LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (LOCF) FOR UNDERGRADUATE PROGRAMMES

Department of Plant Biology and Biotechnology

B.Sc. Plant Biology and Plant Biotechnology

LOYOLA COLLEGE (AUTONOMOUS)
CHENNAI - 600 034

PREFACE

Plant Biology as a subject is about the study of the Kingdom Plantae, its structural diversity, biology, embryology, anatomy, taxonomy, evolution, habits and physiology. The field of plant sciences now encompasses numerous topics, that modern plant biologists are expected to have an extensive knowledge on these areas. The applied field of plant biotechnology includes areas such as plant tissue culture, plant molecular biology and gene manipulation.

The learning outcomes-based curriculum framework for a B.Sc degree in Plant Biology and Plant Biotechnology is designed to develop in students a sound knowledge in Plant Sciences in tune with its advancement and applicability. The framework is expected to assist as well as to improve the curriculum aspects in terms of graduate attributes, qualification descriptors, programme-learning outcomes and course-level learning outcomes.

The Learning Outcomes based approach to Curriculum planning aims to factor in on the aptitude, interests and the strengths of the students during their progress through the coursework. It aims to accompany and at the same time focus on overall student attainment. The main objective of the learning outcomes-based framework is to better equip the students in their pursuit of knowledge, with the required employability skills, innovation in research and entrepreneurship skills.

The course is so designed with substantial amount of practical/project work weaved into every subject, that will help students to apply their theoretical knowledge in experimenting and exploring the subject.

The course is structured to incorporate a skill-based course in Mushroom cultivation and biofertilizer production, coupled with internship in renowned institutes or industries that further augment the practical and entrepreneurship skills of the students.

The main objective of the framework is that the students will be able to explore the changing face of the field of Plant Sciences, the research advancements in the field and the integration of this area of biology into newer fields of Biotechnology.

The program is so designed that students can involve in need-based research at various levels with faculty specialists working in areas spanning from Plant Tissue Culture, Microbial Biotechnology to Phytochemistry. This inculcates in the students the spirit of exploration and application in the field.

The curriculum gives the students ample exposure to the classical and recent developments in the field of Plant Biology that enhances their interest to the level of pursuing higher education leading to research or setting up an industry as in mushroom cultivation.

The students will be able appreciate the varied diversity, intricate anatomical structures and the complex functioning of the plant system through the study of Taxonomy, Anatomy and Physiology of the plants.

The students are also fine-tuned to have greater environmental awareness with enhanced knowledge on sustainability and waste management through papers on Ecology, Environmental Biotechnology and Microbial Biotechnology.

In the LOCF model, the curriculum, teaching pedagogy and assessment methods have been assigned with appropriate cognitive levels as per BLOOM's Taxonomy. The OBE based evaluation methods will enable the assessment of cognitive levels of the students and also would appraise the anticipated attainment of the course outcomes.

Contents

VISION AND MISSION OF LOYOLA COLLEGE

VISION

Towards holistic formation of youth, grounded in excellence, through accompaniment to serve the humanity.

MISSION

- To provide inclusive education through an integral and holistic formative pedagogy.
- To promote skills that prepare them for the future.
- To kindle in young minds the spirit of social and environmental justice with a blend of academic excellence and empathy.
- To stimulate critical and conscientious scholarship leading to meaningful and innovative human capital.

CORE VALUES

- *Cura Personalis*
- Pursuit of Excellence
- Moral Rectitude
- Social Equity
- Fostering solidarity
- Global Vision
- Spiritual Quotient

VISION AND MISSION OF
THE DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY

VISION

Developing students with sound knowledge in Plant Sciences and Biotechnology for effective utilization and management of biological resources towards sustainable development.

MISSION

Disseminating knowledge and imparting skills for employability, innovation in research and entrepreneurship in Plant Sciences and Biotechnology.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	**Academic Excellence and Core Competency** To provide access to quality education and enhance the core competencies in Life Sciences through training using modern tools and techniques.
PEO 2	**Globally Relevant Curriculum and Learning Environment** To constantly innovate and upgrade the curriculum and teaching methodologies to make Life Sciences teaching and learning relevant to the global context.
PEO 3	**Effective Communication, Teamwork and Leadership Skills** To provide an academic environment to students which is conducive for academic excellence, creativity, leadership and life-long learning.
PEO 4	**Environmental Sustainability, Social Responsibility and Ethics** To instill responsibility and concern towards environment, biodiversity, bioethics, and sustainable development into the curriculum of Life Sciences.
PEO 5	**Skill Development, Entrepreneurship and Lifelong Learning** To prioritize experiential learning through specialized professional skill training for a better career with a professional attitude.
PEO 6	**Scientific Temperament** To kindle inquisitiveness and creativity to develop innovative protocols for solving issues related to the environment and conservation through research.

PROGRAMME OUTCOMES (POs)

PO1	**Disciplinary Knowledge** Students will apply the scientific knowledge acquired in Life Sciences and become skilled professionals adhering to the values of sustainable living.
PO2	**Communication Skills, Teamwork and Leadership qualities** Students will enhance their communication skills to develop an attitude to work as a team and hone leadership qualities.
PO3	**Critical thinking, Problem-Solving and Analytical Reasoning** Students will demonstrate analytical reasoning, problem-solving, scientific reasoning, and reflective thinking as professionals in all frontiers of life sciences.
PO4	**Research-Related Skills and Scientific Reasoning** Students will develop and popularize scientific temper to make conceptual contributions in life sciences and promote environmental consciousness.
PO5	**Skill Development, Entrepreneurship and Lifelong Learning** Students will develop skills, tools and techniques to explore prospective avenues of entrepreneurship in emerging areas of life sciences and pursue lifelong learning.
PO6	**Environment and Ethical Awareness** Students will understand and contextualize environmental and ethical issues and contribute towards the betterment of the environment and sustainable growth.
PO7	**Digital Literacy and Self-Directed Learning** Students will engage in self-paced and self-directed lifelong learning through digital literacy for personal development and professional accomplishment.

DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY

BSc Plant Biology and Plant Biotechnology

PROGRAMME SPECIFIC OUTCOME

PSO 1	Understand biodiversity and gain knowledge on morphological and anatomical features of microorganisms, algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.
PSO 2	Describe the process of morphogenesis and reproduction in microorganisms, algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.
PSO 3	Gain awareness on the ecosystems, plant resources and conservation of plant wealth.
PSO 4	Describe the cell structure of prokaryotes and eukaryotes and comprehend the basics of genetics, inheritance and molecular biology.
PSO 5	Acquire knowledge on the function of plants, interaction between plants and microbes and plant disease management.
PSO 6	Demonstrate skills in advanced techniques in plant sciences and biotechnology.
PSO 7	Acquire academic excellence in plant sciences to pursue higher studies, research and employability

B. Sc Plant Biology and Plant Biotechnology Restructured CBCS curriculum with effective from June, 2019

PART	SEMESTER I	SEMESTER II	SEMESTER III	SEMESTER IV	SEMESTER V		SEMESTER VI	CREDITS
I	G. Language (3h/3c)	G. Language (3h/3c)	G. Language (3h/3c)	G. Language (3h/3c)				12
II	General English (6h/3c)	General English (6h/3c)	General English (5h/3c)	General English (5h/3c)				12
III MC	Cell Biology and Evolution (4h/4c)	Algae and Bryophytes (4h/4c)	Fungi (4h/4c)	Angiosperm Taxonomy and Eco. Botany (4h/4c)	Plant Physiology (4h/4c)		Plant Biotechnology (4h/4c)	84
	Plant Anatomy and Embryology (5h/5c)	Pteridophytes, Gymnosperms and Paleobotany (4h/4c)	Microbiology (4h/4c)	Lab - IV (Ang. Taxon and Eco. Botany) (4h/4c)	Genetics and Plant Breeding (4h/4c)		Microbial Technology (4h/4c)	
	Lab - I (Cell Biology and Evolution & Plant Anatomy and Embryology) (3h/3c)	Lab - II (Algae, Bryophytes &Pterido. Gymno. and Paleo Bot.) (4h/4c)	Lab - III (Fungi & Microbiology) (4h/4c)		Plant Diseases and Management (4h/4c)		Ecology and Environmental Biotechnology (4h/4c)	
					Herbal Sciences and Ethnobotany (4h/4c)		LAB- VII (Plant Biotech, Microbial Tech & Ecology and Env.Biotech) (6h/6c)	
					LAB- V (Plant Physiology, Genetics and Plant Breeding) (4h/4c)			
					LAB -VI (Plant Diseases and Management, Herbal Sciences and Ethnobotany) (4h/4c)			
AR/ AO	Animal Diversity (4h/4c)	General Chemistry for Biology-I (3h/2c)	Agricultural Entomology (3h/2c) / Biochemistry (3h/2c)	Animal Biotechnology & Bioinformatics/ Food Chemistry (3h/2c)				12
	Animal Diversity Lab Course (2h/1c)	Chemistry Practical for Biology-I (2h/1c)	Agricultural Entomology Lab course(2h/1c) /Biochemistry lab course (2h/1c)	Animal Biotechnology& Bioinformatics Lab/ Food Chemistry Lab (2h/1c)				
ME				Biological Techniques (6h/6c)	Principles of Agriculture (6h/6c)			12
				Horticulture and Landscaping (6h/6c)	Nanotechnology (6h/6c)			
MS							Production of Mushroom, Bio-fertilizers and Single Cell Protein (12h/15c)	15
BT/AT /NME					MOOC/SSP			4
			Herbal Medicines (3h/2c)	Mushroom Cultivation (3h/2C)				
FC	FC (3/1)	FC (3/2), EVS	FC (2/1)	FC 2(1)				5
CCA	CC	CCA(90/1)						1
ORA			OR	OR (120/2)		**30 days**		2
Hr/C	**30h/22c**	**30h/(23+1c)**	**30/24c**	**30h(24+2c)**	**30h/30**		**30h/33c**	**180(159)**

Internship for 4 weeks during Christmas Holidays

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI
DEPARTMENT OF PLANT BIOLOGY AND PLANT BIOTECHNOLOGY
(2019 - Restructured Curriculum)

OVERALL COURSE STRUCTURE

Sem	Sub. Code	Course Title	T/L	Category	Cr	Hrs
I	UTL 1101	General Tamil – I (Arts & Science)	T	GL	3	3
I	UFR 1101	French for Beginners-I	T	GL	3	3
I	UFR 1102	French for Communication - I	T	GL	3	3
I	UFR 1104	Français Niveau - I	T	GL	3	3
I	UFR 1107	Beginner's French - I	T	GL	3	4
I	UFR 1108	Advanced French - I	T	GL	3	4
I	UOL 1101	Hindi-Prose - I	T	GL	3	3
I	UOL 1102	General Hindi - I	T	GL	3	3
I	UOL 1104	General Sanskrit - I	T	GL	3	3
I	UEL 1201	General English I - Advanced	T	GE	3	6
I	UEL 1202	General English I - Intermediate	T	GE	3	6
I	UEL 1203	General English I - Basic	T	GE	3	6
I	UEL 1208	English for Professional Skills - I	T	GE	3	3
I	UEL 1209	English for Professional Skills - II	T	GE	3	3
I	UPB 1501	Cell Biology and Evolution	T	MC	4	4
I	UPB 1502	Plant Anatomy and Embryology	T	MC	5	5
I	UPB 1503	Lab - I (Cell Biology and Evolution & Plant Anatomy and Embryology)	L	MC	3	3
I	UAZ 1301	Animal Diversity - I	T	AR	2	4
I	UAZ 1302	Animal Diversity Lab Course - I	L	AR	1	2
I	UHE 1001	Personality Development		FC	1	3
II	UTL 2101	General Tamil – II (Arts & Science)	T	GL	3	3
II	UFR 2101	French for Beginners - II	T	GL	3	3
II	UFR 2102	French for Communication - II	T	GL	3	3
II	UFR 2103	Français Niveau - II	T	GL	3	3
II	UFR 2106	Beginner's French-II	T	GL	3	4
II	UFR 2107	Advanced French -II	T	GL	3	4
II	UOL 2101	Hindi-Prose - II	T	GL	3	3
II	UOL 2102	General Hindi - II	T	GL	3	3
II	UOL 2103	General Sanskrit - II	T	GL	3	3
II	UEL 2201	General English II - Advanced	T	GE	3	6
II	UEL 2202	General English II - Intermediate	T	GE	3	6
II	UEL 2203	General English II - Basic	T	GE	3	6
II	UEL 2208	English for Professional Skills - II	T	GE	3	3
II	UEL 2209	English for Professional Skills - II	T	GE	3	3
II	UPB 2501	Algae and Bryophytes	T	MC	4	4

II	UPB 2502	Pteridophytes, Gymnosperms and Paleobotany	T	MC	4	4
II	UPB 2503	Lab - II (Algae, Bryophytes & Pterido. Gymno. and Paleo Bot.)	L	MC	4	4
II	UCH 2301	Chemistry for Biology	T	AR	2	4
II	UCH 2302	Chemistry Practical for Biology	L	AR	1	2
II	UHE 2001	Life Issues and Coping Strategies	T	FC	2	3
III	UTL 3101	General Tamil – III (Arts & Science)	T	GL	3	3
III	UFR 3101	French for Beginners – III	T	GL	3	3
III	UFR 3102	Français Niveau – III	T	GL	3	3
III	UOL 3101	Hindi Poetry – III	T	GL	3	3
III	UOL 3102	General Sanskrit – III	T	GL	3	3
III	UEL 3201	General English Advanced – III	T	GE	3	5
III	UEL 3202	General English - Intermediate – III	T	GE	3	5
III	UEL 3203	General English - Basic – III	T	GE	3	5
III	UPB 3501	Fungi	T	MC	4	4
III	UPB 3502	Microbiology	T	MC	4	4
III	UPB 3503	Lab - III (Fungi & Microbiology)	L	MC	4	4
III	UCH 3403 UAZ 3401	Biochemistry/ Agricultural Entomology	T	AO	2	3
III	UCH 3404 UAZ 3402	Biochemistry Lab/ Agricultural Entomology Lab	L	AO	1	2
III				NME	2	3
III	UHE 3001	Social Awareness	L	FC	1	2
III				ORA		
IV	UTL 4101	General Tamil – IV (Arts & Science)	T	GL	3	3
IV	UFR 4101	French for Beginners - IV	T	GL	3	3
IV	UFR 4102	Français Niveau - IV	T	GL	3	3
IV	UOL 4101	Hindi Poetry - IV	T	GL	3	3
IV	UOL 4102	General Sanskrit - IV	T	GL	3	3
IV	UEL 4201	Introduction to Technical Translation (CBGEP)	T	GE	3	5
IV	UEL 4202	Soft Skills for Professional Development (CBGEP)	T	GE	3	5
IV	UEL 4203	Professional Content Writing (CBGEP)	T	GE	3	5
IV	UEL 4204	English for Technical Writing (CBGEP)	T	GE	3	5
IV	UEL 4205	English for Employability Skills (CBGEP)	T	GE	3	5
IV	UEL 4206	Essential Skills for Group Communication (CBGEP)	T	GE	3	5
IV	UEL 4207	Theatre Performance and Film Review (CBGEP)	T	GE	3	5
IV	UPB 4501	Angiosperm Taxonomy and Eco. Botany	T	MC	4	4
IV	UPB 4502	Lab - IV (Ang. Taxon and Eco. Botany)	L	MC	2	2
IV	UCH 4403	Food Chemistry/	T	AO	2	3

	UAZ 4401	Animal Biotechnology and Bioinformatics				
IV	UCH 4404 UAZ 4402	Food Chemistry Lab/ Animal Biotechnology and Bioinformatics	L	AO	2	3
IV	UPB 4601	Biological Techniques	T	ME	6	6
IV	UPB 4602	Horticulture and Landscaping	T	ME	6	6
IV	UHE 4001	Environmental Studies	T	FC	1	2
IV			T	NME	2	3
IV				ORA		
V	UPB 5501	Plant Physiology	T	MC	4	4
V	UPB 5502	Genetics and Plant Breeding	T	MC	4	4
V	UPB 5503	Plant Diseases and Management	T	MC	4	4
V	UPB 5504	Herbal Sciences and Ethnobotany	T	MC	4	4
V	UPB 5505	LAB- V (Plant Physiology, Genetics and Plant Breeding)	L	MC	4	4
V	UPB 5506	LAB -VI (Plant Diseases and Management, Herbal Sciences and Ethnobotany)	L	MC	4	4
V	UPB 5601	Principles of Agriculture	T	ME	6	6
V	UPB 5602	Nanotechnology	T	ME	6	6
VI	UPB 6501	Plant Biotechnology	T	MC	4	4
VI	UPB 6502	Microbial Technology	T	MC	4	4
VI	UPB 6503	Ecology and Environmental Biotechnology	T	MC	4	4
VI	UPB 6504	LAB- VII (Plant Biotech, Microbial Tech & Ecology and Env.Biotech)	L	MC	6	6
VI	UPB 6701	Production of Mushroom, Bio-fertilizers and Single Cell Protein	L	MS	5	4
VI	UPB 6705	Internship	I	MS	5	
VI	UPB 6706	Production of Mushroom, Bio-fertilizers and Single Cell Protein	P	MS	5	8

COURSES OFFERED TO OTHER DEPARMENTS

Sem	Sub. Code	Course Title	T/L	Category	Cr	Hrs
I	UPB 1301	Plant Diversity	T	AR	2	4
I	UPB 1302	Plant Diversity Lab	L	AR	1	2
III	UPB 3401	Applied Microbiology	T	AO	2	3
III	UPB 3402	Applied Microbiology Lab	L	AO	1	2
III	UPB 3801	Herbal Remedies	T	AO	2	3
IV	UPB 4401	Plant Biotechnology and Biostatistics	T	AO	2	3
IV	UPB 4402	Plant Biotechnology and Biostatistics Lab	L	AO	1	2
IV	UPB 4801	Mushroom Cultivation	L	NME	2	3

Course Descriptors (Offered by the Department)

Semester I

Course Code	**UPB 1501**
Course Title	**CELL BIOLOGY AND EVOLUTION**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	I
Regulation	2019

Course Overview

1. Cell biology is an interdisciplinary subject integrating the fields of biochemistry, molecular cell biology and genetics
2. The aim of the course is to give a basic knowledge about microscopy and the types of cells
3. The different modules of the course will examine the structure and function of membrane, organelles and their chemical composition
4. In this course, we will also examine the structure and molecular organization of chromosomes, cell division types and its abnormalities.
5. The details on the basic theories and the molecular basis of evolution with examples are discussed

Course Objectives

1. To understand and explain the principles of various microscopy and its applications in the study of prokaryotic and eukaryotic cells
2. To discuss the various types of cell organelles, their structure and functions
3. To explain the basis of chromosome structure, organization and chromosomal abnormalities.
4. To elucidate the process of cell divisions, cell cycle and their associated abnormalities.
5. To discuss the various aspects of evolution including organic and synthetic evolutionary theories

Prerequisites	Basic knowledge on Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction: History, microscopy: Light, dark field, phase contrast, fluorescent, SEM and TEM. Cell Theory - Structure of prokaryotic and eukaryotic cell. Cytoplasm and its properties.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	Organelles: Structure and function of cell wall, plasma membrane, ribosomes, endoplasmic reticulum, Golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	Chromosome: Chromosomal nomenclature - chromatids, centromere, telomere, satellite, secondary constriction. Organization of chromosomes - Nucleic acid and histones - types and classification. Lamp brush chromosomes and polytene chromosomes-Karyotype and idiogram.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Cell division: Cell cycle: G0, G1, S and G2 phases– mitosis: open and closed mitosis -amitosis-meiosis. Mitotic abnormalities.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
V	Evolution: Origin of life - theories of organic evolution: Lamarckism, Neo-Lamarckism, Darwinism, Neo-Darwinism, Mutation theory and synthetic theory- Speciation and isolating mechanisms. Molecular evolution.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Verma, P.S and V.K. Agarwal, V.K. 2004. Cell Biology, Genetics Molecular Biology, Evolution and Ecology. S. Chand and Co. New Delhi.
2. Karp, G. 2012. Cell and Molecular Biology. John Wiley and sons, New York.
3. Roy, S.C and De, K. 1997. Cell Biology, New Central Book Agency (P) Ltd. Calcutta.
4. Ambrose, E.J. and Dorothy, M. Easty, 1970. Cell Biology, Thomas Nelson & Sons Ltd., 500 pp.
5. Veer Bala Rastogi, Introductory cytology. Kedar Nath Ram Nath. Meerut 250001.
6. Verma, P.S. and V.K. Agarwal, 1995. Cell and Molecular Biology, 8th Edition, S.Chand & co., New Delhi - 110 055,567pp.
7. Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.
8. Kumar, P. and Mina, U. (2018) Life Sciences: Fundamentals and Practice, Part-I, 6th Edn, Path

finder Publication. p.608.

Suggested Readings

1. Cooper, G. M 1997. The cell – A molecular Approach, ASM Press Washington
2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Kaiser, A., Krieger, Scott and Darnell, J. 2007. Molecular Cell Biology. W.H. Freeman. New York.
3. De Robertis E.D.P. and De Robertis E.M.F. 2006. Cell and Molecular Biology, 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
4. Burke, Jack. D., 1970. Cell Biology, Scientific Book Agency, Calcutta.
5. Cohn, N.S.,1979, Elements of Cytology, Freeman Book Co., New Delhi–110007, 495pp
6. Giese, A.C., 1979. Cell Physiology, Saunders Co., Philadelphia, London, Toronto, 609 pp.
7. Power, C.B., 1989. Essential of Cytology, Himalaya Publishing House, Bombay- 400 004, 368 pp.
8. Dowben, R., 1971.Cell Biology, Harper International Edition. Harper and Row Publisher, New York, 565 pp.
9. Loewy, A.G. and P. Sickevitz, 1969. Cell Structure and Function, Amerind Publishing Co., New Delhi - 110 020,516 pp.
10. Swansen, C.P. and P.L. Webster, 1989. The Cell, Prentice Hall of India Pvt. Ltd., New Delhi - 110 001, 373 pp.
11. Hardin J. and Bertoni G. 2017. Becker's World of the Cell. 9th Edn (Global Edition). Pearson Education Ltd., p.923.
12. Karp G., Iwasa J. and Masall W. 2015. Karp's Cell and Molecular Biology Concepts and Experiments. 8th Edn. John Wiley and Sons. p.832.
13. Cooper G.M. 2019. The Cell – A Molecular Approach, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813.
14. Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. 2018. Essential Cell Biology, 5th Edn., (paperback) W.W. Norton & Company p.864.
15. Alberts B., Johnson B., Lewis J., Morgan D., Raff M., Roberts K. and Walter P. (2015). Molecular biology of cell, 6th edn., Garland Science, Taylor and Francis, p. 1465.
16. Challoner J. 2015. The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press Ltd., p.193.

Web Resources

1 . https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article
2. https://microbenotes.com/types-of-microscopes/
3. https://www.nature.com/scitable/topicpage/mitosis-and-cell-division-205/
4. https://www.khanacademy.org/science/ap-biology/heredity/meiosis-and-genetic-diversity/a/phases-of-meiosis
5. https://plato.stanford.edu/entries/evolution/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and explain the fundamentals of cell structure, composition, function and evolution	K1, K2
CO 2	To examine and assess the structure and functions of organelles in the cellular basis of organisation and the theories of evolution	K3
CO 3	To analyse and differentiate the organelles, chromosomes, cell divisions and different theories on evolution	K4
CO 4	To evaluate the structures of cell organelles with their functions and modern theories on evolution	K5
CO 5	To categorize and simulate the biochemical nature of cell organelles and approaches in molecular evolution	K6

Course Code	**UPB 1502**
Course Title	**PLANT ANATOMY AND EMBRYOLOGY**
Credits	05
Hours/Week	05
Category	Major Core (MC) - Theory
Semester	I
Regulation	2019

Course Overview

1. Plant Anatomy deals with the internal structure and organization of tissues in plants.
2. This course aims at imparting knowledge on the plant cell, tissues and their types and their organization.
3. The anatomy of the stem, root and leaves are dealt with in detail.
4. This course also provides knowledge on secondary growth in plants and anomalies with reference to secondary growth.
5. Topics on Embryology deals with the structure of the anther and development of male gametophyte, pollen structure and the structure of female gametophyte.
6. The importance and types of pollination is also dealt with.
7. This course also highlights the formation and development of embryo in dicots and monocots and the development and types of endosperm.

Course Objectives

1. To understand the scopes and importance of Plant Anatomy and Embryology.
2. To understand the various types of tissue.
3. To gain knowledge on the anatomy of stem, root and leaves.
4. To distinguish between the normal and anomalous secondary growth in plants.
5. To understand structure of anther and ovule.
6. To gain knowledge on male and female gametophytes.
7. To know the significance of pollination, fertilization, endosperm and embryogeny.

Prerequisites	Basic knowledge on Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Cell, Tissues and Meristems:** Structure of a plant cell - Tissues: classification, structure and function of the following tissues: Simple permanent tissues: Parenchyma, collenchyma, sclerenchyma. Fibres and Sclereids; Complex permanent tissues: Xylem and Phloem. Meristems: Classifications - Theories on apical meristem - Apical cell theory, Histogen theory and Tunica - Corpus theory.	**15**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Anatomy of stem:** Tissue systems: Dermal tissue system - Fundamental or ground tissue system, Vascular tissue system, Types of vascular bundles. Primary structure of the stem - Anatomy of Dicot and monocot stems. Normal secondary growth in dicotyledonous. Anomalous secondary growth in *Bignonia*, *Aristolochia,* (dicot stem) *Dracaena* (monocot stem). Nodal Anatomy.	**15**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Anatomy of Root and Leaf:** The Root - Primary structure of dicot root - Anatomy of monocot roots - Secondary growth in dicot roots. Leaf: Anatomy of dicot and monocot leaf - types of stomata in dicots, stomata in monocot-grass type - Leaf abscission.	**15**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Embryology I**: Structure and development of anther, microsporogenesis, structure of mature pollen, Development of male gametophyte. Pollen grains: NPC system of classification. Types, structure and development of ovule, Megasporogenesis, Development of female gametophyte - Monosporic (*Polygonum*), Bisporic (*Allium*) and Tetrasporic (*Peperomia*). Pollination types and contrivances.	**15**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

V	**Embryology II:** Fertilisation, double fertilization, Triple fusion and post fertilization changes. Endosperm - Types (Nuclear, cellular and helobial), endosperm haustoria. Development of dicot embryo (*Capsella*); Development of monocot embryo (*Luzula*). Apomixis - Polyembryony - Parthenogenesis - Parthenocarpy. Applications of Embryology.	**15**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1 Pandey, B.P (2009). Plant Anatomy. S. Chand & Company Ltd., New Delhi.
2. Vashista P. C. (1997). Plant Anatomy. Pradeep Publication, Meerut.
3. Fahn, A, (1992). Plant Anatomy. Pergamon Press.
4. Singh, V., Pande, P. C. and Jain, D. K., 2018. Embryology of Angiosperms, Rastogi Publications, Meerut.
5. Ganguly, A. K. and Kumar, N.C., 2008. Developmental and Experimental Embryology of Angiosperms. Emkay Publications, Delhi.
6. Bhojwani, S. S. and Bhatnagar, S. P., 2009. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.

Suggested Readings

1. Esau, K. (2006): Anatomy of Seed Plants-John Willey Eastern Pvt. Ltd. New Delhi.
2. Cutter E.G. (1989): Plant Anatomy-Part 1 -Addison-Wesley Publishing Co
3. Maheswari P. (1991): An Introduction to Embryology of Angiosperms. Tata-McGraw Hill Publishing Co. Ltd.
4. Swamy B.G.L and Krishnamoorthy K.V (1990): From flower to Fruits, Tata-McGraw Hill Publishing Co Ltd.
5. Annie Ragland, 2009. Developmental Botany, Saras Publications, Nagercoil.

Web Resources

1. https://bit.ly/3GfjKsT
2. https://courses.lumenlearning.com/boundless-biology/chapter/stems/
3. https://courses.lumenlearning.com/ivytech-bio1-1/chapter/roots/
4. https://www.biology-pages.info/P/PlantTissues.html
5. https://academic.oup.com/plcell/article/16/suppl_1/S46/6010562
6. http://mgcub.ac.in/pdf/material/20200501064652545422c4ae.pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and define the types of plant tissues and reproductive structures in plants.	K1, K2
CO 2	To classify and illustrate the anatomical features of stem, root, leaf and the reproductive organs in plants.	K3
CO 3	To differentiate the anatomy of stem, root, leaf and the reproductive organs in plants.	K4
CO 4	To compare and contrast the tissues and anatomical features of stem, root, leaf and the reproductive structures in plants.	K5
CO 5	To compile information on the organization of plant tissues and their role and the processes in the development of embryogenesis in plants.	K6

Course Code	**UPB 1503**
Course Title	**LAB –I (CELL BIOLOGY AND EVOLUTION & PLANT ANATOMY AND EMBRYOLOGY)**
Credits	03
Hours/Week	03
Category	Major Course (MC) - Lab
Semester	I
Regulation	2019

Course Overview

1. This practical course aims at providing with the basic techniques to identify and isolate organelles in the plant cell and to identify and isolate them.
2. This laboratory course ensures a hands-on experience on different microscopes, micrometry and measurement of cell dimensions.
3. This course gives practical knowledge about mitosis and meiosis cell division, polytene chromosomes and spotters on evolution.
4. The practical course helps the student understand the types of plant tissues.
5. The anatomy of the stem, root and leaves are dealt with in detail.
6. This course also provides knowledge on anomalous secondary growth.
7. The Lab course deals with the structure of the anther pollen structure and the structure of female gametophyte.
8. This practical course also highlights the formation and development of embryo in dicots and monocots and the development and types of endosperm.

Course Objectives

1. To understand the structure and functions of different organelles in the plant cell.
2. To perform experiments using microscopes and measure the cell dimensions using micrometry.
3. To prepare smears and squash to study the meiotic and mitotic cell divisions respectively and to identify polytene chromosomes and other spotters in evolution.
4. To prepare microscopic slides on the anatomy of stem, leaf and roots in dicot and monocot.
5. To examine the secondary growth and anomalous secondary growth.
6. To understand the reproductive structures in plants.
7. To examine the embryo structure in dicots and monocots.

Prerequisites	Basic knowledge on Plant Cells, Evolution, Anatomy and Embryology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Cell Biology** Study of organelles / inclusions. Microscopy. Micrometry and measurement of cell dimensions. Mitosis (squash) Meiosis (smear)	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	Polytene chromosomes. Spotters on Evolution.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Anatomy** Tissue types Organization of apical meristems. Anatomy of dicot and monocot stem - Primary structure. Anatomy of dicot root and monocot root - Primary structure. Anatomy of dicot stem - Secondary structure.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Anatomy of dorsiventral leaf and isobilateral leaf. Stomatal types Anomalous secondary growth - *Bignonia*, *Aristolochia* (dicot stem), *Dracaena* (monocot stem). Nodal anatomy. Maceration of wood samples to study fibres, tracheids and vessels.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Embryology** T.S of Anther at various stages of development. Observation of simple (*Catharanthus, Hibiscus*, Grass) and compound pollen grains (*Calotropis, Acacia*). Structure of pollen grains using whole mounts (*Catharanthus, Hibiscus, Acacia*,) Pollen viability test using acetocaramine (*Caesalpinia / Crinum* / *Catharanthus / Tradescantia*) Types of ovules (Permanent slides) L.S. of oily endosperm (*Ricinus*), Freenuclear, cellular and Helobial. Perisperm (*Piper*)	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

	Embryo mounting (*Tridax*) L. S. of monocot embryo (Maize)			

Text Books

1. Verma, P.S and V.K. Agarwal, V.K. 2004. Cell Biology, Genetics Molecular Biology, Evolution and Ecology. S. Chand and Co. New Delhi.
2. Roy, S.C and De, K. 1997. Cell Biology, New Central Book Agency (P) Ltd. Calcutta.
3. Pandey, B.P (2009). Plant Anatomy. S. Chand & Company Ltd., New Delhi.
4. Vashista P. C. (1997). Plant Anatomy. Pradeep Publication, Meerut.
5. Fahn, A, (1992). Plant Anatomy. Pergamon Press.
6. Singh, V., Pande, P. C. and Jain, D. K., 2018. Embryology of Angiosperms, Rastogi Publications, Meerut.
7. Ganguly, A. K. and Kumar, N.C., 2008. Developmental and Experimental Embryology of Angiosperms. Emkay Publications, Delhi.
8. Bhojwani, S. S. and Bhatnagar, S. P., 2009. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.

Suggested Readings

1. Esau, K. (2006): Anatomy of Seed Plants-John Willey Eastern Pvt. Ltd. New Delhi.
2. Cutter E.G. (1989): Plant Anatomy-Part 1 -Addison-Wesley Publishing Co
3. Maheswari P. (1991): An Introduction to Embryology of Angiosperms. Tata-McGraw Hill Publishing Co. Ltd.
4. Swamy B.G.L and Krishnamoorthy K.V (1990): From flower to Fruits, Tata-McGraw Hill Publishing Co Ltd.
5. Annie Ragland, 2009. Developmental Botany, Saras Publications, Nagercoil.

Web Resources

1. https://courses.lumenlearning.com/boundless-biology/chapter/stems/
2. https://courses.lumenlearning.com/ivytech-bio1-1/chapter/roots/
3. https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article
4. https://microbenotes.com/types-of-microscopes/
5. https://www.nature.com/scitable/topicpage/mitosis-and-cell-division-205/
6. https://www.khanacademy.org/science/ap-biology/heredity/meiosis-and-genetic-diversity/a/phases-of-meiosis
7. https://plato.stanford.edu/entries/evolution/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the structure and functions of different organelles in the plant cell and to identify and isolate them; identify the types of tissues.	K1, K2
CO 2	To perform experiments using microscopes and measure the cell dimensions using micrometry; To describe the tissues in plants.	K3
CO 3	To prepare smears and squash to compare and contrast the meiotic and mitotic cell divisions respectively and to identify polytene chromosomes and other spotters in evolution; To compare the anatomy of the various parts of a plant	K4
CO 4	To compare the anatomical structures of stem, root and leaves and the various tissues associated.	K5
CO 5	To examine and summarize the reproductive structures in plants and the development of embryo	K6

Semester II

Course Code	**UPB 2501**
Course Title	**ALGAE AND BRYOPHYTES**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	II
Regulation	2019

Course Overview

1. Algae and Bryophytes course deals with the lower forms of aquatic, photosynthetic and amphibious species of the Plant Kingdom
2. The aim of the course is to give basic knowledge about the general characters of algae, pigmentation, reserve foods and life cycle patterns of the common algal forms.
3. The different modules of the course will examine structure, reproduction and life cycle of different algae and bryophytes
4. In this course, the classification, morphology, anatomy and reproduction of algae and bryophytes will be discussed
5. The details on economic importance and the biotechnological aspects of algae and bryophytes will also be discussed with examples.

Course Objectives

1. To understand the characteristics of algae and bryophytes, their habitats, and classification.
2. To study the structure, life cycle patterns of selected forms of algae and bryophytes.
3. To elucidate the various economic importance of algae and bryophytes.
4. To understand and explain the biotechnological applications of algae.

Prerequisites	Basic knowledge on Biology or Plant Biology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Algae – Overview**: A general account of Algae: Introduction, occurrence, characteristic features, distribution, and classification of algae (general) - Fritsch's classification - salient features of the various classes as per Fritsch's classification - thallus organization - pigmentation- flagellation- reserve food Lifecycle patterns.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Algae - Type Study**: Structure and reproduction with reference to the following algal forms: *Volvox, Chara, Diatoms, Ectocarpus, Sargassum and Gracilaria* (excluding the developmental stages).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Algae – Applications**: Economic importance of algae: Algae as food and fodder, use of algae in agriculture and space research, commercial products of algae: Agar Agar, Alginates, Carrageenin, diatomite, minerals - Algae in medicine. Algal biotechnology: single cell proteins (SCP): *Chlorella, Scenedesmus*, biofuel production. Seaweed cultivation	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Bryophytes - Overview**: General -Introduction - characteristic features-distribution - classification (Rothmaler, 1951) - characteristics of *Hepaticopsida, Anthocerotopsida* and *Bryopsida* - life cycle pattern - economic importance.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Bryophytes - Type Study**: A detailed study of the range of vegetative and reproductive structure - Life cycle of liverworts (*Marchantia*); hornworts (*Anthoceros*) and mosses (*Funaria*) (excluding the developmental stages).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Srivastava, H.N. 1999. Algae. Pradeep publications, Meerut.
2. Sharma, O.P. 2004. A text book of Algae. Tata McGraw- Hill publishing Company Limited, New Delhi.
3. Bilgrami, K.S. and Saha, L.C. 2012. A text book of Algae. CBS Publishers & Distributors Pvt. Ltd., New Delhi.
4. Pandey, S.N., Misra, S.P., and Trivedi, P.S. 1997. A text book of Botany, Vol. II, Vikas Publishing House Pvt. Ltd.
5. Dubey, R.C. 2009. A Textbook of Biotechnology. S. Chand & Company Ltd. New Delhi.

Suggested Readings

1. Bold, H. C. 1982. Morphology of Plants - Wiley Eastern Ltd. New Delhi.
2. Gangulee & Khar, 1980. College Botany, Vol. II Tata McGraw Hill, New Delhi.
3. Sporne, 1967. Bryophytes - Hutchinson & Co, London.
4. Rashid A, 2006. An introduction to Bryophyta, Vikas Publishing, Delhi
5. Raven JA, 1984. Biology of Non-Vascular plants, Wiley Publishing, London.

Web Resources

1. https://www.biologydiscussion.com/algae/classification-algae/classification-of-algae/49912
2. https://archive.bio.org/articles/biotechnology-and-algae
3. http://www.nou.ac.in/econtent/Msc%20Botany%20Paper%20IV/MSc%20Botany%20Paper-IV%20Unit-1.pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the general characters, classification life cycle patterns and economic importance of algae and bryophytes.	K1, K2
CO 2	To examine and illustrate the characteristics, lifecycle and uses of selected forms of algae and bryophytes	K3
CO 3	To analyse and differentiate the morphological, anatomical, reproductive and economic importance of select algae and bryophytes.	K4
CO 4	To compare and contrast the asexual and sexual reproduction in the algae and bryophytes.	K5
CO 5	To compile and summarize the life cycle patterns and reproduction in major forms of algae and bryophytes.	K6

Course Code	**UPB 2502**
Course Title	**PTERIDOPHYTES, GYMNOSPERMS, PALAEOBOTANY**
Credits	04
Hours/Week	04
Category	Major Core (MC) – Theory
Semester	II
Regulation	2019

Course Overview

1. Pteridophytes, Gymnosperms and Paleobotany is an in-depth study on the adaptation and characteristics of the vascular cryptogams and phanerogams.
2. The aim of the course is giving a basic knowledge on the general characteristics, anatomical features, and the reproductive structures of the different groups of these land plants.
3. The different aspects of the course detail on the evolution of the different groups of plants, their salient features and their interrelationships.
4. It also provides extensive information on the economic importance of the various plants under the categories, in terms of food, clothing, and medicine and as products of commerce.
5. The course details the paleobotanical evidences that support the evolution and existence of the fossil plants of the Pteridophytes and Gymnosperms.

Course Objectives

1. To understand the evolution, classification and diversification of the present land plant forms.
2. To provide knowledge on the comparative studies of steles, sporangia and gametangia in eusporangiate and leptosporangiate groups.
3. To impart knowledge on morphology, anatomy and reproduction of selected Gymnosperms.
4. To know about the evolutionary patterns and to study the characteristics and adaptation of the extinct fossil forms.

Prerequisites	Basic knowledge in Biology or Botany

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	General characters of Pteridophytes- Classification (Reimer, 1954) - Salient features of divisions: Psilophyta - Lycophyta - Sphenophyta and Filicophyta -Stelar types and evolution - Heterospory and seed habit - Apospory and apogamy.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	Morphology, anatomy, reproduction and life cycle of the following forms (no developmental aspects): *Psilotum, Lycopodium, Equisetum, Adiantum* and *Marsilea* - Economic importance of Pteridophytes.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	General characters - Concept of pro-gymnosperms - Classification (Sporne, 1965) - Salient features of *Pteridospermales, Cycadales, Coniferales* and *Gnetales.*	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Morphology, anatomy, reproduction and life cycle (no developmental aspects) of *Cycas, Pinus* and *Gnetum* - Economic importance of Gymnosperms.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
V	Introduction - fossils - methods of fossilization - types of fossils: compression, petrifactions, impressions, moulds and casts - techniques to study fossils - determination of the age of fossils - geological time scale. Fossil Pteridophytes: *Lepidodendron, Calamites.* Fossil Gymnosperms: *Williamsonia.*	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Sharma OP, 2017 Pteridophyta. McGraw Hill Education (India) PvtLtd
2. Sharma OP, 2016 Gymnosperms Pragati Prakashan, Meerut
3. Kumaresan and Annie Ragland, 2011 Pteridophytes, Gymnosperms and Paleobotany. Saras Publication
4. KN Prasad 1999. An Introduction to Palaeobotany. APH Publishers
5. Sambamurty AVSS 2005 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishing House Pvt.Ltd.

Suggested Readings

1. Rashid A. 1999. An Introduction to Pteridophyta. South Asia Books.
2. Reddy SM 2003. University Botany - 2. New Age International Publishers, Delhi.
3. Sporne KR. 2015. The morphology of Gymnosperms. Scientific Publishers, Jodhpur.
4. Sporne KR 2018. The morphology of Pteridophytes; the structure of Ferns and Allied Plants. Franklin Classics.
5. Bhatnagar SP 1996. Gymnosperms. New Age International Publishers.
6. Vashishta PC, Sinha AK, Anil Kumar. 2010 Botany for Degree students Pteridophyta. S.Chand and Company Ltd. New Delhi.
7. Vashishta PC, Sinha AK, Anil Kumar. 2010 Botany for Degree students Gymnosperms. S. Chand and Company Ltd. New Delhi.
8. Arnold AC 2008. An Introduction to Paleobotany. Read Books Publisher.

Web Resources

1. https://gurukpo.com/Content/B.SC/Pteridophytes_Gymnosperms_&_Palaeobotany.pdf
2. https://www.easybiologyclass.com/pteriophytes-free-online-study-materials-tutorials-lecture-notes-ppts-mcqs/
3. https://www.pteridoportal.org/portal/index.php
4. https://www.conifers.org/
5. https://courses.lumenlearning.com/boundless-biology/chapter/gymnosperms/
6. https://palaeobotany.org/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the general characters, internal features in the classification of Pteridophytes, Gymnosperms and their fossil members	K1, K2
CO 2	To examine the various aspects in the morphology, anatomy, reproduction and fossil evidences of the various forms of Pteridophytes and Gymnosperms	K3
CO 3	To analyse the general characters, classification, economic importance and evolution of their fossils forms	K4
CO 4	To compare and contrast the morphology, anatomy and reproduction of the different members and their fossil forms	K5
CO 5	To reconstruct and categorize the different members of Pteridophytes and Gymnosperms and integrate the various techniques to study the respective fossil forms	K6

Course Code	**UPB 2503**
Course Title	**LAB. COURSE: II - ALGAE, BRYOPHYTES AND PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY**
Credits	04
Hours/Week	04
Category	Major Core (MC) – Lab
Semester	II
Regulation	2019

Course Overview

1. The Lab II course deals with an extensive study on the lower cryptogams and phanerogams.
2. The practical aspects namely study of the morphology, anatomy and reproductive structures from algae to gymnosperms are covered here.
3. The cultivation of algae and the role of algae in biotechnology is studied.
4. The course also emphasizes on the economically important species from algae to gymnosperms
5. Field trips and specimen collection which is part of the course serve to enlighten and educate the students in line with the theoretical knowledge gained by them.

Course Objectives

1. To study the various types of algae, bryophytes, pteridophytes and gymnosperms and their significance
2. To be able to identify, differentiate and observe the morphological, anatomical and reproductive features of the different groups
3. To understand the economic value of the important algae, bryophytes, pteridophytes and gymnosperm species
4. To identify and appreciate the different fossils forms and their course of formation

Prerequisites	Basic knowledge in Biology or Botany

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Morphological study of the following algal forms - *Volvox, Chara*, Diatoms, *Ectocarpus*, *Sargassum* and *Gracilaria*. Algal Biotechnology: Cultivation of algae (*Chlorella* / *Scenedesmus*) in - Chu 10 medium (Demonstration only)	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	Morphological study of the following bryophyte forms - *Marchantia*, *Anthoceros*, and *Funaria* Study of economically important products obtained from algae and bryophytes	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	Field visit / trip to collect algal specimens - algae herbaria (5 numbers) to be submitted. Study of morphology, anatomy and soral organization in *Psilotum*, *Lycopodium*, *Equisetum*, *Adiantum*, *Marsilea* and economic importance of *Azolla*	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Morphological and anatomical studies of the genera mentioned for detailed study: *Cycas*, *Pinus* and *Gnetum*.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
V	Observations of different types of fossil forms Field trip to an out station to study the flora (ferns and gymnosperms) and fossils. Submission of photographs of at least 10 different Pteridophytes and Gymnosperms	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Mandip Singh, H Sahu, S. B. Chaudhary, A Textbook of Practical Botany 2005 Daya Publishing House
2. Dr. Ashok Bendre , Dr. Ashok Kumar, A Text Book Of Practical Botany Vol-1 2018 Rastogi Publications Shivaji Road Meerut
3. Pandey B.P. , Modern Practical Botany - Vol. 1 2011 S Chand & Company
4. B. P. Pandey, College Botany 2014 Twentieth edition , S Chand Publishing Company
5. Dutta A. C, Botany for Degree Students 1998.Oxford University Press

Suggested Reading

1. Sharma, O.P. 2004. A text book of Algae. Tata McGraw- Hill publishing Company Limited, New Delhi.
2. Bilgrami, K.S. and Saha, L.C. 2012. A text book of Algae. CBS Publishers & Distributors Pvt. Ltd., New Delhi.
3. Sporne, 1967. Bryophytes - Hutchinson & Co, London.
4. Rashid A, 2006. An introduction to Bryophyta, Vikas Publishing, Delhi
5. Rashid A. 1999. An Introduction to Pteridophyta. South Asia Books.
6. Reddy SM 2003. University Botany – 2. New Age International Publishers, Delhi.
7. Bhatnagar SP 1996. Gymnosperms. New Age International Publishers.
8. Vashishta PC, Sinha AK, Anil Kumar. 2010 Botany for Degree students Pteridophyta. S.Chand and Company Ltd. New Delhi.
9. Arnold AC 2008. An Introduction to Paleobotany. Read Books Publisher.

Web Resources

1. https://www.biologydiscussion.com/algae/classification-algae/classification-of-algae/49912
2. https://archive.bio.org/articles/biotechnology-and-algae
3. http://www.nou.ac.in/econtent/Msc%20Botany%20Paper%20IV/MSc%20Botany%20Paper-IV%20Unit-1.pdf
4. https://gurukpo.com/Content/B.SC/Pteridophytes_Gymnosperms_&_Palaeobotany.pdf
5. https://www.easybiologyclass.com/pteriophytes-free-online-study-materials-tutorials-lecture-notes-ppts-mcqs/
6. https://www.pteridoportal.org/portal/index.php
7. https://www.conifers.org/
8. https://courses.lumenlearning.com/boundless-biology/chapter/gymnosperms/
9. https://palaeobotany.org/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the general characters, internal features in the classification of Algae, Bryophytes, Pteridophytes, Gymnosperms and their fossil members	K1, K2
CO 2	To examine the various aspects in the morphology, anatomy, reproduction and fossil evidences of the various forms of Algae, Bryophytes, Pteridophytes and Gymnosperms	K3
CO 3	To analyse the general characters, classification, economic importance and evolution of their fossils forms	K4
CO 4	To compare and contrast the morphology, anatomy and reproduction of the different members and their fossil forms	K5
CO 5	To reconstruct and categorize the different members of Algae, Bryophytes, Pteridophytes and Gymnosperms and integrate the various techniques to study the respective fossil forms	K6

Semester III

Course Code	**UPB 3501**
Course Title	**FUNGI**
Credits	04
Hours/Week	04
Category	Major Core (MC) – Theory
Semester	III
Regulation	2019

Course Overview

1. Fungi is an in-depth study of the most common and important Kingdom Fungi.
2. It deals with the study of the general characters, habit, modes of nutrition of this class of eukaryotes.
3. The course provides a good understanding on the major groups of fungi and the representative forms in terms of their morphological and structural organisation, and their reproductive behaviour.
4. It provides an exhaustive knowledge on the economic importance of this group of organisms, and the genetically engineered forms.
5. The course offers good knowledge on the significance, classification, and organisation of the symbiotic forms, namely the mycorrhiza and the lichens

Course Objectives

1. To provide knowledge on the structure and reproduction of important fungal forms besides giving an overview.
2. To understand the different classes, their habit, and life cycle patterns.
3. To introduce students to basics of fungal biotechnology and genetically engineered forms and their applications.
4. To study the role and significance of the several mutualistic fungal associations, like mycorrhizae and lichens.

Prerequisites	Basic knowledge in Biology, Botany or Zoology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	General Characteristics of fungi - Habit, nutrition types, cell structure, mycelium and its modifications - Reproduction in fungi: vegetative, asexual, sexual, para-sexual; fruiting bodies of sexual and asexual, Life cycle patterns. Salient features of fungal classes - classification (Alexopolus, 1962 & R. Whittaker,1959)	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	Structure and reproduction with reference to the following fungal forms (no developmental stage) *Albugo*, *Rhizopus*, *Aspergillus*, *Saccharomyces*, and *Neurospora*	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	Structure and reproduction with reference to the following fungal forms (no developmental stages) *Peziza*, *Puccinia*, *Polyporus* and *Colletotrichum*	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Economic importance of fungi in general. Importance of fungi in industrial processes: Baker's yeast, penicillin production. Mycorrhiza: Types, identification and importance. Genetic engineering using yeasts - YAC vector	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
V	Salient features of lichens - Nature and association of phycobiont and mycobiont in lichens - classification of lichens - Structure of lichens: External and internal structure - Asexual and Sexual Reproduction in lichens - Economic importance of lichens.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Vashishta, B.R. 2000. Fungi, Chand & Co. New Delhi
2. Harold C. Bold, 1982. Morphology of plants. Wiley- Eastern Ltd.
3. Sathyanarayana, U. 2010. Biotechnology; Books and allied (P) Ltd. Kolkata.Singh, V., Pandey, P.C and Jain, D.K. 2018. A Text Book of Botany. Fifth edn. Rastogi Publications.

Suggested Readings

1. Gangulee and Khar, 1980. College Botany Vol. II, Tata McGraw Hill, New Delhi.
2. Rogers K.2011. "Fungi, Algae and Protists". First Edition. Britannica educational Publishing.
3. Encyclopedia Britannica, 2011. "Fungi Biology and applications". Second Edition. Wiley-Blackwell (John Wiley & sons Ltd.).
4. Encyclopedia Britannica, 2011. Plants, Algae and Fungi". Encyclopedia Britannica Inc.
5. Webster J. and Weber R. W. S. 2007. Introduction to Fungi. Third edition. Cambridge

University Press

Web Resources

1. https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/fungi.html
2. https://www.apsnet.org/edcenter/disandpath/fungalasco/intro/Pages/IntroFungi.aspx
3. https://opentextbc.ca/conceptsofbiologyopenstax/chapter/fungi/
4. https://mycology.adelaide.edu.au/
5. https://courses.lumenlearning.com/microbiology/chapter/fungi/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the general characteristics, interrelationships and uses of the various fungal forms	K1, K2
CO 2	To examine the morphological, anatomical, reproductive, mutualistic behaviour and applications of fungi	K3
CO 3	To analyse and differentiate fungi based on structure, lifecycle, interactions and importance	K4
CO 4	To evaluate the lifecycle of various fungal forms and their economical and biotechnological applications	K5
CO 5	To categorize and summarize the characteristics of the various fungal forms, their mutualistic associations and their applications	K6

Course Code	**UPB 3502**
Course Title	**MICROBIOLOGY**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	III
Regulation	2019

Course Overview

1. Microbiology is an interdisciplinary subject integrating the fields of biochemistry, molecular biology, physiology and genetics of organisms not visible to naked eye.
2. The aim of the course is to give a basic knowledge about the microbes, their classification, and the staining methods used.
3. The different modules of the course will examine the structure and function of membranes and cell wall, functions, and chemical composition.
4. In this course, we will also examine the physiology and genetics of microbes particularly bacteria.
5. The details on the general characters, classification of viruses and their multiplication will be discussed with examples.

Course Objectives

1. To understand the characteristics of microorganisms, their habitats, and classification and to characterize bacteria based on microscopic observation and staining.
2. To classify bacteria based on shape and staining and to describe the methods for cultivation and understand the growth pattern in bacteria.
3. To elucidate the various metabolic processes in microbial cell and to outline the important metabolic pathways.
4. To understand and explain the genetic material in bacteria and distinguish between the different methods of genetic recombination in bacteria.
5. To comprehend the characteristics of viruses, their genetic material and their significance in causing diseases.

Prerequisites	Basic knowledge on Biology or Plant Science

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Introduction and classification**: History of microbiology- microbes and their habitats - scopes of microbiology - general characteristics of microorganisms - Six kingdom classification (Carl Woese, 1977); Bergey's Manual of Systematic bacteriology (major groups). Characterization - microscopic examination - staining (simple, differential and special types).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Structure of bacteria and growth**: Size, shape and arrangement of bacterial cells - ultra structure of bacterial cell; Cultivation of bacteria: nutritional types - culture media types - physical conditions - Reproduction: mode of cell division - Growth: normal growth curve, synchronous - Quantitative measurement of bacterial growth. Pure cultures: methods of isolation - maintenance and preservation.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Microbial Metabolism**: Anabolism and catabolism; Phosphorylation: photo phosphorylation and oxidative phosphorylation; Glycolysis and TCA cycle; anaerobic - fermentation (glycolysis to alcohol production - aerobic respiration. Microbial enzymes and their application.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Microbial Genetics**: Organization of bacterial genome: chromosomal DNA and plasmids; Bacterial recombination: conjugation (F- to F+, Hfr, merozygotes) - transduction (generalized and specialized) - transformation (mechanism). Gene regulation in prokaryotes - lac operon.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Viruses**: General characteristics - structure - composition. David Baltimore classification of viruses (outline) - cultivation - replication - Structure and lifecycle of Plant virus - TMV; Animal viruses: Rabies and HIV; bacterio phages: morphology & structure of T4 and λ phage.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Pelczar, Chan and Kreig, 1993. Microbiology – 5th edition, Tata McGraw-Hill Co Ltd. New Delhi.
2. Ananthanarayanan, R and Panicker, C.K.J. 2002. Text book of Microbiology. VI Edition, Orient Longman, Chennai.
3. Prescott, Haley, Klein, 1993. Microbiology-WCB Publishers, England, Second Edition.
4. Volk Wesley and Wheeler, 1980. Basic Microbiology – J.B. Lippincott and Co. Philadelphia, USA.
5. Perry, J.J. and Staley, J.T. 1997. Microbiology: Dynamics and Diversity, Saunders College, Publishing – USA.

Suggested Readings

1. Buge, E. 1992. Modern Microbiology – Principles and Application – WMC Brown Publishers.
2. Powar, C.B. and Daginawala, 1991. General Microbiology Vol I and II – Himalaya Publishing House, Bombay.
3. Benson, 2001. "Microbiological applications, Laboratory manual in general Microbiology". Eight Edition. McGraw –Hill Companies.
4. Scharlau, 2011 "Handbook of Microbiological Culture Media". 10th Edition.

Web Resources

1. https://micro.magnet.fsu.edu/cells/bacteriacell.html
2. https://biokimicroki.com/methods-for-measuring-bacterial-growth/
3. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Bruslind)/11%3A_Microbial_Nutrition
4. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/7%3A_Microbial_Genetics
5. https://courses.lumenlearning.com/boundless-microbiology/chapter/structure-of-viruses/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and explain the diverse microorganisms including viruses, microbial metabolism, genetics and their classification.	K1, K2
CO 2	To apply and assess the isolation techniques and cultivation of microbes and hence demonstrate their structural, functional and genetical characteristics	K3
CO 3	To analyse and differentiate the types of microorganisms and viruses, their morphology, physiology and genetics	K4
CO 4	To evaluate the processes in microbial metabolism and genetics conditions	K5
CO 5	To categorize and summarize the physiology and genetics of microbes.	K6

Course Code	**UPB 3503**
Course Title	**LAB - III (FUNGI & MICROBIOLOGY)**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Lab
Semester	III
Regulation	2019

Course Overview

1. This lab course introduces the concepts of fungus and bacterial morphology is an interdisciplinary subject integrating the fields of biochemistry, molecular biology, physiology and genetics of organisms not visible to naked eye.
2. The techniques for isolating and handling microbes by various techniques will be followed.
3. An over view on biotechnological products of fungi and microbes will be demonstrated.
4. Examination of internal structure of fungi and colony morphology by microscopical observation will be followed.
5. Spotters on lichens observed.
6. Spotters related to viruses will be observed.

Course Objectives

1. To observe and examine the morphology of fungal and bacterial shapes.
2. Anatomy of fungi and microbial isolation methods to be studied.
3. To visualize fungi and microbes microscopically adopting staining methods.
4. To examine the products related to fungi and other industrial microbes.
5. To gain knowledge about structure of lichens.
6. To have basic knowledge on viruses.

Prerequisites	Basic knowledge on Biology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Morphological study of the following forms *Albugo, Rhizopus, Aspergillus, Saccharomyces, Neurospora, Peziza, Puccinia, Polyporus* and *Colletotrichum*	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	Different Microscopy – microbial photographs. Model preparation – shape & arrangement of bacteria Study on Lichens morphology and anatomy.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	Sterilization: moist heat – dry heat- radiation-filtration. Preparation of culture media, special types of medium. Pour plate - spread plate, streak plate - serial dilution - hanging drop.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Smear preparation – Gram staining, endospore staining, capsular staining IMVIC and fungal staining, Study of economically important products obtained from fungi.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
V	Spotters on Microbial Genetics and viruses Industrial visit related to Fungi and Microbes.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Benson, 2001. "Microbiological applications, Laboratory manual in general Microbiology". Eighth Edition. McGraw –Hill Companies.
2. Scharlau, "Handbook of Microbiological Culture Media". 10thedition.Scharlau.
3. Prescott, H. 2002. Laboratory exercises in Microbiology".5th edition. The McGraw- Hill Companies
4. Vashishta, B.R. 2000. Fungi, Chand & Co. New Delhi
5. Harold C. Bold, 1982. Morphology of plants. Wiley- Eastern Ltd.

Suggested Readings

1. Webster J. and Weber R. W. S. 2007. Introduction to Fungi. Third edition. Cambridge, University Press.
2. Encyclopedia Britannica, 2011. "Fungi Biology and applications". Second Edition. Wiley-Blackwell (John Wiley & Sons Ltd.).
3. Benson, 2001. "Microbiological applications, Laboratory manual in general Microbiology". Eight Edition. McGraw –Hill Companies.

4. Scharlau, 2011 "Handbook of Microbiological Culture Media". 10th Edition..

Web Resources

1. https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/fungi.html
2. https://www.apsnet.org/edcenter/disandpath/fungalasco/intro/Pages/IntroFungi.aspx
3. https://opentextbc.ca/conceptsofbiologyopenstax/chapter/fungi/
4. https://mycology.adelaide.edu.au/
5. https://micro.magnet.fsu.edu/cells/bacteriacell.html
6. https://biokimicroki.com/methods-for-measuring-bacterial-growth/
7. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Bruslind)/11%3A_Microbial_Nutrition
8. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/7%3A_Microbial_Genetics
9. https://courses.lumenlearning.com/boundless-microbiology/chapter/structure-of-viruses/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and to interpret diverse microbes and fungi.	K1, K2
CO 2	To integrate and assess the isolation techniques and cultivation of microbes and fungi	K3
CO 3	To analyse and differentiate microbial culture and internal structure of fungi.	K4
CO 4	To explain the staining methods. To explain the life cycle of fungi.	K5
CO 5	To construct and simulate the structure of lichens and virus. To summarize the structure and reproduction in fungi.	K6

Semester IV

Course Code	**UPB 4501**
Course Title	**ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	IV
Regulation	2019

Course Overview

1. Taxonomy is the subject concerned with the rules governing the classification of plants.
2. The aim of taxonomy includes three aspects namely, identification, nomenclature and classification of plants.
3. The course highlights all the fundamental knowledge on taxonomy such as origin, scope, classification types comprising both classical and advance types of keys.
4. It provides an extensive study on the rules and regulations for naming of plants.
5. Detailed diagnostic characters of importance will be learned by students through which they can easily identify plants along with knowledge gained on the binomial nomenclature of most common plants.
6. The brief history, botanical name, family, uses (nutritional aspects, active compounds and economic importance) and morphology of the useful parts of plants will also be taught to the students through this course.

Course Objectives

1. To equip students to be able to observe, identify and classify plants based on their morphological and anatomical traits.
2. To educate the students on the systems of classification and the rules and regulations of ICN for plant nomenclature.
3. To expound the evolutionary relationship involved in the origin of plant diversity
4. To enrich the students' knowledge on the economic importance of plants in terms of food, medicine and commerce.

Prerequisites	Basic knowledge on Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Introduction and Classification** Origin of angiosperms - Taxonomy: Objectives, importance and scope - Systems of Plant Classification -Types; Bentham & Hooker and Angiosperm phylogeny Group (APG) system (outline only) - taxonomic hierarchy - Botanical keys: Construction of dichotomous keys - Indented and bracketed keys - computer aided interactive and identification keys (DELTA System).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Plant Nomenclature** Plant nomenclature: major provisions of the International Code of Nomenclature (ICN): Effective and Valid publication, Rule of Priority, typification - author citation- rejection and retention of names - Herbarium techniques - Modern trends in Plant taxonomy: Introduction to cladistics and molecular taxonomy.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Type Studies (Families)** Detailed study of the diagnostic characteristics and economic importance of the following families: *Nymphaeaceae, Annonaceae, Rutaceae, Fabaceae* (*Papilionoideae, Caesalpinioideae & Mimosoideae*), *Capparidaceae, Anacardiaceae, Cucurbitaceae.*	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Type Studies (Families)** Detailed study of the diagnostic characteristics and economic importance of the following Families: *Rubiaceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Orchidaceae and Poaceae.*	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Economic Botany** A brief study of the following economically important plants: Brief history, botanical name, family, uses (nutritional aspects, active compounds and importance) and morphology of the useful parts of any three Cereals: Rice, Wheat and Maize, Millets: Ragi, Bajra and Jowar, Pulses: Red gram, Black gram and Ground nut; Spices: Cinnamon, Clove and Cardamom; Condiments: Ginger,	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

	pepper and Chilli; Essential oils: Sandal wood oil, Eucalyptus oil and Lemon grass oil; Edible oil: Sesame oil, Coconut oil and Sunflower oil; Medicinal plants: Asafoetida, Indian periwinkle and Sweet flag; Fibre: cotton, jute and manilla-hemp, Timber: Teak, Shisham and Bijasal; Narcotics: Opium, Ganja and Tobacco and Beverages: Coffee, Tea and Cocoa.			

Text Books

1. Rao K.N. and Krishnamurthy, K.V., 1994. Angiosperms. S. Viswanatham & Co.
2. Pandey, B.P., 1992. Economic Botany. S. Chand & Co, New Delhi.
3. Gurcharan Singh, 2010.Plant Systematics, An integrated approach, Third edition. Science Publishers, Enfield, NH, USA.
4. Kochhar S. L. Economic Botany in the tropics (Fourth edition). Macmillan publishers India Ltd., Delhi.

Suggested Readings

1. Gurcharan Singh, 2010. Plant Systematics An Integrated Approach, Science, Third Edition.
2. Simpson, M.G. 2010. Plant Systematics, Second Edition. Academic Press.
3. Simpson, B.B and Ogorzaly, M, C. 2001. Economic Botany: Plants in Our World, Third Edition. Mcgraw-Hill Higher Education. New York.
4. Pandey b.p. 2000. Simplified course in botany. S. Chand and company ltd. New Delhi.
5. Mitraj. n. Mitra d and Chowdhuri s.k.1990. Studies in botany (vol. i) Mont library, Calcutta.
6. Narayanaswami R.V.,Rao K.N. and Raman, A. 2000. Outlines of Botany. S. Viswanathan and co. Chennai.
7. Verma V.1998. A text book of economic botany. Emkay publications. New Delhi.
8. Albert F Hill; P. P. Sharma, 1996. Hill's economic botany. Tata MC Graw hill. New Delhi.

Web Resources

1. https://www.biologydiscussion.com › essay › taxonomy
2. https://www.wileyindia.com/taxonomy-of-angiosperms.html
3. https://www.easybiologyclass.com/angiosperm-systematics-and-taxonomy-free-online-study-materials-and-lecture-notes/
4. https://www.semanticscholar.org/paper/Taxonomy-of-Angiosperms-Arun-Mohammed/2101895c12d66c885208875a2f0edf7c7260bbe4
5. https://pragatiprakashan.in/taxonomy-of-angiosperms-and-utilization-of-plants.html
6. https://www.nhbs.com/en/morphology-and-economic-botany-of-angiosperms-book

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the basic concepts of Plant Taxonomy, nomenclature and economic importance through type studies of various families	K1, K2
CO 2	To examine and interpret the taxonomical attributes based on the rules and regulations of botanical nomenclature and the usefulness of select plant species	K3
CO 3	To analyze the origin, scope and objectives of Taxonomy through the study of different families and their importance	K4
CO 4	To compare and evaluate the salient features of different plant families and the economic importance of select plants	K5
CO 5	To summarize the classification of angiosperms, key characteristics of families and the uses of the important plants	K6

Course Code	**UPB 4502**
Course Title	**LAB-ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY**
Credits	02
Hours/Week	02
Category	Major Core (MC) - Lab
Semester	IV
Regulation	2019

Course Overview

1. Taxonomy is concerned with the laws governing the classification of plants.
2. The aim of this lab-course includes three aspects I. Identification, II. Nomenclature, and III. Classification of plants.
3. The course highlights all the basic fundamental knowledge on taxonomy such as origin, scope, classification types, and both classical and advance types of keys.
4. It explains the rules and regulation for naming for plants.
5. Detailed diagnostic characters of important will be learned by the students and through that they can easily identify the plants and will have to know the binomials of most of the common plants.
6. Brief history, botanical name, family, uses (nutritional aspects, active compounds and importance) and morphology of the useful parts of plants also will be taught to the students through this course.

Course Objectives

1. To provide a practical skill for plant identification through botanical keys.
2. To give practical knowledge on writing the description to identify the plants.
3. To enrich the students' knowledge on economic importance of plants by providing all the raw materials.
4. To add skills on herbarium techniques.
5. To gain knowledge on the identity of local plants**.**

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Description of plants in technical terms.** A detailed study of vegetative and reproductive morphology of plants. **Type Studies (Families)** Detailed study of the diagnostic characteristics of the following families: *Nymphaeaceae, Annonaceae, Rutaceae, Fabaceae* (*Papilionoideae,Caesalpinioideae & Mimosoideae*), *Anacardiaceae, Cucurbitaceae.*	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Type Studies (Families)** Detailed study of the diagnostic characteristics of the following Families:*Rubiaceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Orchidaceae and Poaceae.* Use of dichotomous key in the classification of the given specimens.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Economic Botany** Study of the following economically important plants: botanical name, family and morphology of the useful parts of any three Cereals: Rice, Wheat and Maize, Millets: Ragi, Bajra and Jowar, Pulses: Red gram, Black gram and Ground nut; Spices: Cinnamon, Clove and Cardamom; Condiments: Ginger, pepper and Chilli; Essential oils: Sandal wood oil, Eucalyptus oil and Lemon grass oil; Edible oil: Sesame oil, Coconut oil and Sunflower oil; Medicinal plants: Asafoetida, Indian periwinkle and Sweet flag; Fibre: cotton, jute and manilla-hemp, Timber: Teak, Shisham and Bijasal; Narcotics: Opium, Ganja and Tobacco and Beverages: Coffee, Tea and Cocoa.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Field trip to any place within or outside the state for three days to study the plants in their natural habitats. Field report to be submitted during the model practical examination.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

V	Submission of field note books and 15 herbarium sheets (1 material from each family). Commonly available plants can be used for herbarium preparation. Herbarium sheets to be prepared and submitted during the semester practical examination.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Sundara Rajan, S. 2000.Practical Manual of Angiosperm Taxonomy. Anmol Publications.
2. Sinha, RK.2010. Practical Taxonomy of Angiosperms. International Publishing Pvt.Ltd.

Suggested Readings

1. Gurcharan Singh, 2010. Plant Systematics an Integrated Approach, Science, Third Edition.
2. Simpson, M.G. 2010. Plant Systematics, Second Edition. Academic Press.
3. Simpson, B.B and Ogorzaly, M, C. 2001. Economic Botany: Plants in Our World, Third Edition. McGraw-Hill Higher Education. New York.
4. Pandey b.p. 2000. Simplified course in botany. S. Chand & Co Ltd. New Delhi.
5. Mitraj N. Mitra D and Chowdhuri S.K.1990. Studies in Botany (vol. i) Mont library, Calcutta.
6. Narayanaswami R.V., Rao K.N. and Raman, A. 2000. Outlines of Botany. S. Viswanathan and Co. Chennai.
7. Verma V.1998.A text book of economic botany. Emkay publications. New Delhi.
8. Albert F Hill; P. P. Sharma, 1996. Hill's Economic Botany. Tata Mc Graw Hill. New Delhi.

Web Resources

1. https://www.biologydiscussion.com › essay › taxonomy
2. https://www.wileyindia.com/taxonomy-of-angiosperms.html
3. https://www.easybiologyclass.com/angiosperm-systematics-and-taxonomy-free-online-study-materials-and-lecture-notes/
4. https://www.semanticscholar.org/paper/Taxonomy-of-Angiosperms-Arun-Mohammed/2101895c12d66c885208875a2f0edf7c7260bbe4
5. https://pragatiprakashan.in/taxonomy-of-angiosperms-and-utilization-of-plants.html

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the basic concepts of Plant Taxonomy, nomenclature and economic importance through type studies of various families	K1, K2
CO 2	To examine and interpret the taxonomical attributes based on the rules and regulations of botanical nomenclature and the usefulness of select plant species	K3
CO 3	To analyze the origin, scope and objectives of Taxonomy through the study of different families and their importance	K4
CO 4	To compare and evaluate the salient features of different plant families and the economic importance of select plants	K5
CO 5	To categorize and summarize the identification and classification of various plant families and the uses of the important plants	K6

Course Code	**UPB 4601**
Course Title	**BIOLOGICAL TECHNIQUES**
Credits	06
Hours/Week	06
Category	Major Elective (ME) - Theory
Semester	IV
Regulation	2019

Course Overview

1. Biological Techniques deals with the classical and recent techniques for studying biological structures.
2. The aim of the course is to instill in students the knowledge and expertise in handling biological instruments
3. The course deals with the study of the various types of microtechniques, preparation of plant material for sectioning, staining and permanent mounting
4. It also covers the various separation techniques used for molecular separation and analysis
5. The course helps to get good knowledge on the various spectroscopic and sedimentation techniques.

Course Objectives

1. To help understand the steps involved in processing of plant tissues using microtechniques, herbarium preparation and karyotyping
2. To understand working principle of the various instruments used in biological studies.
3. To get an in-depth knowledge on the various separation techniques and spectroscopic methods
4. To apply the knowledge of the different techniques to the study of selected plant material

Prerequisites	Basic knowledge in Biology or Botany or Zoology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to microscopy - Plant photography: Macrophotography, Microphotography and photomicrography - camera lucida – micrometry - Haemocytometer. Microtechniques: selection of material, fixation, dehydration, infiltration of wax, embedding, sectioning (Microtomy), staining (classification of stains- single, double and triple staining - Nuclear, cytoplasmic and cell wall stains) and mounting.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	Preparation of permanent slide, leaf clearing, smears and squash techniques. Methods for specific materials: (a) Whole mount of Algae and Fungi, (b) Sectioning of Bryophytes, Pteridophytes and Gymnosperms (c) Maceration and sectioning of angiosperm materials. Herbarium: collection, drying, pasting of plant specimen, protection of herbarium and importance. Idiogram and Karyotyping.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	pH meter: Principles and instrumentation, Centrifugation : Principles, types of centrifuges, types of rotors, application. Sonication, Freezedrying, Cryopreservation	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Spectrophotometric techniques, Instrumentation: ultraviolet and visible spectrophotometry (single and double beam), Spectrofluorimetry, XRD, NMR, Infrared spectroscopy - Atomic emission and atomic absorption spectroscopy - Luminometry - principles and their applications - Mass Spectroscopy- principles of analysis, application.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	Chromatographic techniques: principle and applications – Paper, TLC, Column - Ion exchange , Gel filtration, HPLC and Gas chromatography.- Basic principle and application of electrophoresis (AGE & SDS-PAGE).	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Upadhyay A, Upadhyay K, Nath N 2009. Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House, Delhi.
2. Wilson K and Walker J. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
3. Johanson D. A. 1940.Plant Microtechniques.Tata McGraw Hill.
4. Gray P 1964, Hand Book of Basic Microtechniques, McGraw Hill.

Suggested Readings

1. Palanivelu P 2009. Analytical Biochemistry and Separation Techniques. Twenty-first Century Publications, Madurai.
2. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
3. K. Wilson and KH Goulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn) Edward Arnold, London.
4. Sase John E 1964, Botanical Microtechnique, Oxford IBH
5. Alan Peacock H 1966, Elementary Microtechnique; Edward Arnod Publishers Ltd.
6. Duddington C.L. 1960, Practical Microscopy, Pitman, New York.
7. McCluney C.L 1961, Hand Book of Microscopical Technique, Wafner

Web Resources

1. https://www.spectroscopyonline.com/
2. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/spectrpy/spectro.htm
3. https://www.ltu.edu/engineering/projects/83c24731-ae01-4a41-8875-4248afebf6de/biomedical-engineering/bioinstrumentation-laboratory
4. https://www.khanacademy.org/
5. https://chem.libretexts.org/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the principle of different instrumentation methods and explain the applications behind each method	K1, K2
CO 2	To apply and interpret the results obtained through the application of various biological tools	K3
CO 3	To experiment and analyse the different types of sectioning, staining, separation and spectroscopic methods for the select plant samples	K4
CO 4	Compare and contrast each technique, their features and their significance over other methods	K5
CO 5	Categorize and summarize the different techniques and explain the observations and results obtained from each technique	K6

Course Code	**UPB 4602**
Course Title	**HORTICULTURE AND LANDSCAPING**
Credits	06
Hours/Week	06
Category	Major Elective (ME) - Theory
Semester	IV
Regulation	2019

Course Overview

1. Horticulture is an aesthetic science that deals with the important crops which are grown in the garden.
2. It deals with four branches of horticulture such as vegetable culture, Fruit culture, Floriculture (ornamental gardening), post-harvest technology and preservation.
3. It provides information on nursery establishment and describes species specific propagation techniques, pest, disease, weed, water and nutrient management.
4. This course gives information on different types of gardening, garden adornments and urban horticulture.
5. Landscaping horticulture deals with residential and non-residential garden, plants and tools used and how they are established and maintained.

Course Objectives

1. Understanding the scopes and employment opportunities of horticulture in various sectors.
2. Recall and get overview on various inter disciplines of horticulture and their techniques, application in day-to-day life
3. Explains the various components of nursery, management and propagation techniques.
4. Understanding and learning of different styles of garden, parts of garden and their adornments.
5. Interpret the principles, comparison of residential and non-residential gardens and establishment and maintenance of lawn.

Prerequisites	Basic knowledge on Botany and Zoology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Introduction:** Horticulture, scope and importance, Employment opportunities in horticuture: Nursery operation (nursery manager, propagator and plant technician), Turf grass operation (Landscape technician, golf course architect and supervisor), Crop production (Farm manager, crop grower), Florist operation (Floral designer, Plant rental supervisor), Education (Trainer, researcher and extension incharge), Industrial operation (developer –agro-chemicals, farm machinery), horticulture crop distributors.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Branches of horticulture:** **Pomology:** Classification of fruits based on climatic zones, establishment of an orchards, different layout and planting of fruit tress – Mango and Sapota. **Olericulture:** Classification of vegetables. Establishment and layout of kitchen garden and nutrigarden. Hydrophonics and Aeroponics. **Floriculture:** Floral ornaments and floral arrangements; Garlands and other floral ornaments, floral bouquets, rangoli and hair decorations. Cultural practices of rose, jasmine, cut flowers and its importance. Cut flower preservation methods. Export potential from Tamil Nadu.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Nursery structures and management:** **Nursery structure:** Store house, potting and packing shed, nursery beds, mist chamber, propagating frames, hot beds, green house and glass house. **Nursery management:** Vegetative propagation – cuttings, layering, grafting, preparation of grafting clay, wax, solution and cloth. Pot culture: Selection of pots, preparation of soil mixture, potting repotting and pot arrangements and watering	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

IV	**Gardening:** **Gardening:** History of Gardening, garden types: Formal, informal, residential and non- residential garden. Parts of Garden: Fencing hedge, borders, flower beds, edgings, lawn, steps, drives and paths, water garden, rockery, shrubbery and carpet bedding. **Garden adornments:** Arches, pergolas, vases, floral clocks. Routine garden operations: Soil sterilization, seed sowing, prickling, planting and transplanting, shading pinching, deshooting, disbudding, defoliation, staking, pruning, wintering, clipping, mulching, topiary. **Urban horticulture:-**Roof gardening, kitchen gardening, terrace gardening, landscape gardening, bonsai and its types, terrarium, vertical gardening, window gardens and hanging baskets.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Landscaping:** Principles, categories and components of landscaping - Planning designs for residential and non - residential gardens - vertical landscaping - Plants in the landscape - establishment and maintenance of lawns.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Anthony Youdeowei, Ezedinma F.O.C., and Ochapa C. Onazi, 1986. Introduction to
2. Tropical Agriculture (edited). English Language Book Society (ELBS). Longman.
3. George Acquaah, 2002. Horticulture Principles and Practices.2nd Edition.Pearson Education (Singapore) Pvt.Ltd.,
4. Lateeq Futehally, 1997. Gardens.3rd Edition.National Book Trust. India.
5. Randhawa, G.S. and Amitabh Mukhopadhyay, 1986. Floriculture in India. Allied
6. Publishers Pvt. Ltd., New Delhi.
7. Sheela V. L. 2011. Horticulture. MJP Publishers.

Suggested Readings

1. Edmund, Senn and Andrews (1981). Fundamentals of Horticulture. Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Percy Lancaster (1979) – Gardening in India. Mohan Makhijani and Rekha Printers, New Delhi.
3. Kumerasan, V and Arumugam, N. 2015. Fundamentals of Horticulture and Plant breeding. Saras publication.

Web Resources

1. http://agritech.tnau.ac.in/horticulture/horti_landscaping.html.
2. https://agritech.tnau.ac.in/horticulture/horti_Landscaping_principles.html
3. http://apeda.gov.in/apedawebsite/SubHead_Products/Floriculture.htm

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the scopes and employment opportunities of horticulture in various sectors.	K1, K2
CO 2	To recall and get an overview on various inter disciplines of horticulture and their techniques, application in day-to-day life.	K3
CO 3	To explain the various components of nursery, management and propagation techniques.	K4
CO 4	To understand the different styles of garden, components of garden and their adornments.	K5
CO 5	To interpret the principles, comparison of residential and non-residential gardens and establishment and maintenance of lawn.	K6

Semester V

Course Code	**UPB 5501**
Course Title	**PLANT PHYSIOLOGY**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. The branch of plant sciences that aims to understand how plants live, function and grow. It enables analysing processes in plants, namely – photosynthesis, mineral nutrition, respiration, transportation, and ultimate plant growth and development.
2. Uptake and transport of water and minerals are explained in general. The nutrient supply of plant is presented in details (essential elements, solute transport, and nutritional deficiencies).
3. Most common processes of plant biochemistry and metabolism, such as photosynthesis, are highlighted.
4. Critical knowledge of phyto-hormone biosynthesis, mode and mechanism of action will be highlighted.
5. The basic concepts of plant stress is complemented with the presentation of physiological mechanisms against different environmental stresses.
6. The course thus provides an insight into the physico-chemical organization and the functional aspects of plants.

Course Objectives

1. To understand water relation of plants with respect to various physiological processes.
2. To explain the mineral properties and deficiency symptoms in plants
3. To study the physiological mechanism and significance of photosynthesis and respiration.
4. To understand the physiology of nitrogen fixation in plants.
5. To assess photoperiodism, dormancy and germination in plants

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Plant and Water relations** Water – Properties and its relation to plants. Laws of thermodynamics and its physiological applications. Movement of water from soil to plants- Imbibition, Diffusion, Osmosis, Plasmolysis and Diffusion Pressure Deficit (DPD). Mechanism of water absorbtion and Ascent of sap. Stomatal physiology - Transpiration, Guttation and Antitranspirants.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Mineral nutrition and absorption in plants** Essential and non-essential elements, determination of essentiality of mineral elements, general functions of essential elements: specific role and deficiency symptoms. Hydroponics, aeroponics. Absorption and translocation of solutes (organic and inorganic) - active & passive uptake, Donnan's potential.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Photosynthesis** Definition and its significance. Photosynthetic requirements - chloroplast and its pigments, Absorption of light energy, Excitation of atom or molecules – fluorescence and phosphoresence, Quantum requirements and yield. Red drop and Emmersons Enhancement effect, quantosomes, action spectrum - mechanism of photosynthesis: light reaction, photophosphorylation and production of assimilatory power, dark reaction C3 & C4 pathway. CAM pathway, photorespiration.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Respiration and nitrogen assimilation** Mitochondria and its parts. Glycolysis, Krebs cycle and generation of ATP synthesis through oxidative electron transfer chain (Cytochrome system), chemiosmotic regeneration of ATP, Gluconeogenesis. Sources of nitrogen - plants/soil, nitrogen assimilation and recycling (NR, NiR), symbiotic nitrogen fixation in legumes (N_2ase), amino acid synthesis, reductive and transamination process (GS, GDH, GOGAT). Relation between carbon and nitrogen metabolism.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

V	**Plant Growth and Development** Growth: definition and kinetics - Hormonal regulation of plant growth and development. Auxin, Gibberellic acid, Cytokinin, Ethylene and abscissic acid - Bioassay and mode of action. Physiology of flowering- phytochrome: Photoperiodism types - Vernalization - dormancy of seeds, methods of breaking dormancy, mechanism of seed germination - Basics of signal transduction in plant. An introduction to Abiotic stress physiology (salinity, drought).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Devlin, O.P. 1983. Plant Physiology, Affiliated East West Press Pvt. Ltd. New Delhi.
2. Jain, V.K. 2018. Text Book of Plant Physiology, S. Chand & Company Ltd., New Delhi.
3. Noggle, G.R. & Fritz, G. 1976. Introductory Plant Physiology, Prentice – Hall, India.
4. Ross and Salisbury. (2009). Plant Physiology. Cengage Learning (Thompson), New Delhi, India.
5. Mukherji, S. &Ghosh, A. K. 2005.Plant Physiology. New Central Book Agency, Kolkata.

Suggested Readings

1. Taiz and Zeiger, Plant Physiology, IV edition, 2006, Sinauer Associates, Inc Pub Sunderland, Massachuesetts.
2. Hopkins, WG and Huner NPA.2004. Introduction to plant physiology. John Wiley & sons.
3. Srivastav, LM. 2002, Plant Growth and Development: Hormones and Environment. Academic Press.
4. Basra. A.S., 2004.Plant Growth regulators in Agriculture and Horticulture, International Book Distributing Co.
5. Dwivedi & Dwivedi (2005) Physiology of abiotic stress in plants. Agro bios. India

Web Resources

1. http://www.esalq.usp.br/lepse/imgs/conteudo/Plant-Physiology-by-Vince-Ordog.pdf
2. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4
3. http://employees.csbsju.edu/ssaupe/biol327/Lecture/mineral_nutrition.htm
4. http://employees.csbsju.edu/ssaupe/biol327/Lecture/photosyn-light.htm
5. http://exa.unne.edu.ar/biologia/fisiologia.vegetal/PlantPhysiologyTaiz2002.pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the interaction between soil – plant - air continuum.	K1, K2
CO 2	To illustrate the structure and function of plant organs in plant growth.	K3
CO 3	To explain anabolism, catabolism and growth regulators in plant growth and development.	K4
CO 4	To compare the function of different types of angiospermic plants.	K5
CO 5	To design and evaluate the role of environmental factors against plant growth and development.	K6

Course Code	**UPB 5502**
Course Title	**GENETICS AND PLANT BREEDING**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. Genetics is the study of how living things receive common traits from previous generations.
2. The aim of the course is to gives basic knowledge about gene interaction, linkage and crossing over.
3. The different units of the course will give information about different areas of genetics including structure and function of genetic material, replication and regulation of gene expression.
4. In this course, we will also study about types of mutation, polyploidy and DNA repair mechanisms.
5. Plant breeding deals with introduction, selection and hybridization of plants for better quality progeny.

Course Objectives

1. Understand the Mendelian laws of genetics on segregation and law of independent assortment.
2. Explain patterns of sex-linked inheritance, chromosomal disorders, cytoplasmic inheritance and genetic recombination.
3. Describe DNA replication, gene expression and protein synthesis.
4. Discuss the types of mutations, DNA damage and repair mechanisms.
5. Explain the principles of plant breeding, selection methods and hybridization

Prerequisites	Basic knowledge on Botany and Zoology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Basic Concepts of Genetics:** Genetics - definition - History; Mendelism: Mendel's laws - law of segregation - Monohybrid Cross and modification (incomplete dominance, codominance, lethal genes and pleiotropism) - Dihybrid cross and law of independent assortment.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Gene interaction and Sex linked inheritance:** Modified Mendelian ratios: Complementary genes, supplementary genes, epistatic genes and duplicate genes. Polygenic gene interaction, sex linked inheritance: haemophilia and colour blindness in man. Sex determination in plants. Multiple alleles, cytoplasmic inheritance, linkage and crossing over and chromosome mapping - Genetic recombination: *Neurospora* tetrad formation.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Molecular Genetics:** Organization of the genetic material in prokaryotes (**E. coli**) and comparisons with eukaryotes. DNA the genetic material; structure and organisation of DNA; Supercoiled DNA. Replication of DNA in *E. coli*; Semiconservative replication. Gene and its organization; cistron, recon and muton; Protein synthesis in Prokaryotes; Types of RNA; genetic code; Regulation of gene expression in prokaryotes (*lac* and *trp* operon).	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Chromosomal aberrations, Mutations and Repair mechanisms:** Chromosomal aberrations: duplication, deletion, inversion, translocation; chromosome disorders: Polyploidy; Mutation and its significance - Addition, deletions, and substitutions: transitions and transversion. Transposable elements in plants; DNA repair: proof reading - mismatch repair, Photo reactivation; Dark repair: excision repair, post recombinational repair and SOS - repair	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

	mechanisms. Population genetics: Gene frequency and genotype frequency and equilibrium. Hardy-Weinberg theorem of natural populations.			
V	**Plant Breeding:** Principles of Plant Breeding: Importance of plant breeding and domestication. Plant introduction - Selection methods: mass, Pure line and clonal selection and their importance. Hybridization: types, selection of parents; methods, emasculation, bagging - heterosis - Role of polyploidy in plant breeding.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Chahal, G.S. and Gosal, S.S. 2002. Principles and procedures of plant Breeding. Narosa Publishing House. New Delhi.
2. Singh, B.D. 2005. Plant Breeding, principles and methods (7th Revised and enlarged edition). Kalyani publishers, New Delhi.
3. George M. Malacinski, 2005. Freifelder's Essentials of Molecular Biology. 4th edition. Narosa Publishing House, New Delhi
4. Gupta, P.K. 2007. Genetics -Classical to modern. Rastogi Publications, Meerut, India.
5. Sambamurty, A.V.S.S., 2005. Genetics- second edition. Narosa publishing House, New Delhi.

Suggested Readings

1. George W. Burns, 1969. The Science of Genetics. An introduction to heredity. The Macmillan Company. New York.
2. Karp, G. 1996. Cell and Molecular biology. John Wiley and sons Inc. New York, Singapore.
3. Gardener, J, Simmons, H.J and Snustad, D.P. 1991. Principles of Genetics (8th edition), John Wiley & Sons, New York.
4. Daniel Sundarraj and Thulasidas, G. 1972. Introduction to cytogenetics and Plant Breeding (III Edn.) Popular Book Depot. Madras.
5. Darbeshwar Roy, 2012. Plant breeding - A biometrical Approach. Narosa Publishing House, New Delhi.

Web Resources

1. https://www.visiblebody.com/learn/biology/dna-chromosomes/dna-structure
2. http://www.csun.edu/~cmalone/pdf360/Ch02-1Mono.pdf
3. https://www.iit.edu/sites/default/files/2021-02/mendelian_genetics.pdf
4. https://www.fibl.org/fileadmin/documents/shop/1202-plant-breeding.pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the basic concepts of Genetics and Plant breeding.	K1, K2
CO 2	To describe and interpret the patterns of inheritance in different organisms.	K3
CO 3	To explain and relate the structure and functioning of genetic material under different conditions.	K4
CO 4	To evaluate and devise suitable techniques for crop improvement programmes.	K5
CO 5	To justify the outcome of the experiment /given statement related to genetics and plant breeding scientifically.	K6

Course Code	**UPB 5503**
Course Title	**PLANT DISEASES AND MANAGEMENT**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. Plant Diseases and Management deals with the study on the abnormal functioning of plants due to pathogens and environmental factors and about the control of the pathogens.
2. The aim of the course is to give basic knowledge about the diseases, defence mechanisms and control methods.
3. The different modules of the course will examine the biology, disease cycle, symptoms of fungal, bacterial and viral diseases.
4. In this course, we will also examine the physical, chemical and biological methods of disease control.
5. The details on the role of genetic engineering, a modern strategy for the development of diseases resistance will be discussed with examples.

Course Objectives

1. To understand the process of pathogenesis and its effects on host plants.
2. To explain the resistance mechanisms in plants against diseases.
3. To describe the symptoms of various diseases caused by fungal pathogens.
4. To elucidate the symptoms of various diseases caused by bacteria, viruses, mycoplasmas and nematodes.
5. To understand the physical, chemical, and biological methods to control plant diseases.

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Pathogenesis:** Introduction, concepts, history, classification of disease types, symptoms, causes of plant diseases, environmental factors, and physiological diseases. Virus, prokaryotes and eukaryotes. Host-pathogen interactions: mechanical forces and biochemical weapons (enzymes, toxins and growth regulators). Pathogenic impacts: changes in the host (morphological, anatomical, physiological and biochemical).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Epidemiology and defense mechanisms**: Factors responsible for epiphytotics: (Disease Triangle). Innate characters: morphological, anatomical, physiological and biochemicals. Induced factors: Histological, biochemical, phytoalexins and hypersensitivity reactions. Fundamental concept on cross protection and induced resistance.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Symptomatology and Diseases Life Cycle**: Incitants, symptom manifestation and control measures. Fungal diseases: Damping off of Mustard seedling, Club root of cabbage, Powdery mildew of cucurbits, Ergot of Rye, Smut of Sorghum, Rust of wheat, Blast of Rice, Wilt of tomato and Tikka of Ground nut.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Symptomatology and Diseases Life Cycle:** Incitants, symptom manifestation and control measures. Bacterial diseases: Bacterial blight & Citrus canker, Mycoplasmal disease: Little leaf of brinjal, Viral Diseases: Bunchy top of Banana and Tungro disease of Rice, Nematode disease: Root knot disease of Potato, Insect disease: Galls, Other parasitic diseases of plants: *Cuscuta.*	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

V	Plant disease control: Concepts on prophylaxis. Exclusion: Legislation - plant quarantine principles. Eradication - crop rotation, field sanitation, elimination of alternate hosts, soil treatment and seed treatments. Management strategies: chemical, environmental and - Disease forecasting. Microbial antagonists: Bacterial, Fungal and viral (mode of action, mass production and field application). Engineered resistance against fungal, viral and bacterial pathogens	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Mehrotra. R.S. 1980. Plant Pathology. Tata McGraw Hill, New Delhi.
2. Rangaswamy, G. 1975. Diseases of crop plants in India. 2ndEdn. Prentice Hall, India

Suggested Readings

1. Bilgrami, K.S. and Dube, H.C. 1976. A text book of modern Plant Pathology. Vikas Publishing House Pvt. Ltd., New Delhi.
2. Pandey B.P. 1989. A text book of Plant Pathology, pathogen and plant diseases. S. Chand and Company Ltd., New Delhi.
3. Mukerji, K.G. & Bhasin, J. 1972. Plant diseases of India – A source book. Tata McGraw Hill, New Delhi.

Web Resources

1 . https://ohioline.osu.edu/factsheet/plpath-gen-6
2 . https://www.agric.wa.gov.au/citruscanker/citrus-canker
3 . https://www.apsnet.org/edcenter/disandpath/fungalbasidio/pdlessons/Pages/StemRust.aspx
4 . https://www.cabi.org/isc/datasheet/45797

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To identify and understand the pathogenesis, epidemiology, symptomatology and control measures for plant diseases.	K1, K2
CO 2	To apply and interpret the mechanism of pathogenesis and defense mechanisms of important plant diseases.	K3
CO 3	To analyse and differentiate the plant diseases caused by different pathogens and their control measures.	K4
CO 4	To evaluate and explain the diseases cycle and control methods.	K5
CO 5	To categorize and summarize the disease symptoms and modern strategies in disease control mechanisms.	K6

Course Code	**UPB 5504**
Course Title	**HERBAL SCIENCES AND ETHNOBOTANY**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	V
Regulation	2019

Course Overview

1. Herbal Science deals with the study of common medicinal plants, their macroscopic, microscopic and physical evaluation, classification, adulteration, active and inert constitution, marketing and export of potential herbs.
2. The aim of the course is to give basic knowledge on the common and ethnic medicinal plants, their morphology, chemical constituents and uses.
3. The important aspect of the course is to gain knowledge on the commonly used herbal preparations and their identification, isolation and extraction methods.
4. The course discusses and emphasizes the values of the traditional systems of medicine such as Siddha, Ayurveda and Unani and the role of National Institutes for the conservation as well as the export of plants and their drugs.
5. In this course, the basic knowledge on the tribals of India are discussed in terms of tribal knowledge on medicinal plants, different schemes for tribal development, PR and ethics for documentation of medicinal plants and their drugs.

Course Objectives

1. To analyse the herbal products through the knowledge of pharmacognosy and QAQC test methods.
2. To identify the most commonly used medicinal plants through organoleptic and analytical methods and convey the traditional use of herbs in medicine.
3. To produce commonly used herbal preparations with their potential in medicinal applications.
4. To understand the ethnobotany of India and to know the central institutes involved in medicinal plant research.
5. To gain knowledge and awareness on the role played by the ethnic tribes towards ethnobotany.

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Pharmacognosy** Introduction - history of Pharmacognosy - definitions and terms - Basic concepts: Preparation of drugs for commercial market - Organoleptic evaluation of drugs - microscopic evaluation of drugs - Physical evaluation of drugs - Active and inert constituents of drugs - Classification of drug plants - individual drugs - drug adulteration & substitution. Export potential of herbs.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Organoleptic Study** Detailed organoleptic study of *Adhatoda vasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metal, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus communis, Vinca rosea* and *Zingiber officinale*. Plants in primary health care: common medicinal plants: *Tinospora, Acorus, Ocimum, Turmeric and Aloe*.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Herbal Preparations** Collection of wild herbs - Capsules - compresses - Elixirs - Glycerites - Hydrotherapy or Herbal bath - Herbal oils - Liquid extracts or Tincture - Poultices - Salves - Slippery elm slurry and gruel - Suppositories - Teas. Outline of occurrence, isolation, identification tests, therapeutic effects and pharmaceutical application of alkaloids, terpenoids, glycosides, volatile oils, tannins and resins.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Ethnobotany I** Introduction, origin and basic notion of ethnobotanical study - Ethnobotany as an emerging science and its scope - Ethnobotany in India: Areas and recent studies - Methodologies of ethnobotanical research: Field work, Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethnobotany in Indian systems of medicine (Siddha, Ayurveda and Unani), Role of AYUSH, NMPB, CIMAP and CARI.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

V	**Ethnobotany II** Basic knowledge of tribes in India with special reference to Tamil Nadu - Todas, Irulas and Paliyars. Tribal economy - Schemes of state forests department for tribal development - Tribal knowledge towards disease diagnosis, treatment, medicinal plants. Traditional knowledge and IPR. Ethics of documentation.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Wallis, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd.
2. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
3. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
4. Sharol Tilgner, N. D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by Malloy Lithographing Inc.
5. Pal, D.C. & Jain, S.K.1998. Tribal Medicine. NayaPrakash Publishers, Calcutta.

Suggested Readings

1. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. NayaPrakash Publishers, Calcutta.
2. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1 Ministry of Health, Govt. of India.
3. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
4. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
5. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi.

E-BOOKS:

1. Pharmacognosy, 2015. Wikipedia, the free Encyclopedia.
2. The Siddha Pharmacopoeia of India. Part-1, Volume-1, 1st edition. Government of India, Ministry of Health and Family Welfare, Department of Ayurvda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (Ayush).

Web Resources

1. https://thepharmacognosy.com
2. http://www.mespharmacy.org
3. https://www.ncbi.nlm.nih.gov
4. https://www.herbalgram.org
5. https://www.ddrpharmacy.com
6. https://www.ncbi.nlm.nih.gov
7. http://www.igntu.ac.in
8. https://ethnobiomed.biomedcentral.com

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the pharmacognosy behind ethnobotanical herbs through organoleptic studies and herbal preparations.	K1, K2
CO 2	To apply the ethnobotanical knowledge gained from tribes and organoleptic studies and research for herbal preparations and pharmacognosy.	K3
CO 3	To analyse, test and identify the phytochemicals, present in plants and acquire skills on herbal preparations.	K4
CO 4	To evaluate the ethnobotanical knowledge through analysis of plant compounds and through herbal preparations.	K5
CO 5	To summarize the tribal knowledge, phytochemical analysis and herbal preparations involved in the study and preservation of ethnobotany.	K6

Course Code	**UPB 5505**
Course Title	**LAB - V (PLANT PHYSIOLOGY & GENETICS AND PLANT BREEDING)**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Lab
Semester	V
Regulation	2019

Course Overview

Plant Physiology

1. This lab course includes viz: experiments on water potential, osmatic pressure of a plant cell and the role of water, light, pigments in photosynthesis,
2. Quantitative analysis of primary metabolites formed during plant growth using scientific methods.

Genetics and Plant Breeding

3. The Lab course deals about basic principles of Mendelian genetics
4. The practical work also involves the application of biostatistics to study the law of genetics

Course Objectives

1. To assess the water status and osmotic pressure of a plant cell.
2. To estimate the amount of water, pigments and light involved in photosynthesis.
3. To quantify the primary metabolites formed out of photosynthesis.
4. To study Mendelian genetics.
5. Apply the principles of statistics in mendelian genetics.
6. Problem solving related to crossing over.

Prerequisites	Concepts of Plant Physiology and Genetics

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Assessment of water potential and osmotic pressure of a plant cell.** Potato / Papaya petiole - osmoscope. Determination of water potential by Dye method. Determination of osmotic pressure. Determination of relative water content. Transpiration pull / Ganong's potometer	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Evaluation of leaf pigments, light and water in photosynthesis.** Estimation of chlorophyll and carotenoids. Separation of leaf pigments by column chromatography - Demonstration. Separation of leaf pigments by paper chromatography. Wiltmott's Bubbler on photosynthesis using different light and carbon di oxide concentration.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Quantitative analysis** Estimation of carbohydrates. Estimation of protein. Estimation of total lipids Ganong's Respiroscope- Demonstration Plant growth regulators- Demonstration.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Genetics and plant breeding** Collection of Data (continuous and discrete); Arithmetic mean, standard deviation and standard error. Chi square analysis. Problems on Mendelian Genetics: Monohybrid cross and modification. Dihybrid cross and modification.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Genetics and plant breeding** Gene interactions Mapping of chromosomes. Chromosomal abnormality using onion root tip. Percent seed germination study. Demonstration on emasculation. Spotters related to plant breeding Visit to plant breeding station.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Khadir VMA 2006. Biochemistry & Physiology practical manual.
2. Kuruwanshi, V.B. Guhey, Arti 2016. Practical Manual on Principles of Plant Physiology

Suggested Readings

1. Devlin, O.P. 1983. Plant Physiology, Affiliated East West Press Pvt. Ltd. New Delhi.
2. Taiz and Zeiger, Plant Physiology, IV edition, 2006, Sinauer Associates, Inc Pub
3. Sunderland, Massachuesetts.
4. George W. Burns, 1969. The Science of Genetics. An introduction to heredity. The Macmillan Company. New York.
5. Karp, G. 1996. Cell and Molecular biology. John Wiley and sons Inc. New York, Singapore.
6. Gardener, J, Simmons, H.J and Snustad, D.P. 1991. Principles of Genetics (8th edition), John Wiley & Sons, New York.

Web Resources

1. https://www.youtube.com/watch?v=sMOn04HYRkE
2. https://drive.google.com/file/d/1lz-B_R264O3WgXjC7ZKsHHNgfVEQ3d6M/view
3. https://drive.google.com/file/d/16poExJWqx8bCZcN6maNDuWrohZDpxhzW/view
4. https://mail.google.com/mail/u/0/?tab=rm&ogbl#sent/QgrcJHrtrSpsDxLSCQHxBpFtmvnCtGhShlv?projector=1
5. https://www.visiblebody.com/learn/biology/dna-chromosomes/dna-structure
6. http://www.csun.edu/~cmalone/pdf360/Ch02-1Mono.pdf
7. https://www.iit.edu/sites/default/files/2021-02/mendelian_genetics.pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the interaction between soil – plant - air continuum.	K1, K2
CO 2	To illustrate the structure and function of plant organs in plant growth.	K3
CO 3	To explain anabolism, catabolism and growth regulators in plant growth and development.	K4
CO 4	To compare the function of different types of angiospermic plants.	K5
CO 5	To design and evaluate the role of environmental factors against plant growth and development.	K6

Course Code	**UPB 5506**
Course Title	**LAB -VI (PLANT DISEASES & MANAGEMENT, HERBAL SCIENCES & ETHNOBOTANY)**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Lab
Semester	V
Regulation	2019

Course Overview

1. The different modules of the course will examine the biology, disease cycle, symptoms of fungal, bacterial and viral diseases.
2. In this course, we will also examine the physical, chemical and biological methods of disease control.
3. Herbal Science deals with the study of common medicinal plants, their macroscopic, microscopic and physical evaluation, classification, adulteration, active and inert constitution, marketing and export of potential herbs.
4. The aim of the course is to give basic knowledge on the common and ethnic medicinal plants, their morphology, chemical constituents and uses.
5. The important aspect of the course is to gain knowledge on the commonly used herbal preparations and their identification, isolation and extraction methods.

Course Objectives

1. To study the symptoms, host and pathogen in fungal, bacterial and viral diseases.
2. To identify the most commonly used medicinal plants through organoleptic and analytical methods and convey the traditional use of herbs in medicine.
3. To produce commonly used herbal preparations with their potential in medicinal applications.

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Plant Diseases and Management** Study on the incitants, symptoms of locally available fungal, bacterial and viral diseases. Preparation of PDA, NA and Nutrient Broth. Isolation of plant pathogens from infected tissues and verification (Demonstration).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Plant Diseases and Management** Evaluation of fungicide: Slide germination technique and inhibition zone technique. Estimation of flavonoids and phenols in diseased and healthy plants. Spotters: Botanicals pesticides, Microbial pesticides; Predators and parasites; Chemicals (Organic and inorganic).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Plant Diseases and Management** A survey of plant diseases in and around Chennai – Specimen collection and Herbarium preparation (10). **Herbal Sciences and Ethnobotany** Studies of plants mentioned in the theory in the following aspects. Morphological studies of vegetative and floral parts.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Herbal Sciences and Ethnobotany** Microscopic preparations of root, stem and leaf samples. Stomatal number and stomatal index. Vein islet number. Palisade ratio. Fibres and vessels (maceration). Starch test. Proteins and lipid test.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	Determination of the adulteration of a mixture of leaves. Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, flavonoids, terpenoids, phenolics, glycosides,	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

	volatile oils, tannins and resins. Any 5 herbal preparations. Documentation of knowledge on common medicinal plants – report submission.			

Text Books

1. Wallis, T. E. 1946. Text book of Pharmacognosy, J & A Churchill Ltd.
2. Roseline, A. 2011. Pharmacognosy. MJP Publishers, Chennai.
3. Jain S. K. 1989. Methods and approaches in Ethnobotany, Society of Ethnobotanists, Lucknow.
4. Bilgrami, K.S. and Dube, H.C. 1976. A text book of modern plant pathology. Vikas Publishing House Pvt. Ltd., New Delhi.
5. Pandey B.P. 1989. A text book of plant pathology, pathogen and plant diseases. S. Chand and Company Ltd., New Delhi.
6. Sharol Tilgner, N. D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by Malloy Lithographing Inc.
7. Pal, D.C. & Jain, S.K.1998. Tribal Medicine. Naya Prakash Publishers, Calcutta.

Suggested Readings

1. Pal, D.C. & Jain, S.K., 1998. Tribal Medicine. Naya Prakash Publishers, Calcutta.
2. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1 Ministry of Health, Govt. of India.
3. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
4. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
5. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi.

E-BOOKS:

1. Pharmacognosy, 2015. Wikipedia, the free encyclopedia.
2. The Siddha Pharmacopoeia of India. Part-1, Volume-1, 1st edition. Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (Ayush).

Web Resources

1. https://ohioline.osu.edu/factsheet/plpath-gen-6
2. https://www.agric.wa.gov.au/citruscanker/citrus-canker
3. https://www.apsnet.org/edcenter/disandpath/fungalbasidio/pdlessons/Pages/StemRust.aspx
4. https://www.cabi.org/isc/datasheet/45797
5. https://thepharmacognosy.com
6. http://www.mespharmacy.org
7. https://www.ncbi.nlm.nih.gov
8. https://www.herbalgram.org
9. https://www.ddrpharmacy.com
10. https://www.ncbi.nlm.nih.gov
11. http://www.igntu.ac.in
12. https://ethnobiomed.biomedcentral.com

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the pharmacognosy behind ethnobotanical herbs through organoleptic studies and herbal preparations; To understand plant diseases, their causes and control measures.	K1, K2
CO 2	To apply the ethnobotanical knowledge gained from tribes and organoleptic studies and research for herbal preparations and pharmacognosy. To apply the knowledge on plant diseases for identification.	K3
CO 3	To analyse, test and identify the phytochemicals, present in plants and acquire skills on herbal preparations. To analyse the various types of diseases in plants based on the symptoms and anatomy.	K4
CO 4	To evaluate the ethnobotanical knowledge through analysis of plant compounds and through herbal preparations. To evaluate the biochemical changes caused by disease.	K5
CO 5	To summarize the tribal knowledge, phytochemical analysis and herbal preparations involved in the study and preservation of ethnobotany. To summarize the knowledge on plant diseases for effective control.	K6

Course Code	**UPB 5601**
Course Title	**PRINCIPLES OF AGRICULTURE**
Credits	06
Hours/Week	06
Category	Major Elective (ME) - Theory
Semester	V
Regulation	2019

Course Overview

1. Principles of Agriculture is a course designed to enhance the understanding of the agricultural practices followed in India.
2. This course provides knowledge on fundamental principles of agronomy, soil science and environmental science.
3. This course also highlights the agronomic practices followed in paddy, sugarcane and legumes.
4. Identification on types of pathogens in field crops and various control measures are dealt with in detail.
5. Topics on Integrated pest management and organic farming are discussed in detail.

Course Objectives

1. To understand the history of agriculture, green revolution, classification of crops and role of climates in agricultural production.
2. To gain knowledge on types of agriculture soil, conservation and different irrigation methods.
3. To understand and implement the agronomic practices and cultivation methods on major food crops.
4. To know about agriculture weeds and controlling methods through various practices.
5. To comprehend the characteristics of agriculture pests and Integrated Pest Management.

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Introduction** Origin of Agriculture; technological evolution and history of agriculture - prehistoric agriculture, historical agriculture, feudal agriculture and scientific agriculture. Agriculture in India, green revolution, white and yellow revolution, branches of agriculture. Classification of agricultural crops, modern methods of cultivation. Climatic factors effect on crop growth, impact of climate change on cropping pattern as indicators of environment. - Impact of high-yielding and short-duration varieties on shifts in cropping pattern.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Agricultural Soil and Irrigation** Soil- Physical, chemical and biological properties - Classification of Indian soils - Mineral and organic constituents of soils and their role in maintaining soil productivity. Essential plant nutrients and other beneficial elements in soils and plants. Principles of soil fertility - Use of fertilizer. Role of Nitrogen and phosphorus based fertilizers, biofertilizers. Reclamation of soil. Water-use efficiency in relation to crop production, criteria for scheduling irrigations, ways and means of reducing run-off losses of irrigation water. Drip irrigation, micro irrigation and sprinkler irrigation. Soil and water conservation methods Drainage of water - logged soils, quality of irrigation water, effect of industrial effluents on soil and water pollution.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Sustainable and special agricultural practices** Agricultural implements, Seed bed preparation, ploughing, harrowing, sowing, weeding, leveling, transplantation.- crop rotation, crop diversification, mixed cropping, biological nitrogen fixation, harvesting, Post- harvest methods - Cultural practices of paddy, chickpea and Sugarcane, Kharif and Rabi crops. Seed production and storage. Special practices in Agriculture - High yielding varieties (HYVs), Organic farming, Natural farming and protected cultivations.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

IV	**Weeds and their management** Weeds and their characters; classification of weeds, propagation and dissemination of weed seeds; Crop - weed association, crop - weed competition and allelopathy; Integrated Weed Management (IWM), cultural, biological and chemical control of weeds. Herbicides, types and their role in controlling the weeds.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Agricultural pests and their management** Pests, their characteristics, types, control measures, biological control, Integrated Pest Management (IPM). Pesticides, types and their role controlling the pests. Biotechnology in pest management (Bt strategy).	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. R.L. Arya, S. Arya, Renu Arya, J. Kumar 2015. Fundamentals of Agriculture. Scientific Publishers
2. Shovan Ray (Ed). 2007. Handbook of Agriculture in India. Oxford University Press. New Delhi.
3. Panda, S.C. 2005.Agronomy. Agrobios. Jodhpur.
4. Kumar Arvind, 2006. Concepts of Tropical Agriculture. Eastern Books Corporation, India.
5. Katyayan Arun, 2019 Fundamentals of Agriculture. Kushal Publication & Distributors

Suggested Readings

1. Sreenivas, Y.S. 2009.Advances in Agricultural Research in India, Oxford Book Company. Jaipur.
2. Ramanand Sagar 2009.Advances in Agricultural Biotechnology. Cyber Tech Pub. New Delhi.
3. Hemant Rawat. 2008. Agricultural Biotechnology. Oxford Book Company. Jaipur.
4. Rajendra Reddy and J.P. Abhay Shankar. 2007. Encyclopedia of Agriculture. Commonwealth Pub., New Delhi.
5. T. Yellamanda Reddy and G.H Sankara Reddy, 2010. Principle Of Agronomy. Kalyani Publishers, Chaura Bazar, Ludhiana, Punjab

Web Resources

1. https://drive.google.com/file/d/1jqhy5dpCOA8gJYVc9wU8OUlBnKXkViDX/view
2. https://drive.google.com/file/d/1TYUfg_eAG2prhGUn7YMnz-NCjUAXzq0Y/view
3. https://ipm.ifas.ufl.edu/pdfs/Applying_the_Principles_of_Sustainable_Farming.pdf
4. http://www.jnkvv.org/PDF/050420201342513420082 2.pdf
5. https://www.biodiversitylibrary.org/item/80761#page/1/mode/1up

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the basic concepts related to livestock (Agriculture) production.	K1, K2
CO 2	To explain soil types, soil structure, drainage to reduce soil erosion, water quality and availability to crops.	K3
CO 3	To evaluate the land use for various agronomic practices.	K4
CO 4	To assess sustainable management of plant diseases and weeds in various crop production.	K5
CO 5	To summarize various skills to solve problems related to crop production and management.	K6

Course Code	**UPB 5602**
Course Title	**NANOTECHNOLOGY**
Credits	06
Hours/Week	06
Category	Major Elective (ME) - Theory
Semester	V
Regulation	2019

Course Overview

1. Nanotechnology is an interdisciplinary subject integrating the fields of physics, chemistry and biology.
2. The aim of the course is to give basic knowledge on the science behind nanotechnology, the unique characteristics associated with objects at the nanoscale.
3. It also deals with the study of the nanoproperties by using the different techniques to analyze them
4. The course also deals with the different types of nanostructures, their shapes and behaviour.
5. In this course, we will also examine the numerous applications of nanoparticles in nanomedicine as nanobots, drug carriers and in wound healing
6. The course gives an extensive knowledge on the various industrial and environmental applications of nanotechnology.

Course Objectives

1. To understand the field of nanotechnology in terms of the synthesis, effects, and properties at the nanoscale.
2. To study in depth the unique properties that govern the particles at the nanoscale and the techniques used to study them.
3. To study the classification and characteristics of the different types of nanoparticles.
4. To gain knowledge on the recent and major applications of the nanoparticles in medicine, industry and the environment.

Prerequisites	Basic knowledge on Biology or Botany or Zoology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction - nanoscience - nanotechnology - top down and bottom up approach - nanosized effects – surface to volume ratio - atomic structure – molecules and phases -energy at the nanoscale, molecular and atomic size - quantum effects - methods of synthesis - chemical reduction - reducing agents, capping agents, stabilization of nanoparticles. Biosynthesis - novel synthetic methods using plant extracts and microorganisms	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	Characteristics of nanoparticles - optical, electrical, mechanical, magnetic and catalytic activity - characterisation of nanoparticles using UV - Visible spectroscopy, SEM, TEM, Atomic Force microscopy - Scanning Tunnel microscopy – Photoluminescence	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	Classification of anisotropic nanostructures - one-dimensional nanostructures - nanorods and nanowires - nanoclusters, quantum dots, carbon nanoparticles - Graphene, Fullerenes, carbon nanotubes (CNTs) - single walled CNT & multi - walled CNT, metallic nanotube - gold, silver nanotubes	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Nano materials in Medicine - carriers for drug delivery (DDS) - polymeric nanotubes & solid liquid nanoparticles (SLN), nanobots as carriers, controlled release, site specific targeting. Magnetic nanoparticles as drug carriers and applications of SLN and DDS - nutraceuticals, medicine - antimicrobial activity, wound healing and dressing in cancer	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	Applications of nanoparticles - nanosensors - textiles, food industry - Environmental (wastewater treatment) and bioremediation - paint industry and water - resistant coatings - molecular devices - biotemplates - DNA origami - health hazards and ethical concerns	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Charles P Poole Jr & Frank J Owens (2003) Introduction to Nanotechnology. John Wiley & Sons, Inc, Publications
2. Pradeep T (2007) Nano: The Essentials, Understanding Nanoscience and Nanotechnology. Tata McGraw Hill Publishing Co., Ltd, New Delhi
3. Sulabha K. Kulkarni (2007) Nanotechnology: Principles and practices. Capital publishing Co. New Delhi
4. Sharma P.K. (2008) Understanding Nanotechnology. Vista International Publishing House, Delhi
5. Viswanathan B (2009) Nanomaterials. Narosa Publishing House, New Delhi.

Suggested Readings

1. Chattopadhyay KK and Banerjee AN (2009) Introduction to Nanoscience and Nanotechnology, PHI Learning Private Ltd
2. Christof M Niemeyer, Chad A Mirkin(2004)Nanobiotechnology: Concepts, Applications and Perspectives, Wiley- VCH Verlag GmbH & Co., KGaA
3. Tuan Vo-Dinh (2019) Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, Second Edition, CRC Press
4. David S. Goodsell(2004) Bionanotechnology: Lessons from Nature, John Wiley & Sons
5. Risal Singh Shipra Mital Gupta (2018) Introduction To Nanotechnology Oxford University Press
6. Pradeep T(2017)A Textbook of Nanoscience and Nanotechnology, McGraw Hill Education

Web Resources

1. https://www.nanowerk.com/
2. https://www.loc.gov/rr/scitech/selected-internet/nanotechnology.html
3. https://nano.nature.com/
4. https://www.nano.gov/
5. https://www.nature.com/nnano/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the behaviour, properties, synthesis and applications of molecules at nanoscale in life sciences.	K1, K2
CO 2	To classify and interpret the various types of nanoparticles in terms of behaviour, analysis and uses in life sciences.	K3
CO 3	To analyse the different types of nanoparticles in terms of their morphology, properties and their applications in life sciences.	K4
CO 4	To compare and contrast the properties, analytical methods and role of nanotechnology in various applications in life sciences.	K5
CO 5	To collect and categorize the multifaceted characteristics and uses of nanomaterials in various industries and medicine.	K6

Semester VI

Course Code	**UPB 6501**
Course Title	**PLANT BIOTECHNOLOGY**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	VI
Regulation	2019

Course Overview

1. Plant biotechnology is a set of techniques used to adapt plants for specific needs or opportunities.
2. The techniques of plant organ, tissue and cell culture have evolved over several decades.
3. There has also been a growing interest in the use of suspension and immobilised plant cell cultures and organ cultures for the production of fine chemicals and some specific biotransformation reactions.
4. These techniques combined with recent advances in developmental, cellular and molecular genetics and using conventional plant breeding have turned plant biotechnology into an exciting research field with significant impact on agriculture, horticulture and forestry.

Course Objectives

1. To understand the scope and importance of plant tissue culture in plant sciences.
2. To gain knowledge on the structure and function of plant nuclear and chloroplast genome.
3. To understand the fundamental aspects of molecular biology of leguminous plants in nitrogen fixation.
4. To understand the molecular techniques used in genetic engineering.
5. To understand the concepts of modern technology pertaining to large scale production of transgenic plants.

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Plant Tissue Culture** Definitions, scope, history, importance of plant tissue culture & biotechnology. *In vitro* culture techniques: Sterilization methods, Culture media - composition, types of medium and role of hormones in *in-vitro* culture, Initiation, maintenance and acclimatization. Micropropagation, Anther, Embryo, Callus, Suspension culture and its significance. Somatic embryogenesis and synthesis of artificial seeds. Protoplast culture. Plant protoplasmic isolation and fusion in hybrid production. Somaclonal variation.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Plant Molecular Biology** Organization and expression of nuclear genome (*Arabidopsis thaliana*), and chloroplast genome. Transcription and post -transcriptional modifications in plants. Translation and post-translational modifications in plants. Expression of nitrogen fixing genes in leguminous plants. Molecular interaction between Rhizobial genes and legumes	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Genetic Engineering** Principles of cloning: Restriction enzymes. Vectors: plant viruses (CaMV), bacteriophages (lamda phage and M13), yeast artificial chromosomes (YAC), pBR 322, pUC, binary vectors, shuttle vectors. Libraries: genomic and cDNA, molecular probes. Molecular techniques: Electrophoresis, Southern, Northern, Western & Slot blots. Polymerase Chain Reaction, DNA sequencing.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Plant transformation:** Genetic organization of Ti plasmids - Functions encoded by integrated T-DNA. Molecular mechanism involved in transfer of T- DNA into plants. Gene delivery system: Genetic transformation of plants by *Agrobacteriu*m. Physical methods: Particle gun bombardment, microinjection, electroporation. Importance of promoter and marker genes in plant transformation. Concerns regarding the use of	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

	different promoters and selectable markers.			
V	**Crop Improvement** Plant genome mapping: Molecular markers (RFLP, RAPD, SSR & SNP) and its applications. Transgenic plants for resistance to insect and herbicide. Plant Molecular Farming: Production of plantibodies and pharmaceuticals (Golden rice). IPR, Biosafety and bioethics.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Gupta P. K. 2019. Elements of Biotechnology. Rastogi Publications. Meerut.
2. Ignacimuthu, S., 2012. Biotechnology – An Introduction. Narosa Publishing House Pvt. Ltd. – New Delhi
3. Kalyan Kumar De., 2008. Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
4. Satyanarayana U. 2010. Biotechnology, Books and Allied (P) Ltd. Kolkata.
5. Primrose, S. B. and Twyman, R. M. 2006. Principles of Gene Manipulation and Genomics.7th edition. Blackwell Publishing.

Suggested Readings

1. Grierson, D and Convey, S.N., 1991. Plant Molecular Biology Published in the USA by Chapman and Hall, New York.
2. Ignacimuthu, S.1997. Plant Biotechnology. Oxford Publishing Co. Pvt. Ltd., New Delhi.
3. Rashid, A. 2009. Molecular Physiology and Biotechnology of Flowering plants. Narosa Publishing House Pvt. Ltd., New Delhi.
4. Caldentey, K.M.O. and Barz, W. H. 2002. Plant Biotechnology and Transgenic Plants. Marcel Dekker. Inc.
5. Doyle, A. and Griffiths, J. B., 1999. Cell and Tissue Culture: Laboratory procedures in Biotechnology. John Wiley & Sons Ltd.,
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P., 2008. The Molecular Biology of the cell.5th edition. Garland Science Taylor and Francis Group.

Web Resources

1. https://www.cambridge.org/core/journals/genetics-research/article/principles-of-gene-manipulation-and-genomics-7th-edition
2. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=3
3. http://www.bio-nica.info/biblioteca/OksmanCaldentey2002PlantBiotechnology.pdf
4. https://onlinelibrary.wiley.com/doi/book/10.1002/9780470686522
5. https://cnx.org/resources/7847f7d45e1da2e6977a49af0ef65ad1/PlantBioI-INTRODUCTION.pdf
6. https://pravara.in/wp-content/themes/twentyseventeen/essentials/pdf/elearn/Principles-of-Plant-Biotechnology.pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the working principle of plant tissue culture and molecular techniques	K1, K2
CO 2	To produce transgenic plants using genetic engineering.	K3
CO 3	To differentiate the production methods of genetically modified plants from conventional hybrid plants.	K4
CO 4	To justify plant tissue culture and plant molecular biology are the fundamental units of plant biotechnology.	K5
CO 5	To summarize the importance of plant tissue culture and molecular techniques in crop improvement programme.	K6

Course Code	**UPB 6502**
Course Title	**MICROBIAL TECHNOLOGY**
Credits	04
Hours/Week	04
Category	Major Core (MC) - Theory
Semester	VI
Regulation	2019

Course Overview

1. Microbial Biotechnology deals with the application of microbes in industrial processes.
2. The course deals with the range of products from microbes and strain improvement of microbes.
3. This paper aims at imparting knowledge on the fermentors, their types and conditions required for growth.
4. The course deals with microbial processes and products related to food industry.
5. The course also imparts microbial products and processes related with pharmaceutical industries including production of recombinant proteins and vaccines.
6. The course deals with other products such as aminoacids, organic acids, biofertilizer, bioplastics, biopolymers etc.

Course Objectives

1. To understand the diversity of microbes, and their potential for use in microbial biotechnology.
2. To demonstrate a knowledge of microbial gene and how these can be manipulated
3. To understand microbial growth and conditions required for growth.
4. To demonstrate knowledge on types of fermentors and culture media.
5. To understand processes related to food and beverage industry.
6. To understand the products and processes related to microbes in pharmaceutical industries.
7. To demonstrate knowledge on production of aminoacids, organic acids, biofertilizers etc.,

Prerequisites	Basic knowledge on Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Introduction to fermentation technology:** Chronology and components of fermentation processes - Range of fermentation processes: A general account on microbial biomass, enzymes, metabolites, recombinant products and transformation processes. Isolation, preservation, optimization and improvement of industrially important microorganisms.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Structure of Fermentor and Media Formulation:** Structure of a Fermentor - basic functions - body construction - aerators, agitators (impellers and spargers) - asepsis - containment - valves and steam traps. Types of fermentors: CSTR, Airlift reactor, fluidized bed reactor. Substrates for media preparation - Medium formulation – Sterilization of medium. Steps and methods in recovery of products.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Processes for Food, dairy, beverages:** Single cell proteins (SCP) - SCP as food and feed - mass cultivation of *Spirulina* - Mycoprotein - Production of Yogurt and cheese. Production of alcoholic beverages: Beer and wine fermentation. Traditional fermented food (idly batter, probiotic food)	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Pharmaceutical products:** Antibiotics- sources and types - Production of Penicillin and Streptomycin. Production of recombinant insulin and Hep B vaccine. General account on vitamins - Production of vitamin B_{12}. Transformation of steroids.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Enzymes, Amino acids, Organic acids and other products**: Microbial enzymes - Production and application of amylase, protease, and lipase. Microbes used for amino acid production: production of L- glutamic acids - Organic acids: production of citric acid, acetic acid - Exopolymer production - Biofertilizers and biofuels.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Crueger F and Anneliese Crueger, 2000. Biotechnology: Industrial Microbiology Panima publishing Corporation, New Delhi.
2. Dubey RC 2015. A text Book of Biotechnology, S. Chand Publishers, New Delhi
3. Balasubramanian, D., Bryce, C. F. A., Dharmalingam, K., Green, J. and Kunthala Jayaraman, 1998. Concepts in Biotechnology, COSIST Publications, India.
4. Adams, M.R. and Moss, M.O., 1995. Food Microbiology. New Age International Publishers, New Delhi.
5. Casida, L. E. Jr. 1996. Industrial Microbiology. New Age International Publishers, New Delhi

Suggested Readings

1. Alexander N. Glazer and Hiroshi Nikaido, 1994. Microbial Biotechnology: Fundamentals of Applied microbiology. W.H. Freeman and Co., New York.
2. Satyanarayana U. 2010. Biotechnology, Books and Allied (P) Ltd. Kolkata.
3. Stanbury, P. F., Whittaker, A. and Hall, S.J., 1995. Principles of Fermentation technology First edn, Pergamon Press, UK.
4. Alexander N. Glazer and Hiroshi Nikaido 2007 Microbial Biotechnology: Fundamentals of Applied Microbiology. Cambridge University Press.
5. Shukla P. (Ed) 2016. Microbial Biotechnology: An Interdisciplinary Approach. Taylor and Francis

Web Resources

1. http://ecoursesonline.iasri.res.in/Courses/Agricultural%20Microbiology/AMBE101/Data%20Files/pdf/lec32.pdf
2. https://www.slideshare.net/puppalamuthenna/microbial-products
3. https://www.biotechnologynotes.com/food-biotechnology/cheese/how-to-manufacture-cheese-with-steps-fermentation-biotechnology/14147
4. https://www.onlinebiologynotes.com/human-insulin-production-by-genetic-engineering/
5. https://www.slideshare.net/MominulIslam34/presentation-on-hepatitis-b-recombinant-vaccine
6. https://www.biotechnologynotes.com/antibiotics/penicillin/penicillin-biosynthesis-structure-fermentation-process-and-uses/13843
7. https://www.biotechnologynotes.com/industrial-biotechnology/single-cell-protein/single-cell-protein-scp-production-substrates-microorganisms-advantages-challenges-biotechnology/14143

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO1	To understand and define the process of fermentation and products from microbial based industries.	K1,K2
CO2	To classify and explain the various products from microbes and the types of fermentors, bioprocessing and product recovery.	K3
CO3	To differentiate the types of products and processing in fermentation-based industries related to food, pharmaceutical and industrial products.	K4
CO4	To compare the types of fermentation processes and medium composition in obtaining products from microorganisms and their down streaming.	K5
CO5	To summarize and compile information on various range of microbial based products, their processing, purification and applications	K6

Course Code	**UPB 6503**
Course Title	**ECOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY**
Credits	04
Hours/Week	04
Category	Major Core (MC) – Theory
Semester	VI
Regulation	2019

Course Overview

1. Ecology is the study of how organisms interact with one another and with their physical environment.
2. Biodiversity and conservation unit deals with the protection and management of biodiversity to obtain resources for sustainable development.
3. It also deals with the environment, the basic life support system and its components such as atmosphere, hydrosphere, lithosphere and biosphere.
4. This course gives information regarding basic principles and types of bioremediation.
5. This course also deals how bioremediation employs the living organisms, most notably microorganisms to treat waste water, oil spill and xenobiotics.

Course Objectives

1. Understand the structure and function of various plant ecosystems and ecological factors.
2. Understand the importance of biodiversity and its conservation in protecting nature treasures for future generation.
3. Structure of various components of the environment and impact of pollution.
4. Explain the process of bioremediation, factors associated and methods of bioremediation
5. Comprehend the biological treatment of sewage and describe the biodegradation of xenobiotics.

Prerequisites	Basic knowledge on Botany and Zoology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Ecology - Basic Principles:** Introduction to ecology - ecological principles - structural concepts - ecological factors–physical, chemical, biotic and edaphic factors. Ecosystem: concepts - types, structure and function - productivity and energy flow - food chains and food web, Ecological pyramid. Gene ecology - basic concepts, ecotype, ecophenes, ecads - Microbial communities: Diversity, structure and development.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Biodiversity and Conservation:** Genetic, species and ecosystem diversity. Global biodiversity: Plant diversity, Animal diversity, human diversity and indigenous peoples. Centres of origin of cultivated species. Gene banks of the FAO, IBPTR and CGIAR. The convention of biological diversity. Strategies of biodiversity conservation: *in situ* and *ex situ*.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Environment:** The environment - air, water and soil. Pollution types, causes and impacts on biota: Air pollution, water pollution (heavy metal pollution and thermal pollution) soil pollution (pesticide pollution) (outline only). Nonconventional energy resources-biogas production, methane and hydrogen production-Recycling of waste products-bio-composting and silaging.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Principles and types of Bioremediation:** Introduction to bioremediation - types of bioremediation - factors influencing bioremediation - bioremediation mechanisms; microbes in bioremediation; Bioremediation techniques: ex situ and *in situ* bioremediation; Phytoremediation, Mycoremediation and Phycoremediation; Types of reactors used in bioremediation.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

V	**Treatment of Polluted environments:** Biological treatment of sewage: Attached growth system: Biofilm kinetics - Trickling filters - Rotating biological contactors. Suspended growth system: Activated sludge process. Anaerobic digestion - Tertiary treatment: nitrogen and phosphorus removal; disinfection; removal of heavy metals and pesticides by biosorption; Removal of oil spills by microbes; Degradation of xenobiotics – pathways of phenol and polychlorinated biphenyl degradation; Bioremediation of radionuclides; purification of polluted air using bio-filters - Future prospects.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Dubey, R.C. 2004. A text book of Biotechnology. S. Chand & Company Ltd. New Delhi.
2. Joseph, C, Daniel.1996. Environmental aspects of microbiology. British Sun Publication.
3. Sharma, P.D. 2005. Environmental Microbiology. Narosa Publishing House Pvt. Ltd. New Delhi.
4. Sharma, P.D. 2009. Ecology and Environment. Rastogi Publications, Meerut-New Delhi.
5. Agarwal, V.P., 1988.Forests in India. Oxford & IBH Publishing Co. Pvt. Ltd.
6. Rajendran, P and Gunasekaran,P. 2007. Microbial Bioremediation. MJP Publishers. A unit of Tamil Nadu, Book House, Chennai.

Suggested Readings

1. Raina, M. Maier, Ian L. Pepper, Charles P. Gerba, 2000. Environmental Microbiology. Academic Press. UK.
2. Alexander N. Glazerand Hiroshi Nikaido, 1994. Microbial Biotechnology: Fundamentals of Applied microbiology. W.H. Freeman and Co., New York.
3. Special Issue on Bioremediation & Biodegradation. *Indian Journal of Experimental Biology*, September 2003. Vol.41 (9). National Institute of Science Communication and Information Resources, CSIR, New Delhi.
4. Prabodh K. Maiti and Mait, P.,2011. Biodiversity: Perception, peril and preservation. PHI Learning Private Limited, New Delhi.
5. Rana, S.V.S., 2010. Environmental Biotechnology. Rastogi Publications, Meerut, India.
6. Alan Scragg, 1999. Environmental Biotechnology. Pearson Education Limited.

Web Resources

1. https://nios.ac.in/media/documents/SrSec314NewE/Lesson-25.pdf
2. https://dducollegedu.ac.in/Datafiles/cms/ecourse%20content/PK%20(AECC-EVS)%20Chapter%20-%204%20Biodiversity.pdf
3. https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=79946&printable=1
4. https://clu-in.org/techfocus/default.focus/sec/Bioremediation/cat/Overview/
5. https://www.intechopen.com/chapters/70661

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the basic concepts of ecology, environment and bioremediation.	K1, K2
CO 2	To describe and interpret the importance of biodiversity and its conservation in protecting nature treasures for future generation.	K3
CO 3	To explain the structure of various components of the environment and impact of pollution.	K4
CO 4	Compare the process and methods of bioremediation with conventional treatment methods.	K5
CO 5	Compile the various biological treatment methods and describe the biodegradation of organic wastes in the waste water, petroleum hydrocarbon and xenobiotics.	K6

Course Code	**UPB 6504**
Course Title	**LAB VII (PLANT BIOTECH, MICROBIAL TECH & ECOLOGY AND ENV.BIOTECH)**
Credits	06
Hours/Week	06
Category	Major Core (MC) - Lab
Semester	VI
Regulation	2019

Course Overview

1. This lab course includes experiments on techniques in Plant Tissue Culture and Molecular Biology
2. The practical course gives an exposure on product formation from microbes.
3. The lab work involves study of ecological parameters and water quality analysis.

Course Objectives

1. To prepare MS medium for micropropagation, callus and anther culture.
2. To isolate and separate plant DNA and proteins using electrophoresis.
3. To produce microbial fermentation based products.
4. To analyse water quality and microbial quality of water

Prerequisites	Basic knowledge in Biology and Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Plant Tissue Culture Techniques** Preparation of MS, Nitsch and Modified White's Medium. *In vitro* seed germination and explants preparation. Callus, Embryo and Anther culture. Micropropagation using Meristem and axillary bud culture. Isolation of Protoplast from leaves (mechanical and Enzymatic method)	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Molecular Techniques** Demonstration on Extraction and separation of Plant protein by SDS-PAGE. Extraction and separation of plant DNA by agarose gel electrophoresis.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Microbial Technology** Sterilization, media preparation. Isolation of industrially important microorganisms. Demonstration of Fermentor operation. Batch culture Techniques: a) Still culture & b) Shake culture. Growth measurement in batch fermentation. Cultivation of yeast – biomass production.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Microbial Technology** Ethanol production. Wine fermentation. Citric acid production. Glutamic acid production. Spotters on various types of fermentors. Spotters on different industrial products from microorganisms Visit to Biotech Industries. **Ecology and Environmental Biotechnology** Vegetation analysis– Quadrant and line transect method Estimation of Dissolved oxygen. Estimation of BOD. Determination of net primary productivity. Potability of water (MPN Technique).	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

V	**Ecology and Environmental Biotechnology** Determination of acidity of water. Determination of alkalinity of water. Determination of hardness of water. Hydrolysis of starch. Biodegradation of Petroleum hydrocarbons. Field visit to sewage treatment plant.	**18**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Kalyan Kumar De., 2008. Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
2. Ravindhran, 2013. Practical Manual on Plant Biotechnology.

Microbial and Env. Biotech

1. Crueger F and Anneliese Crueger, 2000. Biotechnology: Industrial Microbiology Panima publishing Corporation, New Delhi.
2. Dubey RC 2015. A Text Book of Biotechnology, S. Chand Publishers, New Delhi
3. Balasubramanian, D., Bryce, C. F. A., Dharmalingam, K., Green, J. and Kunthala Jayaraman, 1998. Concepts in Biotechnology, COSIST Publications, India.

Suggested Readings

1. John M. Walker, Methods in Molecular Biology, Humana, New York, NY
2. Alexander N. Glazer and Hiroshi Nikaido 2007 Microbial Biotechnology: Fundamentals of Applied Microbiology. Cambridge University Press.
3. Shukla P. (Ed) 2016. Microbial Biotechnology: An Interdisciplinary Approach. Taylor and Francis

Web Resources

1. http://www.springer.com/series/7651
2. https://link.springer.com/protocol/10.1007/978-1-0716-1068-8_4
3. https://www.slideshare.net/puppalamuthenna/microbial-products
4. https://www.biotechnologynotes.com/food-biotechnology/cheese/how-to-manufacture-cheese-with-steps-fermentation-biotechnology/14147
5. https://www.onlinebiologynotes.com/human-insulin-production-by-genetic-engineering/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the principle of plant tissue culture and molecular techniques, microbial technology and environmental biotechnology	K1, K2
CO 2	To produce transgenic plants using genetic engineering; To analyse the products of microbial technology. To analyse the water quality	K3
CO 3	To differentiate the production methods of genetically modified plants from conventional hybrid plants. To evaluate the microbial products. To characterize microorganisms in water.	K4
CO 4	To justify plant tissue culture and plant molecular biology are the fundamental units of plant biotechnology. To apply the principles of microbial technology. To apply the principles of environmental biotechnology.	K5
CO 5	To summarize the importance of plant tissue culture and molecular techniques in crop improvement programme. To summarize the principles of microbial technology and environmental biotechnology.	K6

Course Code	**UPB 6701 (Theory)** **UPB 6705 (Internship)** **UPB 6706 (Lab)**
Course Title	**PRODUCTION OF MUSHROOM, BIOFERTILIZER AND SINGLE CELL PROTEIN**
Credits	5 (T) +5 (I) + 5 (P)
Hours/Week	4 (Theory) + 8 (Lab)
Category	MS (Major Skill)
Semester	VI
Regulation	2019

Course overview

1. The course deals with mushrooms**,** the macroscopic fungi that possess fruiting bodies with umbrella shapes**.**
2. Mushroom cultivation and its role as an important food supplement is covered in this course.
3. The economics of mushroom cultivation useful for skill development and entrepreneurship is covered in this course.
4. Organic farming namely their types, recycling, application and future perspectives is dealt here.
5. The course also deals with the types, benefits and production of single cell protein and biofertilizers.
6. The aim of this course is to provide the hands-on training on mushroom, biofertilizers and single cell protein production.

Course Objectives

1. To train the students to gain hands on experience in mushroom cultivation, using different types of mushrooms.
2. To equip the students with skills in bio-composting and biofertilizer production.
3. To instill in students the ability and skills required to become self-employed / entrepreneur.
4. To gain knowledge on the marketing potential of the produced mushroom and composts.

Prerequisites	Skills in basic microbiological techniques

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Mushroom Biology** Morphology - classification: edible and poisonous mushrooms. Life cycle of Basidiomycetes fungi - Breeding and Genetic improvement of mushroom strains. Medicinal and Nutritional value of mushrooms.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Mushroom cultivation Technique** Cultivation conditions for tropical and temperate countries. Isolation, spawn production, growth media, spawn running and harvesting of mushrooms (*Volvariella* spp., *Pleurotus* spp., *Agaricus* spp., *Calocybe* spp., and *Lentinus* spp). Diseases / contamination; Post Harvest Technology: Freezing, drying, freeze drying and canning.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Economics of Mushroom Cultivation** Economics of the production of oyster mushroom, milky mushroom and paddy straw mushroom cultivation: Infrastructure facilities, expenditure on fixed assets, plant and machinery, cost of the project, recurring expenditure, interest and depreciation of the expenditure, cost of production and profit. Entrepreneurship in mushroom cultivation.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Organic farming** Introduction - Definition, history, methods (crop rotation, green manures and compost, biological pest control, and mechanical cultivation), importance. Recycling of biodegradable municipal, agricultural and Industrial wastes; field Application. Future perspectives.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Bio-fertilizers and their Production** Introduction - Types, benefits, uses, Limitations. Microbes as biofertilizer: *Rhizobium*, *Azospirillum*, Cyanobacteria, Mycorrhizae - General account, Isolation, Identification, Mass multiplication, Carrier based inoculants, Application, Crop response. Biofertilizers vs Chemical fertilizers; Quality control; Challenges and opportunities; Biofertilizer Entrepreneurship.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

LAB				
1.	**Mushroom Cultivation** Training on sterilization techniques (Glass wares, Medium, and Laboratory). Microscopical observation of Mushrooms Media preparation; Isolation and purification of mushroom fungus.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
2.	Spawn preparations. Spawn running for *Pleurotus* spp and *Calocybe* spp.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
3.	Cultivation of mushroom – conditions for cultivation of mushroom. Harvesting and preservation.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
4.	Determination of nutritional value: Proteins, sugars, lipids, crude fiber and ash contents.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
5.	Composting of solid waste generated in mushroom cultivation.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
1.	**Biofertilizer Production** Isolation and mass cultivation of the following *i.* *Rhizobium* *ii.* *Azospirillum* *iii.* Blue green alga (*Anabaena /Nostoc*)	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
2.	Packaging of biofertilizers with carrier material.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
3.	Isolation and morphological characterization of VA mycorrhiza from soil.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

4.	Isolation and culture of Phosphate solubilizing microbes.	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**
5.	**SCP production and quality testing:** Cultivation of *Chlorella* / *Spirulina*	**12**	**CO 1 CO 2 CO 3 CO 4 CO 5**	**K1, K2, K3, K4, K5, K6**

Suggested Readings

1. Chang, T.S. and Hayes, W.A. 1978. The Biology and Cultivation of Edible Mushrooms. Academic Press, New York.
2. M.C. Nair, C. Gokulapalan and Lulu Das, 1997. Topics on Mushroom Cultivation. Scientific Publishers, Jodhpur, India.

E-BOOKS:

1. Training Manual on Mushroom Cultivation Technology. UNESCAP.

Web Resources

1. www.unapcaem.org.
2. https://apeda.gov.in › apedawebsite › organic
3. https://extension.psu.edu/six-steps-to-mushroom-farming
4. https://www.mushroomcouncil.com/growing-mushrooms/six-steps-to-mushroom-farming/
5. https://biologyreader.com › biofertilizer-production.html
6. https://apicol.nic.in › Content › ReferenceProject › Bio Fertilizer
7. https://www.biologydiscussion.com/fertilizers/production-of-various-bio-fertilizers-microbiology/66873.
8. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/single-cell-protein
9. https://www.researchgate.net/publication/49619680_Single_Cell_Protein_Production_and_Process

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand Mushroom morphology and applications of biofertilizers.	K1, K2
CO 2	To acquire skills on Mushroom and biofertilizers, isolation and confirmation.	K3
CO 3	To compare methods in large scale cultivation of mushroom and biofertilizers.	K4
CO 4	To demonstrate the techniques in organic farming, marketing of mushroom and biofertilizers.	K5
CO 5	To develop methods and summarize the procedures for production of Biofertilizer (algal and bacterial) and single cell Protein to achieve critical sensibility towards self –employment/entrepreneur.	K6

Course Descriptors (Offered to other Departments)

Course Code	**UPB 1301**
Course Title	**PLANT DIVERSITY**
Credits	02
Hours/Week	04
Category	Allied Required (AR) - Theory
Semester	I
Regulation	2019

Course Overview

1. Plant diversity deals with the study of the different plant species and their significance.
2. The aim of the course is to impart knowledge and understanding on the diversity of plants, their reproduction, life cycle and economic importance.
3. The course helps students to distinguish the lower forms from the higher forms of the plants kingdom.
4. The course aims to educate the students on the economic botany of the important plant species.
5. The course gives a good exposure to the field of herbal science in terms of the common medicinal plants, their biological sources, chemical constituents and uses.

Course Objectives

1. To provide information on the diversity of plants and their significance.
2. To educate the students on the reproduction and lifecycle of various plant forms.
3. To equip students with the knowledge on the taxonomy of angiosperms, to be able to identify and describe the plants.
4. To study about the commonly used plants and their economic importance.
5. To understand and appreciate the value of medicinal plants and their varied uses.

Prerequisites	Basic Knowledge in Biology and Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Plant Diversity-I** Algae: General characteristics, classification (outline), Economic importance, Structure and reproduction of *Ectocarpus*. Fungi: General characteristics, classification (outline), Economic importance, Structure and reproduction of *Puccinia*. Bryophytes: General characteristics, classification (outline), Economic importance, Structure and reproduction of *Funaria*.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Plant Diversity-II** Pteridophytes: General characteristics, classification (outline), Economic importance, Structure and reproduction of *Lycopodium*. Gymnosperms: General characteristics, classification (outline), Economic importance, Structure and reproduction of *Cycas*.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Taxonomy** Outline of classification (Bentham and Hooker's system of classification) - Herbarium techniques – ICN -Types (Holotype, Isotype, Lectotype, Neotype) - Legitimate and illegitimate names - valid publication - author citation. Detailed taxonomic studies of Annonaceae, Rutaceae, Lamiaceae, Euphorbiaceae and Poaceae.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Economic Botany:** Common name, binomial, family, the morphology of the useful parts and uses of -vegetables (beetroot, potato) - fruits (banana, papaya) – cereals (rice, wheat) -pulses (green gram, pigeon pea) - edible oil yielding plants (sesame oil, coconut oil) - fibre yielding plants (cotton, jute) - medicinal plants (vinca, asafoetida) - narcotic plants (tobacco, cannabis) - timber yielding plants (teak, sal) – spices (cardamom, cloves) - condiments (ginger, turmeric) - essential oils (sandal wood oil, eucalyptus oil) - beverages: alcoholic (wine, beer) and non-alcoholic (tea, coffee).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K5**

V	**Herbal medicine** Biological source-vernacular name –scientific name organoleptic studies and uses of *Andrographis paniculata, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Vinca rosea* and *Zingiber officinale*.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Gurcharan Singh, 2010. Plant Systematics an Integrated Approach, Science, Third Edition.
2. Simpson, M.G. 2010. Plant Systematics, Second Edition. Academic Press.
3. Simpson, B.B and Ogorzaly, M, C. 2001. Economic Botany: Plants In Our World, Third Edition. Mcgraw-Hill Higher Education. New York.
4. Pandey b.p. 2000. Simplified course in botany. S. Chand and company ltd. New Delhi.
5. Mitraj. n. Mitra d and Chowdhuri s.k.1990. Studies in botany (vol. i) Mont Lbrary, Calcutta.
6. Narayanaswami R.V.Rao K.N. and Raman, A. 2000. Outlines of Botany. Viswanathan and co. Chennai.
7. Verma V.1998.A text book of economic botany. Emkay publications. New elhi.
8. Albert F Hill; P. P. Sharma, 1996. Hill's economic botany. Tata McGraw hill. New Delhi.

Suggested Readings

1. Encyclopedia Britannica, 2008. Plants, Algae and Fungi (Britannica Illustrated Science Library).
2. Sharma, O.P.2017. Pteridophyta. McGraw Hill Education.
3. Pandey B.P.2001. A Textbook of Botany: Angiosperms. S Chand &Company.
4. Sharma, O.P. 2017. Plant taxonomy. McGraw Hill Education.
5. Kochhar S.L.2016. Economic Botany. Cambridge University Press India Pvt. Ltd.
6. Pandey B.P.1999. Economic Botany. S Chand & Company.

Web Resources

1. https://www.britannica.com/plant/angiosperm
2. http://www.ssbodisha.nic.in › documents › Botany
3. https://www.kngac.ac.in › admin › contents
4. https://www.biologydiscussion.com › plants › life-cycle.
5. https://www.biologydiscussion.com › pteridophytes
6. https://www.econbot.org
7. https://bastyr.edu › academics › herbal-sciences

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the general characteristics of Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, Taxonomy of Angiosperms.	K1, K2
CO 2	To classify and examine the characteristics of Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms and their economic importance.	K3
CO 3	To analyze the classification, the rules and regulations of Botanical nomenclature and dissect out all the characteristic features of the given plants and identify the families of Taxonomy of Angiosperms and explain their economic importance.	K4
CO 4	To evaluate the different plant forms with respect to their traits, binomial, family, useful parts, uses and phytocompounds.	K5
CO 5	To summarize the different plant forms in terms of their characteristics, classification, economic importance and ethnobotany.	K6

Course Code	**UPB 1302**
Course Title	**PLANT DIVERSITY LAB**
Credits	01
Hours/Week	02
Category	Allied Required (AR) – Lab
Semester	I
Regulation	2019

Course Overview

1. The aim of the course is to gain enough knowledge and understand the diversity of plants, their reproduction, life cycle and economic importance.
2. Students can distinguish the lower forms and higher forms of plants through this lab course.
3. The Lab-course also uplift the knowledge of students by classifying, identifying and describing the higher plants.
4. Through the economic botany they learn to differentiate the grains and other common plant products.
5. The herbal science course discuss the common medicinal plants, their biological sources, chemical constituents and uses.

Course Objectives

1. To understand the diversity of plants and their significance.
2. To gain knowledge on the reproduction and lifecycle of various plant forms.
3. To identify and describe the plants based on taxonomy.
4. To identify the commonly used plants and to know their economic importance.
5. To gain knowledge the value of medicinal plants and their uses.

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Plant Diversity-I** Algae: Structure of *Ectocarpus*. Fungi: Structure and observation of different stages of *Puccinia*. Bryophytes: Structure and reproductive parts of *Funaria*.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Plant Diversity-II** Pteridophytes: Structure of *Lycopodium*. Gymnosperms: Structure reproductive parts of *Cycas*.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Taxonomy** Detailed taxonomic studies of Annonaceae, Rutaceae, Lamiaceae, Euphorbiaceae and Poaceae.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Economic Botany:** Common name, binomial, family, the morphology of the useful parts and uses of –vegetables (beetroot, potato) - fruits (banana, papaya) - cereals (rice, wheat) - pulses (green gram, pigeon pea) - edible oil yielding plants (sesame oil, coconut oil) - fibre yielding plants (cotton, jute) - medicinal plants (vinca, asafoetida) - narcotic plants (tobacco, cannabis) - timber yielding plants (teak, sal) – spices (cardamom, cloves) - condiments (ginger, turmeric) - essential oils (sandalwood oil, eucalyptus oil) - beverages: alcoholic (wine, beer) and non-alcoholic (tea, coffee).	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Herbal medicine** Biological source-vernacular name –scientific name organoleptic studies and uses of *Andrographis paniculata, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Vinca rosea* and *Zingiber officinale*.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Sundrara Rajan, S.2003. Practical Manual of Plant Morphology: Algae Fungi Bryophyta Pteridophyta Gymnosperms and Angios. Anmol Publications Pvt Ltd.
2. Bimal K. Chetri, 2018. Laboratory Manual for Algae and Fungi. lulu.com.
3. Mohammed Gufran Khan, Shitie Gatew, et al.2012. Practical Manual for Bryophytes and Pteridophytes. LAP LAMBERT Academic Publishing; Illustrated edition.
4. James W. Byng, 2015. The Gymnosperms Handbook: A practical guide to extant families and genera of the world. Plant Gateway Ltd.

Suggested Readings

1. S.Sundara Rajan, 2003. Practical Manual of Plant Morphology. Anmol Publications Pvt Ltd.
2. Sharma O.P.2017. Pteridophyta. McGraw Hill Education
3. Pandey B.P.2001. A Textbook of Botany: Angiosperms. S Chand &Company.
4. Sharma O.P. 2017. Plant taxonomy. McGraw Hill Education.
5. Kochhar S.L.2016. Economic Botany. Cambridge University Press India Pvt. Ltd.
6. Pandey B.P.1999. Economic Botany. S Chand & Company.

Web Resources

1. https://www.jstor.org/stable/j.ctt19cc1vk.
2. https://pdfs.vip/downloads/practical-taxonomy-of-angiosperms-by-r-k-sinha.
3. https://qegev.melograno.info › Practical-Manual-Of-Angiosperm-Tax.
4. https://horseshoefarm.farm › complete_medicinal_herbal_practical.pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the general characteristics of Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms, Taxonomy of Angiosperms	K1, K2
CO 2	To classify and examine the characteristics of Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms and their economic importance	K3
CO 3	To analyze the classification, the rules and regulations of Botanical nomenclature and dissect out all the characteristic features of the given plants and identify the families of Taxonomy of Angiosperms and explain their economic importance.	K4
CO 4	To evaluate the different plant forms with respect to their traits, binomial, family, useful parts, uses and phytocompounds	K5
CO 5	To summarize the different plant forms in terms of their characteristics, classification, economic importance and ethnobotany	K6

Course Code	**UPB 3401**
Course Title	**APPLIED MICROBIOLOGY**
Credits	02
Hours/Week	03
Category	Allied Optional (AO) - Theory
Semester	III
Regulation	2019

Course Overview

1. The aim of this course is to introduce micro-organisms, its diversity, characteristics, and classification and their use in industry and environment.
2. It deals with morphology, physiology and genetics of bacteria.
3. The different types of media, reproduction, measurements of bacterial growth and isolation of pure bacterial culture in the laboratory give all the essential information on bacteria.
4. Various components of fermentation like fermenter, its structure, substrate, strain improvement and up to product recovery are highlighted.
5. This course gives the essential knowledge on industrial microbiology with the production of enzymes, organic acids, antibiotics, vitamin, fermented products, and beverages.
6. General account on biofertilizers, biopesticides, biopolymers and biosensors are dealt with.
7. This course highlights the role of microorganisms in bioremediation, biodegradation, biomineralization, biomining, bioleaching and biofuels.

Course Objectives

1. To explain the microbial diversity with the kingdom and domain concept.
2. To understand the characteristics and classification of bacteria, fungi, algae and viruses.
3. To know the morphology, physiology, genetics and reproduction of bacteria.
4. To gain knowledge on the nutritional requirements, media types for microbial growth, its measurement and maintenance.
5. To understand the working of the fermenter, its different parts, function, raw materials used in the upstream and downstream of fermentation process.
6. To explain the industrial microbial fermentation of various products.
7. To know the process and microbes involved in bioremediation, biodegradation, biomineralization, biomining, bioleaching and biofuels.

Prerequisites	Basic knowledge in Biology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Introduction** Microbial diversity - Five kingdom system (Whittaker) and three domain concept (Woese) - A general account on characteristics and classification of bacteria, fungi, algae and viruses.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Morphology, physiology and genetics of bacteria** Structure of bacterial cell - capsule, cell wall, plasma membrane, structure and function of flagella, fimbriae and pili - Microbial growth and its measurements - Pure cultures and their maintenance - Nutritional requirements and types of media. Nature of genetic material in bacteria - Replication (θ type) - gene regulation (lac operon) - Reproduction: conjugation, transformation and transduction in bacteria.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Fermentation** Fermenter - Basic functions - body construction - aerators, agitators - asepsis - containment - valves and steam traps - Substrates for industrial fermentation - strain improvement - an outline on fermentation and product recovery (downstream processing).	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Industrial microbiology** Microbial enzymes (Amylase), Organic acid (Citric acid), antibiotics (penicillin), vitamin (Vitamin B12). Fermented products (cheese production), beverages (wine), General account on biofertilizers, biopesticides, biopolymers, biosensors.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Environmental Microbiology** Bioremediation - Domestic sewage and waste water treatment - Biodegradation of xenobiotics - Biomineralization - Biomining and bioleaching – Biofuels.	**12**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Dubey, R. C. and Maheshwari, D.K. 2005. A text book of Microbiology. S. Chand & Co. Ltd., New Delhi.
2. Powar, C.B. and Daginawala, 1991. General Microbiology Vol. I and II – Himalaya Publishing House, Bombay.
3. Pelczar, Chan and Kreig, 1993. Microbiology – 5th Edition, Tata McGraw-Hill & Co. Ltd. New Delhi.
4. Crueger, F. and Anneliese Crueger, 2000. Biotechnology: Industrial Microbiology Panima publishing Corporation New Delhi
5. Adams, M.R. and Moss, M.O. 1995. Food Microbiology New Age International Publishers New Delhi
6. Casida, L.E. Jr. 1996. Industrial Microbiology New Age International Publishers New Delhi.

Suggested Readings

1. Joanne, M. Willey, Linda M. Sherwood and Christopher, J. Woolverton, 2008. Microbiology –
2. McGraw – Hill International Edition (Seventh edition).
3. Daniel Lim, 1998. Microbiology (2nd edition) WCB/ McGraw-Hill.
4. Tortora, Funke and Case, 2006. Microbiology- An Introduction. Pearson Education.
5. Alexander N. Glazer and Hiroshi Nikaido, 1994. Microbial Biotechnology: Fundamentals of Applied microbiology. W.H. Freeman and Co., New York.
6. Benson, 2001. "Microbiological applications, Laboratory manual in general Microbiology". 8th Edition. McGraw –Hill Companies (E-book).
7. Prescott, H. 2002. Laboratory exercises in Microbiology".5th edition. The McGraw- Hill Companies.

Web Resources

1. https://microbiologynote.com/whittakers-five-kingdom-classification/
2. https://microbenotes.com/five-kingdom-system-of-classification-features-and-limitations/
3. https://www.lamission.edu/lifesciences/lecturenote/mic20/Chap06Growth.pdf
4. https://www.biologydiscussion.com/dna/dna-replication/dna-replication-definition-mechanism-and-models-biochemistry/65109

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the microbial diversity and classify them. To explain the structure of fermenter and to give an account on biofertilizers, biopesticides, biopolymers and biosensors.	K1, K2
CO 2	To illustrate the morphology, physiology and genetics of bacteria. To demonstrate the process of fermentation in industry and of bioremediation, biodegradation, biomineralization, biomining, bioleaching and biofuels.	K3
CO 3	To analyze the nutritional requirements and types of media for microbial growth, its measurements, and microbes-raw materials used for fermentation, industry and environment.	K4
CO 4	To compare and contrast the different systems of microbe classification, methods of isolation and maintenance of pure cultures, methods of reproduction in bacteria and steps in downstream processing.	K5
CO 5	To compile the replication and gene regulation in bacteria, strain improvement for industrial fermentation, microbial enzymes and fermented products.	K6

Course Code	**UPB 3402**
Course Title	**APPLIED MICROBIOLOGY LAB**
Credits	01
Hours/Week	02
Category	Allied Optional (AO) - Lab
Semester	III
Regulation	2019

Course Overview

1. This practical course aims at providing with the basic techniques in applied microbiology.
2. This laboratory course ensures a hands-on experience of different sterilization, slide preparation and isolation methods.
3. This course gives practical knowledge about antibiotic activity and staining methods.
4. This course makes the students understand the operations of fermenter.
5. This also creates space for producing and estimating ethanol, wine, citric acid, glutamic acid and isolation of *Rhizobium* and VAM.

Course Objectives

1. To understand the specific requirements of each culture medium, sterilize and prepare them for different cultures in the tissue culture laboratory.
2. To choose the right isolation technique to get the pure microbial culture.
3. To assay the microbial sensitivity and to differentiate bacteria according to Gram Staining.
4. To know and experiment the structure and operation of fermenter.
5. To produce and estimate ethanol, wine, citric acid, and glutamic acid.
6. To isolate *Rhizobium* and VAM fungi.

Prerequisites	Basic knowledge in Biology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Sterilization - Preparation of culture media - nutrient broth and agar - Potato dextrose agar. Permanent slides of bacteria, fungus, algae - morphological features.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	Pour plate, spread plate and Streak plate techniques - serial dilution. Hanging drop method. Antibiotic sensitivity assay Staining method - Gram staining technique.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	Demonstration of fermenter operation.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Ethanol production and estimation. Wine fermentation Citric acid production Glutamic acid production	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	Bio-fertilizers - Isolation of Rhizobium, VAM	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Jain, Monica, 2016. Plant tissue culture - Lab practices made easy (For Beginners) 978-93-84659-55-4, International E-Publication.
2. Rai, M.K.(Edited),2006, Handbook of Microbial fertilizers, Food Products Press® An Imprint of The Haworth Press, Inc. New York, London, Oxford.
3. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.

Suggested Readings

1. Grainger John, Hurst Janet, Burdass Darial, Basic practical microbiology - a manual, 2001, The Society of general Microbiology,UK.
2. Oelkers P, 2016, Molecular Biology laboratory Manuel -Ebook

Web Resources

1. https://www.brainkart.com/article/Preparing-permanent-slides---Materials-and-methods-in-Practical-microtechnique_19129/
2. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/6%3A_Culturing_Microorganisms/
3. http://www.cuteri.eu/microbiologia/manuale_microbiologia_pratica.pdf
4. https://microbeonline.com/gram-staining-principle-procedure-results/
5. https://www.biologyonline.com/dictionary/fermentation

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand the specific requirements of each culture medium, sterilize and prepare them for different cultures in the tissue culture laboratory.	K1, K2
CO 2	To analyse the types of bacteria, microbial sensitivity and various isolation techniques to get the pure microbial culture.	K3
CO 3	To compare the production methods with reference to various microbial products.	K4
CO 4	To demonstrate the lab scale production of fermented products such as wine, ethanol etc.,	K5
CO 5	To summarize the importance of microorganisms in industrial processes.	K6

Course Code	**UPB 3801**
Course Title	**HERBAL MEDICINES**
Credits	02
Hours/Week	03
Category	Non-Major Elective (NME) - Theory
Semester	III
Regulation	2019

Course overview

1. Herbal medicine is the study of the pharmacognosy and the uses of medicinal plants, which are a basis of traditional medicine.
2. Herbal medicine also deals with the study of the extraction of plant based naturally occurring chemicals to treat illnesses or imbalances in the body.
3. The aim of herbal medicine is to combine the traditional empirical knowledge with modern science.
4. The course gives a clear knowledge on traditional system of medicine and also the classification of plants based on biological sources.
5. The course throws light on the important herbal medicine related research institutes of India and their activities.
6. It also discusses the common medicinal plants, their biological sources, chemical constituents and uses.

Course Objectives

1. To educate the students on the basic concepts of herbal medicine.
2. To provide knowledge on the traditional system of medicine and their vast richness.
3. To disseminate the knowledge on the classification of plants based on biological sources and drugs of plants.
4. To provide understanding on the usage of herbal medicine based on important chronic and non-chronic diseases.
5. To gain knowledge on medicinal plants and awareness on conservation of plants.

Prerequisites	Basic knowledge in Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Indian medicinal systems** Indian systems of medicines - Siddha, Ayurveda and Unani systems. Classifications of crude drugs. Role of AYUSH, NMPB and CIMAP. Any ten commonly used medicinal plants in Traditional system of medicines. Drug adulteration.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Drugs from root, underground stem and bark** Drugs from roots (*Rauwolfia*), underground stem (*Zingiber*), Drugs from bark (*Cinnamomum* & *Cinchona*).	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Drugs from leaves, flowers, fruits, seeds and whole plants** Drugs from leaves (*Eucalyptus*, *Ocimum*), flower (*Eugenia*), Fruit (*Emblica*), seeds (*Coriandrum*), Whole plant (*Azadirachta*).	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Drug impact** A brief account of drugs acting on the central nervous system, drugs used in disorders of gastrointestinal tract and cardio vascular drugs, treatment of malaria & blood vessel diseases like varicose veins.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Medicinal plants cultivation** Cultivation of medicinal plants in India. Breeding methods applied to medicinal herbs. Conservation of medicinal plants (*in situ & ex situ).*	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Arumugan, K. R. and Murugesh, N. 2003 Text Book of Pharmacognosy. Sathya publishers, Madurai.
2. Bhattacharjee, S. K. 1998. Hand book of medicinal plants. Pointer publishers, Jaipur.
3. Purohit and Vyas, 2004. Medicinal plant cultivation. Agrobios publication. Jodhpur.
4. Jain, 2001 Medicinal Plants National Book Trust, New Delhi.
5. Thirugagnam, 1995 Muligai Maruthuvam (Tamil) Selvi Pathipakam, Trichy.
6. Roseline A 2011 Pharmacognosy, MJP.

Suggested reading

1. Datta & Mukerji, 1952. Pharmacognosy of Indian roots of Rhizome drugs. Bulletin No.1Ministry of Health, Govt. of India.

2. Young Ken, H.W., 1948. Text Book of Pharmacognosy. Blakiston C., Philadelphia.
3. Shukla, R.S., 2000. Forestry for tribal development. A.H. Wheeler & Co. Ltd., India.
4. Raychudhuri, S.P., 1991. (Ed.) Recent advances in Medicinal aromatic and spice crops. Vol.1, Today & Tomorrow's printers and publishers, New Delhi.
5. Dhavan, B. N. 1986.Ayurvedic Research on Medicinal plants in India. INSA, New Delhi.
7. Kokate, C. K., Purohit, A. P., and Gokhale 2009. Pharmacognosy, Nirali Prakashan, Pune.
8. Agarwal 1985. Drug Plants in India, Kalyani. Publishers, Ludhiana
9. Dananjay J Deshpande, 2010 Handbook of Medicinal Herbs, Agrobios.

Web Resources

1. https://www.jacquifernandez.com.au/herbal-medicine.html.
2. http://www.herbalremediesinfo.com/herbal-medicine.
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1071505/
4. https://www.healthline.com/nutrition/herbal-medicine
5. https://www.hopkinsmedicine.org/health/wellness-and-prevention/herbal-medicine

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To understand and recall the binomial, common name, biological sources and the name of the drug obtained from the medicinal plants.	K1, K2
CO 2	To explain the role of Indian research organization on medicinal plants and teach the commonly used medicinal plants.	K3
CO 3	To classify the crude drugs and differentiate the drug adulterants.	K4
CO 4	To summarize the impact of the drugs on some of the common human diseases.	K5
CO 5	To create awareness on cultivation, conservation and breeding methods of medicinal plants.	K6

Course Code	**UPB 4401**
Course Title	**PLANT BIOTECHNOLOGY AND BIOSTATISTICS**
Credits	02
Hours/Week	03
Category	Allied Optional (AO) - Theory
Semester	IV
Regulation	2019

Course Overview

1. This course aims at providing with different techniques and methodologies involved in plant biotechnology and biostatistics.
2. A detailed study of definitions, scope, history and importance of plant tissue culture, In Vitro culture techniques, and different culture methods helps the students to describe, define, classify, compare and prepare any culture.
3. This course gives an overall view of the genetic engineering and explains different molecular tools and techniques employed in it.
4. This course helps students acquire in depth knowledge on plant transformation with the gene delivery system, genetic organization, promoters and marker genes.
5. This also describes various methods of biostatistics and helps the student to understand, give examples, choose, calculate, and measure the given set of data.

Course Objectives

1. To understand the basics of rDNA technology, concept, principle and applications of genetic engineering.
2. To know the composition, types of media, cultures and role of hormones in *in-vitro* culture.
3. To understand principles, material and methodology of techniques involved in rDNA technology such as Gel Electrophoresis, Blotting techniques, PCR and DNA finger printing.
4. To acquire knowledge on importance of plant tissue culture and molecular biology in transgenic production.
5. To calculate and solve basic statistical operations in biological data.
6. To carry out statistical applications in the analysis of biological data

Prerequisites	Basic knowledge in Biology

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Plant Tissue Culture** Definitions, scope & history and Importance of plant tissue culture & biotechnology. *In vitro* culture techniques: Sterilization methods, Culture media - composition, types of medium and role of hormones in *in-vitro* culture. Inoculation, incubation and acclimatization. Callus, Suspension culture and its significance. Organ culture: Anther, Embryo & shoot tip culture. Somatic embryogenesis and synthesis of artificial seeds. Protoplast culture. Somatic hybridization. Soma clonal variation.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Genetic Engineering** Introduction, scope, Molecular tools: Restriction enzymes, Electrophoresis, Blotting techniques. Polymerase Chain Reaction. DNA sequencing. Cloning Vectors, gene library, cDNA library, molecular probes.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Plant Transformation** Gene delivery system: Particle gun bombardment, microinjection, electroporation. Genetic transformation of plants by *Agrobacterium*: Genetic organization of Ti plasmids. Promoter and marker genes in plant transformation.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Biostatistics - I** Collection and presentation of data: Measures of Central Tendency - Mean, Median, Mode - Measures of dispersion - Standard deviation, Standard error, variance and coefficient of variation.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Biostatistics - II** Population and samples –methods of sampling - Probability - Definition, Rules, Laws, Chi – square - F- test and analysis of variance (One-way analysis) - simple correlation - linear regression analysis. Basics of SPSS, MS Excel.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Gupta P. K. 1994. Elements of Biotechnology. Rastogi Publications. Meerut.
2. Kalyan Kumar De., 1997. Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
3. Mascarenhas A.F., 1991. Hand book of Plant Tissue Culture. Indian Council of Agricultural Research. New Delhi.
4. Khan and Khanum. 1994. Fundamentals of Biostatistics. Ukaaz Publications, Hyderabad.
5. Aaron Poh, 2015. SPSS Statistics for Dummies, 3rd edition. Wiley India Pvt Ltd. New Delhi.
6. Primrose, S. B. and Twyman, R. M. 2006. Principles of Gene Manipulation and Genomics. 7th edition. Blackwell Publishing (E.book).

Suggested Readings

1. Dubey, R.C.1993. Text Book of Biotechnology. S. Chand & Company Ltd., New Delhi.
2. Ignacimuthu, S.1997. Plant Biotechnology. Oxford Publishing Co. Pvt. Ltd., New Delhi.
3. Rashid, A. 2009. Molecular physiology and Biotechnology of Flowering plants. Narosa Publishing House Pvt. Ltd., New Delhi.
4. Gurumani, N. 2010. An Introduction to Biostatistics (2ndEdn). MJP Publishers, Chennai.
5. Annadurai, B. 2007. Text Book of Biostatistics. New Age International, New Delhi.
6. Caldentey, K.M.O. & Barz, W. H. 2002. Plant Biotechnology and Transgenic Plants. Marcel (E.book).

Web Resources

1. https://www.biologydiscussion.com/botany/tissue-culture/tissue-culture-definition-history-and-importance/42944
2. https://plantcelltechnology.com/blog/the-five-ideal-explant-sterilizing-methods-in-tissue-culture/
3. https://www.biotecharticles.com/Applications-Article/Plant-Tissue-Culture-Media-Types-Constituents-Preparation-and-Selection-3940.html
4. https://www.biologydiscussion.com/somatic-hybridization/somatic-hybridization-aspects-applications-and-limitations/10686
5. https://microbenotes.com/restriction-enzyme-restriction-endonuclease/
6. https://cscar.github.io/workshop-spss/the-basics-of-spss.html

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To define and understand the basics of plant tissue culture techniques, genetic engineering, plant transformation and of biostatistics including SPSS and MS Excel.	K1, K2
CO 2	To illustrate the principles of gel electrophoresis, blotting techniques, PCR and DNA sequencing. To apply the measures of central tendency, dispersion and probability.	K3
CO 3	To analyse the types of culture media and the role of hormones in plant tissue culture. To estimate the significance level of a given biological data.	K4
CO 4	To compare and contrast various types of cultures, cloning vectors, genetic libraries, molecular probes, promoters and marker genes in plant transformation. To measure variance and coefficient of variation.	K5
CO 5	To summarise the methods in plant tissue culture and biotechnology. To summarise the application of basic statistical methods with reference to biological data.	K6

Course Code	**UPB 4402**
Course Title	**PLANT BIOTECHNOLOGY AND BIOSTATISTICS LAB**
Credits	01
Hours/Week	02
Category	Allied Optional (AO) - Lab
Semester	IV
Regulation	2019

Course Overview

1. This course provides with the basic techniques in plant biotechnology and biostatistics.
2. This practical course ensures a hands-on experience of different media preparation, sterilization, and cultures from explants.
3. This course gives practical knowledge about extraction and separation of DNA and protein from plant samples and separation through electrophoresis techniques.
4. This course makes the students use MS Excel and SPSS for the collection and measurements of various biological data.
5. This also creates space for applying the measures of central values, measures of dispersion, correlation, dispersion and sampling for the biological data.

Course Objectives

1. To understand the specific requirements of each culture medium and prepare them for different cultures in the tissue culture laboratory.
2. To isolate and extract protein and DNA from plant samples and separate them in electrophoresis
3. To collect and present date, measure the central tendency and dispersion from the given set of experimental data.
4. To assess and analyse the population and samples by employing methods of sampling, analysis of variance, correlation with SPSS and MS Excel.

Prerequisites	Basic knowledge in Biology and Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Preparation of MS Medium. *In vitro* sterilization of explants.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	Callus culture. Meristem Culture and axillary bud culture. Isolation of Protoplast from leaves (mechanical and enzymatic method)	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	Extraction and separation of Plant protein by SDS-PAGE (In batches) Extraction and separation of plant DN A by agarose gel electrophoresis (In batches)	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	Data collection - MS Excel Classification of data: Discrete, continuous and cumulative. Statistical Diagrams: Histogram, Frequency curve, Bar chart, and Ogive curve. Measures of central values: mean, median and mode.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	Measures of dispersion: Range, Mean deviation and standard deviation. Correlation and Regression. Sampling by random number table. Basics of SPSS.	**06**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Shankar Madhan & Rajesh E M, 2013, A Practical Manuel on Basic Techniques in Biotechnology, International E-Publication.
2. Giri, C.C & Giri Archana, Plant Biotechnology Practical Manuel, ISBN 9789389583274.
3. Surya Nandan Meena, Milind Naik, 2019. Advances in Biological Science Research: A Practical Approach, Academic Press, New York, USA.
4. Michael Perlin, William Beckerson, Adarsh Gopinath, 2017. Cell, Genetics, and Molecular Biology: A Lab Manual (First Edition), Cognella Inc., USA.
5. BansalM.P.,2013. Molecular Biology and Biotechnology: basic experimental protocols, The Energy and Resources Institute (TERI), New Delhi, India.

Suggested Readings

1. Harisha, S, 2007. Biotechnology procedures and experiments handbook, Infinity Science Press

LLC, New Delhi, India.
2. Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer,2018. Labster Virtual Lab Experiments: Basic Genetics, Springer Publishers, NY, USA.
3. Leonard Davis,Mark Dibner, James Battey, 2012. Basic Methods in Molecular Biology, Elsevier Science PubilshingCo., NY, USA.
4. Robert F. Schleif, Pieter C. Wensink, 2012.Practical Methods in Molecular Biology, Springer-Verlag, NY, USA.

Web Resources

1. https://www.grin.com/document/265322
2. http://prsvkm.kau.in/sites/default/files/documents/a_plant_biotechnology_laboratory_manual.pdf
3. https://qubeshub.org/publications/2213/1
4. http://users.stat.ufl.edu/~winner/sta6934/st4170_int.pdf
5. https://vulms.vu.edu.pk/Courses/BIO302/Downloads/Practical%20Hand%20outs-Molecular%20Biology%20(BIO302).pdf

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO 1	To define and understand the basics of plant tissue culture techniques, genetic engineering, plant transformation and of biostatistics including SPSS and MS Excel.	K1, K2
CO 2	To illustrate the principles of gel electrophoresis, blotting techniques, PCR and DNA sequencing. To apply the measures of central tendency, dispersion and probability.	K3
CO 3	To analyse the types of culture media and the role of hormones in plant tissue culture. To estimate the significance level of a given biological data.	K4
CO 4	To compare and contrast various types of cultures, cloning vectors, genetic libraries, molecular probes, promoters and marker genes in plant transformation. To measure variance and coefficient of variation.	K5
CO 5	To summarise the methods in plant tissue culture and biotechnology. To summarise the application of basic statistical methods with reference to biological data.	K6

Course Code	**UPB 4801**
Course Title	**MUSHROOM CULTIVATION**
Credits	02
Hours/Week	03
Category	Non Major Elective (NME) - Theory
Semester	IV
Regulation	2019

Course overview

1. The course deals with the biology of mushrooms.
2. The course explains about importance of Mushroom cultivation and its role as an important food supplement
3. The cultivation methods for different types of mushrooms are described.
4. The diseases and problems during mushroom cultivation are studied.

Course Objectives

1. To gain knowledge in mushroom cultivation, using different types of mushrooms.
2. To learn about the importance of mushrooms as food and medicine.
3. To describe the methodology for production.
4. To create awareness on skills required to become self-employed / entrepreneur.
5. To gain knowledge on the marketing potential of mushroom

Prerequisites	Basic knowledge on Biology or Plant Sciences

SYLLABUS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Mushroom Biology:** Morphology - classification: edible and poisonous mushrooms. Medicinal and Nutritional value of mushrooms. Natural condition for mushroom cultivation.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
II	**Mushroom cultivation Techniques - I:** Cultivation conditions for tropical and temperate countries. Isolation, spawn production, growth media, spawn running and harvesting of mushrooms: *Pleurotus* sp., *Calocybe* sp., and *Lentinus* sp.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
III	**Mushroom cultivation Techniques - II** Cultivation conditions for tropical and temperate countries. Isolation, spawn production, growth media, spawn running and harvesting of mushrooms: *Volvariella* sp., *Agaricus* sp., and *Lentinus* sp.	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
IV	**Diseases and Post-Harvest Technology** Diseases / contamination; Post harvest technology: Physical and Chemical methods. Economics of mushroom cultivation: Cost benefit ratio	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**
V	**Composting** Mushroom composting processes - microbiology of composting - fate of pathogens - ingredients in composting - various methods of composting: vermi-composting and home composting - steps in composting	**09**	**CO 1** **CO 2** **CO 3** **CO 4** **CO 5**	**K1, K2, K3, K4, K5, K6**

Text Books

1. Nita Bahl, 2002. Hand Book on Mushroom Cultivation. 4th Edition, Vijay Primlani for Oxford & IBH Publishing Co . , Press, New York, New Delhi.
2. Biswas, S, Datta, M and Nagachan, S.V. 2012. Mushrooms- A manual for cultivation. PHI Learning Private Limited, New Delhi.
3. Krishnamoorthy, 1999. Hand Book of Mushroom Cultivation. TNAU Publications, Coimbatore,TN, India.

Suggested Readings

1. Chang, T.S. and Hayes, W.A. 1978. The Biology and Cultivation of Edible Mushrooms. Academic Press, New York.
2. M.C.Nair, C. Gokulapalan and Lulu Das, 1997. Topics on Mushroom Cultivation. Scientific Publishers, Jodhpur, India.

Web Resources

1. www.unapcaem.org
2. https://www.mushroomcouncil.com/growing-mushrooms/six-steps-to-mushroom-farming/
3. https://www.krishisewa.com/crop-production/46-technology-for-mushroom-cultivation.html
4. https://krishijagran.com/agripedia/a-complete-guide-to-profitable-mushroom-farming-in-india-read-composting-harvesting-techniques/

Course Outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive Level
CO1	To understand the basics of mushroom cultivation and uses of edible mushrooms.	K1,K2
CO2	To classify and explain the various types of mushrooms, their cultivation and importance.	K3
CO3	To differentiate the methods associated with different mushrooms and their nutritional benefits.	K4
CO4	To compare cultivation methods, harvesting and preservation of various mushrooms.	K5
CO5	To summarize and compile information on the cultivation and benefits of various mushrooms	K6

CL AND CO BASED CIA QUESTION PAPER FORMAT FOR UG THEORY COURSES

MC, AR, AO, MS, ME, GL and NME* (excluding other languages)

SECTION	MARKS	Q. NO	K1	K2	K3	K4	K5	K6
A	Answer ALL (6 x 1 = 6)	1	+					
		2	+					
		3	+					
		4		+				
		5		+				
		6		+				
B	Answer 1 out of 2 (1 x 6 = 6)	7			+			
		8			+			
C	Answer 1 out of 2 (1 x 6 = 6)	9				+		
		10				+		
D*	Answer 1 out of 2 (1 x 12 = 12)	11					+	
		12						+
No. of CL based Questions with Max. marks			3 (3)	3 (3)	1 (6)	1 (6)	1 (12)	1 (12)
No. of CO based Questions with Max. marks			CO 1		CO 2	CO 3	CO 4	CO 5
			6 (6)		1 (6)	1 (6)	1 (12)	1 (12)

- ***MC**-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major Skill, **ME**-Major Elective, **GL**-General Languages, **NME**-Non Major Elective.
- **Section A** could have one or more of the following: Fill in the blanks, True or False, Match the following, Definition, Comment on, Reason out etc., But, K1 and K2 should carry equal weightage.
- ***In **Section D** students have choice between K5 and K6. III Component Assessment carries 40% of CIA and the assessment(s) should be for cognitive levels **K1 to K4** and all should carry equal weightage.

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Plant Biology and Biotechnology

FIRST CONTINUOUS ASSESSMENT TEST, AUGUST, 2021

UPB 3501 FUNGI (MC)

II BSc Plant Biology and Biotechnology 15.08.2021

Time : 10.00am to 11.30 am Max. Marks : 30

SECTION A			
Answer ALL the Questions in one or two sentences (6 x 1 = 6 Marks)			
1.	Define the haplo-diplobiontic cycle.	K1	CO1
2.	Recall the salient features of fungi.	K1	CO1
3.	State the importance of mycorrhiza.	K1	CO1
4.	Describe the thallus of Aspergillus.	K2	CO1
5.	Differentiate 'obligate from facultative'.	K2	CO1
6.	Write down any four features of YAC vector.	K2	CO1
SECTION B			
Answer any ONE of the following in 150 words (1 x 6 = 6 Marks)			
7.	Classify 'lichens' giving reasons.	K3	CO2
8.	Illustrate the infective state of Albugo.	K3	CO2
SECTION C			
Answer any ONE of the following in 150 words (1 x 6 = 6 Marks)			
9.	Analyse the fruiting bodies in Fungi.	K4	CO3
10.	Distinguish the different types of mycorrhizae.	K4	CO3
SECTION D			
Answer any ONE of the following in 100 words (1 x 12 = 12 Marks)			
11.	Evaluate the structure and reproduction of Peziza.	K5	CO4
12.	Summarise the lifecycle of Puccinia.	K6	CO5

CL AND CO BASED END SEMESTER EXAMINATION QUESTION PAPER FORMAT FOR UG THEORY COURSES
MC, AR, AO, MS, ME and GL

SECTION		Q. NO	K1	K2	K3	K4	K5	K6
A	(4 x 5 = 20) Answer ALL	1	+					
		2	+					
		3		+				
		4		+				
B	(2 x 10 = 20) Answer 2 out of 4	5			+			
		6			+			
		7			+			
		8			+			
C	(2 x 10 = 20) Answer 2 out of 4	9				+		
		10				+		
		11				+		
		12				+		
D	(2 x 20 = 40) Answer 2 out of 4	13					+	
		14					+	
		15						+
		16						+
No. of CL based Questions with Max. marks			**2 (10)**	**2 (10)**	**2 (20)**	**2 (20)**	**2 (40)**	**2 (40)**
No. of CO based Questions with Max. marks			**CO 1**		**CO 2**	**CO 3**	**CO 4**	**CO 5**
			4 (20)		**2 (20)**	**2 (20)**	**2 (40)**	**2 (40)**

* **MC**-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major Skill, **ME**-Major Elective, **GL**-General Languages.

- **Section A** could have one or more of the following: Fill in the blanks, True or False, Match the following, Definition, Comment on, Reason out, but K1 and K2 should carry equal weightage. In **Section D** students have choice between K5 and K6.

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Plant Biology and Biotechnology

END SEMESTER EXAMINATION, NOVEMBER, 2021

UPB 3501 FUNGI (MC)

II BSc 15.11.2021

Duration : 3 hrs Max. Marks : 100

	SECTION A			
Answer ALL the Questions				
1.	**Define the following**	**(5 x 1 = 5 Marks)**		
a)	Haustorium		K1	CO1
b)	Sporangiophore		K1	CO1
c)	Obligate parasite		K1	CO1
d)	Crozier formation		K1	CO1
e)	Lichens		K1	CO1
2.	**Fill in the blanks**	**(5 x 1 = 5 Marks)**		
a)	Penicillium belongs to _____		K1	CO1
b)	The basidia in Polyporous are _____ shaped		K1	CO1
c)	In budding, the nuclear division is by process of _____		K1	CO1
d)	Powdery mildew is caused by _____		K1	CO1
e)	_____type is a very good example of ectoendomycorrhiza		K1	CO1
3.	**Match the following**	**(5 x 1 = 5 Marks)**		
a)	Albugo	Alcohol production	K2	CO1
b)	Neurospora	Red rot	K2	CO1
c)	Colletotrichum	Hymenomycetes	K2	CO1
d)	Polyporus	Microconidia	K2	CO1
e)	Baker's yeast	Oogamous reproduction	K2	CO1
4.	**TRUE or FALSE**	**(5 x 1 = 5 Marks)**		
a)	Aspergillus belongs to the class Oomycetes		K2	CO1
b)	Asexual reproduction in Peziza is by formation of Chlamydospores		K2	CO1
c)	Dermatomycosis is caused by all, except Trichophyton sp		K2	CO1
d)	Lichens that are closely absorbed to the surface are the Crustose type		K2	CO1
e)	Puccinia graminis is an obligate parasite		K2	CO1
	SECTION B			

Answer any TWO of the following in 150 words		**(2 x 10 = 20 Marks)**	
5.	Explain the lifecycle of Aspergillus.	K3	CO2
6.	Illustrate and explain the structure and applications of YAC vector.	K3	CO2
7.	Prepare and present the salient features of the fungal classes.	K3	CO2
8.	Interpret the economic importance of fungi.	K3	CO2
	SECTION C		
Answer any TWO of the following in 150 words		**(2 x 10 = 20 Marks)**	
9.	Analyse the lifecycle pattern of Rhizopus.	K4	CO3
10.	Classify fungi based on that by Alexopolous and Whittakar.	K4	CO3
11.	Compare the structural properties of different fruiting bodies of fungi.	K4	CO3
12.	Correlate the details on the infection phase of Colletotrichum.	K4	CO3
	SECTION D		
Answer any TWO of the following in 250 words		**(2 x 20 = 40 Marks)**	
13.	Evaluate the lifecycle patterns in fungi with examples.	K5	CO4
14.	Summarise the process of sexual reproduction in yeast with illustrations.	K5	CO4
15.	Lichens are varied in diversity and forms – Substantiate.	K6	CO5
16.	Construct the events in the lifecycle of Puccinia.	K6	CO5

UNIT WISE DISTRIBUTION OF CL AND CO BASED QUESTIONS AND MARKS FOR END OF SEMESTER QUESTION PAPER SETTING FOR UG COURSES
MC, AR, AO, MS, ME and GL

	SECTION A (1 Mark/Question)		SECTION B (10 Marks/Question)	SECTION C (10 Marks/Question)	SECTION D (20 Marks/Question)	
	K1	**K2**	**K3**	**K4**	**K5**	**K6**
UNIT I	2 (1)	2 (1)	-	1 (10)	-	
UNIT II	2 (1)	2 (1)	1 (10)	1 (10)	1 (20)	-
UNIT III	2 (1)	2 (1)	1 (10)	1 (10)	1 (20)	-
UNIT IV	2 (1)	2 (1)	1 (10)	1 (10)	-	1 (20)
UNIT V	2 (1)	2 (1)	1 (10)	-	-	1 (20)
No. of CL based Questions with Max. Marks	**10 (10)**	**10 (10)**	**2 (20)**	**2 (20)**	**2 (40)**	**2 (40)**
No. of CO based Questions with Max. Marks	**CO1**		**CO2**	**CO3**	**CO4**	**CO5**
	20 (20)		**2 (20)**	**2 (20)**	**2 (40)**	**2 (40)**

* **MC**-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major Skill, **ME**-Major Elective, **GL**-General Languages.

- In **Section D** students have choice between K5 and K6.

CL AND CO BASED MARKS DISTRIBUTION FOR DIRECT ASSESSMENTS OF UG COURSES MC, AR, AO, MS, ME and GL

SECTION	CL	CO	CIA I	CIA II	III Component	Semester	Total (200)	CL and CO %
A	K1, K2	CO1	6	6	20	20	52	26%
B	K3	CO2	6	6	10	20	42	21%
C	K4	CO3	6	6	10	20	42	21%
D	K5, K6	CO4, CO5	12	12	-	40	64	32%

* **MC**-Major Core, **AR**–Allied Required, **AO**–Allied Optional, **MS**-Major Skill, **ME**-Major Elective, **GL**-General Languages.

CL AND CO BASED CIA AND SEMESTER QUESTION PAPER FORMAT FOR UG LAB COURSES* (MC, AR, AO, ME)

SECTION	MARKS	Q. NO	K1	K2	K3	K4	K5	K6
A	20	1	+					
		2		+				
B	20	3			+			
C	20	4				+		
D	20	5					+	
E	20	6						+
No. of CL based Questions with Max. marks			1(10)	1(10)	1(20)	1(20)	1(20)	1(20)
No. of CO based Questions with Max. marks			CO 1		CO 2	CO 3	CO 4	CO 5
			2(20)		1(20)	1(20)	1(20)	1(20)

No Comp III for Lab Courses and total marks assigned to CIA is 50

This template for Lab Courses is suggestive. But based on specific requirements **if a department wants to develop a common template (Only one) for all its Lab courses it is encouraged to do so, but the template must have all Cognitive Levels and the final version of the template should be sent to us for approval.**

CL AND CO BASED CIA QUESTION PAPER FORMAT FOR UG THEORY COURSES
(NME-Other Languages only)

SECTION	MARKS	Q. NO	K1	K2	K3	K4
A	Answer ALL (4 x 2 = 8)	1	+			
		2	+			
		3		+		
		4		+		
B	Answer 1 out of 2 (1 x 12 = 12)	5			+	
		6			+	
C	Answer 1 out of 2 (1 x 10 = 10)	7				+
		8				+
No. of CL based Questions with Max. marks			2 (4)	2 (4)	1 (12)	1 (10)
No. of CO based Questions with Max. marks			CO 1		CO 2	CO 3
			4 (8)		1 (12)	1 (10)

- **Section A** could have one or more of the following: Fill in the blanks, True or False, Match the following, Definition, Comment on, Reason out, but K1 and K2 should carry equal weightage.
- III Component Assessment carries 40% of CIA and the assessment(s) should be for cognitive levels K5 and K6 and both should carry equal weightage.

LOYOLA COLLEGE (AUTONOMOUS), CHENNAI 60034

Department of Plant Biology and Biotechnology

END SEMESTER PRACTICAL EXAM, NOVEMBER, 2021

UPB 3503 – FUNGI AND MICROBIOLOGY PRACTICAL (MC)

II BSc Plant Biology and Biotechnology 16.11.2021

Time : 9: 00 am to 12.00 noon Max. Marks : 100

SECTION A		**(20 Marks)**	
1.	Identify, and comment on the spotters A, B, C, D and E	K1	CO1
2.	Identify and comment on the given spotters F, G, H, I and J	K2	CO1
SECTION B		**(20 Marks)**	
3.	Comment critically on the spotters K, L, M and N with suitable diagrams	K3	CO2
SECTION C		**(20 Marks)**	
4.	Comment on the results of O and P (chosen by lot)	K4	CO3
SECTION D		**(20 Marks)**	
5.	Perform sectioning, staining and interpret the results obtained for the given specimens Q and R	K5	CO4
SECTION E		**(20 Marks)**	
6.	Perform the experiment explain the principle, requirements, procedure and interpret the results. Submit the preparations for evaluation.	K6	CO5