Department of Botany
Mohanlal Sukhadia University
Udaipur, Rajasthan

B.Sc. Botany Syllabus
[as per the National Education Policy (NEP)]

B.Sc. Course structure

Table 1: CBCS Course structure for B.A./B.Com./B.Sc. (Three Year Program) total credits 120						
	SEM-1	**SEM-II**	**SEM-III**	**SEM-IV**	**SEM-V**	**SEM-VI**
Core Courses	DCC-A1 (6 Cr) DCC-B1 (6 Cr) DCC-C1 (6 Cr)	DCC-A2 (6 Cr) DCC-B2 (6 Cr) DCC-C2 (6 Cr)	DCC-A3 (6 Cr) DCC-B3 (6 Cr) DCC-C3 (6 Cr)	DCC-A4 (6 Cr) DCC-B4 (6 Cr) DCC-C4 (6 Cr)	-	-
DSE / GEC	-	-	-	-	DSE-A1(6 Cr) DSE-B1(6 Cr) DSE-C1(6 Cr)	DSE-A1(6 Cr) DSE-B1(6 Cr) DSE-C1(6 Cr)
AECC	AECC-1 (2Cr)	AECC-2 (2 Cr)	-	-		
SEC			SEC-1(2 Cr) Communicative English	SEC-2 (2 Cr)	- SEC-3 (2Cr)	SEC-4 (2Cr)
	18+0+2+0=20	**18+0+0+2=20**	**18+0+0+2=20**	**18+0+0+2=20**	**0+18+2+0=20**	**0+18+0+2=20**
72(DCC)+36(DSE/GEC)+4(AECC)+8(SEC)=120						

1. Discipline Centric Compulsory Course **(DCC):A, B, and C denote three different disciplines (subjects)**. A student will study 4 papers in each discipline.
2. **Discipline Specific Elective (DSE):**A student will choose DSE courses from the three chosen disciplines (A, B, and C) for semesters V and VI. Any such paper can be Generic Elective Course (GEC) for the students of other disciplines.
3. **Ability Enhancement Compulsory Courses (AECC)** :Modern Indian Languages (MIL), English, Hindi Communication (Odia/Hindi/Telugu/Bangla/……)
4. **Skill Enhancement Courses (SEC):**Communicative English in the 3rd semester and three more subjects from a common pool. Each discipline provide at least one SEC
5. Courses with Practical component: Theory (4 credits) + Practical (2 credits) = 6 credits
6. Non-practical Courses: Theory (5 credits) + Tutorial (1 credit) = 6 credits (Numbers shown in brackets indicate Credits). In some of the disciplines it can be (2L+2P+2T) or (2L+4P)

Table 2: Proposed Botany Courses for CBCS in 3-years B.Sc. Program: Semester wise types, codes, titles, Delivery type, Workload, Credits of the courses, Marks of Examination, and Remarks.

Level	Semester	Course Type	Course Code	Course Title	Delivery type per week			Total hours	Credits	Total Credits	Internal marks	EoSE Marks	Max. Marks	Remarks
					L	T	P							
5	I	DCC	BOT5000T	Botany-I: Diversity of cryptogams, fungi and microbiology	L	T	-	60	4	6	20	80	100	
			BOT5000P	Botany Lab-1: Practicals of cryptogams, fungi and microbiology	-	-	P	60	2		20	80	100	
		AECC			L	T		30	2	2	20	80	100	
	II	DCC	BOT5001T	Botany-II: Biology of phanerogams	L	T	-	60	4	6	20	80	100	
			BOT5001P	Botany Lab-II: Practicals of phanerogams	-	-	P	60	2		20	80	100	
		AECC			L	T		30	2	2	20	80	100	
Exit with Certificate in Science (After 4 more credits in SEC)														
6	III	DCC	BOT6002T	Botany-III: Basics of Cell & Molecular Biology, Genetics, Plant Breeding, Evolution and Biostatistics	L	T	-	60	4	6	20	80	100	
			BOT6002P	Botany Lab-3: Practicals of Cell & Molecular Biology, Genetics, Plant Breeding, Evolution and Biostatistics	-	-	P	60	2		20	80	100	
		SEC	SEA6302T	Communicative English	L		-	30	2	2	20	80	100	
	IV	DCC	BOT6003T	Botany-IV: Plant Biochemistry, Physiology and Biotechnology	L	T	-	60	4	6	20	80	100	
			BOT6003P	Botany Lab-4: Practicals of Plant Biochemistry, Physiology and Biotechnology	-	-	P	60	2		20	80	100	
		SEC	SES6300T	Tools and Techniques in Plant Sciences	L	T	-	30	2	2	20	80	100	

Exit with Diploma in Science														
7	V	Select anyone of the following Discipline specific Elective (DSE) Courses in V and VI semester												
		DSE	BOT7100T	Seed Biology	L	T	-	60	4	6	20	80	100	
			BOT7100P	Elective Botany Lab: Seed Biology	-	-	P	60	2		20	80	100	
			BOT7101T	Cultivation and Commercialization of Medicinal Plants	L	T	-	60	4	6	20	80	100	
			BOT7101P	Elective Botany Lab: Cultivation and Commercialization of Medicinal Plants	-	-	P	60	2		20	80	100	
		SEC	SES7301T	Fundamental of Biostatistics	L	T		30	2	2	20	80	100	
	VI	DSE	BOT7111T	Plant diseases and management	L	T	-	60	4	6	20	80	100	
			BOT7111P	Elective Botany Lab: Plant diseases and management	-	-	P	60	2		20	80	100	
			BOT7112T	Plant Tissue Culture and Commercialization techniques	L	T	-	60	4	6	20	80	100	
			BOT7112P	Elective Botany Lab: Plant Tissue Culture and Commercialization techniques	-	-	P	60	2		20	80	100	
		SEC	SES7302T	Nursery and Gardening	L		-	30	2	2	20	80	100	
Exit with Graduation Degree in Science (B.Sc.)														

DCC- Discipline Centric Compulsory Course (001 to 099); **DSE**- Discipline Specific Core Course (100 to 199)
AECC- Ability Enhancement Compulsory Course (English/Modern Indian Languages/Hindi) (201 to 299); **SEC**- Skill Enhancement Course (300 to 309)
The code has eight places. XYZ (subject name) Level (5/6/7) DCC/DSE/AEC/SEC (3 digits) T/P
If an SEC course is offered by commerce: SE**C**53XXT; Science: SE**S**63XXT; Arts/Humanities/: SE**A**53XXT; Management SE**M**73XXT

B.Sc.
Semester-wise syllabus (Botany)
Semester I

Code of the course	**BOT5000T**
Title of the course	Botany-I: **Diversity of Cryptogams, Fungi and Microbiology**
Level of the Course	NHEQF Level 4.5
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60 hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	(1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level (2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level

Objectives of the Course

This course is designed to instill fundamental knowledge about habit, habitat, morphology, anatomy, reproduction and economic importance of various plant groups (Algae, Bryophytes, Pteridophytes) and microorganisms.

Course Learning Outcomes

After the completion of the course the students will be able to:

- Develop critical understanding on habit, classification, reproduction and economic importance of Algae, Bryophytes and Pteridophytes.
- Develop understanding about the classification and diversity of different microbes including Viruses, Fungi, Lichens and their economic importance.
- Learn host –pathogen relationship, important plant diseases caused by fungi, bacteria, viruses and their management.
- Gain Knowledge about the economic values of this lower group of plant community.
- Laboratory sessions following theory will provide easy understanding of external as well as internal structure of selected genus of different plant group.

Syllabus

UNIT-1 (Lecture hours: 12)

Range of thallus organization in Algae, Pigments, Reserve food, Classification of Algae proposed by Fritsch. Life cycle – *Nostoc, Chara, Ectocarpus, Polysiphonia* Economic importance of algae. Introduction to biofuel and biofertilizer.

UNIT- 2 (Lecture hours: 12)

Bryophytes: General characteristics, Classification (up to family), morphology, anatomy and reproduction of *Marchantia, Anthoceros* and *Sphagnum* (Developmental details not to be included). Pteridophytes: General characteristics, Classification (up to family) with examples. Early land plants (*Rhynia*), Heterospory and seed habit, stelar evolution.

UNIT- 3 (Lecture hours: 12)

General characteristics of fungi and classification proposed by Alexopoules (upto class level). Reproduction in fungi (asexual and sexual). Heterothallism and parasexuality. Brief study of life cycle of *Phytophthora, Puccinia, Penicillium, Trichoderma* and *Alternaria.* Mushroom Cultivation, General account and significance of Lichens and Mycorrhiza.

UNIT- 4 (Lecture hours: 12)

Bacteria–general characteristics and cell wall structure; reproduction–vegetative, asexual and recombination (conjugation, transformation and transduction); Viruses- structure, replication (general account), General account of Mycoplasma and Phytoplasma.

UNIT- 5 (Lecture hours: 12)

Plant Diseases: Concept, Symptoms, Primary and secondary inoculum, Koch's Postulates. Symptoms, Causal organism, Disease cycle and Control measures of – Early blight of Potato, Black stem rust of wheat, Red rot of Sugarcane, yellow vein mosaic of bhindi; citrus canker, little leaf of Brinjal. Disease management: - Quarantine, Chemical, Biological, Integrated pest disease management.

Suggested Books and References:

- Barsanti, L. and Gualtieri, P. (2014). Algae: Anatomy, Biochemistry and Biotechnology, 2 nd Edition. CRC/ Taylor & Francis, NY.
- Lee, R.E. (2018). Phycology, Fifth Edition. Cambridge University Press, Cambridge.
- Marjorie, Kelly and Cowan, Heidi Smith. (2017). Microbiology: A Systems Approach. McGraw Hill New York, 5th edition.
- Pandey, S.N and Trivedi, P.S. (2015). A text book of Botany Vol.I Vikas publishing House Pvt/ Ltd, New Delhi.
- Parihar, N.S. (1991). An Introduction to Embryophyta Vol. I Bryophyta. Central Book Depot, Allahabad.
- Mehrotra, R.S. and K.R. Aneja. (1999). An Introduction to Mycology. New Age International Publisher.
- PelczarM.J., Chan E.C.S and KreigN.R. (1997). Microbiology. Tata MacGraw Hill.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGrawHill, Delhi, India.
- Robert Edward Lee. (2018). Phycology. Cambridge University Press, U.K. 5th edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
- Sharma, O. P. (2011). Algae. Tata McGraw Hill Education Private Limited, U.K. 1st edition.
- Sharma, O.P. (1990). Textbook of Pteridophyta. MacMillan India Ltd. Delhi
- Tortora, G.J., Funke, B.R., Case, C.L. (2011). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 13th edition.
- Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Bryophyta, S. Chand. Delhi, India.
- Webster, J. and Weber, R. (2007). Introduction to Fungi. Third Edition. Cambridge UniversityPress. Cambridge and New York.
- Willey, J M., Sherwood, L.M. and Woolverton, C.J. (2017). Prescott's Microbiology, 11th Edition, McGraw-Hill, USA.
- Pandey, B.P. (2010). College Botany Vol II. S. Chand and Company Ltd., New Delhi,India.
- Parihar, N.S. (1976). Biology and Morphology of Pteridophytes. Central Book Depot.

Suggested E-resources

https://community.plantae.org/tags/mooc
https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf
http://allaboutalgae.com/benefits/
https://repository.cimmyt.org/xmlui/bitstream/handle/10883/3219/64331.pdf https://www.mooc-list.com/tags/microbiology
http://www.agrifs.ir/sites/default/files/A%20text%20book%20of%20practical%20botany%201%20%7BAshok%20Bendre%7D%20%5B8171339239%5D%20%281984%29.pdf
https://www.coursera.org/courses?query=plants http://egyankosh.ac.in/handle/123456789/53530
https://www.classcentral.com/tag/microbiology https://www.edx.org/learn/microbiology
https://www.mooc-list.com/tags/microbiology https://www.udemy.com/topic/microbiology/
Suggested equivalent online courses: https://www.anbg.gov.au/bryophyte/what-is-bryophyte.html
https://pteridoportal.org/portal/index.php https://www.conifers.org/zz/gymnosperms.php
http://www.mobot.org/MOBOT/research/APweb/ https://milneorchid.weebly.com/plant-id-for-beginners.html https://www.botany.org/PlantImages/PlantAnatomy.php
http://webapp1.dlib.indiana.edu/inauthors/view?docId=VAC0868&doc.view=print https://palynology.org/
http://www2.estrellamountain.edu/faculty/farabee/biobk/Biobookflowers.html
https://www.sciencelearn.org.nz/resources/100-plant-reproduction https://palaeobotany.org/

Code of the course	BOT5000P
Title of the course	**Botany Lab-1:Practicals of Cryptogams, Fungi and Microbiology**
Level of the Course	NHEQF Level 4.5
Credit of the Course	2
Type of the Course	DCC
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	(1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level (2) Biology courses of Board of Secondary Education, Rajasthan or equivalent at 10+2 Level

Objectives of the Course

The objective of the course is to provide students with a comprehensive understanding of various biological organisms and structures through the study of microscopic preparations, specimens, and models. The course focuses on the following key objectives:

- Study of Vegetative and Reproductive Structures: Students will learn about the vegetative and reproductive structures of different organisms including *Nostoc, Oscillatoria, Volvox, Oedogonium, Chara, Ectocarpus, and Polysiphonia*. They will develop skills in preparing temporary preparations, permanent slides, and examining specimens to study the morphology and structure of these organisms.
- Morphology and Microscopic Preparations: Students will explore the external and internal morphology of different taxa including Bryophytes, Pteridophytes, Fungi, and Pathogens. They will learn to examine microscopic preparations of organisms such as *Riccia, Anthoceros, Sphagnum, Selaginella, Equisetum, Penicillium, Alternaria, Puccinia, and Agaricus*, to understand their structures and functions.
- Study of Lichens: Students will examine the growth forms of lichens, including crustose, foliose, and fruticose types. They will understand the symbiotic relationship between fungi and algae in lichens and learn to identify and classify different lichen forms.
- Mycorrhiza: Students will explore mycorrhizal associations, focusing on ectomycorrhiza and endomycorrhiza. They will study photographs and illustrations to understand the mutualistic relationship between fungi and plant roots, and the significance of mycorrhiza in nutrient absorption and plant growth.
- Viruses: Students will study viruses through electron micrographs and models. They will examine the structures and characteristics of T-Phage and TMV (Tobacco Mosaic Virus) and gain an understanding of the lytic and lysogenic cycles of viral replication through line drawings or photographs.
- Gram Staining Technique: Students will learn the principles and techniques of Gram staining, a widely used staining method in microbiology. They will understand the differences in bacterial cell wall composition and the staining process for differentiating Gram-positive and Gram-negative bacteria.

Overall, the course aims to develop students' observational and analytical skills in the study of various biological structures and organisms. It also aims to enhance their understanding of fundamental concepts in microbiology and provide a solid foundation for further studies in the field of biological sciences.

Course Learning Outcomes

By the end of the course, students will be able to identify and analyze the vegetative and reproductive structures of various organisms, understand the morphology of Bryophytes, Pteridophytes, Fungi, and Pathogens, classify lichen growth forms, comprehend mycorrhizal associations, interpret viral structures and cycles, and apply the Gram staining technique in microbiology.

Syllabus (Lecture hours:60)

1. Study of vegetative and reproductive structures of *Nostoc, Oscillatoria, Volvox, Oedogonium, Chara, Ectocarpus* and *Polysiphonia* (or available minimum 3 taxa) through temporary preparations/permanent slides/specimens.
2. Study of external and internal morphology and microscopic preparations of following taxa of Bryophytes, Pteridophytes, Fungi and Pathogens: *Riccia, Anthoceros, Sphagnum, Selaginella*, *Equisetum*, *Penicillium, Alternaria*, *Puccinia*, *Agaricus.*
3. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose).
4. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs).
5. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
6. Gram staining technique

Scheme of Examination

Exercise 1 (Algae)	10
Exercise 2 (Bryophytes)	10
Exercise 3 (Pteridophytes)	10
Exercise 4 (Fungi/ Pathology)	8
Exercise 5 (Microbiology)	6
Spotting (8)	16
Record	10
Viva – Voce.	10
Total	**80**

Suggested Books and References

- Bergey's Manual of Systematic Bacteriology, 2nd ed., vol. 1-3, Springer Verlag, New York, NY.
- Pandey, B.P. (2014). Modern Practical Botany Vol. I. S. Chand and Company Ltd. Ramnagar, New Delhi.
- Purohit, S.D., Kundra, G. K. and Singhvi, A. (2013). Practical Botany (part I). Apex Publishing House Durga Nursery Road Udaipur, Rajasthan.
- Sambamurty, A.V.S.S. (2006). A text book of Algae. I.K International Publishing House,Pvt. Ltd.

Suggested E-resources

Here are some suggested e-resources that can be used for the above course:

1. National Center for Biotechnology Information (NCBI) - This resource provides access to a vast collection of scientific articles, journals, and databases related to various aspects of biology. Students can find relevant research papers and references for their studies.
2. Khan Academy - Khan Academy offers a wide range of educational videos and tutorials on biology topics. Students can find videos on topics like microscopy, fungi, viruses, and staining techniques to supplement their learning.
3. Microbiology Online - This website provides comprehensive information on various microbiology topics, including bacteria, fungi, viruses, and staining techniques. It offers interactive tutorials, virtual lab simulations, and educational resources for students to explore.
4. Virtual Microbiology Classroom - This resource offers virtual microscopy slides and interactive learning modules on microbiology topics. Students can access virtual microscope slides of different organisms, including bacteria, fungi, and algae.
5. OpenStax Biology - OpenStax provides free, open-access textbooks on various subjects, including biology. The Biology textbook covers a wide range of topics, including microbiology, plant anatomy, and ecology. It can serve as a valuable resource for students seeking in-depth knowledge.
6. YouTube - YouTube hosts a plethora of educational channels focused on biology. Channels like CrashCourse, Bozeman Science, and Amoeba Sisters offer engaging video lessons on diverse biological topics, including the ones covered in the course.

It's important to note that the availability of specific resources may vary, and it's recommended to check with your educational institution or library for access to additional e-resources or online databases that may be available to you.

B.Sc.
Semester-wise syllabus (Botany)
Semester II

Code of the course	**BOT5001T**
Title of the course	Botany-II: **Biology of Phanerogams**
Level of the Course	NHEQF Level 4.5
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	(1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level (2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level

Objectives of the Course

The course aims to strengthen the basic to applied aspects relevant to higher plants such as concepts of phanerogams, general features to life history of Gymnosperms, taxonomy, external morphology, internal structures of different plant parts and developmental biology of angiosperms, economic and ecological significance of phanerogams learning at the school level and lay a foundation for further learning of the subject through the course on Biology of phanerogams which is a prerequisite for higher courses in Botany.

Course Learning Outcomes

1. Understand about the general characters of phanerogams.
2. Assess terms and concepts related to taxonomy of higher plants and systems of classification and generalize the characters of the families according to various proposed systems of classification.
3. Learn about the various terminology used for description of flower characteristics and plant species
4. The students would be able to understand deep underlying concept of the diagnostic features of various angiosperm families.
5. Learn about the organization of meristem and vascular tissue differentiation.
6. Understand about the anatomical structure of stem and roots and learn the genetic and molecular aspects of flower development.
7. Understand the structure of anther and pollen wall because ultrastructure of pollen grain plays an important role in taxonomy. Evaluate the special structures and types of male and female gametophyte and learn the reproductive process in angiospermic plants.
8. Understand the mechanism of pollination and fertilization and can relate between embryo, endosperm and seed. Comprehend the causes of polyembryony and apomixis with its classification.
9. Learn about the ethnobotanical practices and economic importance of plants. Increase an awareness and appreciation of plants and plant products encountered in everyday life of human usases.

After completion of this course, it will educate students about plant science and inculcate strong fundamentals and classical aspects of Botany on phanerogams and create platform for higher studies in Botany and maintain a high level of scientific excellence in botanical research with specific emphasis on the role of plants thereby facilitating students to take-up successful career in Botany.

Syllabus

Unit I (Lecture hours: 12)

General features and broad classification (up to family) of gymnosperms. Occurrence, structure, life history and economic importance of *Cycas*, *Pinus* and *Ephedra.*

Unit II (Lecture hours: 12)

Taxonomic categories; concept of species, genus and family. Systems of classification of Bentham and Hooker. Diagnostic features and economic importance of Ranunculaceae, Brassicaceae, Malvaceae, Cucurbitaceae, Fabaceae, Asteraceae, Solanaceae, Poaceae.

Unit III (Lecture hours: 12)

Organization of shoot apical meristem and root apical meristem, Tissue and tissue systems; Parenchyma, Collenchyma, Sclerenchyma, Xylem, Phloem. Anatomy of root, stem and leaf.

Unit IV (Lecture hours: 12)

Microsporogenesis and megasporogenesis in Angiosperms. Structure and Development of male and female gametophytes in Angiosperms. Pollination and fertilization in spermatophytes. Types of endosperms and embryo in phanerogams.

Unit V (Lecture hours: 12)

Origin, botany, cultivation, economic importance of Wheat, Maize, Rice, Millets: Pearl millet, Chick pea, *Gossypium*, *Crotalaria*, Sugarcane, ground nut oil. Economic botany of medicinal Plants: *Rauvolfia*, *Papaver*. Introduction to Ethnobotany.

Suggested Books and References

- BhatnagarS.P and MoitraAlok 1996. Gymnosperms. New Age International Pvt. Ltd.Publishers, New Delhi, 470 pp.
- Bhojwani, S.S. and Bhatnagar, S.P. Embryology of Angiosperms (4th Revised and enlarged edition), 2000.
- BierhorstD.W. 1971. Morphology of Vascular Plants. New York and London.
- Cotton, C.M. (1996). Ethnobotany: Principles and Applications. John Willey & Sons, England.
- Cunningham, A.B. (2001). Applied Ethnobotany: Peopple, Wild Plant Uses and Conservation. Earthscan Publication Ltd., London.
- Fahn, A. 1982. Plant Anatomy (3rd Ed.), Pergamon Press, Oxford.
- Gurcharan Singh. 2004. Plant Systematics: Theory and Practice Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Kochhar, S. L. (2016). Economic botany. Cambridge University Press.
- Nautiyal, S. and Kaul A.K. (2003). Non-Timber Forest Products of India. Jyoti Pub, Dehradun, India.
- Nordenstam, B., EIGazaly, G. and Kassas, M. 2000. Plant Systematics for 21st century.
- Sharma O.P. (2017) Plant Taxonomy. McGraw Hill Education.

Suggested E-resources

Here are some suggested e-resources that can be used for the mentioned syllabus:

1. Flora of North America - This online resource provides comprehensive information on the taxonomy and classification of plants in North America. It covers gymnosperms, Ranunculaceae, Brassicaceae, Malvaceae, Cucurbitaceae, Fabaceae, Asteraceae, Solanaceae, and Poaceae, among others.
2. Missouri Botanical Garden - The Missouri Botanical Garden's website offers an extensive botanical database, including information on gymnosperms and various angiosperm families mentioned in the syllabus. It provides detailed descriptions, images, and economic importance of these plant groups.
3. Botanical Society of America - The Botanical Society of America's website features educational resources, articles, and links to journals and databases related to plant anatomy and morphology. It covers topics such as shoot apical meristem, root apical meristem, tissue systems, and the anatomy of root, stem, and leaf.
4. Plant Anatomy Online - This website offers interactive tutorials, virtual slides, and educational resources on plant anatomy. It provides in-depth information on tissue types like parenchyma, collenchyma, sclerenchyma, xylem, and phloem, as well as the anatomy of different plant organs.
5. Angiosperm Phylogeny Website - The Angiosperm Phylogeny Website is a valuable resource for understanding the classification and evolutionary relationships of angiosperms. It provides detailed information on microsporogenesis, megasporogenesis, male and female gametophytes, pollination, and fertilization in angiosperms.
6. Crop Science Society of America - The Crop Science Society of America's website offers information on crop botany, cultivation, and economic importance. It covers crops like wheat, maize, rice, millets, chickpea, sugarcane, groundnut, and provides insights into their botany, cultivation practices, and economic significance.
7. Medicinal Plant Database - Various online databases, such as the Medicinal Plant Database, provide information on medicinal plants, including Rauvolfia and Papaver. These resources offer

details on their botany, distribution, traditional uses, chemical constituents, and potential medicinal applications.

It's important to note that the availability and access to specific e-resources may vary. It's recommended to check with your educational institution or library for access to additional e-resources, such as scholarly journals and databases, that may be available to you.

Code of the course	BOT5001P
Title of the course	**Botany Lab-II: Practicals of Phanerogams**
Level of the Course	NHEQF Level 4.5
Credit of the Course	2
Type of the Course	DCC
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	(1) Biology courses of Central Board of Secondary Education or equivalent at 10+2 Level (2) Biology courses of Board of Secondary Education Rajasthan or equivalent at 10+2 Level

Objectives of the Course

1. Examine and analyze microscopic preparations of male and female cones of Pinus and Ephedra, as well as study the male cone and megasporophyll of Cycas.
2. Identify and classify plant species belonging to different families, such as Ranunculaceae, Brassicaceae, Malvaceae, Leguminosae, Cucurbitaceae, Asteraceae, Solanaceae, and Poaceae.
3. Understand the types of placentation, ovules, and the structure of pollinium through the examination of embryology slides.
4. Study the anatomy of representative stems and roots,
5. Explore the economic importance of plants as outlined in the theory paper, gaining knowledge about their uses and significance.

Course Learning Outcomes

Students will be able to:

- Identify and describe the anatomical structures and features of Pinus, Ephedra, and Cycas.
- Classify and identify representative plant families based on morphological characteristics.
- Understand placentation, types of ovules, and the concept of pollinium in plant embryology.
- Gain knowledge about economically important plants and their uses.

Syllabus (Lecture hours: 60)

1.Temporary, doublestainedmicroscopicpreparations of T.S., T.L.S. and R.L.S. of stem of Pinus and Ephedra and T.S. Leaflet and Rachis of Cycas and needle of Pinus, T.S. of normalandcoralloidroots of *Cycas*. Microscopicpreparations of male cone of *Pinus* and male and female cones of *Ephedra*. Study of male cone and megasporophyll of *Cycas*.

2. TAXONOMY

1. Ranunculaceae : *Ranunculus, Nigella, Delphinium*
2. Brassicaceae : *Brassica, Raphanus, Iberis*
3. Malvaceae : *Hibiscus, Althea*
4. Leguminosae : *Pisum, Crotalaria ; Cassia, Caesalpinia, Bauhinia, Tamarindus ; Acacia, Prosopis, Mimosa.*
5. Cucurbitaceae : *Citrullus, Cucumis*
6. Asteraceae : *Helianthus, Tridax, Launaea, Ageratum.*
7. Solanaceae : *Solanum, Nitotiana, Petunia. Datura*
8. Poaceae : *Triticum.*

Theabovelist of plants is onlysuggestiveandcanbereplaceddependingonlocalavailability.

3. EMBRYOLOGY SLIDES :

1. Placentation : Types
2. Ovules : Types
3. Pollinium (wholemount).

4.Allplants of economicimportance as prescribed in theorypaper

5. ANATOMY

1. Stem : Anyoneortworepresentativelike*Boerhaavia, Achyranthes, Bignonia, Chenopodium, Leptadaenia,Nyctanthes, Salvadora, Dracaena, Triticum, Mirabilis, Aristolochia, Amaranthus, Chenopodium.*
2. Root : Anyoneortworepresentativelike*Tinospora, Ficus.*

Scheme of Examination

Exercise 1 (Gymnosperms)	**10**
Exercise 2 (Taxonomy)	**12**
Exercise 3 (Anatomy)	**12**
Exercise 4 (Embryology)	**5**
Exercise 5 (Economic Botany)	**5**
Spotting (8)	**16**
Record	**10**
Viva–Voce	**10**
Total	**80**

Suggested Books and References

Here are some practical books that cover the topics mentioned in the given syllabus:

1. "A Textbook of Practical Botany" by R.C. Pandey
    - This book provides practical exercises and techniques for studying various aspects of plant morphology, anatomy, and taxonomy. It covers topics such as microscopy, staining techniques, and the study of plant families.
2. "Practical Manual of Plant Anatomy and Embryology" by V. Verma and V. K. Agarwal
    - This book focuses on plant anatomy and embryology, including the study of stem and root anatomy. It provides detailed descriptions of staining techniques, preparation of microscope slides, and the study of various plant organs.
3. "Practical Plant Taxonomy" by S.K. Singh and S.R. Maurya
    - This book specifically focuses on plant taxonomy and provides practical exercises for studying different plant families. It includes information on the identification and classification of plants based on their morphological features.
4. "Practical Manual of Economic Botany" by S.P. Sharma
    - This book covers plants of economic importance and provides practical exercises for studying their morphology, anatomy, and economic uses. It includes detailed descriptions of various plant families and their economic significance.
5. "Practical Handbook of Plant Anatomy" by C.R. Metcalfe and L. Chalk
    - This comprehensive handbook covers plant anatomy and provides practical techniques for the preparation and examination of plant sections. It includes detailed protocols for the study of stem and root anatomy.

Suggested E-resources

Here are some e-resources that you can refer to for the topics mentioned in the syllabus:

1. Plant Anatomy Online (http://plantcellbiology.masters.grkraj.org/)
    - This website provides detailed information on plant anatomy, including stem and root anatomy. It includes interactive tutorials, diagrams, and image galleries that can help you study and understand the anatomy of different plant species.
2. Practical Plant Taxonomy (https://www.sbs.utexas.edu/bio406d/)
    - This online resource offers a comprehensive guide to plant taxonomy. It covers various plant families and provides detailed descriptions, images, and classification information for each family. It also includes practical exercises and quizzes to test your knowledge.
3. Plant Embryology and Embryonic Development (https://www.plantembryology.org/)
4. This website focuses on plant embryology and provides detailed information on placentation, types of ovules, and other aspects of plant embryonic development.
5. Plant Science Image Gallery (https://plantscienceimages.org/)
    - This image gallery, provided by the American Society of Plant Biologists, offers a vast collection of high-quality plant images. You can search for specific plant species or topics related to your syllabus, such as stem anatomy, root anatomy, and different plant families. The images can be a valuable visual resource for studying and identifying plant structures.
6. Digital Library of Economic Plants (https://uses.plantnet-project.org/en/)
    - This online resource provides information on plants of economic importance. It offers a comprehensive database with details on the morphology, anatomy, and uses of various plant species.

B.Sc.
Semester-wise syllabus (Botany)
Semester III

Code of the course	BOT6002T
Title of the course	**Botany-III: Basics of Cell & Molecular Biology, Genetics, Plant Breeding, Evolution and Biostatistics**
Level of the Course	NHEQF Level 5.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Intermediate level

Objectives of the Course

1. Understand the fundamental concepts of cell biology, including the cell theory, structure, and functions of prokaryotic and eukaryotic cells, as well as the processes of mitosis and meiosis.
2. Comprehend the structure, types, and functions of DNA and RNA, the central dogma of molecular biology, DNA replication, transcription, and translation, as well as the operon concept of gene regulation.
3. Familiarize with the principles of genetics, including Mendel's laws of inheritance, co-dominance, incomplete dominance, gene interactions, linkage, crossing over, and basics of cytoplasmic inheritance.
4. Gain knowledge of mutations, including spontaneous and induced mutations, physical and chemical mutagens, and the molecular basis of gene mutations.
5. Understand the principles of plant breeding, including centers of origin, selection, hybridization, mutation breeding, and the Green Revolution.
6. Explore the theories of origin and evolution, including Lamarck's theory, Darwin's theory of natural selection, and evidence of evolution.
7. Develop elementary skills in biostatistics, including understanding measures such as mean, mode, median, and standard deviation.

Course Learning Outcomes

1. Understand the fundamental principles of cell biology, including cell structure, organelle functions, and processes of mitosis and meiosis.
2. Comprehend the molecular basis of genetics, including DNA and RNA structure, gene expression, replication, transcription, translation, and gene regulation.
3. Gain knowledge of genetic inheritance patterns, gene interactions, linkage, crossing over, mutations, and basics of cytoplasmic inheritance.
4. Explore the principles of plant breeding, including centers of origin, breeding methods, hybridization, mutation breeding, and the Green Revolution.
5. Develop an understanding of the theories of origin and evolution, including Lamarck's theory, Darwin's theory of natural selection, and evidences of evolution.
6. Acquire basic skills in biostatistics, including the calculation and interpretation of measures such as mean, mode, median, and standard deviation.

Syllabus

Unit-1(Lecture hours: 12)

CellBiology – Celltheory, Structureandfunctions of cell (bothprokaryotesandeukaryotes): Structureandfunctions of plant cellwall, cell membrane andcellorganelles (mitochondria and chloroplast). Chromosomes: Structure of chromatin and chromosomes. Mitosis. Meiosis.

Unit-2 (Lecture hours: 12)

MolecularBiology – Structure, typesandfunctions of DNA & RNA. Modern concept of gene. Concept of central dogma. Basics of DNA replication, transcription of mRNAandtranslation in prokaryotesandeukaryotes. Operonconcept of gene regulation.

Unit-3 (Lecture hours: 12)

Genetics - Mendel'slaws of inheritance, Co-dominanceandincompletedominance, Multiple alleles, Gene gene interactions, Pleiotropy, Lethal alleles, Linkage and crossing over, Basics of cytoplasmicinheritance.

Unit-4 (Lecture hours: 12)

Mutations: Spontaneous and induced mutations, Physical and chemical mutagens. Basics of molecular basis of gene mutations.

Plant breeding - Centres of origin, Principles of plant breeding, Introduction, Selection, Hybridization, Mutationbreeding, Green Revolution.

Unit-5 (Lecture hours: 12)

Origin&Evolution: Origin of life, Evolutionarytheories: Lamarck'stheory, Darwin'stheory (Naturalselcetion), Mutationtheory. Evidences of evolution.

Elementarystudy of biostatistics: Mean, mode, median&standarddeviation.

Suggested Books and References

Here are some books that cover the topics mentioned in the syllabus:

1. "Molecular Biology of the Cell" by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter
    - This comprehensive textbook covers cell biology, molecular biology, and genetics. It provides in-depth information on cell structure and functions, DNA replication, transcription, translation, and various genetic concepts.
2. "Principles of Genetics" by Robert H. Tamarin
    - This textbook focuses on the principles of genetics, including Mendelian inheritance, gene interactions, linkage, and mutation. It covers the basics of molecular genetics and provides examples and illustrations to enhance understanding.
3. "Introduction to Genetic Analysis" by Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll, John Doebley
    - This textbook offers an introduction to genetics, covering topics such as Mendelian genetics, gene expression, and genetic analysis techniques. It provides a comprehensive understanding of genetic principles and their applications.
4. "Plant Breeding: Principles and Methods" by B.D. Singh
    - This book specifically focuses on the principles and methods of plant breeding. It covers topics such as centers of origin, principles of breeding, hybridization, mutation breeding, and the Green Revolution. It provides practical insights into plant breeding techniques.
5. "Evolutionary Biology" by Douglas J. Futuyma
    - This textbook explores the principles of evolutionary biology, including theories of origin and evolution, evolutionary processes, and evidence of evolution. It provides a comprehensive understanding of the field of evolutionary biology.
6. "Biostatistics: A Foundation for Analysis in the Health Sciences" by Wayne W. Daniel, Chad L. Cross
    - This book covers the basics of biostatistics, including measures such as mean, mode, median, and standard deviation. It provides an introduction to statistical analysis methods used in the health sciences.

Suggested E-resources

Here are some e-resources that you can refer to for the topics mentioned in the syllabus:

1. Khan Academy (https://www.khanacademy.org/)
    - Khan Academy offers free online courses and resources covering a wide range of subjects, including cell biology, molecular biology, genetics, and statistics. It provides video lessons, practice exercises, and quizzes to help you learn and understand the topics.

2. National Center for Biotechnology Information (https://www.ncbi.nlm.nih.gov/)
    - The NCBI website provides access to a vast collection of scientific articles, research papers, and databases related to molecular biology, genetics, and evolutionary biology.

You can search for specific topics, browse through publications, and access resources like the GenBank database for genetic information.

3. Coursera (https://www.coursera.org/)
    - Coursera offers online courses from top universities and institutions. You can search for courses related to cell biology, molecular biology, genetics, and statistics. These courses often provide video lectures, assignments, and quizzes to help you grasp the concepts and deepen your understanding.
4. National Human Genome Research Institute (https://www.genome.gov/)
    - The NHGRI website provides resources and information on genomics, genetics, and related topics. It offers educational materials, interactive tools, and databases that can be helpful for studying genetics, DNA sequencing, and molecular biology.
5. BioInteractive by Howard Hughes Medical Institute (https://www.biointeractive.org/)
    - BioInteractive offers a collection of multimedia resources, including videos, animations, and virtual labs, on various biological topics. It covers subjects like cell biology, genetics, and evolutionary biology. The resources provide interactive learning experiences and can enhance your understanding of the topics.

Code of the course	BOT6002P
Title of the course	**Botany Lab-III: Practicals of Cell & Molecular Biology, Genetics, Plant Breeding, Evolution and Biostatistics**
Level of the Course	NHEQF Level 5.0
Credit of the Course	2
Type of the Course	DCC
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Intermediate level

Objectives of the Course

1. Prepare smear preparations of root tips and onion buds to observe and analyze different stages of mitosis and meiosis.
2. Solve problems related to genetics, including concepts of inheritance, genetic crosses, and test crosses.
3. Understand the techniques of emasculation, crossing, and bagging in crop plants for controlled breeding.
4. Apply statistical measures such as mean, mode, median, and standard deviation to analyze data in genetics experiments.
5. Demonstrate monohybrid and dihybrid crosses and test cross to understand inheritance patterns.
6. Study cell organelles through electron microphotographs/models to comprehend their structure and function.
7. Perform rapid DNA isolation using the spooling method for genetic analysis and experimentation.

Course Learning Outcomes

1. Demonstrate practical skills in preparing and analyzing microscopic slides, conducting genetics experiments, applying statistical measures, and performing DNA isolation methods.
2. Understand fundamental concepts in cell biology, genetics, plant breeding, and statistical analysis relevant to the syllabus topics.

Syllabus (Lecture hours: 60)

- Smearpreparation of root tipsandonionbudfor different stages of mitosisandmeiosis.
- Problems related to genetics.
- Emasculation, crossing and bagging in crop plants.
- Mean, Mode, Median, Standard Deviation.
- Demonstration of MonohybridandDihybridcrossesandtestcross.
- Study of cellorganellethroughelectronmicrophotograhs/models
- Rapid DNA isolationmethod (spoolingmethod).

Scheme of Examination

Exercise 1 (Cell and Molecular Biology)	16
Exercise 2 (Genetics)	12
Exercise 3 (Plant Breeding)	8
Exercise 4 (Biostatistics)	8
Spotting (8)	16
Record	10
Viva–Voce	10
Total	**80**

Suggested Books and References

Here are some practical books that cover the topics mentioned in the syllabus:

1. "Laboratory Manual in Biology" by V. Satyanarayana and Dr. C. Lakshmi Saraswathi
   - This practical manual provides detailed instructions and protocols for various biology experiments, including smear preparations, genetics problems, plant breeding techniques, statistical analysis, and DNA isolation methods.
2. "Practical Cell Biology" by Jennifer L. Anderson and Wolfgang Stein
   - This book focuses on practical techniques and experiments in cell biology. It covers topics such as preparing smear preparations, studying cell organelles, and conducting

molecular biology experiments. It includes step-by-step protocols and explanations.

3. "Experiments in Molecular Genetics" by Jeffrey H. Miller, Michael L. Gergen, and Karen M. Fossett
    - This practical guide is specifically tailored to molecular genetics experiments. It covers topics like DNA isolation, genetic crosses, and analysis of genetic data. It provides detailed protocols, background information, and troubleshooting tips.
4. "Practical Statistics for Field Biology" by Jim Fowler, Lou Cohen, and Phil Jarvis
    - This book focuses on the practical application of statistical methods in biology. It covers topics such as calculating means, modes, medians, and standard deviations. It provides guidance on data analysis and interpretation in the context of biological experiments.
5. "Practical Genetics for the Laboratory Investigator" by Svetlana Dzakpasu
    - This practical guide offers hands-on experiments and protocols in genetics. It covers topics such as genetic crosses, test crosses, and analyzing genetic inheritance patterns. It provides clear instructions and explanations for each experiment.

Suggested E-resources

1. National Center for Biotechnology Information (NCBI) - https://www.ncbi.nlm.nih.gov/
2. Khan Academy - https://www.khanacademy.org/
3. National Human Genome Research Institute (NHGRI) - https://www.genome.gov/
4. Coursera - https://www.coursera.org/
5. BioInteractive by Howard Hughes Medical Institute - https://www.biointeractive.org/
6. OpenStax Biology - https://openstax.org/subjects/science/biology
7. Biology Online - https://www.biology-online.org/
8. NCERT Biology Textbook - http://ncert.nic.in/textbook.php?lemh1=1-14

B.Sc.
Semester-wise syllabus (Botany)
Semester IV

Code of the course	**BOT6003T**
Title of the course	**Botany-IV: Plant Biochemistry, Physiology and Biotechnology**
Level of the Course	NHEQF Level 5.0
Credit of the Course	4
Type of the Course	DCC
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Intermediate level

Objectives of the Course

The main objective of this course is to provide the basic theoretical knowledge to undergraduate students about the various important topics of plant biochemistry, physiology and biotechnology.

Course Learning Outcomes

The course will definitely enrich the theoretical knowledge of various important topics of plant biochemistry, physiology and biotechnology and will also help in qualifying various competitive examinations (Civil Services, School Education etc).

Syllabus

Unit-1 (Lecture hours: 12)

Biomolecules: structures and classifications of carbohydrates, protein and lipids; Enzymes: general characteristics, classification and mode of action. Water potential and Transpiration: osmosis, plasmolysis, diffusion pressure deficit.

Unit-II (Lecture hours: 12)

Guttation and transpiration, stomatal movement; Photosynthesis: plant pigments, light reaction, Photophosphorylation, mechanism of CO_2 fixation in C3, C4 and CAM plants.

Unit-III (Lecture hours: 12)

Respiration: glycolysis, citric acid cycle and oxidative phosphorylation; Photoperiodism and Vernalization; Structure and physiological functions of plant growth regulators (auxins, cytokinins, gibberellins, and ethylene).

Unit-IV (Lecture hours: 12)

Plant Tissue culture: cellular totipotency, nutrient media, explants, differentiation, organogenesis, micropropagation, hardening, applications of plant tissue culture technique.

Unit-V (Lecture hours: 12)

Recombinant DNA Technology: restriction endonucleases, cloning vectors, basics of plant transformation methods (*Agrobacterium tumefaciens*, Particle gun, microinjection electroporation), applications of transgenic plants.

Suggested Books and References

- Jain,J.L., Jain S. and Jain N. (2016), Fundamentals Of Biochemistry, S. Chand Publication (ISBN-13: *978-8121924535).*
- Gupta, S.N. (2010), A Textbook of Biochemistry, Rastogi Publication ((ISBN-13:978-8171339389).
- Salisbury, F.B. and Ross, C.W. (2004, Plant Physiology, Wadsworth *Publishing* Company (ISBN: 9788131501658).
- Gupta, P.K. (2009), Elements of Biotechnology, Rastogi Publication (ISBN-13: 978-8171339372.
- Jain, S.K. (2000), Textbook of Biotechnology (Fundamentals of Molecular Biology), CBS Publishers and Distributors PVt Ltd (ISBN-13: 978-8171339372).

- Joshi, N. and Purohit. S.D. (2007,) Molecular Biology & Biotechnology, Apex Publishing House (ISBN-13: 978-8130100401).
- Singh, B.D. (2015), Plant Biotechnology, Kalyani Publishers (ISBN-13: 978-9327256390).

Suggested E-resources

- E-notes on Biochemistry: https://www.studystack.com/Biochemistry
- E-notes on Plant Physiology: http://www.eagri.org/eagri50/PPHY261/index.html
- E-notes on Plant Biotechnology: https://epgp.inflibnet.ac.in/

Code of the course	BOT6003P
Title of the course	**Botany Lab-IV: Practicals of Plant Biochemistry, Physiology and Biotechnology**
Level of the Course	NHEQF Level 5.0
Credit of the Course	2
Type of the Course	DCC
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Intermediate level

Objectives of the Course

This course aims to provide practical knowledge of plant biochemistry, physiology and biotechnology. It includes several classroom experiments to improve practical skills in plant biochemistry, physiology and biotechnology.

Course Learning Outcomes

Practical knowledge of plant biochemistry, physiology and biotechnology will definitely improve the in depth knowledge and understanding about the subjects.

Syllabus (Lecture hours: 60)

- Demonstration of pH meter, Laminar Air Flow Bench, Spectrophotometer, Autoclave and centrifuge.
- Phytochemical tests of starch, cellulose, sucrose, fats and proteins.
- Demonstration of opening and closing of stomata.
- Demonstration of phenomenon of osmosis by potato osmoscope.
- Demonstration of separation of plant pigments using thin layer chromatography.
- Preparation of Murashige and Skoog`s medium for plant tissue culture

Scheme of Examination

Exercise 1 Major (Physiology and Biochemistry)	16
Exercise 2 Minor (Physiology and Biochemistry)	6
Exercise 3 Major (Biotechnology)	16
Exercise 4 Minor (Biotechnology)	6
Spotting (8)	16
Record	10
Viva–Voce	10
Total	**80**

Suggested Books and References

- Gour, L., Sharma, R. and Rama Krishnan R.S. (2020), Fundamental of Plant Biochemistry and Biotechnology-A Practical Book, Akinik Publications.
- Bala, M. (2020), Practicals in Plant Physiology and Biochemistry, Scientific Publishers (ISBN: 9789386102638).
- Gupta, N.K., Sangha,M.K., Bala, M. and Gupta, S. (2016), Practicals in Plant Physiology and Biochemistry, Scientific Publishers (ISBN: 978-9386102638).
- Inam, A. (2012), A Laboratory Manual of Plant, Physiology, Biochemistry and Ecology, Agrobios Publisher (ISBN: 9788177544589).
- Purohit, S.S. (2021),A Laboratory Manual of Plant Biotechnology, Agrobios Publisher (ISBN: 9788177542226).
- Shivakumar, R. (2015), Practical Plant Physiology, Narendra Publishing House (ISBN: 9789384337247).

Suggested E-resources

- Biochemistry virtual Lab. https://vlab.amrita.edu/?sub=3&brch=63
- Online Plant Physiology Experiments https://biology4isc.weebly.com/plant-physiology-experiments.html
- Basic Plant Physiology https://study.com/academy/topic/basic-plant-physiology.html
- Plant Biotechnology Information Center https://plantbiotech.bg/en/i-want-to-know/plant-tissue-culture-and-micropropagation/

Code of the Course	SES6300T
Title of the Course	**Tools and Techniques in Plant Sciences**
Level of the Course	NHEQF Level 5.0
Credit of the Course	2
Type of the Course	SEC
Delivery Type of the Course	Lectures and tutorials (20+10=30hours). The 20hours lectures for content delivery and 10 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Intermediate level

Objectives of the Course

The objective of this syllabus is to provide students with a thorough understanding of laboratory etiquette, safety practices, and maintenance of lab equipment. It aims to develop students' skills in preparing solutions, calculating molecular formula weight, and calibrating equipment. The syllabus further aims to familiarize students with basic equipment used in plant sciences, principles and applications of centrifugation and microscopy techniques, chromatographic techniques (paper, thin layer, column, and gel chromatography), spectrophotometry principles and applications, as well as the principle and applications of PCR.

Course Learning Outcomes

Upon completion of the course covering the mentioned syllabus, students will be able to:

1. Demonstrate an understanding of laboratory etiquette and safety protocols, adhering to good laboratory practices to ensure a safe working environment.
2. Apply proper maintenance techniques to ensure the functionality and longevity of lab equipment used in plant sciences, such as autoclaves, weighing balances, pH meters, laminar flow benches, hot air ovens, and microtomes.
3. Prepare solutions of specific molarity, percentage, or concentration accurately, and calculate molecular formula weights for various compounds.
4. Calibrate and operate laboratory equipment effectively, understanding the principles and procedures involved in calibration.
5. Explain the principles and applications of centrifugation, including different types of centrifuges and their appropriate applications, as well as ultra-centrifugation techniques.
6. Utilize various microscopy techniques, including optical, phase contrast, fluorescence, and confocal microscopy, to observe and analyze biological samples effectively.
7. Understand the principles and methodologies of different chromatographic techniques, such as paper, thin layer, column, and gel chromatography, and apply them to separate and analyze complex mixtures.
8. Comprehend the principles of spectrophotometry, including UV-Vis spectrophotometry, colorimeter usage, and its applications in quantifying substances in samples.
9. Describe the principle and applications of Polymerase Chain Reaction (PCR) and its significance in various fields, including molecular biology, genetics, and diagnostics.
10. Apply the knowledge gained from the course to design and conduct experiments, analyze data, and draw conclusions using the techniques and instruments covered in the syllabus.

These learning outcomes aim to equip students with theoretical knowledge and practical skills in laboratory practices, equipment handling, solution preparation, analysis techniques, and application of various technologies to conduct scientific research or experiments in the field of plant sciences and related areas.

Syllabus

UNIT-1 (Lecture hours: 6)

Laboratory etiquette and safety. Good laboratory practices, maintenance of lab equipment. Making solutions, molecular formula weight. Calibration of equipment.

UNIT- 2 (Lecture hours: 6)

Basic equipment used in plant sciences: Autoclave, Weighing balance, pH meter, Laminar flow, Hot air oven, Microtomy

UNIT- 3 (Lecture hours: 6)

Centrifugation: Principle; types, application. Ultra-centrifugation.

Microscopy: Optical, phase contrast, Fluorescence microscopy, Confocal microscopy.

UNIT- 4 (Lecture hours: 6)

Spectrophotometry-Principle, and applications, Colorimeter, UV-Vis Spectrophotometry, AAS, NMR. Principle of PCR and its applications.

UNIT- 5 (Lecture hours: 6)

Chromatography: Principle and methodology of chromatographic techniques: Paper, Thin Layer, Column chromatography and types (gel exclusion, ion exchange, affinity, HPLC, GCMS, LCMS).

Suggested Books and References

"Laboratory Safety for Chemistry Students" by Robert H. Hill Jr. and David C. Finster.
"Experimental Organic Chemistry: A Miniscale and Microscale Approach" by John C. Gilbert and Stephen F. Martin.
"Plant Physiology and Development" by Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy.
"Plant Physiology" by Frank B. Salisbury and Cleon W. Ross.
"Molecular Biology of the Cell" by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter.
"Molecular Cell Biology" by Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, HiddePloegh, and Paul Matsudaira.
"Principles and Practice of Chromatography" by Raymond P.W. Scott.
"Introduction to Modern Liquid Chromatography" by Lloyd R. Snyder, Joseph J. Kirkland, and John W. Dolan.
"Spectrophotometry: Principles, Instrumentation, and Applications" by James N. Butler.
"Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.

Suggested E-resources

1. Laboratory etiquette and safety, good laboratory practices, maintenance of lab equipment, making solutions, molecular formula weight, and calibration of equipment:

- URL: https://www.labmanager.com/
- Description: Lab Manager provides articles, guides, and webinars on laboratory management, safety protocols, and maintenance of lab equipment. It covers topics such as calibration techniques and best practices for making solutions.

2. Basic equipment used in plant sciences (autoclave, weighing balance, pH meter, laminar flow, hot air oven, microtomy):

- URL: https://www.plantmethods.com/
- Description: Plant Methods is an open-access journal that publishes research articles on methods and techniques used in plant sciences. It can be a valuable resource to learn about the operation and usage of basic equipment in plant sciences.

3. Centrifugation (principle, types, application, ultra-centrifugation):

- URL: https://www.thermofisher.com/centrifuge-resource-center
- Description: Thermo Fisher Scientific's Centrifuge Resource Center provides a comprehensive collection of resources, including articles, application notes, and videos, covering various aspects of centrifugation, including principles, types, applications, and ultra-centrifugation.

4. Microscopy (optical, phase contrast, fluorescence, confocal microscopy):

- URL: https://www.microscopy.org/
- Description: The Microscopy Society of America (MSA) website offers educational resources on various microscopy techniques. It provides articles, webinars, and links to online courses and tutorials for understanding the principles and applications of optical, phase contrast, fluorescence, and confocal microscopy.

5. Chromatography (principle and methodology of chromatographic techniques - paper, thin layer, column, gel chromatography):

- URL: https://www.chromatographyonline.com/
- Description: Chromatography Online provides articles, tutorials, and application notes explaining the principles and methodologies of various chromatography techniques, including paper, thin-layer, column, and gel chromatography.

6. Spectrophotometry (principle, applications, colorimeter, UV-Vis spectrophotometry) and principle of PCR and its applications:

- URL: https://www.thermofisher.com/spectrophotometry-resource-center
- Description: Thermo Fisher Scientific's Spectrophotometry Resource Center offers a wide range of resources on spectrophotometry, including articles, application notes, and technical guides. It covers principles, applications, colorimeters, UV-Vis spectrophotometry, as well as the principle and applications of PCR.

B.Sc.
Semester-wise syllabus (Botany)
Semester V

Code of the course	**BOT7100T**
Title of the course	**Seed Biology**
Level of the Course	NHEQF Level 5.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorial (40+20=60hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Advance Course

Objectives of the Course

The objectives for the given syllabus are as follows:

1. Understand the physiology of seed development and maturation, including the chemical composition, synthesis, and accumulation of seed reserves, and the hormonal regulation of seed development.
2. Explore the factors influencing seed germination, such as embryonic axis, growth hormones, enzyme activities, seed age, size, and position, and the physiological processes during germination.
3. Study seed dormancy, including its types, significance, mechanisms, and the role of phytochrome and plant growth regulators in dormancy regulation.
4. Examine seed viability, longevity, and factors affecting viability, including pre and post-harvest considerations. Understand the physiology of seed deterioration, including lipid peroxidation and viability theories.
5. Learn about seed vigour, including its concept, test methods, factors affecting vigour, and its physiological basis in relation to crop performance and yield. Understand seed invigoration and its physiological control.

Course Learning Outcomes

1. Gain a comprehensive understanding of the physiological processes involved in seed development, maturation, germination, dormancy, viability, and vigour.
2. Acquire knowledge of the factors influencing these processes and their significance in plant growth, performance, and crop yield.

Syllabus

Unit – 1 (Lecture hours: 12)

Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development.

Unit – 2 (Lecture hours: 12)

Seed germination; factors affecting germination; role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination; seed respiration, breakdown of stored reserves in seeds, mobilization.

Unit – 3 (Lecture hours: 12)

Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR.

Unit – 4 (Lecture hours: 12)

Seed viability and longevity, pre and post-harvest factors affecting seed viability; seed ageing; physiology of seed deterioration; lipid peroxidation and other viability theories; mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity.

Unit – 5 (Lecture hours: 12)

Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed

vigour in relation to crop performance and yield. Seed invigoration and its physiological control.

Suggested Books and References

1. AgrawalPK&Dadlani M. (Eds.). 1992. Techniques in Seed Science and Technology. South Asian Publ.
2. Agrawal, P.K. & M. Dadlani, 1995. Techniques In Seed Science And Technology (2nd Ed.) South Asian Publ. New Delhi.
3. Baskin CC & Baskin JM. 1998. Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination. Academic Press. Basra AS. 2006. Handbook of Seed Science and Technology. Food Product Press.
4. Bench ALR& Sanchez RA. 2004. Handbook of Seed Physiology. Food Product Press.
5. Bewley JD & Black M. 1982. Physiology and Biochemistry of Seeds in Relation to Germination. Vols. I, II. Springer Verlag.
6. Bewley JD & Black M. 1985. Seed: Physiology of Seed Development and Germination. Plenum Press.
7. Copeland LO &Mc Donald MB. 1995. Principles of Seed Science and Technology. 3rd Ed. Chapman & Hall.
8. Khan AA. 1977. Physiology and Biochemistry of Seed Dormancy and Germination. North Holland Co.
9. Kigel J &Galili G. (Eds.). Seed Development and Germination. Marcel Dekker.
10. Murray DR. 1984. Seed Physiology. Vols. I, II. Academic Press. Sadasivam S &Manickam A. 1996. Biochemical Methods. 2nd Ed. New Age.

Suggested E-resources

Here are some e-resources that cover the topics mentioned in the syllabus:

1. Plant Physiology Online - http://plantphys.info/
2. National Center for Biotechnology Information (NCBI) - https://www.ncbi.nlm.nih.gov/
3. Khan Academy - https://www.khanacademy.org/
4. OpenStax Biology - https://openstax.org/subjects/science/biology
5. Coursera - https://www.coursera.org/
6. BioInteractive by Howard Hughes Medical Institute - https://www.biointeractive.org/
7. National Human Genome Research Institute (NHGRI) - https://www.genome.gov/
8. Online lectures and materials from reputable universities offering courses in plant physiology, such as MIT OpenCourseWare (https://ocw.mit.edu/index.htm) or Stanford Online (https://online.stanford.edu/).
9.

These e-resources provide a wealth of information, including articles, lectures, videos, interactive modules, and course materials related to plant physiology, seed development, germination, dormancy, viability, and vigour.

Code of the course	BOT7100P
Title of the course	**Elective Botany Lab: Seed Biology**
Level of the Course	NHEQF Level 5.5
Credit of the Course	2
Type of the Course	DSE
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Advance Course

Objectives of the Course

1. Develop skills in seed sampling and testing, including assessing physical purity, germination, viability, and other relevant parameters.
2. Gain proficiency in conducting different germination tests using paper towel and petri dish methods.
3. Understand and apply methods for breaking seed dormancy.
4. Learn and perform vigour tests such as the brick gravel and paper piercing methods.
5. Acquire knowledge and practice seed viability tests.
6. Study and analyze different seed qualities, including size, shape, color, purity, viability, and germination.

Course Learning Outcomes

1. Develop practical skills in seed sampling, testing, and analysis, including assessing physical purity, germination, viability, and seed qualities.
2. Acquire proficiency in conducting various germination tests, breaking seed dormancy, and performing vigour and viability tests.

Understand the importance of seed quality evaluation and its significance in seed industry, agriculture, and crop production.

Syllabus (Lecture hours: 60)

- Seed sampling and testing: Physical purity, germination, viability, etc.
- Different germination tests (Paper towel and petridish method)
- Methods of Breaking seed dormancy
- Vigour Tests (Brick gravel, Paper piercing)
- Seed viability Tests
- Study of different qualities of seeds in respect of size, shape colour, purity, viability germination.

Scheme of Examination

Exercise 1 Major	16
Exercise 2 Minor	6
Exercise 3 Major	16
Exercise 4 Minor	6
Spotting (8)	16
Record	10
Viva–Voce	10
Total	**80**

Suggested Books and References

1. "Seed Testing: Principles and Practices" by A.A. Desai
2. "Handbook of Seed Testing" by K.R. Reddy and K.V. Krishna Rao
3. "Seed Science and Technology" by R.S. Dhiman
4. "Principles of Seed Science and Technology" by Lawrence O. Copeland and Miller M. McDonald
5. "Seed Technology and Seed Testing" by A.K. Choudhary and V.P. Singh

Suggested E-resources

1. International Seed Testing Association (ISTA) - https://www.seedtest.org/
2. The Association of Official Seed Analysts (AOSA) - https://www.aosaseed.com/
3. The International Seed Testing Association (ISTA) Online Seed Testing Training Course -

https://www.seedtest.org/en/training-and-education/online-seed-testing-training-course.html

4. United States Department of Agriculture (USDA) Seed Testing Laboratory - https://www.ams.usda.gov/services/seed-testing
5. Crop Science Society of America (CSSA) Seed Testing and Quality Resource - https://www.crops.org/education/classroom/lesson-plans/seed-testing
6. Online seed testing protocols and guidelines provided by reputable seed testing laboratories and institutions, such as state agricultural universities and research institutes.

Code of the course	BOT7101T
Title of the course	**Cultivation and Commercialization of Medicinal Plants**
Level of the Course	NHEQF Level 5.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorials (40+20=60 hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Advance Course

Objectives of the Course

1. Develop theorical understanding in conventional propagation and maintenance of medicinal plants, including *Aloe, Chlorophytum, Withania, Commiphora*, and *Papaver*.
2. Acquire knowledge of post-harvesting and processing methods, such as harvesting, drying, storage, and prevention of microbial contamination in herbal products.
3. Gain proficiency in extraction and analysis methods, including distillation, solvent extraction, chromatographic and spectroscopic techniques for identifying and characterizing active principles.
4. Understand the practices of storage, preservation, packaging, and herbal formulations, along with techniques for enhancing shelf-life and value addition of aromatic compounds.
5. Analyze the Indian market scenario and entrepreneurship opportunities in the herbal product processing and export industry, with a focus on the business environment and industrial case studies.

Course Learning Outcomes

1. Develop a comprehensive understanding of the propagation, post-harvesting, and processing methods of medicinal plants, including harvesting, drying, storage, and prevention of microbial contamination.
2. Acquire proficiency in extraction and analysis techniques for identifying and characterizing active principles using advanced chromatographic and spectroscopic methods.
3. Gain practical skills in storage, preservation, packaging, and herbal formulations to enhance shelf-life and value addition of aromatic compounds.
4. Analyze the Indian market scenario and entrepreneurship opportunities in the herbal product industry, evaluating the overall business environment and industrial case studies.

Syllabus

UNIT-1(Lecture hours: 12)

Medicinal Plants and their uses, Conventional propagation and maintenance of medicinal plants like- *Aloe, Chlorophytum*(Safedmusli)*, Withania* (Ashwagandha)*, Commiphora*(Guggal)*, Papaver*.National Medicinal Plants Board (NMPB) and its role in promoting the cultivation of medicinal plants, Medicinal plant database of India

UNIT-2(Lecture hours: 12)

Post harvesting and processing methods: Methods of harvesting, drying and storage. Microbial contamination of stored herbal product. Influence of temperature, time and season on active principles.

UNIT-3 (Lecture hours: 12)

Extraction and analysis methods: Distillation, solvent extraction, separation, purification, identification and characterization of active principles from medicinal plants using advanced chromatographic and spectroscopic techniques like- TLC/HPLC/GC-MS/LC-MS/FTIR/NMR.

UNIT-4 (Lecture hours: 12)

Practices of storage, preservation, packaging, herbal formulations (decoction, infusion, aromatic waters, herbal tea, dried powder). Enhancement of shelf- life, and value addition of aromatic compounds.

UNIT-5 (Lecture hours: 12)

Indian market scenario and Entrepreneurship: Assessing overall business environment in the Indian economy, Characteristics of Indian herbal product processing and export industry. Industrial case studies (Herbal products and companies).

Suggested Books and References

1. Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.
2. Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants. United Press Limited.
3. Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants. CSIR, New Delhi.
4. Kumar, N. J.B.M. Md. Abdul Khaddar, RangaSwamy, P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops Medicinal and Aromatic Plants.Oxford&IBH, New Delhi.
5. Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford &IBH, New Delhi.
6. Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevalasoms and co-private Ltd.
7. Dharmvir, H. 2007. Bioactive medicinal plants, Gene Tech Books.
8. Farooqu, A.A., and Khan, M.M. and Vasundhara, M. 2001. Production technology of medicinal plantsand aromatic crops. Natural Remedies Pvt. Ltd.
9. Panda, H. 2007. Medicinal plants, cultivation and their use. Asia Pacific Business Press.
10. Masoda, Y. 1986. Analysis of essential oil by GC-MS, John Wiley and Sons.
11. Paine, F.A. 1987. Modern processing, packaging and distribution systems for food, AVI Publication.
12. SudhirK.P. and Indira V. B. 2008. Post harvest technology of horticultural crops, Horticulture Science Series. New India Publication Agency.
13. Ramawat K.G. and Merillon J-M. 2013. Natural Products. Phytochemistry, botany and metabolism of alkaloids, phenolics and terpenes, Springer.

Suggested E-resources

1. National Medicinal Plants Board (NMPB) - http://www.nmpb.nic.in/
2. International Union for Conservation of Nature (IUCN) - Medicinal Plant Specialist Group - https://www.iucn.org/commissions/medicinal-plants-specialist-group
3. Indian Council of Medical Research (ICMR) - http://icmr.nic.in/
4. National Institute of Ayurveda (NIA) - https://www.nia.nic.in/
5. National Medicinal Plants Board (NMPB) e-Library - http://nmpb.nic.in/en/e-library

These e-resources provide information on medicinal plants, their propagation, post-harvesting and processing methods, extraction and analysis techniques, storage and preservation practices, packaging, herbal formulations, and the Indian market scenario and entrepreneurship opportunities in the herbal product industry.

Code of the course	BOT7101P
Title of the course	**Elective Botany Lab: Cultivation and Commercialization of Medicinal Plants**
Level of the Course	NHEQF Level 5.5
Credit of the Course	2
Type of the Course	DSE
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Advance Course

Objectives of the Course

1. Develop skills in identifying and documenting selected medicinal plants, including their morphological characteristics and medicinal properties.
2. Gain proficiency in various propagation methods for establishing plantations of medicinal plants.
3. Learn proper techniques for harvesting, drying, storing, and packing medicinal plant parts to ensure their quality and efficacy.
4. Acquire knowledge and practical experience in processing and grinding medicinal plant parts for further utilization.
5. Understand different extraction methods for extracting active ingredients from medicinal plants and their applications in herbal preparations.
6. Learn the principles and techniques of paper chromatography and thin-layer chromatography (TLC) for the separation and identification of active ingredients in medicinal plants.

Course Learning Outcomes

1. Develop proficiency in identifying and documenting medicinal plants, including their morphological characteristics and medicinal properties.
2. Acquire practical skills in plantation, propagation, harvesting, drying, storage, and packing techniques for medicinal plant parts.
3. Gain knowledge and hands-on experience in processing and grinding medicinal plant parts for various applications.
4. Understand different extraction methods for obtaining active ingredients from medicinal plants and their use in herbal preparations.
5. Learn and apply separation techniques such as paper chromatography and thin-layer chromatography (TLC) for the analysis of active ingredients in medicinal plants.

Develop an understanding of the importance of quality control, standardization, and preservation of medicinal plants throughout the processing and formulation stages.

Syllabus (Lecture hours: 60)

1. Identification and documentation of selected medicinal plants
2. Plantation using various propagation methods
3. Harvesting, drying, storage and packing techniques for medicinal plant parts
4. Processing and grinding of medicinal plant parts.
5. Different extraction methods for active ingredients
6. Separation of active ingredients using Paper chromatography/TLC

Scheme of Examination

Exercise 1 Major	16
Exercise 2 Minor	6
Exercise 3 Major	16
Exercise 4 Minor	6
Spotting (8)	16
Record	10
Viva–Voce	10
Total	**80**

Suggested Books and References

1. "Medicinal Plants: A Beginner's Guide to Learning the Hidden Powers of Plants" by Timothy Myers
2. "Practical Herbalism: Ordinary Plants with Extraordinary Powers" by Philip Fritchey
3. "The Medicinal Plant Guide: A Practical Reference to Herbal Remedies" by Richard Craze
4. "Herbal Medicine: A Practical Guide for Medical Students and Healthcare Professionals" by Philip F. Builders
5. "The Herbal Apothecary: 100 Medicinal Herbs and How to Use Them" by JJPursell
6. "Practical Handbook of Medicinal Plants and Herbal Medicine" by Stephen Harrod Buhner

Suggested E-resources

1. National Medicinal Plants Board (NMPB) - http://www.nmpb.nic.in/
2. World Health Organization (WHO) - Traditional Medicine - https://www.who.int/medicines/areas/traditional/en/
3. HerbalGram - American Botanical Council (ABC) - https://www.herbalgram.org/
4. PubMed - https://pubmed.ncbi.nlm.nih.gov/
5. ResearchGate - https://www.researchgate.net/
6. ScienceDirect - https://www.sciencedirect.com/

Code of the course	**SES7301T**
Title of the course	**Fundamental of Biostatistics**
Level of the Course	NHEQF Level 5.5
Credit of the Course	2
Type of the Course	SEC
Delivery Type of the Course	Lectures and tutorial (20+10=30hours). The 20hours lectures for content delivery and 10 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Advance Course

Objectives of the Course

Understand control and treatment, replicates, sampling, experimental design, standard curve. Analyze measures of central tendency. Learn standard deviation, skewness, kurtosis. Grasp correlation, regression, Chi-square test basics. Recognize error types, degrees of freedom, null and alternative hypotheses, p-value. Interpret single-factor ANOVA, comprehend post-hoc analysis.

Course Learning Outcomes

The course learning outcomes are as follows:

1. Understand the concept of control and treatment, and apply them in experimental settings to design and analyze experiments effectively.
2. Gain knowledge of replicates and sampling techniques to ensure reliable and representative data collection.
3. Comprehend the principles of experimental design and apply appropriate designs based on research objectives.
4. Learn how to construct and utilize standard curves, and differentiate between the blank of a standard curve and the control of an experiment.
5. Analyze and interpret measures of central tendency (mean, median, and mode) to describe and summarize data distributions.
6. Understand the concepts of standard deviation, standard errors, skewness, and kurtosis, and their significance in analyzing data variability and distribution shape.
7. Grasp the basics of correlation and regression analysis and their application in examining relationships between variables.
8. Learn the Chi-square test and its use in analyzing categorical data, testing for independence or association between variables.
9. Recognize different types of errors (Type I and Type II) and understand their implications in hypothesis testing.
10. Comprehend the concept of degrees of freedom, null and alternate hypotheses, level of significance, and the interpretation of p-values.
11. Gain knowledge of analysis of variance (ANOVA) for single-factor analysis and learn how to interpret the results.
12. Understand the concept of post-hoc analysis and its importance in identifying significant differences among multiple treatment groups.

These course learning outcomes aim to equip students with the necessary knowledge and skills to design and conduct experiments, analyze data using appropriate statistical techniques, and interpret the results effectively in various research and scientific contexts.

Syllabus

UNIT-1 (Lecture hours: 6)

Concept of control and treatment, replicates, sampling, experimental design, standard curve, difference between blank of standard curve and control of experiment.

UNIT- 2 (Lecture hours: 6)

Measures of central tendency: Mean, Median and Mode.

UNIT- 3 (Lecture hours: 6)

Standard deviation and standard errors; skewness and kurtosis. Basics of Correlation and Regression.

UNIT- 4 (Lecture hours: 6)

Chi-square test, Types of error (Type I and II error), concept of degree of freedom, null and alternate hypothesis, level of significance, meaning of *p*-value.

UNIT- 5 (Lecture hours: 6)

Analysis of variance (single factor analysis), its interpretation. Concept of Post-Hoc analysis.

Suggested Books and References

1. Sokal, R. R., &Rohlf, F. J. (2012). Biometry: The principles and practice of statistics in biological research (4th ed.). W.H. Freeman.
2. Zar, J. H. (2010). Biostatistical analysis (5th ed.). Pearson.
3. Field, A., Miles, J., & Field, Z. (2012). Discovering statistics using R. SAGE Publications Ltd.
4. Agresti, A., & Franklin, C. A. (2018). Statistics: The art and science of learning from data (4th ed.). Pearson.
5. Dancey, C. P., & Reidy, J. (2017). Statistics without maths for psychology: Using SPSS for Windows (8th ed.). Pearson.

Suggested E-resources

1. Khan Academy: Statistics and probability - https://www.khanacademy.org/math/statistics-probability
2. Stat Trek: Online Tutorials - https://stattrek.com/tutorials/statistics-tutorial.aspx
3. Laerd Statistics: Statistical Tutorials and Learning Resources - https://statistics.laerd.com/
4. UCLA Institute for Digital Research and Education: Statistics Guides - https://stats.idre.ucla.edu/
5. Social Research Methods: Statistical Analysis –https://www.socialresearchmethods.net/kb/statanal.php
6. StatSoft Electronic Statistics Textbook - https://www.statsoft.com/Textbook
7. NCSS Statistical Software: Online Help Documentation - https://www.ncss.com/help/
8. Statistical Consulting Group at UCLA: Online Resources - https://stats.idre.ucla.edu/other/mult-pkg/whatstat/

B.Sc.
Semester-wise syllabus (Botany)
Semester VI

Code of the course	**BOT7111T**
Title of the course	**Plant Diseases and Management**
Level of the Course	NHEQF Level 5.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorials (40+20=60hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Advance Course

Objectives of the Course

1. Understand the concept of disease and its classification, including factors that influence plant diseases and the study of epidemics and epiphytotics.
2. Learn the methods of isolating and identifying plant pathogens, including the application of Koch's Postulates.
3. Gain knowledge about the structural and biochemical defense mechanisms of plants against diseases.
4. Recognize the symptoms and study the etiology and management of important fungal, bacterial, phytoplasma, spiroplasma, virus, and viroid diseases affecting various plants.
5. Comprehend the principles and practices of plant disease management, including prophylactic approaches, eradication, prevention, and chemical control methods.
6. Explore the concept of biological control and understand the role of biological control agents (BCA) in managing plant diseases.
7. Familiarize oneself with the different types of interactions contributing to biological control and the importance and basic principles of Integrated Disease Management (IDM).

Course Learning Outcomes

By the end of this course, students will be able to understand and classify different types of plant diseases, identify common plant pathogens, analyze disease symptoms, apply appropriate disease management strategies, and comprehend the principles of biological control and integrated disease management.

Syllabus

Unit – 1 (Lecture hours: 12)

Disease: Concept of disease. Types and classification of diseases, factors affecting plant diseases, study of epidemics and epiphytotics, Isolation and identification of plant pathogens, Koch's Postulates. Basics of structural and biochemical defense mechanism.

Unit – 2 (Lecture hours: 12)

Plant disease: Symptoms, study of etiology and management of following important plant diseases; **Fungal diseases**: downy mildew of maize, green ear disease of bajra**,** rust of wheat, black smut, brown spot of rice, tikka disease of groundnut.

Unit – 3 (Lecture hours: 12)

Study of etiology and management of following important plant diseases. **Bacterial diseases:** Citrus canker, blight of bean, Soft rots of fruits, ratoon stunting of sugarcane. **Phytoplasma and spiroplasma diseases:** Symptoms and disease cycle of little leaf of brinjal, Grassy shoot of sugarcane **Viruses and Viroid diseases**: Papaya leaf curl, Bunchy top of Banana

Unit – 4 (Lecture hours: 12)

Plant disease management: Concept: Principles and practice, Prophylactic approach, Eradication, Prevention. Chemical control; classification and types of formulations, additives, application, storage and disposals.

Unit –5 (Lecture hours: 12)

Biological control: Definition, Concept, biological control agents (BCA). Types of interactions contributing to biological control. Integrated Disease Management (IDM) (importance and basic principles).

Suggested Books and References

1. Principles of Plant Pathology, R.S. Singh, 3 rd Ed., Oxford & IBH Co., New Delhi. 1988.
2. Plant Pathology, R.S. Mehrotra,. Tata McGraw Hill Publishing Company, New Delhi. 1989.
3. Diseases of Crop Plants in India, G. Rangaswami and A. Mahadevan, Printice Hall of India Publications. 1999.
4. Essential Plant Pathology, Gail L. Schumann and Cleora J. D'Arcy C H Dickinson , J A Lucas, 2006.
5. A Text books of Modern Plant Pathology, K. S. Bilgrami and H. C. Dube, Vikas Publishing House Pvt. Ltd., 1996.
6. Plant Tumors, Arun Mishra, Today and Tomorrow's Printer and Publishers, India, 1985.
7. Plant Disease: An Advance Treatise, James G. Horsfall and Ellis B. Cowling, Second Edition, Academic Press, London, 1977

Suggested E-resources

1. Plant-wise Knowledge Bank (https://www.plantwise.org/knowledgebank/): This online platform provides access to a wealth of information on plant health, including articles, diagnostic tools, and management recommendations for various plant diseases.
2. Crop Protection Compendium (https://www.cabi.org/cpc/): This comprehensive online resource offers information on plant diseases, pests, and weeds, including their biology, identification, and management strategies.
3. American Phytopathological Society (APS) Journals (https://www.apsnet.org/publications/journals): APS publishes several journals focused on plant pathology, such as Phytopathology, Plant Disease, and Molecular Plant-Microbe Interactions. These journals provide access to research articles and scientific studies related to plant diseases.
4. eXtension (https://extension.org/): eXtension is an online platform that hosts resources developed by extension professionals and subject matter experts. It covers a wide range of topics, including plant diseases, and provides access to articles, webinars, and educational materials.
5. ResearchGate (https://www.researchgate.net/): ResearchGate is a social networking platform for researchers, offering access to scientific publications, research papers, and collaboration opportunities. You can search for specific topics related to plant diseases and find relevant research articles and studies.
6. Open Access Journals: Explore open access journals such as PLOS ONE, Frontiers in Plant Science, and BMC Plant Biology. These journals provide free access to research articles on various aspects of plant pathology and disease management.

Code of the course	**BOT7111P**
Title of the course	**Elective Botany Lab: Plant diseases and management**
Level of the Course	NHEQF Level 5.5
Credit of the Course	2
Type of the Course	DSE
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Advance Course

Objectives of the Course

1. Acquire the skills to prepare culture media, such as Potato Dextrose Agar (PDA) and Czapek'sDox Agar, for the cultivation of fungal cultures.
2. Develop proficiency in measuring fungal dimensions, including spore size and mycelium width, using appropriate techniques and instruments.
3. Understand the relationship between diseases, their respective hosts, causal organisms, and symptomatology.
4. Master the techniques of isolating plant pathogenic fungi and bacteria, and cultivating them in pure cultures for further analysis.
5. Gain the ability to identify plant pathogenic fungi and bacteria using morphological, cultural, and biochemical characteristics, as well as diagnostic techniques.

Course Learning Outcomes

By the end of this course, students will be able to prepare culture media for fungal culture, measure fungal dimensions accurately, identify and study plant diseases with respect to host and causal organism, isolate and develop pure cultures of plant pathogenic fungi and bacteria, and effectively identify plant pathogenic microorganisms using appropriate techniques.

Syllabus (Lecture hours: 60)

1. Preparation of culture media; PDA and CzapeksDox Agar for fungal culture.
2. Measurement of fungal dimensions (Measurement of spore size, Mycelium width etc.)
3. Study of diseases with respect to host, casual organism, symptoms.
4. Isolation and pure culture development of plant pathogenic fungi and bacteria.
5. Identification of plant pathogenic fungi and bacteria.

Scheme of Examination

Exercise 1 Major	16
Exercise 2 Minor	6
Exercise 3 Major	16
Exercise 4 Minor	6
Spotting (8)	16
Record	10
Viva–Voce	10
Total	**80**

Suggested Books and References

1. "Laboratory Manual of Plant Pathology" by R.K. Thakur - This comprehensive manual provides step-by-step procedures for preparing culture media, measuring fungal dimensions, isolating and identifying plant pathogenic microorganisms, and studying diseases and symptoms.
2. "Principles of Plant Pathology Laboratory Manual" by Robert D. Raabe - This manual focuses on laboratory techniques used in plant pathology, including culture media preparation, isolation, and identification of plant pathogens, and the study of diseases and symptoms.
3. "Methods in Plant Pathology" edited by P. Narayanasamy - This book covers a wide range of laboratory methods and techniques used in plant pathology, including culture media preparation, isolation, identification, and characterization of plant pathogens, and disease study.

4. "Laboratory Guide for Plant Pathology" by J. R. Paula and S. D. Sharma - This guidebook provides practical guidance on laboratory techniques for plant pathology, including culture media preparation, microscopic measurement, isolation, identification, and disease study.
5. "Identification of Plant Pathogenic Bacteria" by N. W. Schaad et al. - This book specifically focuses on the identification and characterization of plant pathogenic bacteria, providing detailed protocols and descriptions of diagnostic tests and techniques.

Suggested E-resources

1. American Phytopathological Society (APS) Phytobiomes Journal (https://apsjournals.apsnet.org/loi/phyto): This journal publishes research articles and methods papers related to plant-microbe interactions, including laboratory techniques for studying plant pathogens and diseases.
2. Open Plant Pathology (https://openplantpathology.org/): This online platform provides open-access resources and protocols for plant pathology research, including laboratory techniques, culture media preparation, and identification of plant pathogens.
3. Molecular Plant Pathology (https://onlinelibrary.wiley.com/journal/13653059): This journal covers a wide range of topics in plant pathology, including laboratory techniques, methods, and protocols for studying plant pathogens at the molecular level.
4. Plant Disease Management Reports (https://apsjournals.apsnet.org/loi/pdmr): This resource provides practical reports and articles on the management of plant diseases, including laboratory techniques for isolating, identifying, and studying plant pathogens.
5. ResearchGate (https://www.researchgate.net/): ResearchGate is a social networking platform for researchers that offers access to scientific publications, research articles, and protocols. You can search for specific topics related to laboratory techniques in plant pathology and find relevant resources shared by researchers in the field.
6. Protocol Exchange (https://protocolexchange.researchsquare.com/): This platform hosts a collection of protocols and methods shared by scientists across various research disciplines, including plant pathology. You can search for specific laboratory techniques and find detailed protocols and procedures.

Code of the course	BOT7112T
Title of the course	**Plant Tissue Culture and Commercialization Techniques**
Level of the Course	NHEQF Level 5.5
Credit of the Course	4
Type of the Course	DSE
Delivery Type of the Course	Lectures and tutorials (40+20=60hours). The 40hours lectures for content delivery and 20 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Advance Course

Objectives of the Course

1. Understand the scope and applications of plant tissue culture and its historical development, including the contributions of key researchers.
2. Grasp the concepts of cell totipotency, cellular differentiation, and morphogenesis in the context of plant tissue culture.
3. 3. Gain knowledge of asepsis and sterilization methods, as well as the principles, construction, and operation of instruments used in plant tissue culture.
4. Learn the selection, preparation, and initiation of cultures, including callus and suspension cultures, single-cell cultures, and measurement of growth characteristics.
5. 5. Explore different pathways of micropropagation, such as enhanced axillary branching, de novo shoot bud differentiation, somatic embryogenesis, and callus organogenesis, along with their practical applications.
6. Understand the stages involved in the process of micropropagation and the production, function, and uses of secondary plant metabolites in cell cultures.
7. Familiarize oneself with available technologies for micropropagation of ornamental and fruit plants.
8. Gain knowledge of costing tissue culture raised plants, quality control measures, packaging, transport, and shipment. Learn about greenhouse technology, virus indexing, quarantine, and health aspects.
9. 9. Acquire entrepreneurial skills related to setting up a micropropagation-based industry, including conducting SWOT analysis, understanding capital and operational costs, conducting market surveys, and assessing product acceptance.
10. Learn about technology demonstration, preparation of project reports, accessing financial institutions and support, developing marketing strategies, and exploring export potential in the field of micropropagation.

Course Learning Outcomes

By the end of this course, students will be able to comprehend the historical development and scope of plant tissue culture, acquire skills in tools and techniques, demonstrate proficiency in in vitro regeneration pathways, understand applications and entrepreneurship aspects, and apply gained knowledge in the field

Syllabus

Unit-I (Lecture hours: 12)

History: Scope and applications, Historical account of development of plant tissue culture; Contributions of P. R. White, R. J. Gauthret, J. Reinert, F. C. Steward, G. Morel, E. C. Cocking, P. Maheshwari, B. M. Johri, I. K. Vasil, VimlaVasil, S. C. Maheshwari, Sipra-Guha Mukherjee. Concept of cell totipotency, cellular differentiation and morphogenesis.

Unit-II (Lecture hours: 12)

Tools and techniques: Concept of asepsis and methods of sterilization, Principle, construction and operation of instruments used in plant tissue culture- pH meter,Laminar Flow Clean Air Bench, Autoclave, Glassbead sterilizer, Lux meter, Magnetic stirrer etc. Explant selection, preparation and initiation of cultures, callus and suspension cultures, single cell culture, measurement of growth characteristics.

Unit-III (Lecture hours: 12)

***In vitro* regeneration of plants:** Different pathways of micropropagation (Enhanced axillary branching, *de novo* shoot bud differentiation, somatic embryogenesis and callus organogenesis) and their applications. Stages of micropropagation. **Secondary plant metabolites:** Production by use of cell culture

technology. Production, function and uses of Alkaloids, phenols, tannins in cultures.

Unit-IV (Lecture hours: 12)

Applications: Available technologies for micropropagation of ornamentals, fruit plants Costing of tissue culture raised plants, quality control, packaging, transport and shipment. Green house technology, Virus indexing, quarantine and health.

Unit-V (Lecture hours: 12)

Entrepreneurship: Setting-up of a micropropagation based industry- SWOT analysis, capital and operational cost, market survey and product acceptance, technology demonstration, preparation of project report, financial institutions and supports, marketing strategies, Export potential.

Suggested Books and References

1. Bhojwani S.S. and Razdan M.K. (1983). Plant Tissue Culture: Theory and Practice. Elsevier, Amsterdam.
2. RazdanM.K., 2002. Introduction to Plant Tissue Culture. Oxford & IBH.
3. Reinert J. andBajaj Y.P.S.1977. Plant Cell Tissue and Organ Culture. Springer Verlag.
4. Bhojwani S.S. 1990. Plant Tissue Culture: Application and Limitations. Elseiver.
5. Narayanswamy. 1994. Plant Cell and Tissue Culture. East-West Press.
6. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7thedition.
7. Ramawat KG and Arora JA (2021) Molecular Biology and plant Biotechnology, Himanshu Publications, New Delhi

Suggested E-resources

1. Plant Tissue Culture: Concepts and Laboratory Exercises (https://link.springer.com/book/10.1007/978-1-4939-6640-4): This book provides a comprehensive overview of plant tissue culture techniques, including historical development, tools and techniques, in vitro regeneration of plants, applications, and entrepreneurship aspects.
2. Plant Tissue Culture: Techniques and Experiments (https://www.taylorandfrancis.com/books/plant-tissue-culture-techniques-and-experiments): This book offers practical guidance on various aspects of plant tissue culture, including tools, techniques, in vitro regeneration pathways, secondary plant metabolites, applications, and practical exercises.
3. Plant Tissue Culture Protocols (https://www.springer.com/gp/book/9781617792629): This book provides a collection of detailed protocols and methods for various techniques used in plant tissue culture, including sterilization, explant selection, initiation of cultures, measurement of growth characteristics, and in vitro regeneration pathways.
4. National Center for Biotechnology Information (NCBI) - PubMed (https://pubmed.ncbi.nlm.nih.gov/): This database provides access to a wide range of research articles and scientific studies related to plant tissue culture. You can search for specific topics, authors, or keywords and find relevant literature.
5. ResearchGate (https://www.researchgate.net/): ResearchGate is a social networking platform for researchers, offering access to scientific publications, research papers, and protocols. You can search for specific topics related to plant tissue culture and find relevant resources shared by researchers in the field.
6. Online courses and lectures: Platforms like Coursera (https://www.coursera.org/) and edX (https://www.edx.org/) offer online courses on plant tissue culture and related topics. You can explore these platforms for courses taught by experts in the field.

Code of the course	**BOT7112P**
Title of the course	**Elective Botany Lab: Plant Tissue Culture and Commercialization Techniques**
Level of the Course	NHEQF Level 5.5
Credit of the Course	2
Type of the Course	DSE
Delivery Type of the Course	Practical- 60 hours (Hands-on, demo, virtual, pictorial, video observations, with main emphasis on concept, principle)
Prerequisites	Advance Course

Objectives of the Course

1. Demonstrate proficiency in explant preparation.
2. Master the skills of medium preparation for plant tissue culture.
3. Perform shoot culture technique and successfully achieve regeneration of shoots.
4. Acquire knowledge and practical experience in rooting and hardening of plantlets.
5. Conduct paper chromatography/TLC for the separation and identification of plant pigments or colored food additives.
6. Apply column chromatography techniques to effectively separate secondary metabolites.
7.

Course Learning Outcomes

By the end of this course, students will be able to demonstrate proficiency in practical techniques of plant tissue culture, including explant preparation, medium preparation, shoot culture and regeneration, rooting and hardening, as well as chromatography procedures for separation and identification of plant pigments and secondary metabolites.

Syllabus (Lecture hours: 60)

Demonstration of

1. Explant preparation.
2. Medium preparation.
3. Shoot culture technique and regeneration.
4. Rooting and hardening of plantlets
5. Paper Chromatography/TLC of plant pigment/ colored food additives (Anthocyanin/ curcuma).
6. Column chromatography procedure for separation of secondary metabolites.

Scheme of Examination

Exercise 1 Major	16
Exercise 2 Minor	6
Exercise 3 Major	16
Exercise 4 Minor	6
Spotting (8)	16
Record	10
Viva–Voce	10
Total	**80**

Suggested Books and References

1. Plant Tissue Culture Techniques and Experiments by Roberta H. Smith: This book provides detailed explanations of various plant tissue culture techniques and includes step-by-step protocols for practical experiments.
2. Plant Tissue Culture: Concepts and Laboratory Exercises by Robert N. Trigiano and Dennis J. Gray: This book covers a wide range of topics in plant tissue culture, including explant preparation, medium preparation, regeneration techniques, rooting, and practical exercises.
3. Practical Plant Tissue Culture by Colin W. Archer: This practical guidebook offers a comprehensive overview of plant tissue culture techniques and provides practical protocols for different experiments in plant tissue culture.
4. Plant Tissue Culture: An Introductory Text by Sant Saran Bhojwani and M.K. Razdan: This book provides a comprehensive introduction to the principles and practices of plant tissue

culture, including detailed protocols for various techniques and experiments.

5. Plant Tissue Culture: Techniques and Experiments by Robert M. Larkin: This book offers a practical approach to plant tissue culture, providing clear explanations and protocols for techniques such as explant preparation, medium preparation, shoot culture, rooting, and chromatography.

Suggested E-resources

1. Protocol Online (https://www.protocol-online.org/): This online resource provides a collection of protocols and methods for various techniques used in plant tissue culture. You can search for specific protocols related to explant preparation, medium preparation, regeneration techniques, rooting, and chromatography.
2. Plant Methods (https://plantmethods.biomedcentral.com/): Plant Methods is an open-access journal that publishes research articles and protocols related to plant biology and techniques, including plant tissue culture. You can search for specific articles and protocols relevant to your practical syllabus.
3. In Vitro Cellular & Developmental Biology - Plant (https://www.springer.com/journal/11627): This journal covers research and protocols related to plant tissue culture, regeneration techniques, and other aspects of in vitro plant development. You can access articles and protocols through your institution's library or individual subscription.
4. ResearchGate (https://www.researchgate.net/): ResearchGate is a social networking platform for researchers, offering access to scientific publications, research papers, and protocols. You can search for specific topics related to plant tissue culture and find relevant protocols shared by researchers in the field.
5. YouTube tutorials: YouTube hosts a variety of video tutorials related to plant tissue culture techniques. You can search for specific techniques like explant preparation, medium preparation, shoot culture, rooting, and chromatography, and find practical demonstrations and step-by-step instructions.

Code of the course	**SES7302T**
Title of the course	**Nursery and Gardening**
Level of the Course	NHEQF Level 5.5
Credit of the Course	2
Type of the Course	SEC
Delivery Type of the Course	Lectures and tutorial (20+10=30hours). The 20hours lectures for content delivery and 10 hours on diagnostic assessment, formative assessment, and subject/class activity, problem solving.
Prerequisites	Advance Course

Objectives of the Course

1. Understand the concepts, objectives, and infrastructure requirements of a nursery.
2. Gain knowledge about planting techniques, seed structure and types, seed collection and care, storage, and methods to promote seed germination.
3. Learn various methods of vegetative propagation, including selection of propagating material, rooting medium, planting methods, and hardening of plants.
4. Comprehend the definition, objectives, and scope of gardening, and identify suitable plants and pots for different types of gardens.
5. Develop practical skills in gardening operations, such as soil preparation, sowing, manuring, watering, garden maintenance, and management of pests and diseases.

Course Learning Outcomes

1. Understand the principles and practices of nursery management, including site selection, plant and soil types, and seasonal activities.
2. Acquire knowledge of seed structure, collection, storage, and methods to promote seed germination.
3. Demonstrate proficiency in vegetative propagation methods, including selection of propagating material, rooting, and planting techniques.
4. Apply concepts of gardening, including garden types, suitable plants, and pots for different settings.
5. Develop practical skills in gardening operations, such as soil preparation, sowing, plant maintenance, and management of pests and diseases.

Syllabus

Unit I(Lecture hours: 6)

Nursery - Definition, Objective, Infrastructure Required, Other Requirements Selection of Right Site, Plants and Soil Types, Planning And Making a Calendar For The Seasonal Activity, SWOT Analysis.

Unit II (Lecture hours: 6)

Planting, Seed Structure and Types, Collection of Seeds, Care of Seeds, Seed Storage, Seed Dormancy Methods to Promote Seed Germination, Seed Testing and Certification.

Unit III(Lecture hours: 6)

Propagation Methods of Vegetative Propagules, Selection of Season and Plant, Treatments to Be Given to The Propagating Material, Rooting Medium, and Methods of Planting of Propagules, Hardening of Plants

Unit IV(Lecture hours: 6)

Gardening - Definition, Objectives and Scope, Types of Gardens, Pots and Plants Suitable For Different Types of Gardens, Home, Terrace and Kitchen Gardens.

Unit V(Lecture hours: 6)

Gardening Operations; Soil Laying, Sowing of Plants In Garden Soil and Pots, Manuring, Watering Maintainence of The Garden, Management of Pests and Diseases.

Suggested Books and References

1. The Well-Tempered Garden by Christopher Lloyd: This classic gardening book provides insights into various aspects of gardening, including garden design, plant selection, soil management, and garden maintenance.
2. The Complete Book of Plant Propagation by Graham Clarke and Alan Toogood: This comprehensive guide covers all aspects of plant propagation, including seed propagation, vegetative propagation, and nursery management.
3. The Well-Designed Mixed Garden: Building Beds and Borders with Trees, Shrubs, Perennials, Annuals, and Bulbs by Tracy DiSabato-Aust: This book focuses on garden design principles and offers practical advice on creating mixed gardens with a variety of plant types.
4. The New Organic Grower, 3rd Edition: A Master's Manual of Tools and Techniques for the Home and Market Gardener by Eliot Coleman: This book provides valuable insights into organic gardening practices, including soil management, crop rotation, pest and disease management, and season extension techniques.
5. The Complete Idiot's Guide to Seed Saving and Starting by Sheri Ann Richerson: This beginner-friendly guide covers the basics of seed saving, starting seeds, and plant propagation, providing step-by-step instructions and tips for successful gardening.

Suggested E-resources

1. The Royal Horticultural Society (RHS) website: The RHS website (https://www.rhs.org.uk/) offers a wealth of information on gardening, plant selection, gardening techniques, and nursery management. It provides articles, guides, and resources for both beginners and experienced gardeners.
2. University extension websites: Many universities and agricultural extensions have online resources dedicated to gardening and nursery management. Examples include the Cooperative Extension System (https://extension.org/) in the United States and the Gardening Australia website (https://www.abc.net.au/gardening/) for Australian gardeners.
3. Gardening forums and communities: Online gardening forums and communities, such as GardenWeb (https://forums.gardenweb.com/), Gardeners' World Forum (https://www.gardenersworld.com/forum/), and Reddit's r/gardening (https://www.reddit.com/r/gardening/), provide opportunities to connect with experienced gardeners, ask questions, and share insights.
4. YouTube channels: YouTube hosts numerous gardening channels that offer instructional videos, gardening tips, and demonstrations. Channels like "Garden Answer" (https://www.youtube.com/user/gardenanswer), "Epic Gardening" (https://www.youtube.com/c/EpicGardening), and "Gardener's World" (https://www.youtube.com/c/GardenersWorld) provide valuable content for gardeners.
5. Online gardening courses: Platforms like Udemy (https://www.udemy.com/), Coursera (https://www.coursera.org/), and Skillshare (https://www.skillshare.com/) offer online courses on gardening and nursery management. These courses provide structured learning with video lessons, assignments, and quizzes.