practical may be conducted using available facilities. Students' visit to nursery, green house, mist chamber, etc. in nearest locality should be arranged by the Institution.

1. Establishment of cost effective Nursery Unit: design and development
2. Establishment of Garden for economic plants (Vegetable, fruits and medicinal plants): design and development
3. Identification of different types of seeds.
4. Methods of breaking seed dormancy.
5. Preparation of organic manure, vermicompost, etc.
6. Methods of mass propagation and Nursery techniques for various categories of plants.

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7. Planting techniques for various plants mentioned in the syllabus (Rose, Anthurium, Aroids, Orchids), timber (Hollock), medicinal (Turmeric, Garlic, Kalmegh, Tulsi), fruits (Jackfruit), vegetables (Tomato & Cabbage).

Suggested Readings

Ray, P.K. (2020). Essentials of Plant Nursery Management. Scientific Publishers.

Sagwal, S.S. (2020). Forest Nursery: How to Raise and Manage. Scientific Publishers.

Bose T.K. and Mukherjee, D. (1972). Gardening in India, Oxford & IBH Publishing Co., New Delhi.

Bhattacharjee, S.K. (2004) Landscape Gardening and Design with Plants. Aavishkar Publishers and Distributors, Jaipur.

Sandhu, M.K. (1989) Plant Propagation. Wile Eastern Ltd., Bengaluru.

Kumar, N. (1997) Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.

Edmond Musser & Andres. Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.

Agrawal, P.K. (1993). Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.

Janick Jules (1979). Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

Sara Oldfield (2010): Botanic Gardens: Modern-Day Arks. MIT Press, One Rogers Street Cambridge, MA 02142-1209.

Butts, E. and Stensson, K. (2012). Sheridan Nurseries: One hundred years of People, Plans, and Plants. Dundurn Group Ltd.

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GENERIC ELECTIVE (GE) COURSES

BOT-GE-001: MICROBES AND CRYPTOGAMS

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of this paper is to gain knowledge of general characteristics, life cycles of viruses, bacteria, algae, fungi, lichens, bryophytes and pteridophytes and theirs importance.

Learning outcomes

On completion of this course, the students will be able to:

- Develop understanding about microbial world and their Life Cycle.
- Classify them based on their characteristics and structures.
- Develop critical understanding of Classification, structures and life cycles of Bryophytes and Pteridophytes.
- Conduct experiments using skills appropriate to these organisms.

Keywords: Viruses, Bacteria, Algae, Fungi, Bryophytes and Pteridophytes

Unit I: Viruses and Bacteria **15 Lectures**

General characteristics of viruses, types of viruses on the basis of shape and genetic material. Structure and replication of DNA virus (T4 and λ), lytic and lysogenic cycle; RNA virus (TMV), viroides and prions. Economic importance of viruses.

General characteristics of bacteria. Basic concept about Archaebacteria, Eubacteria and mycoplasma.

Bacterial cell structure; Reproduction and recombination (conjugation, transformation and transduction). Binary fission and endospore. Economic importance of bacteria.

Unit II: Algae **15 Lectures**

General characteristics, outline classification and economic importance of algae. Thallus organisation, reproduction and life cycle in *Nostoc*, *Oscillatoria*, *Chlamydomonas, Volvox, Oedogonium, Cladophora, Chara, Vaucheria, Ectocarpus* and *Polysiphonia.*

Unit III: Fungi and Lichens **15 Lectures**

General characteristics, outline classification and economic importance of fungi. Thallus organisation, reproduction and life cycle in *Synchytrium*, *Saprolegnia*, *Albugo*, *Mucor, Penicillium, Aspergillus, Peziza, Puccinia, Ustilago, Agaricus, Ganoderma* and *Alternaria.* Lichens: General characteristics, Growth forms methods of reproduction and their importance.

Unit IV: Bryophytes and Pteridophytes **15 Lectures**

General characteristics, outline classification and comparative study of vegetative and reproductive structures of following genera of bryophytes: *Marchantia, Anthoceros* and *Polytrichum.*

General characteristics, outline classification and life cycles of *Psilotum, Lycopodium, Selaginella* & *Marsilea.*

Practical **60 Lectures**

Section A: Morphological study of available algal specimens.
Section B: Study of Fungal specimens as given in the syllabus.
Section C: Work out Bryophytic and Pteridophytic specimens as given in the syllabus.

Suggested Readings

Singh, R.P. 2018. Microbiology. Kalyani Publishers
Dubey, R.C. and Maheswari, D.K. 2005. A Text Book of Microbiology. S. Chand & Company.
Awasthi, A. K. (2015). Textbook of Algae. Vikas Publishing House Pvt. Ltd.
Sharma, O.P. (2011). A Text Book of Algae. Tata-McGraw Hill Co., New Delhi.
Sharma, P.D. (2017). Mycology and Phytopathology. Rastogi Publications, Merruth, UP.
Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.

Alam Afroz (2019) Textbook of Bryophyta. Wiley Publication.
Sambamurty (2006). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany. IK International Publishers.
Pandey, B.P. (2006). A Text Book of Bryophyta, Pteridophyta and Gymnosperms, IK International Publishing House Pvt. Ltd.
Rashid, A. (2016). An Introduction to Archegoniate Plants. Vikas Publishing House Pvt. Ltd.
Datta, A.C. (1997). Botany for Degree Students. 6th Edition, Oxford University Press, Kolkata.
Gangulee, H.C., Kar, A. K. and Santra, S. C. (2011). College Botany, Vol. II. New Agency, Kolkata.
Pandey B.P (2014): College Botany-Vol-I. S. Chand Publishing Co., New Delhi.

BOT-GE-002: PHANEROGAMS AND PALAEOBOTANY

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of this paper is to gain knowledge on gymnosperms; palaeobotany; Identification, classification, morphology, anatomy, reproduction, phylogeny and economic importance of Angiosperms.

Learning outcomes

On completion of this course, the students will be able to:

On completion of this course, the students will be able to:

- Develop understanding about Phanerogams and their classification and nomenclature.
- Know the morphology, anatomy and reproductive features and phylogeny of Gymnosperm and Angiosperm.
- Develop understanding on salient features, general characters and phylogeny of some selected angiosperm plant families.
- Develop understanding about palaeobotany and fossil types.
- Conduct experiments using skills appropriate these groups.

Keywords: Gymnosperm; Palaeobotany; Angiosperms; Taxonomy & Systematics; ICN; Classification system; Angiosperm families; Salient features; Phylogeny

Unit I: Gymnosperm **12 Lectures**

Gymnosperm: Classification, distribution, morphology, anatomy, gametogenesis, embryology, and economic importance of *Cycas*, *Pinus* and *Gnetum.*

Unit II: Palaeobotany **08 Lectures**

Concept of palaeobotany, Process of fossilization, Fossil types; study of following fossil types: *Rhynia*, *Lyginopteris*, *Williamsonia, Pentoxylon*

Unit III: Angiosperm - Classification, Morphology Anatomy and Reproduction

25 Lectures

Angiosperm: Systems of classification; Concept of plant taxonomy & systematics; taxonomic hierarchy; binomial nomenclature, principles of ICN.

Organization of root and shoot systems; general forms and modification of stem, leaf and root; adaptability of modified forms; tissue organization; General concept of angiospermic flower and floral anatomy, Pollination, Self- incompatibility, Apomixis.

Unit IV Angiosperm Families: Identification, Phylogeny and Economic Importance

15 Lectures

Angiosperm Families: General characters, salient features, phylogeny and economic importance of following angiosperm families: Liliaceae, Orchidaceae, Magnoliaceae, Malvaceae, Rosaceae, Asteraceae, Fabaceae.

Practical **60 Hours**

Section A: Phanerogams

(i) Vegetative, reproductive and anatomical studies of following genera: *Cycas, Pinus, Ginkgo* and *Gnetum.*

(ii) Study of modified angiospermic plant parts.
(iii) Study of essential parts and symmetry of some angiospermic flowers and some special types of inflorescence.
(iv) Pollen viability test by hanging-drop technique in an angiosperm.
(v) Study of some fossil types.

Section B: Anatomy :

(i) Anatomy of primary structure in stems and roots using double staining technique.
(ii) Study of primary and secondary anomalous structures.
(iii) Study of photosynthetic and mechanical tissues.

Suggested Readings

Pandey B.P (2014): College Botany-Vol-I. S. Chand Publishing Co., New Delhi.

Sambamurty (2006). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Palaeobotany. IK International Publishers.

Pandey, B.P. (2006). A Text Book of Bryophyta, Pteridophyta and Gymnosperms, IK International Publishing House Pvt. Ltd.

Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International Publishers, New Delhi, India.

Biswas, C. and B. M. Johri. (1997). Gymnosoperms. Narosa Publishing House. New Delhi.

Pandey, B.P (2013): Taxonomy of Angiosperms. S. Chand & Publishing Co., New Delhi

Singh, G. (2012). Plant Systematics: Theory and Practice. 3rd edition. Oxford & IBH Pvt. Ltd., New Delhi.

Jain, S.K. and Rao, R.R. (1977). Field and Herbarium Methods. Oxford & IBH Pvt Ltd New Delhi.

Pandey, B.P (2012): Plant Anatomy. S. Chand Publishing Co., New Delhi.

Pandey, S. N. and Chadha, A. Plant Anatomy and Embryology. Vikas Pub. House Pvt. Ltd.

Bhojwani, S. S. Dantu, P.K. and Bhatnagar, S. P. The Embryology of Angiosperms, 6/e. Vikas Publishing House Pvt. Ltd.

Singh, Pande and Jain. Embryology of Angiosperms. Rastogi Publication, Meerut, UP.

Pullaiah, T., Lakshminarayana, K. and Hanumantha Rao, B. (2019). Plant Reproduction. 2nd Ed. Scientific Publishers.

Jeffrey, C. (1982). An Introduction to *Plant Taxonomy*. Cambridge University Press, Cambridge.

Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.

BOT-GE-003: ECONOMIC BOTANY AND PLANT RESOURCE UTILIZATION

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of this paper is to gain knowledge on the origin and conservation of cultivated plants like cereals and pulses, plantation crops like sugars yielding plants, spices, beverages, fat and oil yielding plants, aromatic and medicinal plants, timber, rubber and fibre yielding plants.

Learning outcomes

On completion of this course, the students will be able to:

- Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems
- Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership
- Develop a basic knowledge of taxonomic diversity and important families of useful plants
- Increase the awareness and appreciation of plants & plant products encountered in everyday life
- Appreciate the diversity of plants and the plant products in human use

Keywords: Quarantine, germplasm, Cryopreservation, Transgenics, Timber, Aromatic Plants, cereals

Unit I: Origin and conservation of Cultivated Plants **14 Lectures**

Origin, Importance and domestication: Origin of Agriculture and ancient economic botany, Vavilov's Centres of Origin and diversity of crop plants, domestication, evaluation, bioprospection, Major plant introductions; Crop domestication and loss of genetic diversity.

Germplasm augmentation and conservation: History and importance of germplasm collection; Overview of: Ecogeographical distribution of diversity, General account of : Biotechnology in plant germplasm acquisition, plant tissue culture in disease elimination, in vitro conservation and exchange, cryopreservation, transgenics – exchange and biosafety issues.

Plant Quarantine: Principles, objectives and relevance..

Unit II: Cereals and Millets, Pulses and Legumes, Sources of Sugars and Starches

14 Lectures

Origin, evolution and uses of following crops.

Cereals: Wheat, Rice, maize, millets. Pulses: Chickpea, Black gram, Cowpea, Soyabean, Pea, Lentil), and Legumes (lab-lab bean, ricebean, French bean). Sugarcane: processing, products and by-products. Propagation & uses of Sugarbeet and sweet sorghum. Sweet Potato, Yam, Taro and Tapioca.

Unit III: Spices, Beverages, Oil seeds, fats and Essential oils **16 Lectures**

Listing of important spices (Saffron, Cloves, Cardamom, Cinnamon, Tejpat, Nutmeg and Mace, Anise, Cumin, Celery, Tamarind, Vanilla, Asafoetida, Dill, Fenugreek, Fennel), their botanical name, family and part used. Origin, distribution, ecology, botany, cultivation practices, processing of economic plant part/ product, main chemical constituents, and economic importance of following major spices: Turmeric, Ginger, Capsicum, Black Pepper, Coriander.

Beverages (Tea and Coffee): History, origin, growing countries, Botany, cultivation practices, common diseases and pests, major chemical constituents, processing and quality control of economic product.

Oil seeds and fats: General description, classification, extraction and uses of groundnut, coconut, linseed, soybean, mustard.

Essential Oils: General descriptions, uses extraction / distillation of essential oil, chemical constituents of major essential oil yielding aromatic plants, namely Geranium, Lemongrass, Menthol mint, Basil, Eucalyptus, Clove.

Unit IV: Aromatic, Drug-yielding, Medicinal, Timber, Rubber and Fibre yielding plants

16 Lectures

Drug-yielding and Medicinal plants: Fumitories and Masticatories : Processing, therapeutic uses, and health hazards of habit-forming drugs, Botany and cultivation / regulatory practices of such drug yielding plants with special reference to *Papaver, Cannabis* and Tobacco.

Major Medicinal Plants: Botany, Uses, Cultivation and Processing of major medicinal plants, namely: Ashwagandha, Kalmegh, Ghrit Kumari (*Aloe vera*), Amla (*Phyllanthus*), Stevia, Sarpagandha, Digitalis.

Natural Rubber: Pararubber: tapping, processing and uses.

Timber plants and Fibres: General account and Botany of the Tree, wood structure and quality characteristics, and timber processing with special reference to, Saal (*Shorea robusta*), Teak and Pine.

General account of the Fibre yielding plants, Classification based on the origin of fibers, Extraction, processing, morphology and uses of fibers, with special reference to Cotton, Coir, Jute.

Practical **60 Hours**

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, Curcuma 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 *Cymbopogon* spp., Mint, Basil, *Eucalyptus* (specimens/photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of Ashwagandha, Artemisia, Kalmegh, *Phyllanthus*, Satavar, Gilloi, *Digitalis, Papaver* and *Cannabis*.
10. Tobacco: specimen and products of Tobacco.
11. Woods: *Tectona, Pinus*: Specimen, Section of young stem.
12. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Suggested Readings

Alam, Afroz. 2020. A Textbook of Economic Botany and Ethnobotany. IK International Publishing House.

Purohit and Vyas. 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd Ed. Agrobios, India.

Atal, C.K. and Kapur, B.M. (1982). Cultivation and Utilization of Medicinal Plants. CSIR-RRL, Jammu.

Farooqi, A.A. and Sriram, A.H. (2000). Cultivation Practices for Medicinal and Aromatic Crops. Orient Longman Pub.

Sambamurty, AVSS and Subrahmanyam, N.S. (2008). A Textbook of Modern Economic Botany. CBS Publishers & Distributors Pvt. Ltd.

Bhutya, R.K. (2021). Medicinal Plants of India Vol. I & II. Scientific Publishers.

Kumar, N. Spices, Plantation Crop, Medicinal & Aromatic Plants. Medtech Publishers, India.

Patil, D.A. and Dhale, D.A. (2013) Spices and Condiments: Origin, History and Applications. Daya Publishing House, Delhi.

Pandey, B.P. (1999): Economic Botany. S. Chand & Co., New Delhi.

Sarma. O.P . 1996: Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd.

CSIR- Central Institute of Medicinal and Aromatic Plants, Lucknow (2016). Aush Gyanya : Handbook of Medicinal and Aromatic Plant Cultivation.

Kochhar, S.L. (2016). Economic Botany: A Comprehensive Study. 5th Edition. Cambridge

Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers.

Hajra, P.K.; Verma, D.M. & Giri, G.S. 1996. Materials for the Flora of Arunachal Pradesh. Vol.I. Botanical Survey of India, Calcutta.

Giri, G.S.; Pramanik, A. & Chowdhery, H.J. 2008. Materials for the Flora of Arunachal Pradesh. Vol. II. Botanical Survey of India, Kolkata.

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05/7/2021

संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)
राजीव गांधी विश्वविद्यालय
Jt. Registrar (Acad. & Conf.)
Rajiv Gandhi University
Rono Hills, Doimukh (A.P.)

BOT-GE-004: BIODIVERSITY AND CONSERVATION

(Credit Distribution L4:T0:P2 = 6 Credits)

Course Objective

The objective of this paper is to gain knowledge on the Concept and Value of biodiversity, Threats and management of biodiversity, Measurement and Conservation of Biodiversity.

Learning outcomes

After the completion of this course, the learner will be able to:

- Develop understanding of the importance of biodiversity
- Identify the causes and implications of major threats of biodiversity
- Estimate the biodiversity
- Utilize various strategies for the conservation of biodiversity

Keywords: Biodiversity loss, Hotspots, Biodiversity management, Conservation,

Unit I: Concept and Value of biodiversity **15 Lectures**

Concept of biodiversity, genetic, species and ecosystem diversity, Biogeographical classification of India; Value of biodiversity: Economic values, ecological (role in hydrological and biogeochemical cycling) and ecosystem services (social, aesthetic, consumptive, and ethical values of biodiversity).

Unit II: **Threats and management of biodiversity** **15 Lectures**

Natural and anthropogenic threats; Over-exploitation, Habitat destruction, Fragmentation and Species extinctions; IUCN threatened categories; Red data book; Invasions: causes and impacts; Biodiversity Hotspots: concepts, distribution and significance;

Unit III: Measurement of Biodiversity **15 Lectures**

Biodiversity estimation: Floristic sampling strategies and surveys; qualitative and quantitative methods: scoring, richness, density, frequency, abundance, evenness, diversity, community diversity estimation: alpha, beta and gamma diversity.

Unit IV: Conservation of biodiversity **15 Lectures**

In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation (botanical gardens, zoological gardens, gene banks and tissue culture); role of traditional knowledge system in conservation; ecological restoration; afforestation; social forestry; agroforestry; joint forest management. Organizations associated with biodiversity management: IUCN, UNEP, WWF, UNESCO, NBPGR. Biodiversity Acts.

Practical **60 Hours**

1. Study of instruments used to measure microclimatic variables; soil thermometer, maximum and minimum thermometer, anemometer, psychrometer, rain gauze, and lux meter.
2. Determination of pH, bulk density, porosity of soil from different habitats.
3. To study the different methods of sampling (transect and quadrate) of plant community.
4. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method.
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and abundance.
6. To determine basal cover of trees in a forest ecosystem/forest plantation.
7. To study field vegetation with respect to stratification, canopy cover and composition.
8. Study of the species diversity index of vegetation.
9. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
10. Preparation of field report based on the visit to nearby Zoo/Wild Life Sanctuary/National Park/Biosphere Reserve.
11. To locate the hotspots and important phyto-geographical regions in the map of India.

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Suggested Readings

Rajak, A. 2020. Textbook of Biodiversity. 1st edition, Notion Press, India.

Mahanty, S. and Srivastava, A. 2016. Biodiversity and It's Conservation. Disha International Publishing House, India.

Myneni, S.R. 2020. Law of Biodiversity Protection. New Era Law Publication, India.

Laha, R. 2017. Biodiversity conservation and utilization of natural resources with reference to North East India. Panima Publishing Corporation, India.

Singh, J.S., Singh, S.P. and Gupta, S.R.. 2008. Ecology, Environment and Resource Conservation. Anamaya Publications (New Delhi).

Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.

Magurran, Anne E. 2003. Ecological diversity and its measurements. Blackwell Publications.

Gaston, K J. and Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK.

Primack, R.B. 2002. Essentials of Conservation Biology (3rd edition). Sinauer Associates, Sunderland, USA.

Sodhi, N.S., Gibson, L. and Raven, P.H. 2013. Conservation Biology: Voices from the Tropics. Wiley-Blackwell, Oxford, UK.

Heywood V.H. and Watson R.T. (Ed). 1995. Global Biodiversity Assessment: UNEP. Cambridge University Press.

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