FYUGP
2024

DEPARTMENT OF BOTANY

Syllabus for
Undergraduate Programmes (Honours)
Under Credit Semester System
Outcome Based Education
with Effect from 2024 Admissions

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | A+ in the Fifth Cycle of Reaccreditation by NAAC
Changanassery, Kerala, India 686101 | Affiliated to Mahatma Gandhi University, Kottayam

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Dr. Salvy Thomas
Chairman, BOS (Botany)

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Name	Official Address
Dr Dennis Thomas T	Professor Department of Plant Science Central University of Kerala Tejaswini Hills, Periye P O Kasaragod District - 671316.
Dr Gangaprasad A	Professor and Dean Faculty of Science, Department of Botany University of Kerala Kariavattom, Thiruvananthapuram

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ALUMNI REPRESENTATIVE

Name	Official Address
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REPRESENTATIVE FROM INDUSTRY AND ALLIED AREAS

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TEACHERS FROM THE DEPARTMENT NOMINATED BY THE PRINCIPAL TO THE BOARD OF STUDIES

Name
Dr Soni Scaria
Dr Joseph Job
Mr Biju George
Mr Jebin Joseph
Mr Ajeesh Joseph
Mr Tom Joseph

PROGRAMME OUTCOMES

PO1: Develop in-depth conceptual knowledge and skills in the discipline for vertical growth and scholarly pursuits

PO2: Integrate and apply interdisciplinary knowledge incorporating historical, theoretical, scientific, technological, economic, philosophical, cultural, aesthetic and ethical perspectives to address complex challenges in diverse settings

PO3: Demonstrate communication skills promoting adaptability, collaboration and resilience in global and local contexts

PO4: Develop problem solving skills to transfer the knowledge of methods and systems of different disciplines for a sustainable and egalitarian world order

PO5: Cultivate research skills and innovative and critical thinking to contribute to societal development through the creation of sustainable solutions and advancements in the respective fields

PROGRAMME SPECIFIC OUTCOMES

PSO1: Understand, appreciate and communicate the diversity of living beings, their evolutionary history and their niche in the environment as well as their utilitarian values.

PSO2: Develops insight into the functioning of living beings from cellular and molecular levels to organism level.

PSO3: Understand and apply the scientific method and develop skills for the scholarly appraisal of scientific problems related to plant science.

PSO4: Understand the theoretical basis of applied plant biology and develop transferable skills in applied branches such as plant propagation, horticulture and protected farming, crop improvement, economic botany, plant pathology, and plant conservation.

PSO5: Develops skills in the methods and tools in experimental plant sciences so as to enable the creation of new knowledge.

OUTLINE OF DISCIPLINE SPECIFIC COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24BO1DSC100	Major/Minor	Diversity of Land Plants, Interactions and Conservation	5	75	4
SBU24BO1DSC101	Major/Minor	Phycology	5	75	4
Semester II (Course Level: 100 - 199)					
SBU24BO2DSC100	Major/Minor	Understanding Ecosystems and Plant Distribution	5	75	4
SBU24BO2DSC101	Minor	Plant Physiology	5	75	4
Semester III (Course Level: 200 - 299)					
SBU24BO3DSC200	Major	Introduction to Molecular Biology	5	75	4
SBU24BO3DSC201	Major	Fundamentals of Cell Biology	5	75	4
SBU24BO3DSC202	Minor	Bryology, Pteridology and Gymnosperms	5	75	4
Semester IV (Course Level: 200 - 299)					
SBU24BO4DSC200	Major	Phycology and Bryology	5	75	4
SBU24BO4DSC201	Major	Pteridophytes and Gymnosperms	5	75	4
SBU24BO4DSC202	Major/Minor	Taxonomy and Economic Importance of Angiosperms	5	75	4
SBU24BO4INT200	Major	Internship	-	-	2
Semester V (Course Level: 300 - 399)					
SBU24BO5DSC300	Major/Minor	Biochemistry - I	5	75	4
SBU24BO5DSC301	Major/Minor	Angiosperm Morphology, Taxonomy and Economic Botany	5	75	4
Semester VI (Course Level: 300 - 399)					
SBU24BO6DSC300	Major/Minor	Plant Physiology - I	5	75	4
SBU24BO6DSC301	Major/Minor	Mycology and Plant Pathology	5	75	4
SBU24BO6DSC302	Major/Minor	Environmental Science and Human Rights	5	75	4
Semester VII (Course Level: 400 - 499)					
SBU24BO7DSC400	Major/Minor	Biochemistry - II	5	75	4
SBU24BO7DSC401	Major/Minor	Advanced Cell Biology	4	60	4
SBU24BO7DSC402	Major/Minor	Advanced Molecular Genetics	4	60	4
SBU24BO7DSC403	Major/Minor	Scientific Methodology	4	60	4
SBU24BO7DSC404	Major/Minor	Biostatistics	4	60	4
SBU24BO7DSC405	Major/Minor	Proteomics	4	60	4
Semester VIII (Course Level: 400 - 499)					
SBU24BO8DSC400	Major	Genetic Engineering	5	75	4
SBU24BO8DSC401	Major	Bioinformatics	5	75	4
SBU24BO8DSC402	Major	Angiosperm Systematics	5	75	4
SBU24BO8PRJ400	Major	Project			12

OUTLINE OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24BO3DSE200	Elective	Introduction to Plant Biotechnology	4	60	4
SBU24BO3DSE201	Elective	Seed Science Technology	4	60	4
SBU24BO3DSE202	Elective	Evolutionary Biology	4	60	4
Semester IV (Course Level: 200 - 299)					
SBU24BO4DSE200	Elective	Anatomy and Embryology of Angiosperms	4	60	4
SBU24BO4DSE201	Elective	Immunology	4	60	4
SBU24BO4DSE202	Elective	Developmental Biology	4	60	4
Semester V (Course Level: 300 - 399)					
SBU24BO4DSE300	Elective	Fundamentals of Inheritance	4	60	4
SBU24BO4DSE301	Elective	Phytochemistry and Pharmacognosy	4	60	4
SBU24BO4DSE302	Elective	Plant Breeding and Horticulture	4	60	4
SBU24BO4DSE303	Elective	Forensic Botany	4	60	4
SBU24BO4DSE304	Elective	Microbiology and Microbial Biotechnology	4	60	4
Semester VI (Course Level: 300 - 399)					
SBU24BO6DSE300	Elective	Plant Physiology - II	4	60	4
SBU24BO6DSE301	Elective	Space Biology - An Introduction	4	60	4
SBU24BO6DSE302	Elective	Genomics	4	60	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24BO1MDC100	MDC	Gardening and Nursery Management	4	60	3
Semester II (Course Level: 100 - 199)					
SBU24BO2MDC100	MDC	Plant Based Micro Enterprises	4	60	3
Semester III (Course Level: 200 - 299)					
SBU24BO3MDC200	MDC	Conservation Biology and Bioenergy	3	45	3

OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU24BO4SEC200	SEC	Mushroom Production and Value Addition	3	45	3
Semester V (Course Level: 300 - 399)					
SBU24BO5SEC300	SEC	Plant Based Micro Enterprises	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24BO6SEC300	SEC	Techniques in Plant Science	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24BO3VAC200	VAC	Aquaponics	3	45	3
Semester IV (Course Level: 300 - 399)					
SBU24BO4VAC200	VAC	Climate Change	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24BO6VAC300	VAC	Integrated Sustainable Waste and Energy Management	3	45	3

SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO1DSC100	Major/ Minor	Diversity Of Land Plants, Interactions and Conservation	5	75	4
SBU24BO1DSC101	Major/ Minor	Phycology	5	75	4
SBU24BO1MDC100	MDC	Gardening and Nursery Management	4	60	3

SBU24BO1DSC100: DIVERSITY OF LAND PLANTS, INTERACTIONS AND CONSERVATION

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the features of various plant groups	U
CO2	Distinguish the major plant groups	U
CO3	Explain the features and significance of biodiversity	U
CO4	Explain various forms of plant interactions	U
CO5	Identify the features of major group of plants	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	-	2	1	1	-	-
CO2	2	1	-	-	-	2	1	1	-	-
CO3	2	1	-	-	-	2	1	1	-	-
CO4	1	1	-	-	-	1	1	1	-	-
CO5	-	-	-	2		-	-	-	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	x	x	x	-	x
CO2	-	x	x	x	-	x
CO3	-	x	x	-	x	x
CO4	x	-	x	-	x	x
CO5	-	-	-	-	-	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab skill	Viva voce	Field Report	Record work	Test	
CO1	-	x	-	-	x	x
CO2	-	x	-	-	x	x
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	X

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Diversity of Plants (14 Hrs)				
History and scope of plant science Definition and characteristics of plants and evolutionary origin of plants. Characteristics of bryophytes: Adaptations for life on land: water retention, reproduction, and dispersal. Ecological roles of bryophytes in early terrestrial ecosystems	1.1	1,2	3	Lecture
Characteristics of Pteridophytes; Diversity and adaptations of seedless vascular plants. Emergence of vascular tissue and its significance. Transition to a dominant sporophyte generation	1.2	1,2	3	Lecture
Characteristics of Gymnosperms: Evolutionary innovations of seed plants, The significance of seed development and dispersal	1.3	1,2	4	Lecture
Characteristics of Angiosperms; Origins and rapid diversification of flowering plants. Key features of angiosperms, flowers, fruits, and double fertilization. Coevolution with pollinators and other organisms	1.4	1,2	4	Lecture
Module 2: Biodiversity Conservation (20 Hrs)				
Plant diversity and its scope- Genetic diversity, Species diversity and ecosystem diversity, Measures of diversity; alpha, beta, and gamma diversity.	2.1	3	4	Lecture
Endemism, Hotspots, IUCN Red List of Threatened Species	2.2	3	4	Lecture
Significance of Biodiversity; Ecosystem Services Provided by Plants. Food Production and Agriculture Medicinal Plants Timber production and non-timber forest products	2.3	3	6	Lecture
Threats to plant biodiversity: Habitat destruction, Introduced species, Pollution, Direct exploitation, Climate change, Population explosion	2.4	3	3	Lecture
Conservation strategies: Protected areas, ex situ conservation, and community-based approaches	2.5	3	3	Lecture
Module 3: Plant Interactions (11 Hrs)				
Plant- Plant interactions; Competition, Allelopathy and Semiochemicals. Facilitation and Mutualism	3.1	4	4	Lecture
Plant-Animal interactions; Pollination, seed dispersal, Mutualism, Herbivory and plant defences	3.2	4	3	Lecture
Plant-Microbe interactions: Mycorrhizae, Cyanobacterial associations, nutrient cycling, nitrogen fixation, and rhizosphere interactions.	3.3	4	4	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Plant Diversity Practical (30 Hrs)				
Identification of gametophyte and sporophyte of Bryophytes	5.1	1,2, 5	7	Hands on experiments
Identification of gametophyte and sporophyte of Pteridophytes	5.2	1,2, 5	8	Hands on experiments
Identification of gametophyte and sporophyte of Gymnosperms	5.3	1,2, 5	7	Hands on experiments
Identification of gametophyte and sporophyte of Angiosperms	5.4	1,2, 5	8	Hands on experiments
Conduct field work in a natural area under the guidance of a teacher	5.5	1,2, 5		

Reference

1. Coutler J.M & Chamberlain C. J, Morphology of Gymnosperms. Central Book Depot Allahabad.1958.
2. Dutta S.C, An Introduction to Gymnosperms, Kalyan Publishing Co. New Delhi. 1991.
3. Pandey S. N, A text book of Botany, Vikas Publishing House.New Delhi, 2006.
4. Rasheed A, An Introduction to Pteridophyta, Vikas Publishing House. New Delhi, 1999.
5. Singh, Pande Jain. 2007, *Diversity of Microbes and Cryptogam*, Rastogi
6. Smith GM Cryptogamic Botany vol.1
7. Smith GM Cryptogamic Botany vol.2Bhatnagar S P & Moitra A., Gymnosperms, New Age International (P) Ltd., New Delhi.2003
8. Sporne KR Morphology of Gymnoperm
9. Vashista B. R .1993. *Bryophyta*. S Chand & Co., New Delhi.
10. Vashista B. R, 1993. *Pteridophyta*, S Chand & Co., New Delhi
11. Vashista B. R, Gymnosperms, S Chand & Co., New Delhi. 1993.

Course designed by: Mr Biju George

SBU24BO1DSC101: PHYCOLOGY

Type of Course	Major/ Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe and distinguish the terminologies used in phycological studies.	U
CO2	Explain the diversity in the habitat and structure of algae.	A
CO3	Explain the ecological relevance and potential role of algae in human welfare	A
CO4	Explain the algal culture methods	A
CO5	Compare the different kinds of life cycle patterns shown by algae	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	1	-	1
CO2	2	1	-	-	-	1	-	-	-	1
CO3	2	-	1	1	-	1	2	-	1	1
CO4	-	1	2	1	1	1	1	-	1	1
CO5	1	1	-	-	-	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Oral Presentation	Quiz	Assignment	Written Test	MCQ	
CO1	-	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	x	-	x	x	
CO5	x	x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Viva voce	Observation of Practical Skills	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	x	x	x	x	x	x
CO3	-	-	-	-	-	-
CO4	x	x	x	x	x	x
CO5	-	-	-	-	-	-

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Algae (8 Hrs)				
General characters of algae.	1.1	1,5	2	Lecture
Algae in aquatic, terrestrial and Extreme habitats	1.2	2	2	Lecture
Reproductive methods in algae. Life cycles of algae.	1.3	5	2	Lecture
Classification of algae by Fritsch F. E. (1935). Brief introduction to Algae Base	1.4	1	2	Lecture
Module 2: Detailed Type study (25 Hrs)				
General characters of the classes with special reference to the systematic position, habitat, thallus structure, reserve food, reproduction and life cycle Cyanophyceae: *Nostoc and Oscillatoria* Chlorophyceae: *Chlamydomonas, Chlorella, Volvox, Spirogyra, Cladophora and Chara.* Xanthophyceae: *Vaucheria* Bacillariophyceae*:Pinnularia* Phaeophyceae: *Sargassum* Rhodophyceae: *Polysiphonia*	2.1	1,2, 5	25	Lecture, Demonstration
Module 3: Applied Phycology (12 Hrs)				
Algal culture: scope and a brief account on isolation, purification and culture methods.	3.1	3,4	4	Lecture, Demonstration
Useful aspects of algae: Algae as Food and fodder	3.2	3	2	Lecture
Industrial phycology; Algae as source of valuable commercially important products-carrageenin, agar-agar, alginate, pigments, Medicine, enzymes, diatomite, biofuel, bioethanol, antibiotics	3.3	3	2	Lecture
Algae in soil fertility: Soil algae and cyanobacteria. Biofertilizers.	3.4	3	2	Lecture
Algae as pollution indicator and in waste water treatment, Phycoremediation.	3.5	3	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Morphology of algae (20 Hrs)				
Cyanophyceae: *Nostoc; Oscillatoria*, Chlorophyceae: *Chlamydomonas, Chlorella, Spirogyra, Cladophora, Chara*. Xanthophyceae: *Vaucheria* Bacillariophyceae: *Pinnularia* Phaeophyceae: *Sargassum*; Rhodophyceae: *Polysiphonia*	5.1	2	20	Demonstration and Hands on
Module 6: Algal Culture (10 Hrs)				
Algal medium Preparation	6.1	4	5	Hands on Experiment
Isolation and Culture	6.2	4	5	Hands on Experiment

Reference

1. Bilgrama K. S & Saha L. C., Text Book of Algae, C B S Publishers & Distributors, 1996.
2. Chapman, V J. The Algae, Macmillan& co. Ltd, London, 1962.
3. Fritsch F E. Structure and Reproduction of Algae, Vol.1: Cambridge University Press, London, 1945.
4. Gilbert M Smith. Cryptogamic Botany (Vol. 1): Algae and Fungi. Tata McGraw Hill Edition 2000
5. Singh, Pande and Jain, Diversity of Microbes and Cryptogam, Rastogi Publications, 2007.
6. Smith GM Cryptogamic Botany vol.1. 1980
7. Pringsheim E G. Pure culture of Algae. Cambridge University Press 2015
8. Sharma O.P. Text Book of Algae. Tata Mc. Graw Hill Co, 2004.
9. Vasishta B R, Sinha A. K, Singh V.P. Botany for Degree Students- Algae, S Chand & Co. Ltd. New Delhi, 2004.

Course designed by: Mr Jebin Joseph

SBU24BO1MDC100: GARDENING AND NURSERY MANAGEMENT

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Propagate diverse crops using sexual & asexual methods.	A
CO2	Manage nurseries: Including site, soil, irrigation, propagation, pests, & stock.	An
CO3	Produce fruits & vegetables: Sustainably with optimal yield & quality.	A
CO4	Develop industry skills: Problem-solving, communication, collaboration, project management, financial & marketing principles.	An
CO5	Design & cultivate landscapes: Using diverse plants & appropriate techniques.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	1	-	3	-	2	-	-	-	-
CO2	-	1	2	3	2	2	3	-	-	-
CO3	-	1	2	3		2	2	-	3	-
CO4	-	-	-	-	-	1	1	3	3	-
CO5	1	-	-	3	-	2	3	2	3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical Assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	x	-	x	x	x
CO5	x	x	-	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab Involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	-	x
CO4	-	x	x	-	-	x
CO5	x	x	x	x	-	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Horticulture (10 Hrs)				
Definition, Scope, and Importance of Horticulture: Historical overview of horticulture, Economic and social significance of horticulture in India, Classification of horticultural crops: fruits, vegetables, flowers, ornamentals, spices, medicinal plants	1.1	1	2	Lecture/Demonstration
Plant Growth and Development: Factors affecting plant growth and development: light, temperature, water, nutrients, soil, air Plant hormones and their roles in growth and development	1.2	1	2	Lecture/Demonstration
Plant Propagation: Importance and types of plant propagation: sexual and asexual methods Seed propagation: seed selection, storage, pre-treatment, sowing methods Vegetative propagation: cutting, layering, grafting, budding, tissue culture	1.3	1	3	Lecture/Demonstration
Nursery Management: Importance of nursery management in horticulture Nursery planning and layout: site selection, soil preparation, irrigation systems, plant growing structures Nursery operations: seedbed preparation, sowing, transplanting, watering, fertilization, pest and disease control, Nursery stock management: grading, labelling, packaging, storage	1.4	2	3	Lecture/Demonstration
Module 2: Fruit and Vegetable Production (10 Hrs)				
Importance of Fruits and Vegetables in Food Security and Nutrition: Nutritional value of fruits and vegetables, Role of fruits and vegetables in promoting health and well-being.	2.1	3	2	Lecture/Demonstration
Fruit Production: Site selection and soil preparation for specific fruit crops Planting techniques, spacing, and irrigation requirements for fruit trees, Training and pruning methods for different fruit trees, Nutrient management and pest and disease control strategies for fruit trees, Harvesting, post-harvest handling, and storage of fruits.	2.2	3	4	Lecture/Demonstration
Vegetable Production: Site selection and soil preparation for specific vegetable crops, planting techniques, spacing, and irrigation requirements for vegetables, Training and support systems for vegetable crops, Nutrient management and pest and disease control strategies for vegetables Harvesting, post-harvest handling, and storage of vegetables.	2.3	3	4	Lecture/Demonstration

Module 3: Floriculture and Ornamental Horticulture (10 Hrs)				
Importance of Floriculture and Ornamental Plants: Role of flowers and ornamental plants in landscaping and beautification, Environmental benefits of flowers and ornamental plants.	3.1	4	2	Lecture/Demonstration
Flower Production: Types of flower gardens: annuals, perennials, mixed borders, rock gardens, Propagation techniques for common ornamental plants, Planting and maintenance of lawns and hedges, Container gardening and hydroponics, Floral arrangement and decoration.	3.2	4	4	Lecture/Demonstration
Ornamental Plant Production: Propagation techniques for common ornamental shrubs and trees, Planting and maintenance of ornamental shrubs and trees, Pruning and shaping techniques for ornamental plants, Pest and disease control strategies for ornamental plants.	3.3	4	4	Lecture/Demonstration
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Practical Horticulture (15 Hrs)				
Seed Testing and Preparation: Germination testing of seeds, Seed treatment methods: scarification, stratification, soaking.	5.1	1	5	Demonstration/ Hands on training
Vegetative Propagation Techniques: Practice of cutting, layering, grafting, and budding methods, Care and maintenance of propagated plants	5.2	1	10	Demonstration/ Hands on training
Module 6: Practical Floriculture and Ornamental Horticulture (15 Hrs)				
Hydroponics: Setting up and operating a hydroponic system	6.4	5	5	Demonstration
Floral Arrangement Workshop: Creating different floral arrangements for various occasions	6.5	5	10	Demonstration/ Hands on training

Reference

1. Arya, P.S. (Latest edition). Vegetable Seed Production Principles. Kalyani Publishers, Hyderabad.
2. Biswas, T.D., & Mukherjee, S.K. (Latest edition). Text Book of Soil Science. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Bose, T.K., & Somkuwar, M.G. (Latest edition). Principles of Tropical Horticulture. New Age International Publishers, New Delhi.
4. Chadha, K.L. (Latest edition). Handbook of Horticulture. ICAR, New Delhi.

5. Edmond, J.B., Sen, T.L., Andrews, F.S., & Halfacre, P.G. (Latest edition). Fundamentals of Horticulture. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
6. Gosal, S.L. (Latest edition). Principles of Fruit Production. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Kaul, T.N. (Latest edition). Biology and Conservation of Mushroom. Oxford and IBH Publishing Co. Ltd.
8. Kumar, N. (Latest edition). Introduction to Horticulture. Rajalakshmi Publications, Nagarcoil.
9. Randhawa, G.S., & Mukhopadhyay, A. (Latest edition). Floriculture in India. Allied Publishers Pvt. Ltd., Ahmedabad.
10. Rao, K.M. (Latest edition). Text Book of Horticulture. Macmillan India Ltd.
11. Sadhu, M.K. (Latest edition). Plant Propagation. New Age International Publishers, New Delhi.
12. Thorpe, T.A. (Latest edition). Dictionary of Applied Plant Biology and Related Sciences. Oxford University Press, New Delhi.

Course designed by: Dr. Salvy Thomas

SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO2DSC100	Major/ Minor	Understanding Ecosystems and Plant Distribution	5	75	4
SBU24BO2DSC101	Minor	Plant Physiology	5	75	4
SBU24BO2MDC100	MDC	Plant Based Micro Enterprises	4	60	3

SBU24BO2DSC100: UNDERSTANDING ECOSYSTEMS AND PLANT DISTRIBUTION

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic concepts of plant ecology.	R
CO2	Describe the characteristics and structure of a plant community	U
CO3	Outline the structure and function of an ecosystem.	A
CO4	Explain the ecological interconnections of life on earth.	U
CO5	Describe the principles governing plant distribution and distinguish between the various phytogeographical locations of India.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	-	-	1	1	-	1	-
CO2	3	2	-	-	-	1	2	-	-	-
CO3	1	-	-	-	-	2	1	2	1	-
CO4	2	1	-	-	-	1	2	2	1	-
CO5	2	1	2	-	-	1	2	2	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open Book Test	Written Exam	
CO1	x	x	-	-	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	-	x	x	x	x
CO5	x	x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Practical skills	Record	Viva voce	Field report	Lab Test	
CO1	-	-	-	x	-	x
CO2	x	x	x	x	-	x
CO3	x	x	x	x	x	x
CO4	-	-	-	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Plant Ecology (7 Hrs)				
Definition and scope of plant ecology, branches of ecology, ecological hierarchy-individual, population, community, ecosystem.	1.1	1	3	Lecture
Types of ecosystems- Terrestrial (Grassland, desert and forest), Aquatic (freshwater and marine)	1.2	1	4	Lecture
Module 2: Autecology & Synecology (16Hrs)				
Ecosystem components- abiotic and biotic. Productivity – primary, secondary, gross and net productivity. Food chain, food web and trophic levels. Ecological pyramids - pyramid of numbers, biomass and energy	2.1	2, 3	7	Lecture
Community structure and organization- Key concepts: species interactions, species richness, species diversity, habitat, niche, ecological indicators, ecotone and edge effect, Foundation species, keystone species, Umbrella species.	2.2	2, 3	5	Lecture
Ecological Succession: types, processes, climax community, Hydrosere and Xerosere.	2.3	3,4	4	Lecture
Module 3: Population and Community Ecology (12 Hrs)				
Population characteristics: Metapopulations, growth form and carrying capacity, Ecotypes and Ecads.	3.1	3,4	5	Lecture
Community characteristics: Quantitative (e.g., frequency, density and abundance), Qualitative (e.g., physiognomy and phenology), Synthetic (e.g., dominance). Ecotone and edge effect, Habitat, ecological niche and microclimate.	3.2	3,4	7	Lecture and Problem Solving
Module 4: Fundamentals of Phytogeography (5 Hrs)				
Principles governing plant distribution, factors affecting plant distribution, theories of distribution, different types of distribution of vegetations on the earth, continuous and discontinuous distribution.	4.1	5	5	Lecture
Module 5: **Major Phytogeographical regions of India (5 Hrs)**				
Western Himalayas, Eastern Himalayas, Gangetic Plain, Deccan, Western coasts of Malabar, Assam and Bay Islands of Andaman and Nicobar.	5.1	5	5	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Ecosystem Types (20 Hrs)				
Conduct field visits to diverse Terrestrial ecosystem types (Minimum of Three Days) under the guidance of a teacher and prepare a report with support of Geo-tagged photographs.	7.1	2& 3	20	Demonstration / Field visit / Team Based Learning
Module 8: Diversity Study (10 Hrs)				
Assessment of diversity, abundance, and frequency of plant species by quadrat method (Grasslands, forests).	7.2	3& 5	10	Demonstration / Field visit / Team Based Learning

Reference

1. Amal Raj S. Introduction to environmental science and technology. Laxmi Publications Pvt. Ltd., New Delhi.
2. Asthana D K, Meera Asthana, 2006. A text book of environmental studies. S Chand.
3. Bharucha, Erach, 2003. The Biodiversity of India. Mapin Publishing Co., New Delhi.
4. H D Kumar, 2000. Modern Concepts of Ecology. Vikas Publishing House, New Delhi.
5. Mani M S, 1974. Ecology and Biogeography in India. W Junk B V Publishers, Netherlands.
6. Misra D D, 2008. Fundamental concepts in Environmental Studies. S. Chand & Co. Ltd., New Delhi.
7. Nayar M P, 1996. Hot Spots of Endemic Plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Trivandrum.
8. Odum E P, 1971. Fundamentals of Ecology. WB Sunders.
9. Panday S N, S P Misra, 2011. Environment and Ecology. Ane Books Pvt.Ltd. New Delhi
10. Peter Stiling, Ecology: Global insights and investigations. 2012, Mc Grew Hill.
11. Santhra S C, 2004. Environmental Science. New Central Book Agency.
12. Smith T. M. and Smith R. L. 2012 Elements of ecology, Pearson publication, New Delhi

Course designed by: Mr. Ajeesh Joseph

SBU24BO2DSC101: PLANT PHYSIOLOGY

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss different mechanisms involved in water intake and transportation in the plants and its regulation	U
CO2	Explain the transportation of photosynthates	U
CO3	Explain different biochemical pathways involved in photosynthesis and nitrogen assimilation	U
CO4	Perform various experiments related to plant system functioning and evaluate the results of the same.	A
CO5	Demonstrate and explain various experiments related to plant physiology	U

Cognitive Levels- R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	-	2	2	1	-	-
CO2	2	1	-	-	-	2	2	1	-	-
CO3	2	2	-	-	-	2	2	1	-	-
CO4	1	1	-	-	-	1	1	1	-	-
CO5	1	1	-	2	-	1	1	-	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x		x	x	-	x
CO2	-	x	x	x	-	x
CO3	-	x	x	-	x	x
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab skill	Viva voce	Lab Report	Record work	Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Plant Water Relations (9 Hrs)				
Physical and physiological aspects of water absorption- Diffusion, imbibition, osmosis.	1.1	1	2	Lecture
Concept and components of Water potential. Cell membrane permeability and its importance.	1.2	1	1	Lecture
Absorption of water- active and passive. Pathway of water movement, symplast, apoplast, transmembrane pathways.	1.3	1	2	Lecture
Ascent of sap, cohesion and adhesion, transpiration pull, SPAC concept.	1.4	1	2	Lecture
Transpiration- types, mechanism H+ - K+ ion exchange, significance, anti-transpirants, guttation.	1.5	1	2	Lecture
Module 2: Photosynthesis (26 Hrs)				
Structural organization of chloroplast, Photosynthetic pigments, antenna complexes and reaction centre.	2.1	3	2	Lecture
Photo excitation and energy transfer, conversion of light energy to chemical energy, Fluorescence, phosphorescence.	2.2	3	3	Lecture
Concept of two photosystems. Cyclic & non-cyclic photophosphorylation (Z- scheme).	2.3	3	3	Lecture
Carbon assimilation pathways- C3, C4, CAM. Photorespiration.	2.4	3	12	Lecture
Photosynthetic response by leaf, Photosynthetic response by light, Photosynthetic response by temperature, Photosynthetic response by carbon dioxide.	2.5	3	6	Lecture
Module 3: Nitrogen Metabolism (5 Hrs)				
Nitrogen in the environment and N cycle	3.1	3	1	Lecture
Assimilation of nitrate by plants.	3.2	3	1	Lecture
Ammonium assimilation	3.3	3	1	Lecture
Biological N fixation	3.4	3	2	Lecture
Module 5: Translocation in the Phloem (5 Hrs)				
Pathways of Translocation	5.1	2	1	Lecture
Pressure Flow model	5.2	2	1	Lecture
Phloem Loading and Unloading	5.3	2	2	Lecture
Photosynthate Allocation and Partitioning	5.4	2	1	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Module 7: Core Experiments (20 Hrs)				
Determination of osmotic pressure by tissue weight method Separation of Chlorophyll pigments by paper chromatography.	7.1	4	20	On hand experiment

Effect of carbon dioxide concentration on the rate of photosynthesis by Hydrilla plants Demonstration of osmosis using plant membrane Estimation of total chlorophyll in the leaf sample				
Module 8: Demonstration Experiments (10 Hrs)				
Determination of transpiration under different environmental conditions using Ganong's Potometer Relation between transpiration and absorption Evolution of O2 during photosynthesis Light screen experiment Mohl's experiment Experiment with variegated leaf Measurement of growth using Arc auxanometer Experiment with Kleinostat	8.1	5	10	Demonstration

Reference

1. Datta, S.C. (1989) *Plant Physiology*, Central Book Depot, Allahabad.
2. Dayananda B, 1999. Experiments in Plant Physiology. Narosa Publishing House, New Delhi.
3. Hopkins W G, Norman P A Huner, 2008. Introduction to plant physiology. John Wiley and sons. New York.
4. Jain J L, Sanjay Jain, Nitin Jain, 2005. Fundamentals of Biochemistry. S Chand, New Delhi.
5. Jain, V. K. (1996) *Fundamentals of Plant Physiology*, S Chand and Company, Delhi.
6. Lehninger A L, 1961. Biochemistry. Lalyan publishers, Ludhiana.
7. Pandey S N, Sinha B K, 2006. Plant Physiology. Vikas Publishing House Pvt. Ltd.
8. Sadasivam S, Manickan A, 2009. Biochemical Methods. New Age International Ltd. New Delhi.
9. Srivastava H.S. (2005) *Plant Physiology*. Rastogi Publications, Meerut.
10. Taiz, L. and Zeiger, E. 2010. Plant Physiology, Fifth Edition. Sinauer Associates. Sunderland, MA.
11. Verma V, 2007. Textbook of Plant Physiology. Ane Books India, New Delhi.

Course designed by: Mr Biju George

SBU24BO2MDC100: PLANT-BASED MICROENTERPRISES

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Summarize key principles in organic farming, horticulture, tissue culture and mushroom cultivation, fruits and vegetable technology including sustainable practices and business considerations.	U
CO2	Elaborate the various composting techniques, artificial vegetative propagation practices, tissue culture techniques and mushroom cultivation	R
CO3	Point out the skills needed in organic farming and horticultural practices.	R
CO4	Elaborate the techniques involved in tissue culture, fruits/vegetable preservation and mushroom cultivation	U
CO5	Practice the methods of organic farming, horticulture, tissue culture and mushroom cultivation,	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	2	1	-	-	2	2	2	-
CO2	1	-	2	2	-	-	2	2	2	-
CO3	2	-	2	2	-	-	2	2	2	-
CO4	3	-	2	2	-	-	2	2	2	-
CO5	-	-	2	2	-	-	2	2	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	-	x	X	x
CO2	x	x	x	x	X	x
CO3	x	x	x	x	X	x
CO4	x	x	x	x	X	x
CO5	x	x	x	x	X	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1			x	x	x	x
CO2			x	x	x	x
CO3			x	x	x	x
CO4			x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Organic farming (5 Hrs)				
Introduction to Organic farming- Advantages of Manures over fertilizers. NPK value- Definition and significance.	1.1	1	2	Lecture
Common organic manures – bone meal, cow dung, poultry waste, oil cakes, Green manure (special reference to major element in the composition) Preparation of compost- vermicompost, vermiwash; KHAMBA compost Biofertilizers-Definition and Types –, Rhizobium, Mycorrhiza, Blue green algae and Azolla.	1.2	1, 2	2	Lecture
Biological control Agents- Trichoderma, Bacillus; Biopesticides – Tobacco and Neem decoction.	1.3	2	1	Lecture
Module 2: Horticulture (6 Hrs)				
Types of soil, preparation of potting mixture, Garden tools and implements.	2.1	2, 3	1	Lecture
Methods of plant propagation- Sexual (seed propagation) and Asexual; Artificial methods (cutting, grafting, budding and layering); Use of growth regulators for rooting.	2.2	2, 3	3	Lecture
Gardening - Types of gardens– Ornamental and Landscape garden, kitchen garden, Water garden and aquascaping, Aquarium plants and its propagation, Garden components (Brief account only), Bonsai & Terrarium.	2.3	1,3	2	Lecture
Module 3: Mushroom cultivation (5 Hrs)				
Scope and Significance of Mushroom cultivation, Edible and poisonous mushroom. Health benefits	3.1	2	1	Lecture
Types of commercially cultivated mushrooms - button mushroom, oyster mushroom and milky mushroom Spawn -Definition	3.2	4	1	Lecture
Cultivation methodology of Oyster mushroom – using paddy straw and saw dust. Layout and set up of a mushroom house (small scale). Processing of mushrooms and Value added products- mushroom - pickle, candy, dried mushroom	3.3	4	3	Lecture

Module 4: Fruit and vegetable technology (8 Hrs)				
Elementary knowledge on horticultural types of fruits and vegetables, Concept of shelf life and perishable fruits, Ripening and biological ageing, Storage and preservation concerns.	4.1	3	2	Lecture
Fruits preservation-Room temperature (Juice, syrup, squash), heat treatment (Jelly, jams), Dehydration (sun drying, application of sugar syrup,salt), freezing	4.2	4	3	Lecture
Vegetable preservation-packaging and storage, dehydration techniques, vegetable products (flakes, chips, dried powder), frozen vegetables, Preservation by Canning and bottling.	4.3	4	3	Lecture
Module 5: Plant tissue culture (6 Hrs)				
Concept of totipotency, definition of explant, callus. Infrastructure of a tissue culture laboratory. Solid and liquid media – basic components of tissue culture medium. Sterilization of explants. Inoculation and incubation. Sterilization of explants. inoculation and incubation.	5.1	1,2 ,4	3	Lecture
Micro propagation: different stages, organogenesis and embryogenesis	5.2	1,2 ,4	3	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Practical (30 Hrs)				
Preparation of potting mixture	7.1	5	1	Hands on training
Hands on training in grafting	7.2	5	3	Hands on training
Hands on training in budding	7.3	5	3	Hands on training
Hands on training in layering	7.4	5	3	Hands on training
Training in mushroom cultivation	7.5	5	10	Hands on training
Tissue culture; media preparation and micro propagation	7.6	5	10	Hands on training

Reference

1. Adams C R, Early M P, 2004. Principles of Horticulture. Elsevier, N. Delhi.
2. Alvares, C. 1996. The Organic Farming Source Book. The Other India Press, Mapusa, Goa.
3. Barton West R, 1999. Practical Gardening in India. Discovery Pub. House, New Delhi.
4. Edmond J B, Senn T L, Andrews F S, Halfacre P G, 1975. Fundamentals of Horticulture (IV Edn). TMH, New Delhi.
5. George Acquciah, 2004. Horticulture: Principles and Practices (II Edn). Prentice Hall. India.

6. Gopal Chandha De, 2002. Fundamentals of Agronomy. Oxford and IBH Publishing House.
7. Hudson T, Hartmann, Dale E Kester, 2001. Plant Propagation, Principles and Practices (VI Edn). Prentice Hall, India.
8. Kalyan Kumar De, 1996. Plant Tissue Culture. New Central Book Agency (P) Ltd.
9. Kaul T N, 2002. Biology and Conservation of Mushroom. Oxford and IBH Publishing Co.
10. Pandey R K, S K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.
11. Purohit S S, 2005. Plant Tissue Culture. Student Edition.
12. Razdan M K, 1995. Introduction to Plant Tissue Culture (II Edn). Oxford and IBH Publishing Co.
13. Rema L P, 2006. Applied Biotechnology. MJP Publishers
14. Sathe, T.V. 2004, Vermiculture and Organic Farming. Daya Publishers.
15. Sharma R R, 2005. Propagation of Horticultural Crops. Kalyani Publishers.
16. Sharma, Arun K. 2002. A Handbook of Organic farming. Agrobios, India.
17. Singh B D, 1996. Biotechnology. Kalyani Publishers.

Course designed by: Mr Tom Joseph

SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO3DSC200	Major	Introduction to Molecular Biology	5	75	4
SBU24BO3DSC201	Major	Fundamentals of Cell Biology	5	75	4
SBU24BO3DSC202	Major/ Minor	Bryology, Pteridology and Gymnosperms	5	75	4
SBU24BO3DSE200	Elective	Introduction to Plant Biotechnology	4	60	4
SBU24BO3DSE201	Elective	Seed Science Technology	4	60	4
SBU24BO3DSE202	Elective	Evolutionary Biology	4	60	4
SBU24BO3MDC200	MDC	Conservation Biology and Bioenergy	3	45	3
SBU24BO3VAC200	VAC	Aquaponics	3	45	3

SBU24BO3DSC200: INTRODUCTION TO MOLECULAR BIOLOGY

Type of Course	Major/Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Comprehend the fundamentals of heredity, genetic material, and pivotal studies leading to the identification of DNA as the genetic material.	U
CO2	Explain DNA structure and its replication, including primary and secondary structures, variations, and genetic implications.	U
CO3	Demonstrate proficiency in understanding the structure and functions of various RNA molecules.	U
CO4	Explain genome anatomy, including DNA topology, supercoiling, chromatin structure, organization of eukaryotic chromosomes, and the significance of gene distribution.	U
CO5	Identify and explain DNA errors and demonstrate a deep understanding of DNA repair mechanisms, characteristics and roles of transposable elements and genetic recombination in genome evolution.	U

Cognitive Levels; R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	3	2	-	2	2	2	-	1	-
CO2	-	3	2	-	2	2	1	2	1	-
CO3	-	3	2	-	2	2	1	-	1	-
CO4	-	3	2	-	2	2	1	-	1	-
CO5	-	3	2	-	2	2	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open Book Test	Written Exam	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	-	x	x
CO5	x	x	x	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Practical skills	Lab Involvement	Viva voce	Lab Test	Record	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	-	x	x
CO5	x	x	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Genetic material (6 Hrs)				
Introduction to heredity and the genetic material, characteristics of genetic material.	1.1	1	2	Lecture
Early studies on DNA [works of F. Miescher, Albert Kossel, Phoebus Levene, Erwin Chargaff], The discovery of transforming principle [Griffith's experiment], Identification of the transforming principle [Avery, MacLeod and McCarty's experiment]; [Hershey and Chase experiment]	1.2	1	2	Lecture
Watson and Crick's discovery of the structure of DNA, discovery of RNA as the genetic material in some organisms [Heinz Fraenkal-Conrat's experiment].	1.3		2	Lecture
Module 2: Structure of DNA (6 Hrs)				
Primary structure; structure of nitrogen bases, structure of nucleotides, formation of polynucleotide strands	2.1	2	2	Lecture
secondary structures of DNA; A, B and Z DNA, circular and linear DNA, non-canonical structures, DNA triplex and quadruplex, genetic implications of DNA structure.	2.2	2	4	Lecture
Module 3: DNA replication (5 Hrs)				
Suspected forms of DNA replication, conservative, dispersive and semi-conservative, Meselson and Stahl's experiment	3.1	2	1	Lecture
Modes of replication- theta replication, rolling circle replication, linear eukaryotic replication, replicon, requirements of replication, direction of replication, continuous and discontinuous replication, Okazaki fragments, experiment by Reiji Okazaki, details of bacterial DNA replication, enzymes and proteins involved.	3.2	2	2	Lecture
Details of eukaryotic DNA replication, enzymes and proteins involved, end replication problem, telomeres and telomerase, fidelity of DNA replication, DNA replication inhibitors	3.3	2	2	Lecture
Module 4: Structure and types of RNA molecules (4 Hrs)				
Early RNA world, structure of RNA	4.1	3	1	Lecture
Types of RNAs and their function: mRNA, tRNA (Structure	4.2	3	3	Lecture

of tRNA, clover leaf and 'inverted L' models, wobble hypothesis), rRNA, snRNA, snoRNA, miRNA				
Module 5: Genome topology (11 Hrs)				
DNA Topology- Linking Number, Twist and Writhe; DNA supercoiling - positive and negative, role of topoisomerase in addition and removal of supercoils.	5.1	4	2	Lecture
Anatomy of Eukaryotic genome; chromatin, histone proteins, nucleosome, chromatosome, higher order chromatin structure	5.2	4	3	Lecture
structure of eukaryotic chromosome, molecular structure of centromere and telomere.	5.3	4	3	Lecture
Distribution of genes in chromosomes, gene deserts, c-value paradox, Types of DNA sequences in eukaryotes – unique sequence DNA, repetitive DNA, DNA renaturation kinetics, Cot curve.	5.4	4	3	Lecture
Module 6: DNA Errors and DNA Repair Mechanisms (7 Hrs)				
Point Mutations-Transitions and Transversions; Insertions or deletions; Spontaneous DNA Damage from Hydrolysis and Deamination, Depurination, Alkylation, Oxidation and Radiation exposure, inaccurate base-pairing due to Base Analogues and Intercalating Agents.	6.1	5	3	Lecture
DNA repair mechanisms- mismatch repair, direct repair, base-excision repair, nucleotide excision repair, and Recombinational DNA Repair.	6.2	5	4	Lecture
Module 7: Transposable elements (6 Hrs)				
General characteristics of transposable elements; Transposition- replicative transposition and non-replicative transposition and genome evolution.	7.1	5	3	Lecture
Transposable elements in bacteria – types; transposable elements in eukaryotes – Ac and Ds elements in maize and transposable elements in humans	7.2	5	3	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 8: Problems (10 Hrs)				
Work out problems based on DNA structure	8.1	2	10	Discussion and Problem Solving
Module 9				
Isolation of DNA from plant tissue (Basic Protocol)	9.1	2	15	Laboratory Work
Discuss the components of DNA and the importance of its structure in the extraction process.	9.2	2	5	Laboratory Work
Module 10: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell (4th Ed.), Garland Science, New York.
2. Becker, W. M. and Klein smith, L. J., World of the Cell (6th Ed.), Benjamin Cummings.
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5. Harvey, L., Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, D, Molecular Cell Biology (4th Ed.), W. H. Freeman, New York
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Course designed by: Mr Ajeesh Joseph

SBU24BO3DSC201: FUNDAMENTALS OF CELL BIOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate fundamental concepts in cell biology	U
CO2	Analyze Cellular Structures and Functions	An
CO3	Apply Knowledge to Cell Cycle Regulation	A
CO4	Interpret Chromosomal Aberrations	An
CO5	Integrate Historical Context into Cell Biology Understanding	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	-	-	-	1	-	-	-	-
CO2	-	2	-	-	1	1	2	-	1	-
CO3	-	2	1	-	1	1	1	-	1	-
CO4	-	2	-	1	1	1	1	-	1	-
CO5	1	1	-	-	-	1	1		-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Oral presentation	Quiz	Class test	Viva	
CO1	x	-	-	x	-	x
CO2	x	-	-	x	-	x
CO3	-	x	-	x	-	x
CO4	-	x	-		x	x
CO5	-	-	x	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Lab involvement	Record	Lab Test	
CO1	x	x	-	x	x	x
CO2	x	x	-	x	x	x
CO3	-	x	x	x	x	x
CO4	x	x	-	x	x	x
CO5	-	-	-			

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Cell Biology (4 Hrs)				
History, Cell theory, cell as a system.	1.1	1,5	4	Lecture
Module 2: Cell Architecture and Membrane Structure (8 Hrs)				
Cell Architecture: prokaryotic and eukaryotic cells.	2.1	1,2	1	Lecture
Origin of Eukaryotic cell: Endosymbiont theory	2.2	2	1	Lecture
Cell membrane structure: Composition and structural Organization.	2.3	2	3	Lecture
Role of Proteins in membrane transport: Channel proteins, Pump, Carrier Proteins	2.4	2	3	Lecture
Module 3: Structure and Functions of Cell Components (14 Hrs)				
Cell organelles	3.1	2	10	Lecture
Cytoskeleton: definition, functions, components. Motor proteins	3.2	2	4	Lecture
Module 4: Cell Cycle and Cell Division (7 Hrs)				
Overview of the Cell Cycle	4.1	1, 3	1	Lecture
Mitosis	4.2	3	2	Lecture
Meiosis	4.3	3	3	Lecture
Cell Cycle Control Mechanism	4.4	3	1	Lecture
Module 5: Chromosomes (12 Hrs)				
Nucleosome model, Karyotype	5.1	4	2	Lecture
Morphology, Special types of chromosomes - salivary gland, Lamp brush and B chromosome.	5.2	4	4	Lecture
Chromosomal aberrations: Numerical aberrations	5.3	4	3	Lecture
Chromosomal aberrations: Structural aberrations	5.4	4	3	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7 Cell structure (10 Hrs)				
Prepare slides of prokaryotic and eukaryotic cells for microscopic observation.	7.1	2	6	Demonstration
Observe and compare the characteristics of different model organisms	7.2	1	4	Demonstration
Module 8NCell division (14 Hrs)				
Study of the different stages of mitosis using onion root tip squash.	8.1	3	6	Hands-on training
Find out the mitotic index	8.2	3	2	Hands-on training

Study of the different stages of meiosis	8.2	3	6	Hands-on training
Module 8 Chromosomes (6 Hrs)				
Analyze karyotypes from various organisms	9.1	4	3	Demonstration
Identify and discuss chromosomal abnormalities.	9.2	4	3	Demonstration

Reference

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell (4th Ed.), Garland Science, New York, 2002.
2. Becker, W. M. and Klein smith, L. J., World of the Cell (6th Ed.), Benjamin Cummings, 2005.
3. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis, Martin Raff, Essential cellbiology (IV Edn). Garland Science, Taylor and Francis group, 2013.
4. Cooper GM and Hausman, The Cell, a molecular approach, 6th Edition, Sinauer Associates, Sunderland, 2013
5. Gerald Karp, Cell and Molecular biology: Concepts and experiments (V Edn). John Wiley & Sons. 2007
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Course designed by: Mr. Jebin Joseph

SBU24BO3DSC202: BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS

Type of Course	Major/Minor		
Course Level	200 -299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the concepts of Bryology, Pteridology, and Gymnosperms.	U
CO2	Analyse the diverse reproductive strategies employed by Bryophytes, Pteridophytes, and Gymnosperms.	An
CO3	Evaluate the ecological and economic contributions of Bryophytes, Pteridophytes, and Gymnosperms.	E
CO4	Differentiate and compare the distinguishing characteristics of major groups within Bryophytes, Pteridophytes, and Gymnosperms.	An
CO5	Deconstruct and compare the life cycle patterns of Bryophytes, Pteridophytes, and Gymnosperms, highlighting key evolutionary transitions.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	1	-	-	2	1	1	-	-
CO2	2	1	2	-	-	3	2	1	2	1
CO3	3	-	-	3	-	2	2	2	2	1
CO4	3	-	1	3	-	2	1	1	1	1
CO5	2	-	2	-	-	2	2	2	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	-	x	x	x
CO4	x	x	x	x	x	x
CO5	-	x	-	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	-	-	x	-	-	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	-	x
CO4	x	x	x	x	-	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism
Theory (45 Hours)

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Bryophytes (14 Hrs)				
Introduction General characters – habitat, habit, reproduction, and life cycle of Bryophytes; alternation of generation. Classification; Kasyap and Smith. Evolution of sporophyte and gametophyte in Bryophytes	1.1	1,3	3	Lecture/Demonstration
Detailed Type Study General characters of the following major groups with special reference to the systematic position, occurrence, structure (morphology and anatomy), reproduction -vegetative, asexual, and sexual (excluding developmental stages) and life cycle of the following types: Hepaticopsida: *Riccia*, *Marchantia* Anthocerotopsida: *Anthoceros* Bryopsida: *Funaria*	1.2	2	8	Lecture/Demonstration
Ecological and Economical Importance Bryophytes as ecological indicators, role in plant succession, prevention of soil erosion, water retention, Economic importance of Bryophytes: Antibiotics, Horticultural importance.	1.3	3	3	Lecture/Demonstration
Module 2: Pteridophytes (16 Hrs)				
General Characters of Pteridophytes General characters of Pteridophytes, basic life cycle patterns in pteridophytes; life cycles of homosporous and heterosporous pteridophytes, vascular tissues in Pteridophytes, stelar types and their evolution, Classification of Pteridophytes by Smith	2.1	1,3	3	Lecture/Demonstration
Detailed Type Study: Structural organization of sporophyte and gametophyte (development of sex organs not necessary) of Psilotum, Selaginella and Marsilea	2.2	2	10	Lecture/Demonstration
General topics Heterospory and seed habit, Economic importance of Pteridophytes, ecological importance of Pteridophyte	2.3	3	3	Lecture/Demonstration
Module 3: Gymnosperms (15 Hrs)				
General characters of Gymnosperms General features in the morphology anatomy and reproduction of Gymnosperms, Habit, distribution of Gymnosperms and life cycle of Gymnosperms. Classification of Gymnosperms (Sporne's system)	3.1	1,3	3	Lecture/Demonstration
Type Study of Gymnosperms Morphology, anatomy, reproduction and life cycle of	3.2	2	10	Lecture/Demonstration

Cycas, *Pinus* and *Gnetum*				
Affinities of Gymnosperms Affinities of Gymnosperms, Economic and Ecological importance of Gymnosperms	3.3	3	2	Lecture/Demonstration
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Bryology (10 Hrs)				
Study of the thallus morphology and anatomy of the following bryophytes; *Riccia*, *Marchantia*, *Anthoceros* and *Funaria*	5.1	4,5	10	Hands on training
Module 6: Pteridology (10 Hrs)				
Study of the morphology, anatomy and reproductive structures of the following pteridophytes; *Psilotum*, *Selaginella* and *Marsilea*	6.1	4,5	10	Hands on training
Module 7: Gymnosperms (10 Hrs)				
Study of the morphology, anatomy and reproductive structures of the following gymnosperms; *Cycas*, *Pinus* and *Gnetum*.	7.1	4,5	10	Hands on training

Reference

1. Bhatnagar S P & Moitra A., 2003, Gymnosperms, New Age International (P) Ltd., New Delhi.
2. Bower F.O, Primitive Land Plants, Cambridge, London1935.
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Course designed by: Dr. Salvy Thomas

SBU24BO3DSE200: INTRODUCTION TO PLANT BIOTECHNOLOGY

Type of Course	Major/Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the basic concepts and history of Plant Tissue Culture.	U
CO2	Describe the procedure and processes involved preparing a plant tissue culture medium.	A
CO3	Describe the various procedures of micropropagation.	U
CO4	Explain the technique of haploid production through tissue culture	U
CO5	Explain the problems involved in secondary metabolite production using tissue culture.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	2	2	1	2	-	2	-
CO2	-	3	2	2	2	1	2	-	2	-
CO3	1	2	2	2	2	1	2	-	2	-
CO4	2	2	2	2	2	1	2	-	2	-
CO5	2	2	2	2	2	1	2	-	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open Book Test	Written Exam	
CO1	X	x	-	x	x	x
CO2	X	x	x	x	x	x
CO3	X	x	x	x	x	x
CO4	X	x	x	-	x	x
CO5	X	x	x	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Practical skills	Lab Involvement	Viva voce	Lab Test	Record	
CO1	X	x	x	x	x	x
CO2	X	x	x	x	x	x
CO3	X	x	x	x	x	x
CO4	X	x	x	x	x	x
CO5	X	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: History and basic concepts (3 Hrs)				
Experiments of Gottlieb Haberlandt, P R White, Gautheret, Nobecourt, Skoog and Steward.	1.1	1	1	Lecture
Cellular totipotency, in vitro differentiation–redifferentiation and re-differentiation, Advantages and disadvantages of micropropagation	1.2	1	2	Lecture
Module 2: Tissue Culture Media (6 Hrs)				
Basic components of tissue culture media, inorganic nutrients, carbon source, vitamins, organic supplements, chelating agents, plant hormones, gelling agents, adsorbents, pH of medium.	2.1	2	3	Lecture
General methodology of medium preparation with special reference to MS medium	2.2	2	3	Lecture
Module 3: Sterilization techniques (5 Hrs)				
Sterilization of equipments, glasswares, medium and explant. Sterilization using hot air, steam, filter, UV, alcohol and chemicals.	3.1	2	3	Lecture and demonstration
Working of hot air oven, glass bead sterilizer, autoclave and laminar air flow chamber, layout of a tissue culture lab	3.2	2	2	Lecture and demonstration
Module 4: Micropropagation (7 Hrs)				
Micropropagation- different methods – axillary bud proliferation, meristem and shoot tip culture, direct and indirect organogenesis, somatic embryogenesis, Synthetic seed production	4.1	3	5	Lecture
Hardening, transplantation and field evaluation, somaclonal variation,	4.2	3	2	Lecture
Module 5: Haploid production through tissue culture (7 Hrs)				
Production of haploids through tissue culture; androgenic methods, gynogenic methods,	5.1	4	4	Lecture
Uses of haploids, thin cell layer culture, triploid plant production, cryopreservation of plant cells	5.2	4	3	Lecture
Module 6: Secondary metabolite production (7 Hrs)				
Basics of suspension culture technique; single cell production and culture.	6.1	5	2	Lecture
Production of secondary metabolites- medium composition for secondary metabolite production, cell immobilization, biotransformation	6.2	5	5	Lecture
Module 7: Protoplast isolation and fusion (10 Hrs)				
Methods; mechanical, enzymatic, use of osmoticum, protoplast purification, protoplast viability testing, protoplast culture techniques and medium	7.1	5	5	Lecture
Somatic hybridization, spontaneous fusion, induced fusion, selection of hybrids, cybrids, applications of protoplast	7.2	5	5	Lecture

fusion				
Module 8: Media Preparation (10 Hrs)				
Preparation of nutrient medium – Murashige and Skoog medium	8.1	2	5	Laboratory Work
Establishing shoot tip, axillary bud cultures, synthetic seed production	8.2	3	5	Laboratory Work
Module 9: Laboratory Visit (5 Hrs)				
Visit a well-equipped biotechnology lab and submit a report along with the practical record.	9.1	3	5	Industrial Visit
Module 10: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Collin, H. A., & Edwards, S. (1998). Plant cell culture.
2. Dixon, R. A., & Gonzales, R. A. (Eds.). (1994). Plant cell culture: a practical approach (No. 145). IRL press.
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6. Thieman, W. J. (2009). Introduction to biotechnology. Pearson Education India.
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Course designed by: Mr. Ajeesh Joseph

SBU24BO3DSE201: SEED SCIENCE AND TECHNOLOGY

Type of Course	DSE		
Course Level	200 -299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse the significance of seeds in plant life cycles, understanding their structure, development, and physiological processes.	An
CO2	Apply seed production principles for various crops, including pollination, fertilization, seed quality assessment, and storage methods.	A
CO3	Evaluate seed processing and treatment techniques, including cleaning, grading, scarification, and dormancy breaking, for optimal germination and seedling establishment.	E
CO4	Design and implement seed technology innovations for enhancing agricultural productivity, including seed testing, certification, and genetic improvement programs.	E
CO5	Critically assess the societal and environmental implications of seed production and technology, promoting sustainable practices and ethical considerations.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E – Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	3	2	3	2	1	2	2
CO2	1	1	2	3	1	2	3	1	3	1
CO3	1	1	2	3	1	2	2	1	3	1
CO4	-	-	3	3	2	3	3	2	3	3
CO5	1	-	2	2	1	2	3	2	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	X	x	x	x
CO2	x	x	X	x	x	x
CO3	x	x	-	x	x	x
CO4	-	x	-	x	x	x
CO5	-	x	-	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Seed Morphology and Physiology (10 Hrs)				
Significance of seeds: Evolution, dispersal, propagation, and economic importance.	1.1	1	2	Lecture/Demonstration
Seed structure and development: Anatomy, ontogeny, and physiological processes.	1.2	1	2	Lecture/Demonstration
Seed dormancy and germination: Types, mechanisms.	1.3	1	3	Lecture/Demonstration
Seed quality assessment: Physical, physiological, and genetic parameters	1.4	1	3	Lecture/Demonstration
Module 2: Seed Production and Management (8 Hrs)				
Pollination and fertilization: Processes, mechanisms, and factors affecting seed set	2.1	2	2	Lecture/Demonstration
Seed production for major crops: Techniques, best practices, and environmental considerations	2.2	2	3	Lecture/Demonstration
Seed harvesting and post-harvest handling: Drying, cleaning, processing, and storage	2.3	2	3	Lecture/Demonstration
Module 3: Seed Processing and Treatment (9 Hrs)				
Seed cleaning and grading: Principles, methods, and equipment.	3.1	3	2	Lecture/Demonstration
Seed scarification and stratification: Techniques and applications for dormancy breaking	3.2	3	3	Lecture/Demonstration
Seed treatment techniques: Chemical, biological, and physical methods for enhancing germination and protecting against pests and diseases	3.3	3	4	Lecture/Demonstration
Module 4: Seed Technology and Innovation (9 Hrs)				
Seed testing and certification: Standards, procedures, and importance for quality assurance	4.1	4	3	Lecture/Demonstration
Genetic improvement of seeds: Breeding techniques, marker-assisted selection, and GMOs	4.2	4	3	Lecture/Demonstration
Emerging technologies in seed science: Seed priming, encapsulation, and nanotechnology applications	4.3	4	3	Lecture/Demonstration
Module 5: Societal and Environmental Impacts (9 Hrs)				
Seed security and food systems: Access, availability, and global challenges	5.1	5	3	Lecture/Demonstration
Intellectual property rights and seed industry dynamics: Patents, germplasm ownership, and farmer rights	5.2	5	3	Lecture/Demonstration
Environmental aspects of seed production and technology: Biodiversity, sustainability, conservation and ethical considerations	5.3	5	3	Lecture/Demonstration
Module 6: Seed Morphology and Anatomy (15 Hrs)				
Observe and describe the external and internal morphology of different seeds of various types (e.g., beans, peas, maize, sunflower), using Dissecting microscopes, scalpels, forceps, slides, stains.	6.1	1	3	Hands on training

Seed Germination and Factors Affecting: Investigate the factors affecting seed germination and assess various germination techniques using Germination chambers or trays, filter paper, seeds of different species, various light sources, temperature-controlled environments, different solutions (e.g., gibberellic acid, water).	6.2	3	3	Hands on training
Seed MC% and Viability Testing: Determine the MC% and viability of seeds using various testing methods such as Moisture analyser, Hot air oven Seed viability testers (e.g., tetrazolium test, H_2O_2 test), seeds of different ages and storage conditions.	6.3	3	3	Hands on training
Seed Processing and Storage Techniques: Understand seed processing and storage techniques to maintain seed quality using Cleaning and grading equipment (e.g., sieves, blowers), drying equipment, storage containers, seeds of different species, moisture meter, humidity control devices.	6.4	4	3	Hands on training
Seed Pathology and Seed-borne Diseases: Identify common seed-borne diseases and understand their impact on seed health and crop productivity using Diseased seeds, magnifying glasses, Petri dishes, and dissecting microscopes.	6.5	5	3	Hands on training
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

References

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2. Agarwal, S.K., and B. Singh. Seed Science and Technology (Fifth Edition) Kalyani Publishers, Ludhiana, India. 2023.
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Course designed by: Dr. Salvy Thomas

SBU24BO3DSE202: EVOLUTIONARY BIOLOGY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describes the various evidences for the process of evolution.	U
CO2	Explain the main forces of evolution and the interplay among them	U
CO3	Explain the conditions and process of formation of new species	U
CO4	Explains the process of evolution above species level over a long geological time	U
CO5	Independently investigate evolutionary questions using literature and analyses of empirical data.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2				2	2	1		
CO2	2	1				2	2	1		
CO3	2	2				2	2	1		
CO4	1	1				1	1	1		
CO5	1	1		2		1	1		2	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x		x	x		x
CO2		x	x	x		x
CO3		x	x		x	x
CO4			X		x	x
CO5			X		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to theory of organic evolution (4 Hrs)				
Historical context and key contributors	1.1	1	6	Lecture
Evidence for evolution: Fossil record, Embryology, Comparative anatomy, Geographical (Darwin's Finches and Marsupials in Australia), Vestigial organs, molecular biology, Artificial selection, Direct observation Experimental evidences (Richard Lenski)	1.2	1	8	Lecture

Module 2: Microevolution, Fitness and Natural selection (16 Hrs)				
Microevolution and Agents of Evolutionary Change: Mutation, Gene flow, Non-random mating, Genetic drift, Natural selection	2.1	2	6	Lecture
Sex and genetic shuffling, Evolutionary fitness, Selection (Stabilizing, Directional and disruptive) Sexual selection	2.2	2	10	Lecture
Module 3: Speciation (14 Hrs)				
The processes of speciation	3.1	3	2	Lecture
Types of speciation; Based on geographical origin, Based on genetic and causal basis	3.2	3	8	Lecture
Reproductive isolation and speciation; Premating, Prezygotic and Postzygotic	3.3	3	4	Lecture
Module 4: Macroevolution (16 Hrs)				
Stasis, Character change, Lineage splitting and Extinction Punctuated equilibrium and Gradualism	4.1	4	6	Lecture
Adaptive radiation, Convergent evolution, Extinction and mass extinctions, Divergent evolution, Coevolution	4.2	4	10	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. David Sadava.et.al, Life-The science of Biology, Sinauer Associates Inc,2011
2. Futuyma, Douglas J., Evolutionary biology. 3rd Sinauer Associates Inc, Publishers, Sunderland. 1998
3. Monroe W Strickberger. Evolution. Jones and Bartlett publishers 19
4. Pandey S.N.et al, 2006, A text book of Botany, Vikas Publishing House, New Delhi.
5. Simpson, The Major Features of Evolution, Oxford and IBH Publishing, New Delhi.

SBU24BO3MDC200: CONSERVATION BIOLOGY AND BIOENERGY

Type of Course	MDC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the Foundations of Conservation Biology and Bioenergy	U
CO2	Analyse Threats to Biodiversity	An
CO3	Describe conservation strategies	A
CO4	Assessment of conservation's role in climate change mitigation and adaptation	An
CO5	Explain Conservation Planning and Implementation	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	2	-	1	-	-	-	-
CO2	-	-	1	2	-	1	1	-	1	1
CO3	-	-	1	2	1	1	1	-	2	-
CO4	-	-	1	1	1	1	2	1	2	1
CO5	-	-	1	1	-	1	1	1	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	x	-	x	x	-	x
CO4	-	x	x	-	x	x
CO5	-	x	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Conservation Biology (9 Hrs)				
Conservation biology: past and present	1.1	1	2	Lecture
Biodiversity: species, genetic, and ecosystem diversity.	1.1	1	3	Lecture
Biogeographical classification of India and glimpses of Indian biodiversity and conservation areas.	1.2	1	2	Lecture
Biodiversity: Ecosystem Functions and services.	1.3	1	2	Lecture, Discussion
Module 2: Threats to Biodiversity (9 Hrs)				

Impact of climate change on biodiversity	2.1	2	3	Lecture, Discussion
Threats like overexploitation, fragmentation, habitat loss, invasive species, poaching of wildlife, fire.	2.2	2	3	Lecture
Effect of degeneration of biodiversity on the future of evolution.	2.3	2	3	Lecture, Discussion
Module 3: Conservation Strategies: (18 Hrs)				
Global biodiversity conservation planning and priorities. Biodiversity conservation in India: Western Ghats and Himalayas	3.1	3	2	Lecture
Endangered and Endemic species of India	3.2	3, 5	2	Lecture
In-situ and Ex-situ Conservation:Manipulation of wild populations: control of predators, herbivores and competitors; management of problem species; captive breeding; plant propagation; re-establishment and relocation; advance technology in service of endangered species, zoos and botanical gardens, conservation of plant diversity in seed banks, gene banks or germplasm reserves, national park, sanctuaries.	3.3	3, 5	10	Lecture
Conservation strategies in the face of climate change mitigation and adaptation approaches Sustainable Development Goals 2030	3.4	3, 5	4	Lecture, discussion
Module 4: Bioenergy (9Hrs)				
Definition of bioenergy, Importance and relevance in the context of renewable energy, Types of Bioenergy: Biodiesel, bioethanol, biofuels, and biogas.	4.1	1, 3	3	Lecture, discussion
Biomass-based bioenergy: solid and liquid Biochemical conversion pathways: anaerobic digestion, fermentation, and combustion. Thermochemical conversion pathways: pyrolysis, gasification, and combustion	4.2	1,3	3	Lecture, discussion
Sources of biomass: agricultural residues, forestry residues, energy crops, Algae and microorganisms and organic wastes. Sustainable biomass production and harvesting practices.	4.3	1,3	3	Lecture, discussion
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Prashantkumar Joshi and Pushyamitra Joshi, Textbook of Conservation Biology, Evincepub Publishing, 2020
2. Megadiversity Conservation: Flora, Fauna and Medicinal Plants of India's Hot Spots By AB Chaudhuri, D. D. Sarkar Published by Daya Books, 2004
3. Gren Lucas and Hugh Synge, The IUCN Plant Red data book, The WWF.
4. Edward O. Guerrant, Kayri Havens, Mike Maunder, Peter H., Ex Situ Plant Conservation: Supporting Species Survival in the Wild Raven Published by Island Press, 2004
5. P.D. Sharma, Ecology and Environment, 10th Ed., Rastogi Publications, 2009
6. Peter D Stiling, Ecology: Theories and Applications, 4th Ed., Prentice Hall India Learning Private Limited, 2002
7. Navjot S. Sodhi and Paul R. Ehrlich, Conservation Biology for All, first ed., Oxford UniversityPress,

2010.https://conbio.org/images/content_publications/ConservationBiologyforAll_reducedsize.pdf
8. https://sdgs.un.org/goals
9. Mitigation and Adaptation | Solutions – Climate Change: Vital Signs of the Planet (nasa.gov)
10. https://sustainabledevelopment.un.org/memberstates/india#:~:text=Swachh%20Bharat%20%2D%20Swasth%20Bharat%20(Clean,child%20and%20maternal%20mortality%20rates.
11. https://iea.blob.core.windows.net/assets/aff480dc-d861-4d80-8a68-ba5309aa0f23/CIAB_Case_Studies_2006.pdf

Course designed by: Mr Jebin Joseph

SBU24BO3VAC200: AQUAPONICS

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Obtain and demonstrate technological knowledge and understanding of aquaponic systems	U
CO2	Be able to grow fish and vegetables in aquaponics	U
CO3	Assess the value of aquaponics in terms of ecological, social and economic importance	U
CO4	Be able to design and construct a simple aquaponic unit	U
CO5	Provides an excellent model of nature's biological cycles for observation	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5										

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction (20 Hrs)				
Introduction to aquaponics	1.1	1,2,3	5	Lecture
Living organisms in aquaponics-fish	1.2	1,3,5	5	Lecture
Living organisms in aquaponics-plants	1.3	1,3,5	5	Lecture
Living organisms in aquaponics-bacteria	1.4	1,3,5	5	Lecture

Module 2: Water analyse in aquaponics (10 Hrs)				
pH and alkalinity of the water	2.1	2,3	5	Lecture
Nitrogen cycle and nutrient flows	2.2	2,3	5	Lecture
Module 3: Fish and plant management in aquaponics (10 Hrs)				
Fish management	3.1	4,5	5	Lecture
Plant management: health and nutrition	3.2	4,5	5	Lecture
Module 4: Design and maintenance (10 Hrs)				
Aquaponics system design and considerations	4.1	1,2,4	5	Lecture
Maintenance of the aquaponics system	4.2	1,2,4	5	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Recsetar, M.& Kelly, A. 2015.Is Aquaponics for you. Realities and Potentials for Arkansas. University of Arkansas Cooperative Extension Service FSA 9618. 6 pp.
2. Rakocy, J., Losordo, T.& Masser, M.1992.RecirculatingAquacultureTankProduction Systems. Integrating Fish and Plant Culture. SRAC Publication No. 454. 8 pp.
3. Tyson, R.V., Treadwell, D.D., Simonne, E.H.2011.Opportunitiesandchallengesto sustainability in aquaponic systems. Horttechnology, 21 pp. 6-13
4. Love, D.C., Uhl, M.S., Genello, L., 2015. Energy and water use of a small-scale raft aquaponics system in Baltimore, Maryland, United States. Aquaculture Engineering 68 pp 19-27.
5. Goddek S et al. 2015. Challenges of Sustainable and Commercial Aquaponics. Sustainability vol. 7 no. 4, pp. 4199-4224
6. Eck, M., Sare, A.R., Massart, S., Schmautz, Z., Junge, R., Smits, T.H.M., Jijakli, M.H.,2019. Exploring bacterial communities in aquaponic systems. Water (Switzerland) 11, pp 1-16.
7. Kyaw, T.Y., Ng, A.K., 2017. Smart Aquaponics System for Urban Farming. Energy Procedia 143, 342-347.
8. Mamatha, M.N., Namratha, S.N., 2018.Design & implementation of indoor farming using automated aquaponics system. 2017 IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials. Proceedings 2 pp 396-401.

Course designed by: Mr Tom Joseph

SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO4DSC200	Major	Phycology and Bryology	5	75	4
SBU24BO4DSC201	Major	Pteridophytes and Gymnosperms	5	75	4
SBU24BO4DSC202	Major/ Minor	Taxonomy and Economic Importance of Angiosperms	5	75	4
SBU24BO4DSE200	Elective	Anatomy and Embryology of Angiosperms	4	60	4
SBU24BO4DSE201	Elective	Immunology	4	60	4
SBU24BO4DSE202	Elective	Developmental Biology	4	60	4
SBU24BO4SEC200	SEC	Mushroom Production and Value Addition	3	45	3
SBU24BO4VAC200	VAC	Climate Change	3	45	3

SBU24BO4DSC200: PHYCOLOGY AND BRYOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe and distinguish the morphology of algae and bryophytes	U
CO2	Explain the diversity in the habitat and structure of algae and bryophytes.	U
CO3	Explain the ecological relevance and potential role of algae and bryophytes and the algal culture methods	U
CO4	Explains the reproductive mechanism in bryophytes and algae	U
CO5	Compare the different kinds of life cycle patterns shown by algae and bryophytes	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
PHYCOLOGY				
Module 1: Introduction to Algae (6 Hrs)				
General characters of algae.	1.1	1,2	2	Lecture
Reproductive methods in algae.	1.2	1,4	2	Lecture
Life cycles of algae.	1.3	1,5	1	Lecture
Classification of algae by Fritsch F. E. (1935).	1.4	1	1	Lecture
Module 2: Detailed Type study (14 Hrs) General characters of the classes with special reference to the systematic position, habitat, thallus structure, reserve food, reproduction (excluding developmental stages) and life cycle.				
Cyanophyceae: *Nostoc and Oscillatoria.*	2.1	1,2,4,5	2	Lecture
Chlorophyceae: *Chlamydomonas, Chlorella, Volvox, Oedogonium, Cladophora and Chara.*	2.2	1,2,4,5	6	Lecture
Xanthophyceae: *Vaucheria.*	2.3	1,2,4,5	1	Lecture
Bacillariophyceae: *Pinnularia.*	2.4	1,2,4,5	1	Lecture
Phaeophyceae: *Sargassum.*	2.5	1,2,4,5	2	Lecture
Rhodophyceae: *Polysiphonia.*	2.6	1,2,4,5	2	Lecture
Module 3: Algal ecology (2 Hrs)				
Algae as primary producers and ecosystem engineers Algal associations and its significance, Parasitic algae Symbiotic algae-association of algae with fungi, bryophytes, pteridophytes, gymnosperms, angiosperms, invertebrates). Role of algae in N2 fixation	3.1	1,3	2	Lecture
Module 4: Applied Phycology (4 Hrs)				
Useful aspects of algae: Algae as Food and fodder	4.1	1,3	1	Lecture
Industrial phycology; Algae as source of valuable commercially important products-carrageenin, agar-agar, alginate, pigments, Medicine, enzymes, diatomite, biofuel, bioethanol, antibiotics	4.2	1,3	1	Lecture
Algae in soil fertility: Soil algae and cyanobacteria. Biofertilizers.	4.3	1,3	1	Lecture
Algae as pollution indicator and in waste water treatment, Phycoremediation.	4.4	1,3	1	Lecture
Module 5: Harmful effects of algae (3 Hrs)				
Algal blooms, red tides, eutrophication, neurotoxins	5.1	1,3	1	Lecture
Module 6: Algal culture				
Scope and a brief account on isolation, purification and culture methods.	6.1	1,3	2	Lecture
BRYOLOGY				
Module 7: Introduction (5 Hrs)				
General characters	7.1	1,2,4,5	2	Lecture
Land adaptations of bryophytes.	7.2	1,2,4,5	1	Lecture
life cycle of Bryophytes; alternation of generation.	7.3	1,2,4,5	1	Lecture
Classification of bryophytes	7.4	1,2,4,5	1	Lecture

Module 8: Detailed Type Study (7 Hrs) General characters of the following major groups with special reference to the systematic position, occurrence, structure (morphology and anatomy), reproduction -vegetative, asexual, and sexual (excluding developmental stages) and life cycle of the following types:				
Hepaticopsida: *Riccia, Marchantia*	8.1	1,2,4,5	3	Lecture
Anthocerotopsida: *Anthoceros*	8.2	1,2,4,5	2	Lecture
Bryopsida: *Pogonatum*	8.3	1,2,4,5	2	Lecture
Module 9: Ecological and Economic Importance. (2 Hrs)				
Ecological importance of bryophytes	9.1	1,2,4,5	1	Lecture
Economic importance of bryophytes	9.2	1,2,4,5	1	Lecture
Module 10: Origin and Evolution of Bryophytes (2 Hrs)				
Concept of algal and pteridophytic origin of bryophytes	10.1	1,2,4,5	2	Lecture
Module 11: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module12 Phycology (15 Hrs)				
Make micro preparations of thallus structures of the types mentioned in the syllabus.	12.1	1,2,3	5	Practical
Conduct a field visit to marine and fresh water ecosystem rich in algae under the guidance of a teacher to expose algal diversity. Submit a report with geo-tagged photographs	12.2	1,2,3	5	Practical
Familiarizing the technique of algal collection and preservation	12.3	1,2,3	5	Practical
Module 13: Bryology (15 Hrs)				
Conduct a survey and submit a report with geo-tagged photos / images of gametophytes and/or sporophytes archegoniates in your locality.	13.1	1,2,3,5	5	Practical
Riccia and *Anthoceros*– Morphology and anatomy of thallus. *Pogonatum*- Morphology of the sporophyte and gametophyte	13.3	1,2,3,5	10	Practical

Reference

1. Bilgrama K. S & Saha L. C. 1996. Text Book of Algae, C B S Publishers & Distributors.
2. Fritsch F E. 1945. Structure and Reproduction of Algae. Vol.1: Cambridge University Press, London.
3. Mamatha Rao, 2009, Microbes and Non flowering plants- impact and application. Ane Boopks PvtLtd.
4. Rasheed A. 2000. An Introduction to Bryophyta. Vikas Publishing House, New Delhi.
5. Sharma O.P. 2004. Text Book of Algae. Tata Mc. Graw Hill Co.
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7. Smith GM Cryptogamic Botany vol.1

8. Smith GM Cryptogamic Botany vol.2
9. Vashista B. R .1993. Bryophyta. S Chand & Co., New Delhi.
10. Vasishta B R, Sinha A.K, Singh V.P. 2004. Botany for Degree Students- Algae, S. Chand & Co. Ltd. New Delhi.

Course designed by: Tom Joseph

SBU24BO4DSC201: PTERIDOPHYTES AND GYMNOSPERMS

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the general features of pteridophytes and gymnosperms	U
CO2	Compare and distinguish the features of pteridophytes with respect to its habitat, morphology, anatomy and reproduction.	U
CO3	Compare and distinguish the features of gymnosperms with respect to its habitat, morphology, anatomy and reproduction.	U
CO4	Describe the different economic and ecological uses of pterdophytes and gymnosperms	U
CO5	Distinguish the anatomical features of various organs of pteridophytes and gymnosperms	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1				2	1	1		
CO2	2	1				2	1	1		
CO3	2	1				2	1	1		
CO4	1	1				1	1	1		
CO5				2					2	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	x	x	x		x
CO2		x	x	x		x
CO3		x	x		x	x
CO4	x		x		x	x
CO5						

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab skill	Viva voce	Lab Report	Record work	Test	
CO1		x			x	x
CO2		x			x	x
CO3						
CO4						
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: General Characters of Pteridophytes (5 Hrs)				
General characters of Pteridophytes, basic life cycle patterns in pteridophytes	1.1	1	2	Lecture
Vascular tissues in Pteridophytes, stelar types and their evolution	1.2	1	2	Lecture
Classification of Pteridophytes by Smith	1.3	1	1	Lecture
Module 2: Detailed Type Study (20 Hrs)				
Structural organization of sporophyte and gametophyte (development of sex organs not necessary) of *Psilotum, Lycopodium, Selaginella, Equisetum, Pteris and Marsilea*	2.1	2	20	Lecture
Module 3: General topics (2 Hrs)				
Heterospory and seed habit	3.1	1	1	Lecture
Economic importance of Pteridophytes, ecological importance of Pteridophytes	3.2	4	1	Lecture
Module 4: General characters of Gymnosperms (3 Hrs)				
General features in the morphology anatomy and reproduction of gymnosperms.	4.1	1	1	Lecture
Habit, distribution of gymnosperms and life cycle of gymnosperms.	4.2	1	1	Lecture
Classification of gymnosperms (Sporne's system)	4.3	1	1	Lecture
Module 5: Type Study of Gymnosperms (12 Hrs)				
Morphology, anatomy, reproduction and life cycle of *Cycas, Pinus and Gnetum*	5.1	3	12	Lecture
Module 6: Affinities of Gymnosperms (3 Hrs)				
Affinities of Gymnosperms	6.1	4	2	Lecture
Economic and ecological importance of Gymnosperms	6.2	4	1	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Pteridophytes (20 Hrs)				
Study of the morphology, anatomy and reproductive structures of the following pteridophytes; *Psilotum, Lycopodium, Selaginella, Equisetum, Pteris and Marsilea*	7.1	5	20	Hands on experiment
Module 8: Gymnosperms (10 Hrs)				
Study of the morphology, anatomy and reproductive structures of the following gymnosperms; *Cycas, Pinus and Gnetum*	8.1	5	10	Hands on experiment
Module 9: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Bhatnagar S P & Moitra A., Gymnosperms, New Age International (P) Ltd., New Delhi.2003
2. Coutler J.M & Chamberlain C. J. Morphology of Gymnosperms. Central Book Depot Allahabad.1958.
3. Dutta S.C, An Introduction to Gymnosperms, Kalyan Publishing Co. New Delhi. 1991.
4. Pandey S. N, A text book of Botany, Vikas Publishing House.New Delhi, 2006.
5. Rasheed A, An Introduction to Pteridophyta, Vikas Publishing House. New Delhi, 1999.
6. Sporne KR Morphology of Gymnoperm
7. Vashista B. R, Gymnosperms, S Chand & Co., New Delhi. 1993.

Course designed by: Biju George

SBU24BO4DSC202: TAXONOMY AND ECONOMIC IMPORTANCE OF ANGIOSPERMS

Type of Course	Major/Minor		
Course Level	200 -299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe plant morphology using scientifically accurate terminologies	U
CO2	Identify plant taxa based on morphological features	U
CO3	Explain the taxonomic tools, techniques and methods for plant identification and naming.	A
CO4	Explain the evolutionary relationships among plant groups included in the syllabus.	U
CO5	State the economic importance of plants included in the syllabus, in terms of food, medicine and commerce.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	-	x	x	x	x	x
CO2	x	-	x	x	x	x
CO3	-	x	-	x	x	x
CO4	-	x	-	x	x	x
CO5	x	-	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Morphology of Angiosperms (7 Hrs)				
Leaf: Simple leaf and compound leaf, Phyllotaxy	1.1	1	1	Lecture, Demonstration
Inflorescences: Cymose, Racemose and Special type	1.2	1	2	Lecture, Demonstration
Flowers: Based on position of ovary, symmetry and number of whorls	1.3	1	2	Lecture, Demonstration
Fruits: Simple, Multiple and Aggregate	1.4	1	2	Lecture, Demonstration
Module 2: Different Taxonomic Approaches and Tools (7 Hrs)				
Different Taxonomic Approaches: Types of classification, Bentham and Hooker's system of classification, binomial nomenclature; cytotaxonomy, chemotaxonomy.	2.1	3,4	5	Lecture
Herbarium preparation, importance of herbarium.	2.2	3	2	Lecture and Demonstration
Module 3: Detailed Study of Angiosperm Families and Economic Botany (24 Hrs)				
Study of the following families of Bentham and Hookers system of classification with special reference to major identifying characters and economic importance: Annonaceae, Malvaceae, Rutaceae, Leguminosae, Apiaceae (Umbelliferae), Rubiaceae, Asteraceae, Apocynaceae, Lamiaceae (Labiatae), Euphorbiaceae, Arecaceae (Palmae), Poaceae (Gramineae).	3.1	2	24	Lecture, Demonstration
Module 4: Economic and Medicinal Plants (7 Hrs)				
Economic Botany: Study of the following economic plants with special reference to their botanical name, family, morphology of useful part, economic products and uses. Cereals: Paddy,Wheat. Pulses: Green gram, Bengalgram. Tuber crops: Tapioca. Spices: Pepper, Cardamom. Beverages: Tea, Coffee. Oil yielding plants: Coconut, Groundnut Fiber yielding plants: Cotton, Coir. Timber yielding plants: Teak, Rosewood. Latex yielding plants: Pararubber. Biopesticides: Neem, Tobacco. Ornamental plants: Rose, Orchids, Anthurium.	4.1	5	4	Lecture, Demonstration
Study of the following medicinal plants with special reference to their binomial, family, morphology of useful parts and uses. *Adhatoda vasica, Aloe vera, Bacopa moniri, Catharanthus roseus Eclipta alba, Azadirachta indica, Ocimum sanctum, Phyllanthus amarus, Rauvolfia serpentina, Sida acuta*	4.2	5	3	Lecture, Demonstration

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Identification of Plants (30 Hrs)				
Identification of leaf, inflorescence and fruit types Identify the member plants belonging to the families mentioned in the syllabus	5.1	2,3	25	Hands on experiment
Describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family.	5.2	2,3		Hands on experiment
Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphology, Botanical name and family.	5.3	5	5	Hands on experiment
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Annie Ragland and V Kumaresan, Morphology of Angiosperms, Taxonomy and Economic Botany; Saras Publication; 1st edition, 2018.
2. Arun K. Pandey and Shruti Kasana Plant Systematics; CRC Press; 1st edition, 2021.
3. Ashok Bendra and Ashok Kumar, Economic botany. Rastogi publications, Meerut, 1980.
4. B P Pandey, A Textbook of Botany: Angiosperms - Taxonomy, Anatomy, Embryology and Economic Botany; S Chand & Co Ltd, 2016.
5. Henry and Chandra Bose an Aid to the International Code of Botanical Nomenclature. Botanical Survey of India. Coimbatore, 2001.
6. Gurucharan Singh, Plant Systematics Theory and Practice 3Ed; Oxford & IBH Publishing Co Pvt.Ltd, 2019.
7. Jain S K A Manual of Ethnobotany, Scientific Publishers, India, 2004.
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9. Pandey B.P., Economic Botany S. Chand& Company Ltd. New Delhi, 2000.
10. Pandey & Misra, Taxonomy of Angiosperms. Ane Book Pvt. Ltd, 2008.
11. http://www.theplantlist.org/

Course designed by: Jebin Joseph

SBU24BO4DSE200: ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the various types of cells, tissues and tissue systems in plant body	R
CO2	Explain and distinguish the plant body based on its anatomy	U
CO3	Explain the process of normal and anomalous secondary growth in plants, based on the detailed anatomical study of selected plants.	U
CO4	Describe the process of reproduction in angiosperms by studying the development of reproductive organs, gametophytes in them.	U
CO5	Show the distinct patterns of endosperm and embryo development in angiosperms.	U

Cognitive Levels; R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	-	-	2	-	1	-	-
CO2	2	2	-	-	-	1	-	1	-	-
CO3	2	2	-	-	-	1	-	1	-	-
CO4	1	1	-	-	-	1	-	1	-	-
CO5	2	2	-	-	-	1	1	1	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open Book Test	Written Exam	
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	-	x	-	x	x
CO4	x	x	x	x	x	x
CO5	x	-	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Cell, Tissues and Tissue Systems (13 Hrs)				
The plant cell wall, gross structure, primary and secondary cell walls, channels of intercellular transport; pits, plasmodesmata.	1.1	1	2	Lecture & Demonstration

Non-living inclusions in plant cells: food products, secretory products.	1.2	1	2	Lecture & Demonstration
Tissues- simple, complex, composition of xylem and phloem, Meristematic tissue, types.	1.3	1	4	Lecture & Demonstration
Tissue Systems; Epidermal tissue-epidermis, cuticle, trichome, stomata, hydathodes, bulliform cells, cork and silica cells. Ground Tissue - cortex, endodermis, pericycle, pith and pith rays. Vascular Tissue - different types of vascular bundles and their arrangement in root and stem.	1.4	1	5	Lecture & Demonstration
Module 2: Structure and Organisation of Root and Shoot Apices (2 Hrs)				
Apical cell theory, Histogen theory, Tunica-Corpus theory and Korper- Kappe theory	2.1	2	2	Lecture
Module 3: Plant Body and Secondary Growth (9Hrs)				
Primary structure of stem, root and leaf (dicot and monocot). Cambium; Development, structure and function.	3.1	2	3	Lecture & Demonstration
Normal secondary growth in dicot stem and root; stelar and extra-stelar, periderm, bark, polyderm, rhytidome and lenticels.	3.2	3	3	Lecture & Demonstration
Anomalous secondary growth in Bougainvillea stem, Bignonia stem and Dracaena stem.	3.3	3	3	Lecture & Demonstration
Module 4: Wood Anatomy (3 Hrs)				
Wood; basic structure, heart wood, sap wood, hard wood, softwood, tyloses, growth rings and dendrochronology, porous and non-porous wood, ring porous and diffuse porous wood, woodrays; structure and celltypes, uniseriate and multiseriate rays; heterocellular and homocellular rays.	4.1	3	3	Lecture & Demonstration
Module 5: Microsporogenesis (4 Hrs)				
Anther; structure, different types, pollinium, development, dehiscence. Development of male gametophyte, pollen germination and viability	5.1	4	4	Lecture
Module 6: Megasporogenesis (6 Hrs)				
Structure and development of ovule, placentaion types. Structure of mature embryo-sac monosporic (polygonum type), bisporic (Allium type) and tetrasporic (Plumbago Type, Peperomia Type and Fritillaria Type).	6.1	4	6	Lecture & Demonstration
Module 7: Pollination and Fertilization (4 Hrs)				
Pollination, mechanisms and agencies, natural Mechanisms to prevent self- pollination herkogamy, heterostyly, protrandry and protogyny, Special types of pollination mechanism, Fertilisation; syngamy, triple fusion.	7.1	4 & 5	4	Lecture
Module 8: Embryo Development (4 Hrs)				
Development of endosperm, Types cellular, nuclear and helobial endosperms. Structure of embryo in dicots and monocots,	8.1	4 & 5	4	Lecture

Polyembryony and apomixes- apogamy and apospory, parthenocarpy.				
Module 9: Plant Anatomy (10 Hrs)				
Cell and tissue types- Simple and Complex Non-living inclusions – Starch grains, Cystolith, Raphides and Aleurone grains. Primary structure of stem, root and leaf-Dicots and Monocots.	9.1	1,2	5	Laboratory Work
Stomatal types: - anomocytic, anisocytic, paracytic and diacytic	9.2	1	1	Laboratory Work
Secondary structure of dicot stem and root. Anomalous secondary structure of Bougainvillea stem, Bignonia stem and Dracaena stem.	9.3	3	4	Laboratory Work
Module 10: Angiosperm Embryology (5 Hrs)				
Anther (Monothecous and Dithecous), Embryo Sacs, embryo and Placentation types.	10.1	4,5	5	Laboratory Work
Module 11: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

References

1. Maheshwari P., An introduction to the Embryology of Angiosperms, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1971.
2. Roy, Pijush. Plant anatomy. New Central Book Agency, 2020.
3. Fahn A. Plant Anatomy (3rd edition), Pergamon Press Oxford. 1982.
4. Foaster A.S. and Giffad E.M., Comparative Morphology of Vascular Plants. Allied Pacific Pvt. Ltd. Bombay, 1962.
5. Maheshwari P., An introduction to the Embryology of Angiosperms, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1971.
6. Shivanna K.R. and B.M. Joshi, The Angiosperm Pollen Structure & Function, Wiley Eastern Ltd., New Delhi, 1985.

Course designed by: Mr. Ajeesh Joseph

SBU24BO4DSE201: IMMUNOLOGY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Theory (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	The course is designed for students with no prior knowledge of immunology and students are encouraged to understand the fundamentals of immunology	U
CO2	understanding of key concepts in immunology along with overall organization of the immune system.	U
CO3	Appreciate the significance of maintaining a state of immune tolerance sufficient to prevent the emergence of autoimmunity.	U
CO4	To make them understand the salient features of antigen antibody reaction & its uses in diagnostics and various other studies.	U
CO5	Learn about immunization and their preparation and its importance.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Innate Immunity (17 Hrs)				
First-Line Defenses, Physical Barriers: Skin, Mucous Membrane. Chemical Barriers, Normal Microflora	1.2	1,2	3	Lecture
Introduction to Cells of the Immune System, Granulocytes, Agranulocytes.	1.3	1,2	3	Lecture

Cell Communication: Surface Receptors Adhesion Molecules, Cytokines, Pattern Recognition Receptors (PRRs)	1.4	1,2	3	Lecture
Complement System: Activation Pathways of the Complement System, Effects of the Complement System	1.5	1,2	2	Lecture
Phagoctytosis,	1.6	1,2	2	Lecture
Inflammation: Steps of the Inflammatory Response, Fever	1.7	1,2	2	Lecture
Interferon Response.	1.8	1,2	2	Lecture
Module 2: Adaptive Immunity (27 Hrs)				
Antigens,	2.1	1,2	1	Lecture
T Lymphocytes	2.2	1,2	1	Lecture
Major Histocompatibility Complex Molecules,	2.3	1,2	2	Lecture
Activation of T Lymphocytes,	2.4	1,2	2	Lecture
Functions of T Lymphocytes, Cytotoxic vs Helper T Cells,	2.5	1,2	2	Lecture
B Lymphocytes,	2.6	1,2	3	Lecture
Antibodies,	2.7	1,2	3	Lecture
Classes of Antibodies,	2.8	1,2	2	Lecture
Outcomes of Antibody Binding to Antigen, T Dependent & T Independent Antigens,	2.9	1,2	2	Lecture
Clonal Selection, Antibody Class Switching, Affinity Maturation,	2.10	1,2	2	Lecture
Primary and Secondary Response of Adaptive Immunity.	2.11	1,2	3	Lecture
Immune Tolerance,	2.12	1,2	2	Lecture
Regulatory T Cells, Natural Killer Cells	2.13	1,2	2	Lecture
Module 3: Autoimmunity and Immunodeficiency (3 Hrs)				
Immunological Tolerance, Autoimmunity, Classification of Autoimmune diseases Mechanisms of autoimmunity. Hypersensitivity, types of hypersensitivity reactions and their features, Immunodeficiency disease	4.1	1,3	3	Lecture
Module 4: Applied Immunology (13 Hrs)				
Production and uses of monoclonal antibodies;	3.1	4,5	3	Lecture
Vaccines: Basic strategies, inactivated and live attenuated pathogens, subunit vaccines, recombinant vaccines (e.g., Hepatitis B vaccine), DNA vaccines. Modern approaches to vaccine development - edible vaccines	3.2	4,5	5	Lecture
Cancer immunotherapy	3.3	4,5	5	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Ananthanarayan, R. and Panicker, C. K. J. (2008). Textbook of Microbiology. Orient Longman Private Ltd.
2. Ananthanarayan, R. and Panicker, C. K. J. (2009). Ananthanarayan and Paniker's Textbook of Microbiology. Orient Longman Limited Universities Press (India) Pvt.

Ltd.
3. Coleman, R. M. (1992). Fundamentals of Immunology. McGraw-Hill Higher Education.
4. Wise, D. J. and Carter, G. R. (2004). Immunology - A Comprehensive Review. Iowa State University Press, Blackwell Science Co.
5. Schlegel, H. G. General Microbiology. 7th Edition. Cambridge University Press, New York, USA.
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10. Frank, S. A. (2002). Immunology and Evolution of Infectious Disease. Princeton University Press.
11. Sharma, K. (2009). Manual of Microbiology: Tools and Techniques. 2nd Edition. Ane Book's Pvt. Ltd., New Delhi.

Course designed by: Mr Tom Joseph

SBU24BO4DSE202: DEVELOPMENTAL BIOLOGY

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe basic concepts in developmental biology	U
CO2	Explain the molecular mechanism of axis formation in Drosophila	U
CO3	Explain the molecular mechanism of body patterning in Drosophila	U
CO4	Distinguish the molecular aspects of gametogenesis	U
CO5	Explains the mechanism of plant development	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2				2		1		
CO2	1	2				2		1		
CO3	1	2				2		1		
CO4	1	2				2		1		
CO5	1	2				2		1		

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x		x	x		X
CO2		x	x	x		X
CO3		x	x		x	X
CO4			x		x	X
CO5			x		x	X

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Concepts of Developmental Biology (17 Hrs)				
An overview of plant and animal development,	1.1	1	2	Lecture
Cell fate and Potency in plants and animals	1.2	1	1	Lecture
Levels of cell commitment (Specification and determination).	1.3	1	2	Lecture
Strategies of specification- Autonomous specification, conditional specification and syncytial specification. Cell lineages and fate map;	1.4	1	4	Lecture
Mechanisms of developmental commitment - cytoplasmic determinants and cell induction (endocrine signaling, paracrine signaling and juxtacrine signaling.	1.5	1	3	Lecture

Genomic equivalence. Competency of cells; Stem cells – embryonic stem cells and adult stem cells;	1.6	1	2	Lecture
Mutants and transgenics in analysis of development	1.7	1	1	Lecture
Brief introduction to Model organisms - *Drosophila, Bacillus subtilis, Saccharomyces cerevisiae, Caenorhabditis elegans and Arabidopsis*	1.8	1	2	Lecture
Module 2: Cellular and Molecular Mechanisms in the Early Development of *Drosophila* (21 Hrs)				
Early development and axis specification in *Drosophila.*	2.1	2	3	Lecture
Anterior-posterior patterning	2.2	2	1	Lecture
Maternal contribution in development of drosophila larva.	2.3	2	3	Lecture
Development of body plan in Drosophila – segmentation genes (gap genes, pair-rule genes and segment polarity genes.	2.4	3	8	Lecture
Segment identity by homeotic genes – Antennapedia complex, bithorax complex and realisator genes	2.5	3	3	Lecture
Dorsal-ventral patterning	2.6	2	3	Lecture
Module 3: Biochemical and molecular aspects gametogenesis and fertilization (10 Hrs)				
Germ cell specification (in Drosophila and mammals), Germ cell migration (InDrosophila and mammals) and gametogenesis (in mammals) Fertilization (biochemical and molecular aspects) - external fertilization (seaurchins) and internal fertilization (mammals). Prevention of Polyspermy.	3.1	4	10	Lecture
Module 4: Plant development (12 Hrs)				
Introduction to model plants used for development studies in plant system, advantages of each system with special emphasis on model plant Arabidopsis; Arabidopsis Embryogenesis: Stages in the development of embryo, Origin of polarity- Mechanisms of Auxin transport and developmental effects of auxin, Establishment of polarity in embryogenesis, Genes essential for embryo formation (GURKE, FACKEL, GNOM, MONOPTEROS), Radial patterning in plants and the genes involved in it (ATML1, PDF2, CRE or WOL); Shoot and root development- Establishment of SAM and RAM. Lateral roots, Root hairs- determination of trichoblast and atrichoblast identity; Leaf development and Phyllotaxy; Transition to flowering, floral meristems and floral development; Homeotic genes in plants. Senescence, programmed cell death and hypersensitive response in plants	4.1	5	12	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones). Biochemistry and Molecular biology of Plants. L K International Pvt. Ltd.

2. Lincoln Taiz, Eduardo Zeiger. Plant physiology (IIEdn). Sinaeur Associates, Inc. Publishers.
3. Maheswari P.An introduction to the embryology of Angiosperms. McGraw Hill.
4. R M Twyman, Instant notes in Developmental Biology. Viva Books Private Limited
5. S S Bhojwani, S P Bhatnagar. The Embryology of Angiosperms (IV Edn). Vikas Publishing House Pvt Ltd.
6. Scott F Gilbert. Developmental Biology (IX Edn). Sinauer Associates.

Course designed by: Mr Biju George

SBU24BO4SEC200: MUSHROOM PRODUCTION AND VALUE ADDITION

Type of Course	SEC		
Course Level	200 - 299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Identify and classify edible and medicinal mushrooms.	U
CO2	Understand the biology and ecological requirements of different mushroom species.	U
CO3	Apply basic principles of mushroom cultivation and spawn production.	A
CO4	Develop skills in post-harvest handling and preservation techniques for mushrooms.	E
CO5	Evaluate the economic feasibility and potential of value-added mushroom products.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2	1	3	-	2	2	1	1	1
CO2	2	3	-	3	-	3	3	1	1	2
CO3	1	1	2	3	1	2	2	1	3	2
CO4	-	-	-	1	-	1	1	1	2	1
CO5	-	-	-	2	-	1	3	2	2	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	-	x	x	x	x	x
CO3	x	x	-	x	x	x
CO4	x	x	-	x	x	x
CO5	-	x	-	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Mushrooms (6 Hrs)				
Biology and morphology of edible mushrooms	1.1	1	1.5	Lecture/Demonstration
Classification and identification of common edible mushrooms	1.2	1	1.5	Lecture/Demonstration
Nutritional value and medicinal properties of mushrooms	1.3	1	1.5	Lecture/Demonstration

Ecological roles of mushrooms and their interaction with plants	1.4	2	1.5	Lecture/Demonstration
Module 2: Cultivation Techniques (6 Hrs)				
Factors affecting mushroom growth and yield	2.1	2	1.5	Lecture/Demonstration
Substrate preparation and sterilization methods	2.2	2	1.5	Lecture/Demonstration
Cultivation techniques for different types of mushrooms (button mushrooms, oyster mushrooms, milky mushrooms)	2.3	2	1.5	Lecture/Demonstration
Management of pests and diseases in mushroom cultivation	2.4	2	1.5	Lecture/Demonstration
Module 3: Post-Harvest Management and Processing (6 Hrs)				
Harvesting and handling of mushrooms	3.1	3	1.5	Lecture/Demonstration
Sorting, grading, and packaging of mushrooms	3.2	3	1.5	Lecture/Demonstration
Preservation techniques for fresh and dried mushrooms	3.3	3	1.5	Lecture/Demonstration
Processing methods for value-added products (pickles, sauces, powders,)	3.4	3	1.5	Lecture/Demonstration
Module 4: Value-Added Products and Economic Potential (6 Hrs)				
Nutritional and medicinal potential of value-added products	4.1	4	2	Lecture/Demonstration
Economic feasibility and market analysis of mushroom cultivation	4.3	4	2	Lecture/Demonstration
Role of mushroom production in rural development and sustainability	4.4	4	2	Lecture/Demonstration
Module 5: Future Prospectus in Mushroom cultivation (6 Hrs)				
Medicinal mushrooms and their therapeutic applications	5.1	5	2	Lecture/Demonstration
Myco-remediation and the use of mushrooms for bioremediation	5.2	5	2	Lecture/Demonstration
Future prospects and challenges of the mushroom industry	5.4	5	2	Lecture/Demonstration
Module 6: Mushroom Production and Value Addition (15 Hrs)				
Microscopic observation of fungal structures	6.1	1	3	Demonstrate/ Hands on training
Identification of common edible mushrooms using keys and manuals	6.2	1	3	Demonstrate
Preparation of a mushroom bed substrate	6.3	3	3	Demonstrate/ Hands on training
Inoculation of a spawn substrate	6.4	3	3	Demonstrate/ Hands on training
Demonstration of mushroom harvesting and post-harvest handling techniques	6.5	4	3	Demonstrate/ Hands on training
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Kaul, T.N. (Latest edition). Biology and Conservation of Mushroom. Oxford and IBH Publishing Co. Ltd.

2. Krishna, K.M., & Awasthi, O.P. (2019). Mushroom Cultivation. Scientific Publishers, Jodhpur, India.
3. Sharma, O.P. (2016). Handbook of Mushroom Cultivation. International Book Distributors, Dehradun, India.
4. Sidhu, G.S. (2017). Mushrooms: Cultivation, Processing and Marketing. Kalyani Publishers, New Delhi, India.
5. Suryanarayana, D. (2020). Cultivation and Uses of Edible and Medicinal Mushrooms. MJP Publishers, Chennai, India.
6. Tewari, J.P. (2018). Mushroom Cultivation: A Practical Guide. New Age International Publishers, New Delhi, India.
7. Thakur, B.K., & Kaul, T.N. (2015). Mushroom Diversity in India: Status and Potential. Springer, New Delhi, India

Course designed by: Dr. Salvy Thomas

SBU24BO4VAC200: CLIMATE CHANGE

Type of Course	VAC		
Course Level	200 -299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe different proxies and methods used to study climate change	U
CO2	Explain the climate variability and the mechanism behind climate change	U
CO3	Distinguishes the impact of climate change on agriculture and food security	U
CO4	Explains climate change mitigation strategies	U
CO5	Discuss the impact of climate change in Kerala	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	-	-	2	-	-	1	2
CO2	2	-	1	-	-	2	-	-	1	2
CO3	2	-	1	-	-	2	-	-	1	2
CO4	2	-	1	-	-	2	-	-	1	2
CO5	2	-	1	-	-	2	-	-	1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	-	x	x	x	-	x
CO2	-	x	x	x	-	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	x	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Climate Change and Global Warming (25 Hrs)				
Climate and weather	1.1	1	1	Lecture
Climate Change and Climate Variability	1.2	2	5	Lecture
Global Warming and Its Causes	1.3	2	6	Lecture
Climate Change Effects-Slow Onset and Extreme Events	1.4	2	5	Lecture
Managing Climate Change and Green House Gases	1.5	2	3	Lecture
India's Nationally Determined Contributions (NDC) And Intended Nationally Determined Contributions (INDC)	1.6	4	5	Lecture

Module 2: Impact of Climate Change in Agriculture and Food Security (11 Hrs)				
Impact Of Climate Change on Agriculture Food Security and Vulnerable People	2.1	3	5	Lecture
Climate Change Adaptation and Mitigation In Agriculture Sectors	2.2	4	4	Lecture
Remote Sensing in Agriculture for Smart Decisions	2.3	4	2	Lecture
Module 3: Impact of Climate Change in Kerala (9 Hrs)				
Case Study of Ravages of Climate Change in Kerala	3.1	5	5	Lecture
Case Study of Action Plan to Combat Climate Change	3.2	5	4	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

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2. https://www.fao.org/3/cc2274en/cc2274en.pdf
3. https://iccs.kerala.gov.in/?page_id=3010
4. https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SRCCL-Complete-BOOK-LRES.pdf
5. http://www.gci.org.uk/Documents/Global-Warming-the-Complete-Briefing.pdf
6. https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf
7. https://iccs.kerala.gov.in/?page_id=3010
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9. Næss LO, Bang G, Eriksen S, Vevatne J (2005) Institutional adaptation to climate change: flood responses at the municipal level in Norway. Global Environ Change Part A 15(2):125–138
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11. McMichael AJ, Powles JW, Butler CD, Uauy R (2007) Food, livestock production, energy, climate change, and health. Lancet 370:1253–1263.pdf

Course designed by: Mr Biju George

SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO5DSC300	Major/ Minor	Biochemistry - I	5	75	4
SBU24BO5DSC301	Major/ Minor	Angiosperm Morphology, Taxonomy and Economic Botany	5	75	4
SBU24BO4DSE300	Elective	Fundamentals of Inheritance	4	60	4
SBU24BO4DSE301	Elective	Phytochemistry and Pharmacognosy	4	60	4
SBU24BO4DSE302	Elective	Plant Breeding and Horticulture	4	60	4
SBU24BO4DSE303	Elective	Forensic Botany	4	60	4
SBU24BO4DSE304	Elective	Microbiology and Microbial Biotechnology	4	60	4
SBU24BO5SEC300	SEC	Plant Based Micro Enterprises	3	45	3

SBU24BO5DSC300: BIOCHEMISTRY – I

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the stabilizing interactions in biological macromolecules	U
CO2	Describe various properties of water and solutes	U
CO3	Distinguish the features of acid and bases	U
CO4	Explain the feature of carbohydrates and lipids	An
CO5	Perform titration experiment and quantitative analysis of carbohydrates and lipids	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Stabilizing Interactions in Biological Macromolecules. (6 Hrs)				
Atoms- Smallest Unit of Matter, Atomic Structure, Elements of Life, Atomic Properties, Electron Orbitals & Energy Shells, Octet Rule.	1.1	1	1	Lecture
Isotopes, Radioactive Isotopes, Half-life	1.2	1	1	Lecture
Introduction to Chemical Bonding, Intramolecular vs. Intermolecular Bonds, Covalent Bonds, Polar Covalent Bonds.	1.3	1	1	Lecture
Noncovalent Bonds, lonic Bonding, ionic interactions, salt bridge, Hydrogen Bonding, Importance of hydrogen bonds, hydrophobic interactions, van der Waals forces, concept of dipole, instant and induced dipole. Importance of these noncovalent interactions in macromolecular interaction using examples.	1.4	1	3	Lecture
Module 2: Water (6 Hrs)				
Introduction to Water.	2.1	2	1	Lecture
Properties of Water- Cohesion and Adhesion, Density, Thermal, High Specific Heat, High Heat of Vaporization,	2.2	2	2	Lecture
The Universal Solvent, Solubility, dielectric constant. Comparison between Water and non polar solvents. Homogenous vs. Heterogenous Solutions, Hydrophilic vs. Hydrophobic, Diffusion, Osmosis.	2.3	2	3	Lecture
Module 3: Solution Chemistry (3 Hrs)				
Solution, composition, Aqueous Solution	3.1	2	1	Lecture
Concentrations based on Volume:Molarity(M), Normality (N),Weight/volume percent (w/v %), Volume/volume percent (v/v%), Milligram percent (mg %), Osmolarity	3.2	2	2	Lecture
Module 4: Acids and Bases (9 Hrs)				
Autoionization of Water, Proton Hopping pH, pOH, pH Scale, Acids and Bases, Amphiprotic Molecules, Relative strength of acids and bases,	4.1	3	3	Lecture
Acid Dissociation Constant, Degree of ionization of acid, Inverse relation between acid strength and pK_a, Relate pK_a & pH, Henderson Hasselbalch Equation, calculation of problems associated with this equation. Determining Predominate Species.	4.2	3	3	Lecture
Titration, Titration curve of weak acids, Buffer Solution, Biological Buffers, Regulation of the pH of blood in mammals.	4.3	3	3	Lecture
Module 5: Carbohydrates (13 Hrs)				
Carbohydrates, Monosaccharides, Stereochemistry of aldo and keto Monosaccharides, Monosaccharide	5.1	4	5	Lecture

Configurations, Cyclic Monosaccharides, Hemiacetal vs. Hemiketal, Anomer, Mutarotation, Pyranose Conformations, Common Monosaccharides,				
Derivatives of carbohydrates and their importance in biological structure and function: sugar acids, sugar, alcohols, deoxy sugars, sugar esters, amino sugars, glycosides, Reducing Sugars, Reducing Sugars Tests, Glycosidic Bond, Disaccharides, Glycoconjugates,	5.2	4	3	Lecture
Polysaccharides, Cellulose, Chitin, Peptidoglycan, Starch, Glycogen, Lectins. Importance of proteoglycans and glycoproteins in cell structure and function	5.3	4	5	Lecture
Module 6: Lipids (8 Hrs)				
Lipids, Fatty Acids, Fatty Acid Nomenclature, Omega-3 Fatty Acids,	6.1	4	3	Lecture
Triacylglycerols, Glycerophospholipids, Sphingolipids, Sphingophospholipids, Sphingoglycolipids, Waxes, Eicosanoids, Isoprenoids, Steroids, Steroid hormones, Lipid Vitamins.	6.2	4	5	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 7: Biochemistry				
General test for carbohydrates - Molischs test	7.1	4,5	5	Practical
Tests for reducing sugars and non-reducing sugars, Fehling's test.	7.2	4,5	5	Practical
carry out a semi-quantitative Benedict's test on a reducing sugar using dilution, standardising the test and using the results (colour standards or time to first colour change) to estimate the concentration	7.3	4,5	7	Practical
Colour test for starch - lodine test.	7.4	4,5	3	Practical
The emulsion test for lipids	7.5	4,5	4	Practical
Preparation of buffer	7.6	1	3	Practical
Acid base titration	7.7	1	3	Practical
Module 8: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Biochemistry Vat, D., Voet, 1.6. Publisher: Wiley; 3rd edition
2. Lehninger Principles of Biochemistry David L. Nelson, Michael M. Cox. Publisher: W. H. Freeman, Fourth Edition
3. Jeremy M Berg; John Tymocko; Lubert Stryer (2012), Biochemistry, 7*/6*h edition (or older), Wiley.

4. Plummer D.T. (1988) An Introduction to Practical Biochemistry, Tata McGraw- Hill Publishing Company, New Delhi.
5. Sadasivam. S & Manickam, A. (1996) Biochemical Methods. New Age International (P) Ltd. New

Course designed by: Mr Tom Joseph

SBU24BO5DSC301: ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe morphology of angiosperm plants.	U
CO2	Identification of angiosperm families mentioned in the syllabus using morphological features.	A
CO3	Identify plants using various taxonomic tools and techniques	A
CO4	Explain different taxonomic approaches in plant systematics	U
CO5	Describe the economic importance of plants in terms of food, medicine and commerce	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	MCQ Test	
CO1	-	x	x	x	x	x
CO2	x	-	x	x	x	x
CO3	-	x	-	x	x	x
CO4	-	x	-	x	x	x
CO5	x	-	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	-	-	-	-	-	-
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	-	-	-	-	-
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Angiosperm Morphology (10 Hrs)				
Description of Plants: Habit, leaf features: simple, compound, phyllotaxy, venation	1.1	1	2	Lecture, Demonstration
Inflorescences: Racemose types, Cymose types, Special type	1.2	1	2.5	Lecture, Demonstration
Types of flowers: Based on symmetry, based on the position of the ovary, based on floral whorls, based on the arrangement of floral whorls. Description of floral characters Floral formula, floral diagram	1.3	1	3	Lecture, Demonstration
Fruits: Different types of fruits belonging to Simple, fleshy, dry dehiscent, indehiscent, aggregate, and multiple fruits.	1.4	1	2.5	Lecture, Demonstration
Module 2: Different Taxonomic Approaches and Tools (9 Hrs)				
Systems of Classification- Linnean sexual system (Brief account), Bentham and Hooker (Detailed account), APG system (Brief account).	2.1	3,4	4	Lecture
Binomial Nomenclature, ICBN, BSI (Brief account)	2.2	3	1	Lecture
Interdisciplinary approach in Taxonomy: Cytotaxonomy, Chemotaxonomy, Molecular taxonomy and Numerical taxonomy	2.3	4	2	Lecture
Tools of angiosperm taxonomy Herbarium technique- Preparation of herbarium, preservation	2.4	4	1	Lecture, Demonstration
Botanical gardens, Flora, monograph, Taxonomic Keys and online databases: the Plant list (brief account)	2.5	3	1	Lecture
Module 3: Detailed Study of Angiosperm Families (20 Hrs)				
Study of the following families of Bentham and Hooker's System with special reference to their morphological and floral characters. Special attention shall be given to common and economically important plants within the families. Annonaceae, Malvaceae, Rutaceae, Mimosaceae, Caesalpiniaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Sapotaceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Arecaceae, Poaceae.	3.1	2	20	Lecture, Demonstration
Module 4: Economic Botany and Ethnobotany (6 Hrs)				
Study of the following groups of plants based on their uses with special reference to the botanical name, family and morphology of the useful part, Cereals- Rice, Wheat, Maize Millets- Ragi Pulses- Green gram, Bengal gram, Black gram Fruits- Apple, Pineapple, Grape, Mango and Banana Fibre yielding plant – Cotton, Jute, Coir Vegetables- Bitter gourd, Snake gourd, Ash gourd, Ladies finger, Carrot and Cabbage. Sugar- Sugar cane, Sugar beet Timber yielding plants- Teak wood and Jack wood, Rose	4.1	5	3	Lecture, Demonstration

wood Beverages- Tea, Coffee Oil yielding plants- Ground nut, Gingelly, coconut Rubber yielding plants- Para rubber Spices and condiment - Cardamom, cloves, ginger, star anise, nutmeg, pepper, Asafoetida Insecticide-yielding Plants- Tobacco and Neem				
Ethnobotany and its significance. Methodology of ethnobotanical studies Study of the following plants used in daily life by tribals and village folks for Food (Jack fruit), Shelter (Bamboo, Calamus) and Medicine (Trychopus, Turmeric)	4.2	5	3	Lecture, Demonstration

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Identification of Plants (30 Hrs)				
Identification of leaf, inflorescence and fruit types Identify the member plants belonging to the families mentioned in the syllabus	5.1	2,3	20	Hands on experiment
Describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family.	5.2	2,3	5	Hands on experiment
Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.	5.3	5	5	Hands on experiment
Module 6: Field visit				
Prepare a herbarium of 20 plants with field notes.	6.1	3		Hands on experiment
Conduct a study tour for five days under the supervision of teachers.	6.2	2,3, 5		
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Annie Ragland and V Kumaresan, Morphology of Angiosperms, Taxonomy and Economic Botany; Saras Publication; 1st edition, 2018.
2. Arun K. Pandey and Shruti Kasana Plant Systematics; CRC Press; 1st edition, 2021.
3. Ashok Bendra and Ashok Kumar, Economic botany. Rastogi publications, Meerut, 1980.
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7. Jain S K A Manual of Ethnobotany, Scientific Publishers, India, 2004.
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9. Pandey B.P., Economic Botany S. Chand& Company Ltd. New Delhi, 2000.
10. Pandey & Misra, Taxonomy of Angiosperms. Ane Book Pvt. Ltd, 2008.
11. http://www.theplantlist.org/

Course designed by: Mr Jebin Joseph

SBU24BO4DSE300: FUNDAMENTALS OF INHERITANCE

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Define genetics and its historical significance.	U
CO2	Explain the basic concepts of heredity.	U
CO3	Explain the pedigree pattern of traits and genetical disorders	U
CO4	Explain the basic concept of population genetics and its relevance in evolutionary studies	U
CO5	Apply the concept of mechanism of inheritance to workout various problems related to genetics	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1		2	1			2	1	1		1
CO2		2	1			2	1	1		1
CO3		2	1			2	1	1		1
CO4		2	1			2	1	1		1
CO5		2	2			2	1	1		1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1		x	x	x		x
CO2		x	x	x		x
CO3			x		x	x
CO4			x		x	x
CO5	x		x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Mendelian Genetics (13 Hrs)				
Gregor Mendel's experiments and laws, understanding the concept of genotype, phenotype, alleles, homozygous, and heterozygous	1.1	1,2,5	3	Lecture
Extensions of Mendelian Genetics: non-Mendelian inheritance patterns, incomplete dominance, codominance, gene interactions producing novel phenotypes	1.2	1,2,5	6	Lecture
Various forms of epistasis	1.3	1,2,5	2	Lecture

Concept of multiple alleles and polygenic traits.	1.4	1,2,5	2	Lecture
Module 2: Linkage (16 Hrs)				
Linkage and Crossing Over: Chromosomal Basis of Inheritance - relationship between genes and chromosomes	2.1	1,2,5	4	Lecture
Concept of genetic linkage - role of crossing over in genetic recombination	2.2	1,2,5	4	Lecture
Three-point test cross and construction of linkage maps, double crossing over, interference and coincidence	2.3	1,2,5	4	Lecture
Sex determination and sex-linked traits.	2.4	1,2,5	4	Lecture
Module 3: Applications of Classical Genetics (11 Hrs)				
Pedigree Analysis: Symbols used in the construction of pedigree chart,	3.1	3,5	2	Lecture
Inheritance pattern of autosomal dominant and recessive traits.	3.2	3,5	3	Lecture
Inheritance pattern of sex linked dominant and recessive traits.	3.3	3,5	3	Lecture
Common genetic disorders, genetic counselling, ethical considerations of genetic counseling.	3.4	3,5	3	Lecture
Module 4: Population genetics and its significance in evolutionary biology (10 Hrs)				
Concept of population, gene pool,	4.1	4,5	2	Lecture
Hardy-Weinberg principle and its assumptions, Hardy-Weinberg Equilibrium, -	4.2	4,5	2	Lecture
Factors disrupting Hardy-Weinberg Equilibrium – genetic drift, natural selection, migration and immigration, and their implications	4.3	4,5	4	Lecture
Bottleneck effect and founder effect, speciation and Macroevolution.	4.4	4,5	2	Lecture
Module 5: Genetics Problems (10 Hrs)				
Practice solving problems related to the above concepts	5.1	5	10	Problem solving
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Benjamin A Pierce, Genetics: A Conceptual Approach, 6th edition, WH Freeman, 2017
2. Daniel L. Hartl and Andrew G. Clark. Principles of Population Genetics
3. LH Heartwell, Genetics: From Genes to Genomes, 5th edition, McGraw-Hill Education, 2014
4. Peter J, Snustad, M.J. Simmons, Principles of Genetics, 7th edition, 2015
5. Robert Brooker, Concepts of Genetics, 2nd edition, McGraw-Hill Publishing Company, 2016
6. Scott Freeman and Jon C. Herron. Evolutionary Analysis
7. William Stansfield, Schaum'S Easy Outline of Genetics, 4th edition, TATA McGraw Hill, 2011

Course designed by: Mr Biju George

SBU24BO4DSE301: PHYTOCHEMISTRY AND PHARMACOGNOSY

Type of Course	DSE		
Course Level	300 - 399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the fundamental concepts of phytochemistry and their relevance to plant biology.	U
CO2	Identify and classify secondary metabolites based on their chemical properties and biosynthetic pathways.	U
CO3	Understand the principles and techniques for extraction, isolation, and purification of plant-derived natural products.	U
CO4	Analyse the pharmacological activities and medicinal uses of important medicinal plants and their bioactive compounds.	An
CO5	Appreciate the importance of sustainable practices in pharmacognosy and bioprospecting of natural resources.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	2	-	-	-	3	2	1	1	2
CO2	-	1	1	-	1	3	3	1	2	2
CO3	-	-	2	-	2	2	2	1	3	2
CO4	1	2	2	2	1	2	3	2	2	3
CO5	-	-	1	-	1	1	2	1	1	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	-	-	x	x	x
CO4	x	x	-	x	x	x
CO5	-	x	-	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Phytochemistry (8 Hrs)				
Plant metabolites: primary vs. secondary	1.1	1	3	Lecture/ Demonstration
Classification of secondary metabolites: alkaloids,	1.2	2	3	Lecture/

terpenoids, phenolics, etc.				Demonstration
Factors affecting production and accumulation of secondary metabolites in plants	1.3	1	2	Lecture/ Demonstration
Module 2: Isolation and Characterization of Secondary Metabolites (11 Hrs)				
Extraction techniques: conventional and modern methods (solvent extraction, chromatography, etc.)	2.1	3	4	Lecture/ Demonstration
Separation and purification techniques: chromatography (column, TLC, HPLC), spectroscopy (UV-Vis, MS, NMR)	2.2	3	4	Lecture/ Demonstration
Structure elucidation of natural products using spectroscopic techniques	2.3	3	3	Lecture/ Demonstration
Module 3: Pharmacognosy of Medicinal Plants (10 Hrs)				
Medicinal plant resources: traditional knowledge, ethnobotany, and modern exploration	3.1	4	3	Lecture/ Demonstration
Active constituents and pharmacological activities of selected medicinal plants	3.2	4	3	Lecture/ Demonstration
Standardization and quality control of herbal drugs	3.3	4	4	Lecture/ Demonstration
Module 4: Bioactive Compounds and Therapeutic Applications (8 Hrs)				
Mechanisms of action of plant-derived drugs: alkaloids, terpenoids, phenolics, etc.	4.1	4	3	Lecture/ Demonstration
Drug discovery from plants: bioprospecting, bioassay-guided fractionation	4.2	4	3	Lecture/ Demonstration
Challenges and future prospects of plant-based medicines	4.3	4	2	Lecture/ Demonstration
Module 5: Sustainable Practices and Ethno pharmacology (8 Hrs)				
Conservation of medicinal plants and biodiversity	5.1		2	Lecture/ Demonstration
Sustainable harvesting and cultivation practices for medicinal plants	5.2	5	2	Lecture/ Demonstration
Bio-piracy and ethical considerations in drug discovery	5.3	5	2	Lecture/ Demonstration
Integration of traditional knowledge with modern scientific research	5.4	5	2	Lecture/ Demonstration
Module 6: Phytochemistry and Pharmacognosy (15 Hrs)				
Qualitative tests for identification of major secondary metabolite classes	6.1	3	3	Demonstrate/ Hands on training
Extraction and preliminary purification of a plant extract	6.2	2	3	Demonstrate/ Hands on training
Microscopic and morphological identification of important medicinal plants	6.3	2	3	Demonstrate/ Hands on training
Evaluation of herbal drugs for adulteration and quality parameters	6.4	4	3	Demonstrate/ Hands on training
Field visit to a medicinal plant garden or nursery	6.5	5	3	Demonstrate/ Hands on training
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Chopra, S.L., Nayar, S.L., & Chopra, I.C. (1986). Glossary of Indian Medicinal Plants. National Institute of Science Communication and Information Resources.
2. Evans, W.C. (2009). Trease and Evans' Pharmacognosy (16th Edition). Elsevier, Edinburgh, UK.
3. Kokate, C.K., Purohit, A.P., & Gokhale, S.B. (2013). Pharmacognosy (19th Edition). Nirali Prakashan, Mumbai.
4. Nadkarni, K.M. (1999). Indian Materia Medica (2nd Edition). Popular Prakashan, Mumbai.
5. Rangari, U.D. (2022). Pharmacognosy and Phytochemistry. Career Publications, Meerut, India.

Course designed by: Dr Salvy Thomas

SBU24BO4DSE302: PLANT BREEDING AND HORTICULTURE

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	**-**	**60**
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explains different conventional approaches of plant breeding	U
CO2	Discuss about recent trends in plant breeding	U
CO3	Describes different plant propagation methods	U
CO4	Explain new trends in horticulture with their advantages and limitations	U
CO5	Demonstrate basic techniques in plant breeding and plant propagation	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	2	-	1	-	1	-	-
CO2	-	-	-	2	-	1	-	1	-	-
CO3	-	-	-	2	-	1	-	1	-	-
CO4	-	-	-	2	-	1	-	1	-	-
CO5	-	-	-	2	-	1	-	1	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	-	x	x	-	x
CO2	-	x	x	x	-	x
CO3	-	x	x	-	x	x
CO4	-	-	x	-	x	x
CO5	x	-	x	-		x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: First Generation of Plant Breeding (7 Hrs)				
Objectives of plant breeding	1.1	1	1	Lecture
Domestication and Centres of origin of cultivated plants.	1.2	1	1	Lecture
Plant introduction- Quarantine regulations, acclimatization. Agencies of plant introduction in India	1.3	1	2	Lecture
Mass selection	1.4	1	1	Lecture
Pure line selection	1.5	1	1	Lecture
Clonal selection	1.6	1	1	Lecture
Module 2: Second Generation of Plant Breeding (7 Hrs)				
Hybridization; Procedure of hybridization	2.1	1	2	Lecture

Heterosis in plant breeding and inbreeding depression	2.2	1	1	Lecture
Polyploidy breeding,	2.3	1	2	Lecture
Mutation breeding: Mutagens- physical and chemical, spontaneous and induced mutations, effects of mutation, methods of mutation breeding.	2.4	1	2	Lecture
Module 3: Third Generation of Plant Breeding (8 Hrs)				
Transgenic breeding; Definition of Genetic Engineering in Plant Breeding, Historical Background, Importance and Purpose of Genetic Engineering in Plant Breeding	3.1	2	2	Lecture
Case Studies; Examples of Successful Genetic Engineering in Plant Breeding Bt Cotton, Golden Rice, Virus-resistant Papaya	3.2	2	6	Lecture
Module 4: Fourth Generation of Plant Breeding (10 Hrs)				
Definition of Genome Editing in Plant Breeding, Historical Context and Evolution of Genome Editing Technologies, Significance and Impact on Plant Breeding	4.1	2	2	Lecture
Introduction to Genome Editing Technologies; CRISPR-Cas9 System, TALEN (Transcription Activator-Like Effector Nucleases), ZFN (Zinc Finger Nucleases)	4.2	2	5	Lecture
Applications of Genome Editing in Plant Breeding	4.3	2	3	Lecture
Module 5: Plant Propagation (1 Hr)				
Plant propagation; seed propagation and hybrid seeds	5.1	3	1	Lecture
Module 6: Artificial vegetative propagation methods (5 Hrs)				
Cutting – stem cutting, root cutting and leaf cutting. Use of growth regulators for rooting.	6.1	3	1	Lecture
Layering - Simple layering, Air layering, Compound layering, Trench layering, Mount layering.	6.2	3	2	Lecture
Grafting- Approach grafting, Cleft grafting, Wedge grafting.	6.3	3	1	Lecture
Budding - Patch budding, Chip budding, Flap budding.	6.4	3	1	Lecture
Module 7: Modern Farming Practices (7 Hrs)				
Precision Farming; Need for precision agriculture, technologies for precision farming, fertigation, methods of irrigation, crop scouting	7.1	4	2	Lecture
Protected farming and plant growing structures; green houses, shade house and polyhouse.	7.2	4	2	Lecture
Hydroponics –Systems of hydroponic culture, advantages and disadvantages. The nutrient solution, rooting media. Aeroponics and aquaponics	7.3	4	3	Lecture
Module 8: Practical (15 Hrs)				
Demonstration of Emasculation and bagging	8.1	5	2	Demonstration
Visit to a plant breeding station and preparation of report	8.2	5		Field visit
Field training in hybridization	8.3	5	2	
Attempt hybridization using a suitable plant and present an illustrated report of observations	8.4	5		Demonstration
Field training in grafting, budding and air layering	8.5	5	6	Demonstration
Propagate any three plants using grafting, budding and air layering and present an illustrated report	8.6	5		Demonstration
Training in the preparation of hydroponic system	8.7	5	5	Demonstration
Develop a mini hydroponic system at home, using available resources, and present a report of the same	8.8	5		Experiment

Module 9: Teacher Specific Content

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)

This content will be evaluated internally

Reference

1. Adams C R, Early M P, 2004. Principles of Horticulture. Elsevier, N. Delhi.
2. Allard R W. Principles of Plant Breeding. John Wiley and Sons, Inc.
3. Barton West R, 1999. Practical Gardening in India.Discovery Pub. House, New Delhi.
4. Ghahal G S and Gosal S S. Principles and procedures of Plant Breeding. Narosa Publishing House.
5. Kumar N, 1994. Introduction to Horticulture. Rajalakshmi Pub. Nagarcoil
6. Linda William, 2005. Ornamental Science Demystified. Tata Mc Graw hill Co. 14. Percy Lancasher, 2004. Gardening in India. Oxford IBH Publishing Co. Pvt. Ltd.
7. Manibhushan Rao K, 1991. Text Book of Horticulture. Macmillan India Ltd.
8. Singh B D. Plant Breeding: Principles and methods. Kalyani Publications.

Course designed by: Mr Biju George

SBU24BO4DSE303: FORENSIC BOTANY

Type of Course	DSE		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the role of plants and plant materials as evidence in criminal investigations.	U
CO2	Master the identification and analysis of plant structures and materials relevant to forensic science.	An
CO3	Apply botanical principles and techniques to interpret plant evidence and reconstruct events.	A
CO4	Critically evaluate the scientific validity and limitations of botanical evidence in legal proceedings.	E
CO5	Communicate botanical findings effectively in written and oral formats for presentation.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	-	2	3	1	2	1
CO2	2	2	2	3	1	3	3	1	3	2
CO3	1	1	3	3	1	3	3	1	3	2
CO4	-	-	3	-	-	2	3	2	3	3
CO5	-	-	2	-	1	1	2	3	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	-	x	x	x
CO4		x	-	x	x	x
CO5	x	x	-	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Forensic Botany (8 Hrs)				
Definition and applications of forensic botany	1.1	1	2	Lecture/Demonstration
Types of plant evidence: wood, pollen, spores, seeds, fruits, fibres, DNA	1.2	1	2	Lecture/Demonstration

Importance of proper collection, preservation, and chain of custody	1.3	1	2	Lecture/Demonstration
Ethical considerations and legal aspects of botanical evidence	1.4	1	2	Lecture/Demonstration
Module 2: Plant Identification in Forensics (11 Hrs)				
Morphological characters for plant identification: leaves, stems, flowers, fruits, seeds	2.1	2,3	3	Lecture/Demonstration
Identification keys and manuals for botanical evidence	2.2	2,3	3	Lecture/Demonstration
Microscopic and anatomical analysis of plant materials	2.3	2,3	3	Lecture/Demonstration
Geographical distribution and ecological context of evidence plants	2.4	2,3	2	Lecture/Demonstration
Module 3: Pollen and Spore Analysis (10 Hrs)				
Morphology and identification of pollen and spores	3.1	2,3	2	Lecture/Demonstration
Pollen transfer, deposition, and persistence in the environment	3.2	2,3	2	Lecture/Demonstration
Pollen analysis of crime scene samples: air filters, clothing, vehicles	3.3	2,3	3	Lecture/Demonstration
Spore analysis in forensic palynology: fungal spores, algae, mosses	3.4	2,3	3	Lecture/Demonstration
Module 4: Wood and Fiber Analysis (8 Hrs)				
Anatomy and identification of different wood types	4.1	2,3	2	Lecture/Demonstration
Physical properties and forensic applications of wood evidence	4.2	2,3	2	Lecture/Demonstration
Textile fibres: natural and synthetic, identification and analysis	4.3	2,3	2	Lecture/Demonstration
Trace wood and fibre evidence: clothing, furniture, tools	4.4	2,3	2	Lecture/Demonstration
Module 5: DNA Analysis and Advanced Techniques (8 Hrs)				
Plant DNA extraction, amplification, and analysis in forensic cases	5.1	4,5	4	Lecture/Demonstration
DNA profiling and matching techniques for plant evidence	5.2	4,5	4	Lecture/Demonstration
Module 6: Forensic Botany (15 Hrs)				
Observation and identification of common plant evidence materials	6.1	1	2	Demonstration/ Hands on training
Techniques for proper collection and packaging of plant evidence	6.2	2,3	2	Demonstration/ Hands on training
Microscopic examination of plant evidence using keys and manuals	6.3	2,3	2	Demonstration/ Hands on training
Preparation and observation of pollen and spore slides	6.4	2,3	2	Demonstration/ Hands on training
Pollen identification using keys and reference collections	6.5	2,3	2	Demonstration/ Hands on training
Microscopic observation of wood and fibre structures	6.6	2,3	2	Demonstration/ Hands on training

Research paper analysis and critical discussion on a recent forensic botany case	6.7	4,5	3	Demonstration/ Hands on training
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Datta, S.K. (2012). Forensic Science & Evidence Collection. Scientific Publishers, Jodhpur.
2. Goud, J.V., & Gupta, U. (2020). Forensic Palynology: A Practical Guide for India. Springer Nature, Singapore.
3. Guleria, S., & Tiwari, S.C. (2017). Forensic Botany: Principles and Applications. New Age International Publishers, New Delhi.
4. Kumar, D. (2014). The Forensic Use of Botanical Materials (2nd Edition). CRC Press, Taylor & Francis Group, Boca Raton, FL.
5. Mukherjee, P.K. (2015). A Textbook of Medical Jurisprudence and Toxicology (7th Edition). Academic Publishers, Kolkata.
6. Mulligan, G.A. (2020). Forensic Botany: Plants and Crime Scene Evidence. Taylor & Francis, New York.
7. Rao, K.N., & Rao, P.R. (2018). Forensic Botany in India. Daya Publishing House, Delhi.
8. Rao, T.S.S. (2018). Forensic Wood Identification: Case Studies from India. Springer Nature, Singapore.
9. Rao, V.G. (2013). Forensic Science: An Introduction. Oxford University Press, New Delhi.
10. Singh, N., & Chauhan, D.S. (2015). Forensic Palynology: A Handbook for Crime Scene Investigators. I.K. International Publishing House Pvt. Ltd., New Delhi.
11. The Indian Penal Code (1860): Available online
12. Watkins, J.E. (2009). Forensic Plant Science. CRC Press, Boca Raton, FL.

Course designed by: Dr. Salvy Thomas

SBU24BO4DSE304: MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Cite the classification of microbes and state their economic importance	R
CO2	Differentiate between the eubacteria, archaea bacteria, virus and a protozoan based on their unique features.	A
CO3	Describe the essential features of bacterial chromosome and explain the genetic recombination strategies in them.	U
CO4	Explain the concept of parasitism and describe the various steps in the pathogenesis of bacterial and viral diseases.	U
CO5	Describe the scope and various aspects of microbial biotechnology.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	1	-	-	-
CO2	2	2	1	-	-	2	1	-	1	-
CO3	-	2	-	-	-	2	-	-	2	-
CO4	-	2	-	-	-	2	-	-	2	-
CO5	-	2	-	-	-	2	-	-	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open book test	Written test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	-	x	-	x	x
CO5	x	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Microbiology (8 Hrs)				
History of microbiology. Introduction to microbial classification (Bacteria and Virus) - Taxonomic ranks, Characters used in identification and classification;	1.1	1	2	Lecture
Three domain system and Bergey's Manual.	1.2	1	2	Lecture

Microbes in Food (baking, brewing and food spoilage), medicine (production of antibiotics), Industry, Agriculture (role in N2 fixation, as biofertilizers or PGPR) and mineral cycling.	1.3	1	4	Lecture
Module: 2 Procaryotic Cell Structure and Viruses (10 Hrs)				
Cell wall composition, structure, function, cell wall and Gram staining mechanism,	2.1	2	3	Lecture
Structures external to cell wall: Flagella: structure of flagella, different types of arrangements of flagella, Fimbriae and pili. Structures internal to cell wall: Plasma membrane, composition, structure and function, cytoplasm, ribosome, nucleoid, plasmid, inclusions, endospores.	2.2	2	2	Lecture
Variation in cell structure: Archaea and Eubacteria.	2.3	2	2	Lecture
Characteristics of viruses, size range, host range. Classification of viruses, Structure of viruses: general morphology, nucleic acids, capsid and envelope, Ultra structure of TMV and T4 bacteriophages.	2.4	2	3	Lecture
Module 3: Genetic Material in Bacteria (5 Hrs)				
Genetic material in bacteria. Bacterial chromosome. Extra-chromosomal genetic elements, plasmid, DNA replication-Theta and Rolling Circle types replication	3.1	3	2	Lecture
Mechanism of genetic recombination–transformation, transduction and conjugation.	3.2	3	3	Lecture
Module 4: Microbial Pathogenicity (6 Hrs)				
Types of parasitism-ectoparasite; endoparasite. Pathogen and pathogenicity, Primary (frank) pathogen, Opportunistic pathogen, Host-final host, intermediate host, transfer host, reservoir host.	4.1	4	3	Lecture
Microbial Mechanisms for Escaping Host Defenses: - Evasion of Host Defenses by Viruses, Evasion of Host Defenses by Bacteria.	4.4	4	3	Lecture
Module 5: Microbial Biotechnology (16 Hrs)				
Industrial Microbiology: Isolation of metabolite producing bacteria: Primary and Secondary screening. Types of Bioreactors – Airlift and Stirred tank. Fermentation process - batch, fed batch and continuous fermentation. Process control during fermentation - pH, aeration, agitation, temperature, foam control. Downstream processing. Large scale production of antibiotics -Streptomycin ; Industrial chemicals – ethanol and Acetone.	5.1	5	10	Lecture
Scope and Applications of Microbial Biotechnology: In Human Therapeutics, In Agriculture, In Food Technology, In Environment, Bioremediation, Bio mining, Waste Water Treatment and Biosensors	5.2	5	3	Lecture
Essentials of Bioremediation: Importance and advantages of bioremediation,	5.4	5	3	Lecture

bioaugmentation; Cleaning reactions - aerobic and anaerobic biodegradation, organisms used for bioremediation, cleaning strategies for water and soil - in situ and ex situ technologies.				
Module 6: Bacterial Isolation and Staining (12 Hrs)				
Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.	6.1	2	5	Demonstration
Differential staining of bacteria using Gram stain.	6.2	2	7	Laboratory Work
Module 7: Media preparation and sterilization (3 Hrs)				
Preparation and sterilization of various microbial culture media and inoculation.	7.1	2	3	Demonstration
Module 8: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Adams, M.R. and M.O. Moss, Food Microbiology, Panima Publishing, 1995.
2. Alexander N Glazer, Hiroshi Nikaido. Microbial Biotechnology: Fundamentals of applied microbiology. Cambridge University Press, 2007.
3. Casida, L.E.(Jr.)., Industrial Microbiology. New Age International, 2005.
4. El-Mansi, E. M. T., Jens Nielsen, David Mousdale, and Ross P. Carlson, eds. Fermentation microbiology and biotechnology. CRC press, 2018.
5. George J. Banwant, Basic Food Microbiology. CBS Publishers and Distributors, 2004.
6. George N. Agrios, Plant Pathology, Academic Press Ltd., London, 1988.
7. Hale M.E, The Biology of Lichen, 3rd edition Edward Arnold, London, 1983
8. James M. Jay, Modern Food Microbiology. CBS Publishers and Distributors, 2005.
9. Kun LY., Microbial Biotechnology. World Scientific,2006.
10. Prescott, and Joanne M. Willey. Prescott's Microbiology. New York: McGraw-Hill, 2011.
11. Sharma P.D, The Fungi, 2nd Edition, Rasthogi publications, 2004.
12. Susan R. Barnum. Biotechnology an introduction. Thomson Brooks/cole, 2005.

Course designed by: Mr Ajeesh Joseph

SBU24BO5SEC300: PLANT-BASED MICROENTERPRISES

Type of Course	SEC		
Course Level	300 -399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Summarize key principles in organic farming, horticulture, tissue culture and mushroom cultivation, fruits and vegetable technology including sustainable practices and business considerations.	U
CO2	Elaborate the various composting techniques, artificial vegetative propagation practices, tissue culture techniques and mushroom cultivation	R
CO3	Point out the skills needed in organic farming and horticultural practices.	R
CO4	Elaborate the techniques involved in tissue culture and fruits/vegetable preservation.	U
CO5	List out the requirements and procedure for mushroom cultivation.	R

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	2	1	-	-	2	2	2	-
CO2	1	-	2	2	-	-	2	2	2	-
CO3	2	-	2	2	-	-	2	2	2	-
CO4	3	-	2	2	-	-	2	2	2	-
CO5	-	-	2	2	-	-	2	2	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open Book Test	Written Test/MCQ	
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Organic farming (7 Hrs)				
Introduction to Organic farming- Advantages of Manures over fertilizers. NPK value- Definition and significance.	1.1	1	2	Lecture
Common organic manures – bone meal, cow dung, poultry waste, oil cakes, Green manure (special reference to major	1.2	1, 2	4	Lecture

element in the composition) Preparation of compost-vermicompost, vermiwash; KHAMBA compost Biofertilizers-Definition and Types –, Rhizobium, Mycorrhiza, Blue green algae and Azolla.				
Biological control Agents- Trichoderma, Bacillus; Biopesticides – Tobacco and Neem decoction.	1.3	2	1	Lecture
Module 2: Horticulture (10 Hrs)				
Types of soil, preparation of potting mixture, Garden tools and implements.	2.1	2, 3	2	Lecture
Methods of plant propagation- Sexual (seed propagation) and Asexual; Artificial methods (cutting, grafting, budding and layering); Use of growth regulators for rooting.	2.2	2, 3	5	Lecture
Gardening - Types of gardens– Ornamental and Landscape garden, kitchen garden, Water garden and aquascaping, Aquarium plants and its propagation, Garden components (Brief account only), Bonsai & Terrarium.	2.3	1,3	3	Lecture
Module 3: Mushroom cultivation (6 Hrs)				
Scope and Significance of Mushroom cultivation, Edible and poisonous mushroom. Health benefits	3.1	2	1	Lecture
Types of commercially cultivated mushrooms - button mushroom, oyster mushroom and milky mushroom Spawn -Definition	3.2	5	1	Lecture
Cultivation methodology of Oyster mushroom – using paddy straw and saw dust. Layout and set up of a mushroom house (small scale). Processing of mushrooms and Value added products- mushroom - pickle, candy, dried mushroom	3.3	5	4	Lecture
Module 4: Fruit and vegetable technology (10 Hrs)				
Elementary knowledge on horticultural types of fruits and vegetables, Concept of shelf life and perishable fruits, Ripening and biological ageing, Storage and preservation concerns.	4.1	3	2	Lecture
Fruits preservation-Room temperature (Juice, syrup, squash), heat treatment (Jelly, jams), Dehydration (sun drying, application of sugar syrup,salt), freezing	4.2	4	4	Lecture
Vegetable preservation-packaging and storage, dehydration techniques, vegetable products (flakes, chips, dried powder), frozen vegetables, Preservation by Canning and bottling.	4.3	4	4	Lecture
Module 5: Plant tissue culture (12 Hrs)				
Concept of totipotency, definition of explant, callus. Infrastructure of a tissue culture laboratory. Solid and liquid media – basic components of tissue culture medium. Sterilization of explants. Inoculation and incubation. Sterilization of explants. inoculation and incubation.	5.1	1,2,4	6	Lecture
Micro propagation: different stages, organogenesis and embryogenesis	5.2	1,2,4	6	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

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Course designed by: Mr Ajeesh Joseph

SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO6DSC300	Major/ Minor	Plant Physiology - I	5	75	4
SBU24BO6DSC301	Major/ Minor	Mycology and Plant Pathology	5	75	4
SBU24BO6DSC302	Major/ Minor	Environmental Science and Human Rights	5	75	4
SBU24BO6DSE300	Elective	Plant Physiology - II	4	60	4
SBU24BO6DSE301	Elective	Space Biology - An Introduction	4	60	4
SBU24BO6DSE302	Elective	Genomics	4	60	4
SBU24BO6SEC300	SEC	Techniques in Plant Science	3	45	3
SBU24BO6VAC300	VAC	Integrated Sustainable Waste and Energy Management	3	45	3

SBU24BO6DSC300: PLANT PHYSIOLOGY - I

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Discuss different mechanisms involved in water intake and transportation in the plants and its regulation	U
CO2	Explain the transportation of minerals and photosynthates	U
CO3	Explain different biochemical pathways involved in photosynthesis and nitrogen assimilation	U
CO4	Perform various experiments related to plant system functioning and evaluate the results of the same.	A
CO5	Demonstrate and explain various experiments related to plant physiology	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	-	2	2	1	-	-
CO2	2	1	-	-	-	2	2	1	-	-
CO3	2	2	-	-	-	2	2	1	-	-
CO4	1	1	-	-	-	1	1	1	-	-
CO5	1	1	-	2	-	1	1	-	2	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	-	x	x	-	x
CO2	-	x	x	x	-	x
CO3	-	x	x	-	x	x
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab skill	Viva voce	Lab Report	Record work	Test	
CO1	-	-	-	-	-	-
CO2	-	-	-	-	-	-
CO3	-	-	-	-	-	-
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Plant Water Relations (6 Hrs)				
Physical and physiological aspects of water absorption- Diffusion, imbibition, osmosis.	1.1	1	1	Lecture
Concept and components of Water potential. Cell membrane permeability and its importance.	1.2	1	1	Lecture
Absorption of water- active and passive. Pathway of water movement, symplast, apoplast, transmembrane pathways.	1.3	1	1	Lecture
Ascent of sap, cohesion and adhesion, transpiration pull, SPAC concept.	1.4	1	1	Lecture
Transpiration- types, mechanism H+ - K+ ion exchange, significance, anti-transpirants, guttation.	1.5	1	2	Lecture
Module 2: Mineral Nutrition and Solute Transport (8 Hrs)				
Plant Essential Nutrients	2.1	2	2	Lecture
Soil, Root and Microbes in relation to mineral nutrients	2.2	2	2	Lecture
Solute transport across membrane	2.3	2	2	Lecture
Membrane transport proteins	2.4	2	1	Lecture
Ion transport in roots	2.5	2	1	Lecture
Module 3: Photosynthesis (21 Hrs)				
Structural organization of chloroplast, Photosynthetic pigments, antenna complexes and reaction centre.	3.1	3	2	Lecture
Photo excitation and energy transfer, conversion of light energy to chemical energy, Fluorescence, phosphorescence.	3.2	3	2	Lecture
Concept of two photosystems. Cyclic & non-cyclic photophosphorylation (Z- scheme).	3.3	3	3	Lecture
Carbon assimilation pathways- C3, C4, CAM. Photorespiration.	3.4	3	8	Lecture
Photosynthetic response in relation to leaf, light, temperature, carbon dioxide.	3.5	3	6	Lecture
Module 4: Nitrogen Metabolism (5 Hrs)				
Nitrogen in the environment and N cycle	4.1	3	1	Lecture
Assimilation of nitrate by plants.	4.2	3	1	Lecture
Ammonium assimilation	4.3	3	1	Lecture
Biological N fixation	4.4	3	2	Lecture
Module 5: Translocation in the Phloem (5 Hrs)				
Pathways of Translocation	5.1	2	1	Lecture
Pressure Flow model	5.2	2	1	Lecture
Phloem Loading and Unloading	5.3	2	2	Lecture
Photosynthate Allocation and Partitioning	5.4	2	1	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Core Experiments (20 Hrs)				
Determination of osmotic pressure by tissue weight method Separation of Chlorophyll pigments by paper chromatography. Effect of carbon dioxide concentration on the rate of photosynthesis by Hydrilla plants Demonstration of osmosis using plant membrane Estimation of total chlorophyll in the leaf sample	6.1	4	20	Hands on experiment
Module 7: Demonstration Experiments (10 Hrs)				
Determination of transpiration under different environmental conditions using Ganong's / Farmer's Potometer Relation between transpiration and absorption Evolution of O2 during photosynthesis Light screen experiment Mohl's experiment Experiment with variegated leaf Measurement of growth using Arc auxanometer Experiment with Kleinostat	7.1	5	10	Demonstration
Module 8: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

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Course designed by: Mr Biju George

SBU24BO6DSC301: MYCOLOGY AND PLANT PATHOLOGY

Type of Course	Major/Minor		
Course Level	300 - 399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic understanding of fungal biology and plant disease		

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the terminologies in fungal biology and plant pathology and use them accurately to describe and identify fungi, Lichen and plant disease.	A
CO2	Illustrate and explain the morphology and reproductive structures of fungi and Lichen	A
CO3	Describe the economic and ecological importance of fungi and Lichen	U
CO4	Distinguish common plant diseases based on symptoms and control methods	U
CO5	Explain the plant defence Mechanisms	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	1	-	1	-	1	-	-
CO2	1	-	-	1	-	1	-	-	-	1
CO3	-	-	-	1	-	1	2	-	-	1
CO4	1	-	1	2	-	1	-	-	1	-
CO5	-	1	-	2	1	1	1	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Lab Test	Written Test/MCQ	
CO1	x	-	x	x	-	x
CO2	x	-	x	x	-	x
CO3	-	x	x	-	x	x
CO4	x	-	x	x	x	x
CO5	-	x	x	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab skill	Viva voce	Lab Report	Record work	Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: The Characteristic Features of Fungi (2 Hrs)				
The characteristic features of fungi: defining the fungal kingdom. The History of Mycology- Peoples and Their Contributions.	1.1	1	2	Lecture
Module 2: Classification (8 Hrs)				
Classification Ainsworth (1973): The diversity of fungi – The morphology reproduction life cycles of the fungi belonging to the major clades. Mastigomycotina – *Albugo* Zygomycotina – *Rhizopus* Ascomycotina – *Saccharomyces*, *Pencillium*, *Xylaria* Basidiomycotina – *Puccinia*, *Agaricus* Deuteromycotina – *Cercospora*	2.1	1,2	8	Lecture
Module 3: Lichens (4 Hrs)				
General character	3.1	1,3	1	Lecture
Major Classes: Crustose, Squamalose, Foliose, Fruticose Structural organization of *Usnea* and *Parmelia*	3.2	1,2	3	
Module 4: Ecological and Economic importance on fungi and lichen: (3 Hrs)				
Fungi and Lichen: food, medicine and industrial applications.	4.1	3	2	Lecture
Fungal and lichen ecosystem services- colonizers, decomposers and recyclers	4.2	3	1	Lecture
Module 5: General Introduction to Plant Pathology (4 Hrs)				
History of plant pathology, Classification of plant diseases on the basis of causative organism; fungi, bacteria, virus, insect pest; symptoms and dissemination of diseases.	5.1	1,5	2	Lecture
Disease cycle, persistence of pathogen between crops and during unfavourable seasons.	5.2	1,5	2	Lecture
Module 6: Plant Defense Against Pathogens (10Hrs)				
Preexisting defense structures and chemicals	6.1	5	4	Lecture
Defense through lack of essential factors	6.2	5	3	Lecture
Induced structural defense, Induced biochemical defense,	6.3	5	3	Lecture
Module 7: Plant disease management (5Hrs)				
Physical, chemical and biological control	7.1	4	3	Lecture
Integrated disease and pest management	7.2	4	2	Lecture
Module 8: Major diseases in plants (9 Hrs)				
Study on the following diseases with emphasis on causative organism, symptoms, and control mechanism. bunchy top of Banana, leaf mosaic of Tapioca, abnormal leaf fall of Rubber, quick wilt of Pepper, leaf roller of Rice, red rot of Sugarcane.	3.1	4	9	Lecture and Demonstration

Practical

Module 9: Practical (30Hrs)				
Thallus or reproductive Structural organization of following fungi Mastigomycotina – *Albugo* Zygomycotina – *Rhizopus* Ascomycotina – *Saccharomyces*, *Pencillium*, *Xylaria* Basidiomycotina – *Puccinia*, *Agaricus* Deuteromycotina – *Cercospora*	9.1	1,2	25	Hands on Training
Structural organization of *Usnea* and *Parmelia*	9.2	1,2	5	Hands on Training
Module 10: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Alexopoulos, C. J., C. W. Mims, and M. Blackwell, Introductory Mycology, John, Wiely & Sons.Inc., New York & London, 1996.
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Course designed by: Mr Jebin Joseph

SBU24BO6DSC302: ENVIRONMENTAL SCIENCES AND HUMAN RIGHTS

Type of Course	Major		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse the fundamental principles of Environmental sciences and their application to plant life.	An
CO2	Explain the causes and consequences of various environmental pollutants and their impact on ecosystems.	U
CO3	Critically evaluate the importance of biodiversity and explore conservation strategies for natural resources.	E
CO4	Advocate for sustainable practices and environmental awareness through effective communication.	A
CO5	Critically evaluate the challenges and successes of protecting human rights for diverse groups in India and globally.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	1	-	2	3	1	2	1
CO2	1	-	2	-	-	2	3	1	3	1
CO3	3	-	2	-	-	2	3	1	3	2
CO4	1	-	1	-	-	1	2	3	2	-
CO5	-	-	-	-	-	1	3	2	3	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	-	x	-	x
CO5	-	x	-	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	-	x
CO4	-	x	x	-	-	x
CO5	-	-	-	-	-	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Foundations of Environmental Science (2 Hrs)				
Concept of Environment: Defining environmental science, its interdisciplinary nature, and its role in understanding the interconnectedness of life and the environment.	1.1	1	1	Lecture/Demonstration
Branches of Environmental Science: Exploring various sub-disciplines, pollution science, resource management, and conservation biology.	1.2	1	1	Lecture/Demonstration
Module 2: Plants in Environmental Context (8 Hrs)				
Plant Adaptations: Understanding how different plant forms (xerophytes, hydrophytes, epiphytes, etc.) have evolved to thrive in diverse environments.	2.1	1	3	Lecture/Demonstration
Species Interactions: Examining the complex relationships between plants and other organisms, including competition, parasitism, mutualism, and their impact on ecosystem dynamics.	2.2	1	3	Lecture/Demonstration
Plant community development: Analysing the process of change in plant communities over time, including hydrosere and xerosere examples.	2.3	1	2	Lecture/Demonstration
Module 3: Global Environmental Challenges (10 Hrs)				
Environmental Pollution: Unveiling the sources and consequences of air, water, land, noise, thermal, and radioactive pollution, with specific focus on India's context.	3.1	2	2	Lecture/Demonstration
Management Strategies: Exploring solutions like solid waste management, phytoremediation, and environmental impact assessment (EIA) for polluted areas.	3.2	2	4	Lecture/Demonstration
Global Issues: Discussing the impacts of climate change, acid rain, and ozone layer depletion on agricultural productivity, human health, and ecosystems.	3.3	2	4	Lecture/Demonstration
Module 4: Biodiversity and Sustainable Practices (10 Hrs)				
Biodiversity Concepts: Defining biodiversity, its types, and its significance in maintaining healthy ecosystems.	4.1	3	2	Lecture/Demonstration
Focus on India: Exploring the Western Ghats as a biodiversity hotspot, understanding the importance of wetlands, and analysing the IUCN Red List and its role in conservation efforts.	4.2	3	3	Lecture/Demonstration
Conservation Strategies: Examining in-situ and ex-situ methods for preserving biodiversity, highlighting the role of national parks and wildlife sanctuaries in Kerala, and discussing Joint Forest Management (JFM).	4.3	4	3	Lecture/Demonstration
Sustainable Development: Balancing resource utilization with environmental protection, emphasizing renewable resources, ecological footprints, and the role of ecotourism.	4.4	4	2	Lecture/Demonstration
Module 5: Human rights (15 Hrs)				
National and International Perspectives: Definitions of Human Right, Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects, Human Rights	5.1	5	5	Lecture

International Norms, UDHR-Civil and political rights-Economic, social and cultural rights-Rights against torture, Discrimination and forced labour-Rights of the child, Human Rights and duties in India- Preamble to the Indian Constitution-Human Rights and Duties in Indian constitution				
Deprivation of Human Rights-The core issues: Poverty-Overpopulation- Illiteracy-Unsustainable Development, Disadvantageous Groups (Women, Children, SC/ST, Homeless and slum dwellers, physically and mentally handicapped, refugees and internally displaced persons.	5.2	5	5	Lecture
Redressal Mechanisms against Human Rights Violation: Judiciary - Government systems for Redressal - NHRC and other Statutory Commissions- Media Advocacy-Creation of Human Rights Literacy and Awareness.	5.3	5	5	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Environmental Sciences and Human Rights (30 Hrs)				
Estimation of CO2, Dissolved O2 and total alkalinity of water samples (Titrimetric)	6.1	1,2	6	Demonstration / Hands on training
Determination of pH of soil and water	6.2	1,2	4	Demonstration / Hands on training
Assessment of diversity, abundance, and frequency of plant species by quadrate method (Grasslands, forests)	6.3	3,4	4	Demonstration / Hands on training
EIA studies in degraded areas (Sampling – line transect, Quadrate)	6.4	3,4	4	Demonstration / Hands on training
Visit to any forest types including grasslands and preparation of the list of Rare and threatened (R&T) plants (no collection of specimens) OR Visit to any ecotourism centre in Kerala and prepare a report on the project.	6.5	3,4	4	Demonstration / Hands on training
Collection, identification and preparation of the list of invasive species in the locality.	6.6	3,4	4	Demonstration / Hands on training
Study of anatomical, morphological, physiological adaptation of plants to the environment (Xerophytic, Hydrophytic, Epiphytic and Halophytic)	6.7	1,2	4	Demonstration / Hands on training
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Agarwal, D.K. (2022). Environment and Ecology (10th Edition). Scientific Publishers, Jodhpur.
2. Chapman J L, Reiss M J (2005) Ecology: Principles and Applications. Cambridge University Press.
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Course designed by: Dr Salvy Thomas

SBU24BO6DSE300: PLANT PHYSIOLOGY - II

Type of Course	DSE		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Students will be familiar with the advance of ideas in plant physiology	U
CO2	Summarise the physiology of different plant life processes.	U
CO3	Students will be able appreciate the complexities and the regulatory mechanisms operating behind plant growth and development	U
CO4	Investigate the role of biotic and abiotic components in plant Stress	U
CO5	Explain the process of cellular respiration	U

Cognitive Levels
R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Sensory Photobiology (7 Hrs)				
Structure, function and mechanisms of action of phytochromes,	1.1	1,2,3	1	Lecture
phytochrome mediated plant responses.	1.2	1,2,3	1	Lecture
Photoperiodism and biological clocks – circadian rhythms, Vernalization.	1.3	1,2,3	1	Lecture
Floral induction and development;	1.4	1,2,3	2	Lecture

Blue light response, function and mechanisms of action of cryptochromes, phototropins, zeaxanthine	1.5	1,2,3	2	Lecture
Module 2 Plant growth and Movements (6 Hrs)				
Growth and Movements: Sigmoid curve, measurement of growth, regions of growth	2.1	1,2,3	2	Lecture
Tropic and nastic movements with reference to geotropism,	2.2	1,2,3	2	Lecture
Senescence and Abscission.	2.3	1,2,3	2	Lecture
Module 3: Plant Hormones (5 Hrs)				
Plant growth regulators Biosynthesis, storage, breakdown, transport, physiological effects	3.1	1,2,3	1	Lecture
Mechanism of action of plant growth hormones,	3.2	1,2,3	2	Lecture
Elicitors	3.3	1,2,3	2	Lecture
Module 4: Responses and Adaptations to Abiotic Stress (11 Hrs)				
Water stress – deficit and flooding.	4.1	1,2,3,4	2	Lecture
Salinity stress,	4.2	1,2,3,4	2	Lecture
high temperature stress, low temperature stress – chilling and freezing,	4.3	1,2,3,4	2	Lecture
trace element toxicity, air pollution stress,	4.4	1,2,3,4	1	Lecture
Oxidative stress and antioxidation mechanisms.	4.5	1,2,3,4	2	Lecture
Biotic stress (Pathogen)	4.6	1,2,3,4	2	Lecture
Module 5: Secondary Metabolites and plant Defence (16 Hrs)				
Classification of secondary metabolites, role in growth, development and defense	5.1	1,2,3,4	2	Lecture
Terpenes	5.2	1,2,3,4	1	Lecture
Phenolic compounds, flavonoids- anthocyanins, anthocyanidins, flavones and flavonoids,	5.3	1,2,3,4	2	Lecture
Nitrogen containing compounds - alkaloids,	5.4	1,2,3,4	1	Lecture
Cyanogenic glycosides, glucosinolates, nonprotein Amino acids	5.5	1,2,3,4	2	Lecture
Plant defense against insect herbivores; constitutive and induced defense,	5.6	1,2,3,4	2	Lecture
Role of jasmonic acid in plant defense	5.7	1,2,3,4	2	Lecture
Proteins inhibiting herbivore digestion	5.8	1,2,3,4	2	Lecture
Defense against pathogens	5.9	1,2,3,4	2	Lecture
Module 6: Respiration (15 Hrs)				
Glycolysis and its regulation, fates of pyruvate-fermentation; Etner doudoroff pathway. Gluconeogenesis-reactions and regulation.	6.1	5	8	
Citric acid cycle- amphibolic nature of the cycle, anaplerotic reactions, regulation and energetics.	6.2	5	7	
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Datta, S.C. (1989) Plant Physiology, Central Book Depot, Allahabad.
2. Dayananda, B. (1999) Experiments in Plant Physiology, Narosa Publishing House, New Delhi.
3. De Robertis, E.D.P. and De Robertis, E.M.F. Jr. (2002) Cell and Molecular Biology,
4. Lipponcott Williams and Wilkins. USA.
5. Hopkins, W.G. (1999) Introduction to Plant Physiology. John Wiley and sons, New
6. York.
7. Jain J.L. Sanjay Jain &Nitin Jain. (2005) Fundamentals of Biochemistry. S. Chand
8. & Company Ltd., New Delhi.
9. Jain, V. K. (1996) Fundamentals of Plant Physiology, S Chand and Company, Delhi.
10. Kochar, P.L. (1964) A Text Book of Plant Physiology, Atmaram & Sons, Delhi.
11. Lehninger A.L. (1961) Biochemistry, Lalyan Publishers, Ludhiana.
12. Nelson, D.L. and Cox, M.M. (1993) Principles of Biochemistry. MacMillan Worth
13. Publications.

Course designed by: Mr Tom Joseph

SBU24BO6DSE301: SPACE BIOLOGY - AN INTRODUCTION

Type of Course	DSE		
Course Level	300 -399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the fundamental principles of space biology	U
CO2	Explain the cellular and molecular biology in space	U
CO3	Explain the role of various agencies and facilities in space biology studies	U
CO4	Distinguish the effect of microgravity on biological system	U
CO5	Describe the applications of space biology	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-	1	-	1	-	-
CO2	-	2	-	-	-	2	-	1	-	-
CO3	-	1	-	-	-	1	-	1	-	-
CO4	-	2	-	-	-	1	-	1	-	-
CO5	-	1	-	-	-	1	-	1	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	-	-	x	x	-	x
CO2	-	x	x	x	-	x
CO3	-	-	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fundamental principles of Space Biology (15 Hrs)				
Overview of Space Biology and its significance	1.1	1	2	Lecture
Impact of microgravity on biological systems,	1.2	4	3	Lecture
Adaptation of organisms to space environments	1.3	1	3	Lecture
Exploration of potential extraterrestrial life	1.4	1	1	Lecture
Analyze the effects of space conditions on living organisms	1.5	1	2	Lecture
Explore the potential for life beyond Earth	1.6	1	1	Lecture
Case studies on the effects of microgravity	1.7	4	3	Lecture
Module 2: Cellular and Molecular Biology in Space (15 Hrs)				

Cellular response to microgravity,	2.1	4	3	Lecture
Genetic and epigenetic changes in space	2.2	2	2	Lecture
Impact on cellular signaling pathways,	2.3	2	2	Lecture
Effects of microgravity on physiology of organisms,	2.4	4	2	Lecture
Adaptations of various organisms to space conditions	2.5	2	3	Lecture
Immunological changes in space	2.6	2	3	Lecture
Module 3: Agencies and Facilities in Space Biology Studies (15 Hrs)				
NASA, ESA, Roscosmos, space biology research programs and missions	3.1	3	6	Lecture
International Space Station (ISS) and its role in space biology, Ground-based facilities for space biology research	3.2	3	5	Lecture
Space simulators and analog environments, research centres focusing on space biology, Funding opportunities for space biology research	3.3	3	4	Lecture
Module 4: **Applications of Space Biology (15 Hrs)**				
Understanding aging and disease through space studies	4.1	5	4	Lecture
Search for extraterrestrial life, Potential habitable zones in the solar system and beyond	4.2	5	3	Lecture
Growing plants in space, Sustainable life support systems for long-duration space missions	4.3	5	4	Lecture
Ethical Considerations: Ethical implications of space biology research, Responsible conduct in space exploration	4.4	5	4	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Calvin R. McClinton and William R. Sears. Principles of Bioastronautics
2. Jay C. Buckey Jr. Space Physiology.
3. Gilles Clément. Fundamentals of Space Biology: Research on Cells, Animals, and Plants in Space.
4. Richard L. Sarnat and James C. Snapper. Space, Time, and Medicine.
5. William J. Kaufmann III. Introduction to Space Science.
6. Kevin W. Plaxco and Michael Gross. Astrobiology: A Brief Introduction.
7. Brian Clegg. Gravity: How the Weakest Force in the Universe Shaped Our Lives.

Course designed by: Mr Biju George

SBU24BO6DSE302: GENOMICS

Type of Course	Major/Minor		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	57	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the Genome Mapping Techniques and sequencing	U
CO2	Analyze and Interpret Genome Sequences	U
CO3	Explain Transcriptomics Techniques	U
CO4	Describe Genomic Tools for Genome Project	U
CO5	Explore Comparative Genomics and Genome Editing	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	1	1	1	-	-	-	-
CO2	-	1	1	-	1	1	1	-	1	1
CO3	-	1	1	-	1	1	1	-	1	1
CO4	-	1	1	-	1	1	-	-	1	1
CO5	-	1	-	1	1	1	-	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Oral Presentation	Written test	MCQ	
CO1	x	x	x	x	x	x
CO2	-	x	x	x	-	x
CO3	x	-	-	x	-	x
CO4	-	x	x	x	x	x
CO5	x	-	-	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Genome Mapping and Sequencing (12 Hrs)				
Genetic and physical maps, DNA markers for genetic mapping –RFLP, SSLP, SNP, physical mapping – restriction mapping; optical mapping, FISH, STS mapping, The methodology for DNA sequencing- Sanger's chain termination method, automated DNA sequencing, pyrosequencing, nanopore sequencing, Assembly of contiguous DNA sequence; whole genome shot gun approach, clone contig approach; chromosome walking, clone finger printing , Approaches used in sequencing Haemophilus influenzae genome and human genome, Important findings of the completed genome projects: Human genome project, Rice genome project, Arabidopsis genome project, E. coli genome project, Wheat genome project.	1.1	1,2, 4	12	Lecture and Demonstration

Module 2: Understanding a Genome Sequence (18 Hrs)				
Locating the genes in a genome sequence; orf scanning, applications of codon bias, exon intron boundaries and upstream regulatory sequences, homology search, experimental techniques for gene location; Determining the functions of individual genes ; computer based techniques – homology analysis , orthologous and paralogous genes , experimental techniques ; analysis by gene inactivation-homologous recombination, transposon tagging, RNAi , site directed mutagenesis; analysis by gene over expression	1.3	2,4	18	Lecture and Demonstration
Module 3: Transcriptomics (9Hrs)				
Transcriptome, Trascriptome analysis through SAGE, DNA micoarray, Chromatin immunoprecipitation	3.1	3	9	Lecture and Demonstration
Module 4: Comparative Genomics (6 Hrs)				
Comparative genomics in gene mapping, comparative genomics as a tool in evolutionary studies, metagenomics	4.1	4, 5	3	Lecture and Demonstration
Module 5: Genome Editing (15 Hrs)				
Biology of Endonucleases (Zinc-Finger Nuclease, TALENs and CRISPRs), genome editing using Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALEN), Engineered meganucleases and CRISPR/Cas system; genome editing in model organisms, leapfrogging, Therapeutic Genome Editing in Human Hematopoietic Stem and Progenitor Cells, CRISPR/Cas9-based In Vivo Models of Cancer;	5.1	5	15	Lecture and Demonstration
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. D Peter Snustad, Michael J Simmons. Principles of genetics (V Edn). John Wiley and Sons.
2. David P Clark, Molecular biology. Elsevier.
3. David W Mount. Bioinformatics: sequence and genome analysis. CBS publishers & distributors.
4. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski. Recombinant DNA (IIIEdn). W H Freeman.
5. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. Biochemistry. W HFreeman and company.
6. Krishnarao Appasani (Editor) Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery, Cambridge University Press
7. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres. Genetics: From genes to genomes (II Edn). McGraw Hill.
8. Robert J Brooker. Genetics: analysis & principles (III Edn). McGraw Hill.
9. S B Primrose, R M Twyman. Principles of gene manipulation and genomics (VII Edn). Blackwell publishing.

Course designed by: Jebin Joseph

SBU24BO6SEC300: TECHNIQUES IN PLANT SCIENCE

Type of Course	SEC		
Course Level	300 -399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate proficiency in various imaging techniques, including microscopy, fluorescence microscopy, and electron microscopy, for cellular analysis.	U
CO2	Apply principles of cell fractionation and centrifugation to separate cellular components, interpreting data from analytical and ultracentrifugation techniques. Employing autoradiography and spectrophotometry for quantitative analysis.	U
CO3	The student will become adept in chromatography principles and techniques, including paper chromatography and column chromatography, for biomolecule separation and characterization.	U
CO4	Employ advanced characterization techniques such as mass spectrometry, X-ray diffraction, and electrophoresis for molecular analysis	U
CO5	Demonstrate practical skills in applying biochemistry techniques, including plant pigment separation, nucleic acid isolation, electrophoresis, PCR	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Microscopy (8 Hrs)				
Principles of microscopy- Types of microscopes: Optical, electron, and fluorescence microscopes, Importance of resolution and magnification. Light Microscopy, Basics of light microscopy. Brightfield and phase contrast microscopy. Limitations and enhancements of light microscopy.	1.1	1	3	Lecture
Fluorescence Microscopy: Principles of fluorescence and fluorochromes. Applications in cell biology: Live cell imaging, immunofluorescence. Principles of Excitation emission and fluorophore selection. Commonly used fluorescent dyes. Confocal microscopy, FRET.	1.2	1	2	Lecture
Electron Microscopy: Transmission and scanning electron microscopy. Sample preparation techniques: Fixation, embedding, sectioning, Interpretation of electron micrographs.	1.3	1	2	Lecture
Applications of Fluorescence Microscopy: Chromosome analysis: Banding techniques. Fluorescence in situ hybridization (FISH) and chromosome painting. Advanced applications: Live cell imaging, super resolution microscopy	1.4	1	1	Lecture
Module 2: Cell fractionation and Centrifugation. (8 Hrs)				
Centrifugation Basics, Principles of centrifugation. Different types of centrifuges: Fixed angle, swinging bucket. Factors influencing centrifugation.	2.1	2	2	Lecture
Differential and Density Gradient Centrifugation: Techniques for separating cellular components. Sucrose density gradient and CsCl2 gradient centrifugation.	2.2	2	2	Lecture
Analytical Centrifugation and Ultracentrifugation-Techniques: Sedimentation velocity and equilibrium. Ultracentrifugation and its applications in molecular biology. Interpretation of analytical and ultracentrifugation data.	2.3	2	4	Lecture
Module 3: Radioisotopes and basic spectroscopy (4 Hrs)				
Introduction to Radioisotopes: Basics of radioisotopes and their use in biology. Types of radiation and their effects on biological molecules. Safety considerations in handling radioisotopes.	3.1	2	1	Lecture
Autoradiography and Pulse Chase Experiment Basic Principles and applications in studying cellular dynamics.	3.2	2	2	Lecture
Basics of Spectrophotometry-Principles of spectrophotometry. Applications in quantifying biomolecules. UV –Visible spectrophotometry and its limitations.	3.3	2	1	Lecture

Module 4: Chromatography and characterization techniques (6 Hrs)				
Basic Chromatography Principles: Overview of chromatography principles. Types of chromatography: Gas, liquid, affinity, size exclusion. Factors influencing chromatographic separation.	4.1	3	2	Lecture
Paper Chromatography and Column Chromatography Basics, Techniquesand applications in separating biomolecules. Types of paper hromatography. Column chromatography: Principles and applications.	4.2	3	2	Lecture
Characterization Techniques- Mass Spectrometry: Principles and applications. Xray Diffraction and Xray Crystallography. Electrophoresis techniques: AGE, PAGE, SDSPAG	4.3	3	2	Lecture
Module 5: Nucleic Acid Isolation (2Hrs)				
Nucleic acid isolation, chemistry and procedure	5.1	4,5	2	Lecture
Module 6: Electrophoresis and Blotting(4Hrs)				
Agarose gel electrophoresis and visualization of the nucleic acid bands;	6.1	4,5	2	Lecture
Blotting techniques; Southern, Northern and Western blotting and hybridization,	6.2	4,5	1	Lecture
Probe preparation via nick translation, random priming, end labeling, radioactive and non radioactive probes;	6.3	4,5	1	Lecture
Module 7: DNA sequencing (13 Hrs)				
Sanger's dideoxy method, working of automated DNA sequencer, pyrosequencing, Nanopore sequencing;	7.1	4,5	2	Lecture
Polymerase chain reaction; An Overview	7.1	4,5	1	Lecture
Components and Conditions for PCR Optimization,	7.2	4,5	2	Lecture
Primer Designing	7.3	4,5	2	Lecture
Symmetric PCR, Asymmetric PCR, Inverse PCR, Anchored PCR, Quantitative real time PCR, SYBR Green and TaqMan chemistries,	7.4	4,5	3	Lecture
Applications of PCR, DNA finger printing	7.5		3	Lecture
Module 8: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Alberts, B., et al. (2014). Molecular Biology of the Cell.
2. Murphy, D. B., & Davidson, M. W. (2012). Fundamentals of Light Microscopy and Electronic Imaging. Wiley.
3. Pawley, J. B. (2006). Handbook of Biological Confocal Microscopy (3rd ed.). Springer.
4. Hayat, M. A. (2000). Principles and Techniques of Electron Microscopy: Biological Applications (4th ed.). Cambridge University Press.
5. Bowman, R. H., et al. (1970). Centrifugation: Practical Manual. American Elsevier Pub.Co.
6. Berg, J. M., et al. (2015). Stryer's Biochemistry (8th ed.). W. H. Freeman.
7. Richmond, R. C., & Sykes, G. (2004). Isotopes in Biological Dinitrogen Fixation Research. Springer.

8. Comas, I., & Schuenemann, V. J. (2018). A Brief Review of Molecular Archaeology.
9. Miller, J. M. (2010). Chromatography: Concepts and Contrasts. John Wiley & Sons.
10. Ettre, L. S., & Snyder, L. R. (1976). Quantitative Paper Chromatography of
11. Carbohydrates. Analytical Chemistry, 48(4), 586592.
12. Skoog, D. A., et al. (2017). Fundamentals of Analytical Chemistry. Cengage Learning.
13. Jürgen H. Gross (Ed.). (2005). Mass Spectrometry: A Textbook.
14. Drenth, J. (2007). Principles of Protein Xray Crystallography. Springer.
15. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGrawHill Publishing Co. Ltd. New Delhi. 3rd edition.
16. Nelson, D. L., & Cox, M. M. (2008). Lehninger Principles of Biochemistry. W. H. Freeman.

Course designed by: Mr Tom Joseph

SBU24BO6VAC300: INTEGRATED SUSTAINABLE WASTE AND ENERGY MANAGEMENT

Type of Course	VAC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)	-		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the fundamentals of waste and energy Management Fundamentals.	U
CO2	Explain solid waste management.	A
CO3	Expertise in Wastewater Management.	A
CO4	Describe Energy Management	An
CO5	Equip students with the knowledge of emerging trends in waste management.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	1	-	1	1	-	1	1
CO2	-	-	1	-	-	1	1	-	1	1
CO3	-	-	1	-	-	1	1	-	1	1
CO4	1	-	1	-	-	1	1	-	1	1
CO5	-	-	1	-	1	1	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva Voce	Home assignments	In-class discussions	Case study report	MCQ	
CO1	-	x	x	-	x	x
CO2	-	x	x	-	x	x
CO3	-	x	x	-	x	x
CO4	x	x	x	x	-	x
CO5	x	-	x	x	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Waste Management (9Hrs)				
Definition and importance of waste management	1.1	1	1	Lectures and Discussions
Classification of waste: solid, liquid, and gaseous Hazardous and non-hazardous waste	1.2	1	1	Lectures and Discussions
Sources and factors influencing waste generation	1.3	1	1	Lectures and Discussions

Collection and Logistics of Waste: Methods of waste collection. Transportation and logistics in waste management, Role of technology in waste collection	1.4	1	3	Lectures and Discussions
Present status of waste management in India: Current challenges and issues Policy and regulatory framework Socio-economic factors affecting waste management	1.5	1	3	Lectures and Discussions
Module 2: Solid Waste Management (9 Hrs)				
Introduction to Solid Waste Management: Definition and characteristics of solid waste E waste and Plastic waste Importance of solid waste management	2.1	2	4	Lectures and Discussions
Solid Waste Treatment and Disposal Landfilling and its environmental impact. Incineration and alternative technologies. Recycling and resource recovery	2.2	2	5	Lectures and Discussions
Module 3: Waste water management (9 Hrs)				
Overview of Wastewater Management: Importance of wastewater management Types and sources of wastewater	3.1	3	4	Lectures and Discussions
Wastewater Treatment Processes: Physical, chemical, and biological treatment methods Wastewater reuse and recycling Challenges in wastewater treatment	3.2	3	5	Lectures and Discussions Debate
Module 4: Energy Management (9 Hrs)				
Energy sources and their impact on the environment Integration of renewable energy in Industry and residence	4.1	1, 4	4	Lectures and Discussions
Integrated Waste and Energy Management: Waste-to-energy concept: Bio energy; Biogas production from organic waste. Case studies on successful energy recovery projects in India	4.2	4	3	Lectures and Discussions Case study
Energy Efficiency in Waste Management Sustainable practices in waste management. Role of energy efficiency in waste reduction	4.3	4	2	Lectures and Discussions
Module 5: Emerging Trends in Waste Management (9 Hrs)				
Circular Economy and Zero Waste Initiatives: Concepts and principles. Case studies of successful implementations	5.1	5	6	Lectures and Discussions
Smart Technologies in Waste Management	5.2	5	3	Lectures and Discussions
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Ada, E., Ilter, H.K., Sagnak, M. and Kazancoglu, Y. (2023), "Smart technologies for collection and classification of electronic waste", International Journal of Quality & Reliability Management, Vol. ahead-of-print No. ahead-of print. https://doi.org/10.1108/IJQRM-08-2022-0259
2. Ahmed, M.M., Hassanien, E. & Hassanien, A.E. IoT-based intelligent waste management system. Neural Comput & Applic 35, 23551–23579 (2023). https://doi.org/10.1007/s00521-023-08970-7
3. Anirban Goutam Mukherjee, Uddesh Ramesh Wanjari, Rituraj Chakraborty, Kaviyarasi Renu, Balachandar Vellingiri, Alex George, Sundara Rajan C.R., Abilash Valsala

Gopalakrishnan, “A review on modern and smart technologies for efficient waste disposal and management”, Journal of Environmental Management, Volume 297, 2021, https://doi.org/10.1016/j.jenvman.2021.113347.
4. Craig B. Smith, Kelly E Parmenter "Energy Management Principles" 2nd ed. Elsevier 2016
5. Czekała, W.; Drozdowski, J.; Łabiak, P. Modern Technologies for Waste Management: A Review. *Appl. Sci.* 2023, *13*, 8847. https://doi.org/10.3390/app13158847
6. https://shaktifoundation.in/wp-content/uploads/2021/12/CaseStudies_DSM_2016.pdf
7. J.D. Nixon, P.K. Dey, S.K. Ghosh, Energy recovery from waste in India: An evidence-based analysis, Sustainable Energy Technologies and Assessments, Volume 21, 2017, Pages 23-32, https://doi.org/10.1016/j.seta.2017.04.003
8. Mackenzie L. Davis and Susan J. Masten "Principles of Environmental Engineering and Science" McGraw-Hill Education, 2013
9. Nelson, V.C., & Starcher, K.L. Introduction to Renewable Energy”. 2nd ed. CRC Press. 2015 https://doi.org/10.1201/b19621
10. Pichtel, John. “Waste Management Practices.” 2nd ed. CRC Press, 2014.
11. Sadhan Kumar Ghosh, Circular Economy: Global Perspective First Ed, Springer Singapore, 2020

Course designed by: Mr Jebin Joseph

SEMESTER VII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO7DSC400	Major/Minor	Biochemistry - II	5	75	4
SBU24BO7DSC401	Major/Minor	Advanced Cell Biology	4	60	4
SBU24BO7DSC402	Major/Minor	Advanced Molecular Genetics	4	60	4
SBU24BO7DSC403	Major/Minor	Scientific Methodology	4	60	4
SBU24BO7DSC404	Major/Minor	Biostatistics	4	60	4
SBU24BO7DSC405	Major/Minor	Proteomics	4	60	4

SBU24BO7DSC400: BIOCHEMISTRY – II

Type of Course	Major/Minor		
Course Level	400 - 499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Theory (Hrs)**	**Theory (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the importance of biomolecules and its chemical diversity in shaping the biological structure and function.	U
CO2	Describe the structure of an amino acid and the formation and breakage of a peptide bond.	U
CO3	Explain the structure and functioning of enzymes	U
CO4	Globular and fibrous proteins play important roles in biological processes.	U
CO5	Perform qualitative and quantitative estimation of protein	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Amino acids (2 Hrs)				
Classification, Structure, Three & One Letter Code, Nonpolar Amino Acids, Polar Amino Acids, Aromatic Amino Acids,Charged Amino Acids, properties of proteinogenic amino acids, Essential & nonessential Amino Acids	1.1	1,2	2	Lecture
Module 2: Amino acid Titration (4 Hrs)				
Zwitterion, Non-lonizable Vs. lonizable R-Groups, Isoelectric Point, Isoelectric Point of Amino Acids with lonizable R-Groups,	2.1	1,2	2	Lecture
Titrations of Amino Acids with Non-lonizable R-Groups, Titrations of Amino Acids with lonizable R- Groups, pH,pKa and titration curve characteristic of amino acids, Amino Acids and Henderson-Hasselbalch.	2.2	1,2	2	Lecture
Module 3: Protein (4 Hrs)				
Peptide Bond, Primary Structure of Protein, Altering Primary Protein Structure, Drawing a Peptide, Determining Net Charge of a Peptide, Isoelectric Point of a Peptide, Approximating Protein Mass,	3.1	1,2,3	2	Lecture
Peptide Group, concept of dihedral angles phi and psi, importance of these dihedral angles in protein structure and function, Ramachandran plot and its importance in protein structure determination: Atypical Ramachandran Plots,	3.2	1,2,3	2	Lecture
Module 4: Hierarchy of protein structures (5 Hrs)				
Primary, secondary, tertiary and quaternary structure of proteins.	4.1	1,3,4	1	Lecture
Important secondary structures alpha helix, Alpha Helix Pitch and Rise, Alpha Helix Hydrogen Bonding, Alpha Helix Disruption,	4.2	1,3,4	1	Lecture
Beta Strand, beta sheets, Antiparallel and Parallel Beta Sheets, Beta Turns, other turns and loops.	4.3	1,3,4	1	Lecture
Tertiary Structure of Protein, protein domain and motifs, supersecondary structures and its importance in determining protein function.	4.4	1,3,4	1	Lecture
Quaternary Structure, Simple Vs. Conjugated Proteins, Fibrous and Globular Proteins.	4.5	1,3,4	1	Lecture
Module 5: Protein folding (4 Hrs)				
Denaturation, Anfinsen Experiment,	5.1	1,3,4	2	Lecture
Protein Folding, Chaperone Proteins, Prions	5.2	1,3,4	2	Lecture
Module 6: Enzymes Basics & Catalysis (9 Hrs)				
Enzymes, Enzyme-Substrate Complex, Lock and Key Vs. Induced Fit Models,	6.1	4,5	2	Lecture
Optimal Enzyme Conditions,Activation Energy,	6.2	4,5	2	Lecture
Types of Enzymes,	6.3	4,5	1	Lecture
Cofactors	6.4	4,5	2	Lecture

Catalysis, Electrostatic and Metal lon Catalysis, Covalent Catalysis	6.5	4,5	2	Lecture
Module 7: Enzyme Kinetics (8 Hrs)				
Reaction Rate, Enzyme Kinetics, Rate Constants and Rate Law, Reaction Orders, Rate Constant Units,	7.1	4,5	2	Lecture
Initial velocity, Vmax, Km, Steady-State Conditions, Michaelis-Menten Assumptions, Michaelis-Menten Equation,	7.2	4,5	2	Lecture
Lineweaver-Burk Plot, Michaelis-Menten vs. Lineweaver-Burk Plots, Shifting Lineweaver-Burk Plots,	7.3	4,5	2	Lecture
Calculating Vmax, Calculating Km, Kcat, specificity constant	7.4	4,5	2	Lecture
Module 8: Enzyme Inhibition and Regulation (9 Hrs)				
Enzyme Inhibition, Irreversible Inhibition, Reversible Inhibition,	8.1	4,5	1	Lecture
Inhibition Constant, Degree of Inhibition, Apparent Km and Vmax, Inhibition Effects on Reaction Rate,	8.2	4,5	2	Lecture
Competitive Inhibition, Uncompetitive Inhibition, Mixed Inhibition, Noncompetitive Inhibition,	8.3	4,5	2	Lecture
Allosteric Regulation, Allosteric Kinetics, Allosteric Enzyme Conformations, Allosteric Effectors, Concerted (MWC) Model, Sequential (KNF) Model, Sequential (KNF) Model,	8.4	4,5	2	Lecture
Negative Feedback, Positive Feedback,	8.5	4,5	1	Lecture
Post Translational Modification, Ubiquitination, Phosphorylation, Zymogens	8.6	4,5	1	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 9: Biochemistry Practical (30 Hrs)				
Colour tests for proteins in solution – Million's test	9.1	1,3	5	practical
The biuret test for proteins to identify the contents of solutions	9.2	1,3	5	practical
Quantitative estimation of protein using colorimeter	9.3	1,3	10	practical
Quantitative estimation of enzymes using colorimeter	9.4	1,5	10	Practical
Module 10: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Biochemistry Vat, D., Voet, 1.6. Publisher: Wiley; 3rd edition
2. Lehninger Principles of Biochemistry David L. Nelson, Michael M. Cox. Publisher: W. H. Freeman, Fourth Edition
3. Jeremy M Berg; John Tymocko; Lubert Stryer (2012), Biochemistry, 7th edition (or older), Wiley.
4. Plummer D.T. (1988) An Introduction to Practical Biochemistry, Tata McGraw- Hill Publishing Company, New Delhi.

5. Sadasivam. S & Manickam, A. (1996) Biochemical Methods. New Age International (P) Ltd. New

Course designed by: Mr Tom Joseph

SBU24BO7DSC401: ADVANCED CELL BIOLOGY

Type of Course	DSE		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60		60
Pre-requisite (if any)	Foundations in cell biology		

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate a comprehensive understanding of the fundamental cellular processes.	U
CO2	Application of Cytoskeletal Concepts to explain cellular movements, organelle transport, and structural organisation in various cellular contexts.	A
CO3	Analyse and comprehend the regulatory mechanisms governing the cell cycle, cellular adhesion, protein targeting, and signal transduction pathways, including recognising extracellular and intracellular signals and the role of receptors.	An
CO4	Integrate knowledge of cellular communication, secretion, endocytosis, and cell death processes, emphasizing the coordination of these functions in maintaining cellular homeostasis, responding to environmental cues, and executing programmed cell activities.	An
CO5	Develop critical thinking skills to analyze and solve problems related to cellular processes.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	2	1	1	1	1	-	-	1	-
CO2	-	2	1	1	1	1	1	1	1	1
CO3	-	2	1	1	1	1	1	1	1	1
CO4	-	2	1	1	1	1	1	1	1	1
CO5	-	2	1	1	1	1	-	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	Viva	Quiz	MCQ	Written Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	-	x	x	x
CO5	x	x	-	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Transmembrane Transport of Ions and Small Molecules (7 Hrs)				
Polarity of cell Overview of Transmembrane Transport,	1.1	1	2	Lecture
Three Main Classes of Membrane: membrane transport proteins, Facilitated Transport of Glucose and Water, ATP-Powered Pumps and the Intracellular Ionic Environment,	1.2	1	3	Lecture
Nongated Ion Channels and the Resting Membrane Potential, Cotransport by Symporters and Antiporters, Transcellular Transport.	1.3	1	2	Lecture
Module 2: Cell organisation and movement (9 Hrs)				
Microfilaments: G-actin, F- actin Structure, properties and formation of Actin Filaments, Function of Microfilaments in Endocytosis Organization of Actin-Based Cellular Structures. Actin-Based Motor Proteins - Myosins- structure and function	2.1	2	4	Lecture
Microtubule: Structure and Organization, αβ-Tubulin Dimers. Microtubule Based Motor Proteins: Kinesins and Dyneins, structure and functions Cilia and Flagella: Microtubule-Based Surface Structures – structure and movements	2.2	2	3	Lecture
Intermediate Filaments: Structure and functions	2.3	2	2	Lecture
Module 3: Eukaryotic Cell Cycle (13 Hrs)				
Stages of Mitosis emphasis on formation of mitotic chromosomes and mitotic spindle, dissolution of nuclear membrane and organelle partition, chromosome movement in Anaphase. Cytokinesis and formation of cell plate in plant cell.	3.1	3	4	Lecture
Stages of Meiosis; Significance of meiosis in generating genetic variation.	3.2	3	2	Lecture
Cell cycle control system: extracellular and intracellular signals, Extracellular Signals Govern Cell Cycle Entry, Cyclins and Cyclin-dependent kinases. Irreversible Commitment to cell Division and Cell Cycle START/ Restriction Point, S-phase, Entry into Mitosis, Completion of Mitosis, Chromosome Segregation and Exit from Mitosis, Surveillance Mechanisms in Cell Cycle Regulation: checkpoints pathways– DNA damage checkpoint, spindle assembly checkpoint.	3.3	3	4	Lecture
Cancer biology: introduction, cause	3.4	3,5	3	Lecture
Module 4: Integrating cells into tissues (6 Hrs)				
Cell-Cell and Cell–Extracellular Matrix Adhesion: An Overview, Cell-Cell and Cell Extracellular Matrix Junctions and Their Adhesion Molecules.		2	2	Lecture
The Extracellular Matrix: The Basal Lamina, Connective Tissue.		2	2	Lecture
Adhesive Interactions in Motile and Nonmotile Cells.		2	2	Lecture

Integration of Cells in Plant Tissues.				
Module 5: Moving proteins into membranes and organelles (5 Hrs)				
Targeting Proteins to and Across the ER Membrane, Insertion of Membrane Proteins into the ER, Protein Modifications, Folding, and Quality Control in the ER	5.1	4	3	Lecture
Targeting of Proteins to Mitochondria and Chloroplasts, Targeting of Peroxisomal Proteins, Transport Into and Out of the Nucleus	5.2	4	2	Lecture
Module 6: Vesicular Traffic, Secretion, and Endocytosis (6 Hrs)				
Early Stages of the Secretory Pathway, Later Stages of the Secretory Pathway		4	3	Lecture
Receptor-Mediated Endocytosis, Directing Membrane Proteins and Cytosolic Materials to the Lysosome.		4	3	Lecture
Module 7: Cell communication and Cell signalling (9 Hrs)				
Cell communication: general principles. Signalling molecules and their receptors, external and internal signals that modify metabolism, growth, and development of plants.		3	3	Lecture
Receptors: Cell surface receptors – ion-channel linked receptors, G-protein coupled receptors, and Tyrosine-kinase linked receptors (RTK), Steroid hormone receptors. Insulin signaling pathway		3	3	Lecture
Signal transduction pathways, Second messengers, Regulation of signaling pathways. Bacterial and plant two-component signaling systems.		3, 5	3	Lecture
Module 8: Cell Death and Its Regulation (5 Hrs)				
Programmed cell death, Proteins Participate in the Apoptotic Pathway, Caspases, Role of Mitochondria in Apoptosis in Vertebrate Cells.	8.1	3,4	2	Lecture
Intrinsic and extrinsic pathway	8.2	3,4, 5	2	Lecture
Apoptosis and Necrosis	8.3	3,5	1	Lecture
Module 9: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell (4th Ed.), Garland Science, New York, 2002.
2. Becker, W. M. and Klein smith, L. J., World of the Cell (6th Ed.), Benjamin Cummings, 2005.
3. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander D. Johnson, Julian Lewis, Martin Raff, Essential cell biology (IV Edn). Garland Science, Taylor and Francis group, 2013.
4. Cooper GM and Hausman, The Cell, a molecular approach, 6th Edition, Sinauer Associates, Sunderland, 2013
5. Gerald Karp, Cell and Molecular biology: Concepts and experiments (V Edn). John Wiley & Sons. 2007
6. Gupta, P. K. Cell and Molecular Biology (2nd Ed.), Rastogi Publication, Meerut 17, 2003.

7. Harvey, L., Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, D (2000) Molecular Cell Biology (4th Ed.), W. H. Freeman, New York, 2000
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Course designed by: Mr. Jebin Joseph

SBU24BO7DSC402: ADVANCED MOLECULAR GENETICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate a thorough comprehension of recombination in bacterial systems.	U
CO2	Explain the intricacies and processes involved in the transcription of genes in bacteria and eukaryotes.	U
CO3	Explain genetic code, mRNA structure, translation processes, and post-translational modifications in both prokaryotes and eukaryotes.	U
CO4	Elucidate the organization of organelle genome and explain the mechanism of gene regulation in organisms	U
CO5	Explain the concept of Epigenetics and comment on epigenetic effects and their molecular mechanism.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	3	2	-	2	2	2	-	1	-
CO2	-	3	2	-	2	2	1	2	1	-
CO3	-	3	2	-	2	2	1	-	1	-
CO4	-	3	2	-	2	2	1	-	1	-
CO5	-	3	2	-	2	2	1	-	1	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open Book Test	Written Exam	
CO1	x	x	-	x	x	x
CO2	x	x	x	x	x	x
CO3	x	-	x	-	x	x
CO4	x	x	x	x	x	x
CO5	x	-	x	-	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Recombination (5 Hrs)				
Basics, Horizontal and Vertical genetransfers, types; Homologous genetic recombination- Holiday model and Double Strand Break Repair Model;	1.1	1	2	Lecture

Mechanisms and components required for recombination (Prokaryotic system only) Rec BCD Enzyme, Chi- sites, Activity of Rec A protein, components involved in branch migration and resolution; splice (crossover) or patch (non-crossover) types; gene conversion.	1.2	1	3	Lecture
Module 2: Transcription (8 Hrs)				
Transcription, concept of gene, one gene one enzyme hypothesis, complementation test, requirements for transcription, the template and non-template strands of DNA, experiments by Julius Marmur:	2.1	2	4	Lecture
Promoters; bacterial and eukaryotic RNA polymerase; bacterial and eukaryotic process of, Transcription inhibitors.	2.2	2	4	Lecture
Module 3: RNA processing (4 Hrs)				
RNA processing; addition of 5' cap and 3'polyA tail, RNA splicing, Alternative splicing, exon shuffling, cis and trans splicing, tRNA gene structure and processing, rRNA gene structure and processing, RNA editing.	3.1	2	4	Lecture
Module 4: Genetic code and Translation (7 Hrs)				
The genetic code, breaking the genetic code, characteristics of the code, Exceptions to the standard code; Structure of mRNA, monocistronic and polycistronic mRNAs	4.1	3	2	Lecture
Composition and assembly of prokaryotic and eukaryotic ribosomes, three-dimensional structure of ribosome, process of translation in prokaryotes and eukaryotes, polyribosomes	4.2	3	2	Lecture
mRNA surveillance; non-sense mediated mRNA decay, non-stop mRNA decay, stalled ribosome, translation inhibitors, Post translational modifications of proteins and molecular chaperons	4.3	3	3	Lecture
Module 5: Organelle genome (3 Hrs)				
Mitochondrial genome - gene structure and organization, yeast mtDNA, human mtDNA, plant mtDNA, replication, transcription and translation of mtDNA, non-universal codons in mtDNA, evolution of mtDNA,	5.1	4	2	Lecture
chloroplast genome - gene structure and organization, replication, transcription and translation of cpDNA, evolution of cpDNA	5.2	4	1	Lecture
Module 6: Gene regulation (15 Hrs)				
Importance of gene regulation, Genes and regulatory elements, Levels of gene regulation, gene regulation in bacterial cells; operon structure, negative and positive control, inducible and repressible operons.	6.1	4	3	Lecture
Lac operon of *E.coli*, positive control and catabolite repression, trp operon of E.coli, attenuation and antitermination, Antisense RNA and bacterial gene regulation, regulation of ompFgene, riboswitches and bacterial gene regulation.	6.2	4	5	Lecture
Gene regulations in eukaryotes; histone modification – methylation and acetylation, control of flowering in Arabidopsis through acetylation of histone, chromatin	6.3	4	5	Lecture

remodeling, DNA methylation, Transcriptional Control by transcription factors, transcriptional activators and coactivators, GAL4 and galactose metabolism,				
Transcriptional repressors, transcriptional enhancers and insulators, regulation of transcriptional stalling and elongation, gene regulation through RNA splicing, gene regulation through degradation of RNA, mechanism of generegulation by RNAi, gene regulation through processes that affect translation or by modification of proteins.	6.4	4	2	Lecture
Module 7: Epigenetics (3 Hrs)				
History and development of ideas, genetic maternal effect, genomic imprinting and genetic conflict hypothesis.	7.1	5	1	Lecture
epigenetic effects – epigenetic changes induced by maternal behavior, epigenetic effects caused by prenatal exposure, molecular mechanism of epigenetic changes, the epigenome.	7.2	5	2	Lecture
Module 8: Problems based on DNA Structure (5 Hrs)				
Work out problems based on DNA Structure, Transcription, and Translation	8.1	2	5	Discussion & Problem Solving
Module 9: Isolation of DNA (10Hrs)				
Isolation of DNA from plant tissue (Suitable for molecular Studies)	9.1	2	5	Laboratory Work
Spectrophotometric purity analysis and quantification of DNA	9.2	2	5	Laboratory Work
Module 10: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell (4th Ed.), Garland Science, New York.
2. Becker, W. M. and Klein smith, L. J., World of the Cell (6th Ed.), Benjamin Cummings.
3. Cooper GM and Hausman, The Cell, a molecular approach, 6th Edition, Sinauer Associates, Sunderland
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5. Harvey, L., Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, D, Molecular Cell Biology (4th Ed.), W. H. Freeman, New York
6. Lodish, H. F. (2008). Molecular cell biology. Macmillan.
7. Pierce, B. A. (2012). Genetics: a conceptual approach. Macmillan.
8. R M Twyman. (2001) Instant notes in Developmental Biology. Viva Books Private Limited
9. Scott F Gilbert. (2010) Developmental Bilogy (IX Edn). Sinauer Associates.

Course designed by: Mr. Ajeesh Joseph

SBU24BO7DSC403: SCIENTIFIC METHODOLOGY

Type of Course	Major/Minor		
Course Level	400 -499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explains the basic principles of scientific research	U
CO2	Distinguishes the philosophical underpinnings of science	U
CO3	Describe the process of scientific research	U
CO4	Explain the process of scientific communication	U
CO5	Distinguishes the ELSI in scientific research	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	2	1	-	1	-	2
CO2	-	-	-	-	2	1	-	1	-	2
CO3	-	-	-	-	2	1	-	1	-	2
CO4	-	-	-	-	2	1	-	1	-	2
CO5	-	-	-	-	2	1	-	1	-	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Assignment	MCQ Test	Viva voce	Quiz	Test	
CO1	x	x	x	x	-	x
CO2	x	x	x	x	-	x
CO3	-	x	x	-	x	x
CO4	-	-	x	-	x	x
CO5	-	-	x	-	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: What is science? (7 Hrs)				
Definition of science	1.1	1	1	Lecture
Characteristics of science: Purposive, Systematic, Objective, Empirical, Publically Verifiable, Replicable, Consistent, Predictable, Tentative, Falsifiable, Reductive, Parsimonious.	1.2	1	4	Lecture
Demarcation of science from pseudoscience	1.3	1	2	Lecture
Module 2: The Philosophical Underpinnings of Science (11 Hrs)				
Epistemology: Proposition, Justification, Conditions Belief, Truth, Knowledge, Tripartite Analysis of Knowledge	2.1	2	3	Lecture

Epistemology: Sources of Knowledge; Intuition Serendipity, Authoritative Knowledge, Logical Knowledge Empirical Knowledge.	2.2	2	4	Lecture
Logic and Reasoning: Inference, Syllogisms, Modus Ponens, Modus Tollens, Logical Fallacies, Deduction, Induction, Hypothetico – Deduction, Abduction	2.3	2	4	Lecture
Module 3: Scientific Research Methodology (20 Hrs)				
Search vs research	3.1	3	2	Lecture
Methodology vs methods	3.2	3	2	Lecture
Hallmarks of scientific research methodology: Purpose Rigor, Precision, Confidence, Objective	3.3	3	3	Lecture
Types of Research: Descriptive, Explanatory, Exploratory Historical, Experimental -Scientific Method, Co Relational, Basic /Pure. Applied, Practical/Action Research	3.4	3	8	Lecture
The Seven-Step Process in scientific research methodology: Identify a broad problem area, Define the problem statement, develop hypotheses, Determine measures, Data collection, Data analysis, Interpretation of data	3.5	3	5	Lecture
Module 4: Publication of Research Outcomes (10 Hrs)				
IMRAD structure	4.1	4	4	Lecture
The process of review and Research articles, Publication ethics, open access journals, predatory publications.	4.2	4	3	Lecture
Reference management software and Plagiarism checkers	4.3	4	3	Lecture
Module 5: Ethical, Legal and Social Implications in Research (12 Hrs)				
Ethical implications; Autonomy, dignity, and rights of individuals, potential risks and benefits of the research, informed consent, and justice and fairness	5.1	5	4	Lecture
Legal implications: Data protection, intellectual property rights (Patent, Trademark, GI, Trade secret, Copyright, Design), Plagiarism, confidentiality and liability	5.2	5	4	Lecture
Social implications: equity, access, diversity, inclusion and potential for social inequalities or discrimination.	5.3	5	4	Lecture
Module 6: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Arora, P. N., Malhan, P. K. (2010). Biostatistics. India: Himalaya Publishing House.
2. Banerjee, P. K. (2007). Introduction to biostatistics (a textbook of biometry). S. Chand Publishing.
3. Creswell, J. W., Creswell, J. D. (2017). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. United States: SAGE Publications.
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5. Holmes, D., Moody, P., Dine, D., & Trueman, L. (2017). Research methods for the biosciences. Oxford university press.
6. Jeffrey A Lee, 2009. The Scientific Endeavour: Methodology and perspectives of sciences. Pearson.

7. Khanal, A. B. (2015). Mahajan's Methods in Biostatistics For Medical Students and Research Workers. India: Jaypee Brothers Medical Publishers Pvt. Limited.
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Course designed by: Mr Biju George

SBU24BO7DSC404: BIOSTATISTICS

Type of Course	Major/Minor		
Course Level	400 -499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply basic statistical concepts and terminology to analyse biological data sets.	A
CO2	Master descriptive statistics for summarizing and visualizing botanical data.	An
CO3	Perform and interpret hypothesis testing to draw conclusions from experimental data.	E
CO4	Use appropriate statistical tools and software for data analysis in Botanical research.	An
CO5	Effectively communicate statistical results in written and oral presentations.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	2	3	2	-	3	-
CO2	-	-	2	-	2	3	2	-	3	-
CO3	-	-	3	-	3	3	2	-	3	2
CO4	-	-	2	-	3	3	2	-	-	2
CO5	-	-	2	-	2	-	-	3	-	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	-	-	-	x
CO5	x	x	-	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	-	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	-	x	x	x
CO5	x	x	x	-	-	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Biostatistics and Data Collection (8 Hrs)				
Definition and importance of biostatistics in biological research	1.1	1	2	Lecture/Demonstration
Types of data (quantitative, qualitative, nominal, ordinal) and their characteristics, Data management	1.2	1	2	Lecture/Demonstration
Principles of data collection: sampling methods, experimental design, data quality control	1.3	1	2	Lecture/Demonstration
Introduction to statistical software (e.g., R, SPSS)	1.4	1	2	Lecture/Demonstration
Module 2: Descriptive Statistics (10 Hrs)				
Measures of central tendency (mean, median, mode) and dispersion (range, variance, standard deviation)	2.1	2	4	Lecture/Demonstration
Frequency distributions and histograms	2.2	2	2	Lecture/Demonstration
Descriptive statistics for qualitative data (frequencies, percentages)	2.3	2	2	Lecture/Demonstration
Data transformation and standardization	2.4	2	2	Lecture/Demonstration
Module 3: Inferential Statistics and Hypothesis Testing (11 Hrs)				
Concepts of hypothesis testing, null and alternative hypotheses, Type I and II errors	3.1	3	2	Lecture/Demonstration
Parametric and non-parametric tests: t-test, ANOVA, Chi-square test	3.2	3	7	Lecture/Demonstration
Power analysis and sample size determination	3.3	3	2	Lecture/Demonstration
Module 4: Correlation, Regression and Experimental Design (8 Hrs)				
Correlation analysis: Pearson's correlation coefficient, Spearman's rank correlation coefficient	4.1	4	2	Lecture/Demonstration
Linear regression analysis: model fitting, coefficient of determination, prediction intervals	4.2	4	2	Lecture/Demonstration
Principles of experimental design: control groups, randomization, replication	4.3	4	2	Lecture/Demonstration
Various experimental design for biological research	4.4	4	2	Lecture/Demonstration
Module 5: Data Visualization and Communication (8 Hrs)				
Importance of data visualization in scientific communication	5.1	5	2	Lecture/Demonstration
Types of data visualization and analysis: bar charts, pie charts, boxplots, scatter plots.	5.2	5	2	Lecture/Demonstration
Graphical principles and effective design strategies	5.3	5	2	Lecture/Demonstration
Scientific writing and presentation of statistical results	5.4	5	2	Lecture/Demonstration
Module 6: Biostatistics (15 Hrs)				
Hands-on exercises on data collection techniques in botanical research	1.1	4,5	3	Demonstrate/ Hands on training

Familiarization with basic statistical software functions with reference to the statistical tools included in the syllabus	1.2	4,5	12	Demonstrate/ Hands on training
Module 7: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Campbell, R.C. (2020). Statistics for Biology and Medicine (5th Edition). Pearson Education, London.
2. Deshpande, A.D. (2010). Biostatistics for Medical and Biological Research.
3. Garg, S.K. (2020). Biostatistics for Pharmaceutical and Biological Research. Khanna Publishers, Delhi.
4. Gupta, S.C. (2018). Fundamental of Statistics. Sultan Chand & Sons, New Delhi.
5. Gupta, S.C., & Kapoor, V.K. (2015). Fundamentals of Applied Statistics. Sultan Chand & Sons, New Delhi.
6. Kothari, C.R. (2012). Research Methodology: Methods and Techniques (2nd Edition). New Age International Publishers, New Delhi.
7. Pandey, G.N. (2017). Biostatistics: A Practical Guide. Academic Publishers, Jaipur.
8. Singh, A., & Kumar, S. (2021). Biostatistics: A Comprehensive Approach. PHI Learning Pvt. Ltd., New Delhi.
9. Singh, A., & Singh, J. (2014). Elementary Biostatistics for Students of Zoology, Botany, Agriculture and Forestry. Rastogi Publications, Meerut.
10. Sokal, R.R., & Rohlf, F.J. (2012). Introduction to Biostatistics (2nd Edition). W.H. Freeman and Company, New York.

Course designed by: Dr. Salvy Thomas

SBU24BO7DSC405: PROTEOMICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain procedures to characterize protein in a complex biological sample.	U
CO2	Explain various experiments to separate the complex biological mixture and then identify the protein of interest.	U
CO3	Explain the utility of proteomics and its potentials to understand complex biological phenomenon and problems in biotechnology industry.	U
CO4	Distinguish various methods of protein sequencing	U
CO5	Explain various protein interactions	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Working with proteins (23 Hrs)				
Protein Purification, Protein Extraction, Differential Centrifugation, Salting Out, Dialysis	1.1	1,2,3	4	Lecture
Column Chromatography, lon-Exchange Chromatography, Anion-Exchange Chromatography, Cation-exchange	1.2	1,2,3	8	Lecture

chromatography, Size Exclusion Chromatography, Affinity Chromatography, Specific Activity, HPLC.				
Native Gel Electrophoresis, SDS-PAGE, SDS-PAGE Strategies, Isoelectric Focusing, 2D-Electrophoresis, Diagonal Electrophoresis,	1.3	1,2,3	8	Lecture
Spectrophotometry, Mass Spectrometry, Mass Spectrum, Tandem Mass Spectrometry, Peptide Mass Fingerprinting	1.4	1,2,3	3	Lecture
Module 2: Proteomics (9 Hrs)				
Proteome, Proteome analysis through 2D PAGE, MALDI-TOF	2.1	1,2,3	6	Lecture
Analysis of protein – protein interaction; phage display and yeast two hybrid system, tandem affinity purification, protein interaction maps.	2.2	1,2,3	3	Lecture
Module 3: Protein sequencing (10 Hrs)				
Overview of Direct Protein Sequencing, Amino Acid Hydrolysis, FDNB,Chemical Cleavage of Bonds, Peptidases, Edman Degradation, Edman Degradation Sequenator and Sequencing Data Analysis, Edman Degradation Reaction Efficiency, Ordering Cleaved Fragments,Strategy for Ordering Cleaved Fragments, Indirect Protein Sequencing Via Geneomic Analyses	3.1	1,2,3	10	Lecture
Module 4: Protein interactions (18 Hrs)				
Introduction to Protein-Ligand Interactions, Protein-Ligand Equilibrium Constants, Protein-Ligand Fractional Saturation Myoglobin vs. Hemoglobin, Heme Prosthetic Group Hemoglobin Cooperativity, Hill Equation,Hill Plot, Hemoglobin Binding in Tissues & Lungs, Hemoglobin, Carbonation & Protonation, Bohr Effect, BPG Regulation of Hemoglobin, Fetal Hemoglobin,Sickle Cell Anemia	4.1	1,2,3	8	Lecture
Protein-DNA interactions	4.2	1,2,3	5	Lecture
Protein-Protein interactions	4.3	1,2,3	5	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. C. Branden and J. Tooze, Introduction to protein structure, Garland Publishing, 1998.
2. Nelson, D.L. and Cox, M.M. (1993) Principles of Biochemistry. MacMillan Worth Publications.
3. P. Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersay, USA, 2003.
4. Plummer D.T. (1988) An Introduction to Practical Biochemistry, Tata McGraw- Hill Publishing Company, New Delhi.
5. R. D. Appel and D.F. Hochstrasser, Proteome Research: New Frontiers in Functional Genomics, Springer, 1997
6. R.M. Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.

7. Sadasivam. S & Manickam, A. (1996) Biochemical Methods. New Age International (P) Ltd. New
8. Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007.

Course designed by: Tom Joseph

SEMESTER VIII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24BO8DSC400	Major	Genetic Engineering	5	75	4
SBU24BO8DSC401	Major	Bioinformatics	5	75	4
SBU24BO8DSC402	Major	Angiosperm Systematics	5	75	4
BBO8DHRPJ	Major	Project			12

SBU24BO8DSC400: GENETIC ENGINEERING

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Theory (Hrs)**	**Theory (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Construct and modify vectors for specific purposes like gene expression, replication and selection markers.	U
CO2	Develop proficiency in fundamental gene cloning techniques.	U
CO3	Compare different gene transfer methods based on efficiency and specificity.	U
CO4	Explain the applications of plant genetic engineering in the field of agriculture, medicine, environment and industry.	U
CO5	Understand molecular tools used in genetic engineering.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	-	-	1	-	-	-	-
CO2	-	1	1	-	1	1	-	-	-	-
CO3	-	-	-	-	1	1	2	-	-	-
CO4	1	-	1	-	-	1	1	-	1	-
CO5	-	-	-	2	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Enzymes Used in Genetic Engineering (8 Hrs)				
Restriction enzymes, Phosphatase, polynucleotide kinase, single strand specific nucleases; DNA polymerases (DNA Polymerase I, Klenow fragment, T4DNA Polymerase, T7 DNA Polymerase); RNA Polymerases (T3, T7, SP6); Reverse Transcriptase (AMV, MoMLV), Ligases (T4 DNA ligase, E.coli DNA ligase), Taq polymerase.	1.1	1,2,3	8	Lecture
Module 2: Gene Cloning (21 Hrs)				
Methods of gene cloning, Cloning vectors for E.coli, Biology of plasmids (conjugative, nonconjugative, relaxed and stringent control of copy number) Plasmid based vectors, pBR 321, pUC series,	2.1	1,2,3	3	Lecture
Biology of Lambda phage (lytic and lysogenic cycle), λ bacteriophage based vectors (insertional and replacement), in vitro packaging;	2.2	1,2,3	3	Lecture
Biology of M13 bacteriophage, M13 phage based vectors,phagemids,	2.3	1,2,3	3	Lecture
High capacity vectors: cosmids, P1 phage based vectors, bacterial artificial chromosomes. Advantages of each vector.	2.4	1,2,3	3	Lecture
Cloning vectors for eukaryotes, Agrobacterium tumefaciens and the biology of crown gall formation, Agrobacterium Ti plasmid based vectors	2.5	1,2,3	5	Lecture
yeast artificial chromosomes	2.6	1,2,3	2	Lecture
Linkers, adapters, homopolymer tailing	2.7	1,2,3	2	Lecture
Module 3: Selection and Screening of Recombinant Clones (3 Hrs)				
Insertional inactivation, alpha complementation and blue white selection, colony and plaque hybridization, immunological screening	3.1	1,2,3,4	3	Lecture
Module 4: Advanced Transgenic Technology (10 Hrs)				
Inducible expression systems – examples, site-specific recombination for in vivo gene manipulation, gene targeting, gene silencing using antisense RNA and RNAi. In vitro mutagenesis - site-directed mutagenesis.	4.1	1,2,3,4,5	10	Lecture
Module 3: cDNA synthesis (3 Hrs)				
Different methods of first strand and second strand of cDNA synthesis	5.1	1,2,3,4,5	3	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 4: Practical (30 Hrs)				
1. Isolation of chromosomal and plasmid DNA from bacterium 2. Restriction digestion of DNA and assigning restriction sites 3. Isolation of plant genomic DNA 4. Designing a primer for a well characterized E.coli gene 5. PCR amplification of the gene from E.coli DNA using the designed primer 6. RAPD analysis of three closely related bacterial strain 7. AGE	1.1		30	Practical
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski. Recombinant DNA (III Edn). W H Freeman.
2. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres . Genetics: From genes to genomes (II Edn). McGraw Hill.
3. S B Primrose, R M Twyman. Principles of gene manipulation and genomics (VII Edn). Blackwell publishing.
4. T A Brown. Genomes (II Edn). Bios. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres . Genetics: From genes to genomes (II Edn). McGraw Hill.

Course designed by: Tom Joseph

SBU24BO8DSC401: BIOINFORMATICS

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	State fundamental bioinformatics concepts and tools	U
CO2	List out the various biological databases and explain their unique features	U
CO3	Utilise suitable tools to study molecular sequences	A
CO4	Compare and align sequences using BLAST and FASTA	A
CO5	Investigate evolutionary relationships through phylogenetic trees	A

Cognitive Levels:R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Assignment	Viva voce	Open Book Test	Written Exam	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	-	x	x
CO4	x	x	x	x	x	x
CO5	x	-	x	-	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x	x	x	x
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Bioinformatics introduction (2 Hrs)				
An Introduction to bioinformatics. Scope and relevance of bioinformatics.	1.1	1	2	Lecture
Module 2: Biological Databases (15 Hrs)				
Online databases and search tools, data organization, NCBI. Biological databases, structural databases, DNA	2.1	2	5	Lecture

and RNA sequence databases.				
Unique features of –Nucleic acid sequence databases Gene Bank, ENA, DDBJ. Protein sequence databases: Gen Bank, SWISS-PROT	2.2	2	5	Lecture
Protein structure database: Protein Data Bank Bibliographic databases: PubMed	2.3	2	5	Lecture
Module 3: Tools to study molecular sequences (12 Hrs)				
Molecular visualisation- RasMol, PyMOL, Sequence retrieval and submission – Entrez, BankIt	3.1	3	3	Lecture
Introduction to PERL, programming using PERL, Use of PERL in Bioinformtics, Writing Perl Scripts to Perform Sequence Analysis- Calculating GC Content, Finding Reverse Complement, Finding the Frequency of a Motif.	3.2	3	9	Lecture
Module 4: Sequence Alignment (6 Hrs)				
Sequence comparison, Pair wise sequence alignment, Global alignment: Use of ALIGN, Local alignment: Use of BLAST, FASTA. Amino acid substitution matrices PAMand BLOSUM,	4.1	4	6	Lecture
Module 5: Phylogeny Analysis (10 Hrs)				
Multiple sequence alignment: Use of ClustalW	5.1	5	5	Lecture
Phylogenetic analysis: Use of PHYLIP, MEGA	5.2	5	5	Lecture

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 6: Data Banks (10 Hrs)				
Familiarise with various biological databases Download nucleotide sequence from GenBank /ENA/ DDBJ	6.1	2	10	Hands-on Training
Module 7: Molecular visualisation (10 Hrs)				
Molecular visualisation- RasMol, PyMOL. Writing Perl Scripts to Perform Sequence Analysis- Calculating GC Content, Finding Reverse Complement, Finding the Frequency of a Motif.	7.1	3	10	Hands-on Training
Module 8: Phylogenetic analysis (10 Hrs)				
Phylogenetic analysis using MEGA and PHYLIP	8.1	5	10	Hands-on Training
Module 9: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

References

1. Bosu, O., & Thukral, S. K. (2007). Bioinformatics: Databases, tools, algorithms. Oxford Higher Education.
2. Brown, T. A. (2020). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
3. Choudhuri, S. (2014). Bioinformatics for beginners: genes, genomes, molecular evolution, databases and analytical tools. Elsevier.
4. Claverie, J. M., & Notredame, C. (2003). Bioinformatics: A beginners Guide.

5. Gibas, C., & Jambeck, P. (2001). Developing bioinformatics computer skills. O' Reilly Media, Inc.
6. Mount, D. W. (2004). Bioinformatics: sequence and genome analysis.
7. S Ignasimuthu, 2009. Basic Bioinformatics. Narosa Publications.
8. https://omicstutorials.com/a-comprehensive-guide-to-perl-programming-for-biologists/

Course designed by: Mr. Ajeesh Joseph

SBU24BO8DSC402: ANGIOSPERM SYSTEMATICS

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Critically evaluate historical and contemporary systems of Angiosperm classification, including artificial, natural, and phylogenetic approaches.	E
CO2	Apply the principles and rules of botanical nomenclature to correctly name, validate, and interpret Angiosperm taxa.	A
CO3	Analyse and utilize diverse taxonomic data sources, including morphology, anatomy, cytology, chemotaxonomy, and molecular biology, to assess Angiosperm relationships.	An
CO4	Construct and interpret phylogenetic trees using phenetic and cladistic approaches to understand patterns of diversification in Angiosperms.	E
CO5	Apply taxonomic tools, including keys, floras, herbarium specimens, and field studies, to accurately identify and classify Angiosperms, particularly focusing on the rich diversity of Kerala.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	-	2	1	2	3	2	1	2	2
CO2	1	-	1	-	-	2	-	-	-	-
CO3	3	-	3	1	3	3	2	-	3	3
CO4	2	-	2	1	2	3	2	-	3	3
CO5	3	-	2	1	1	2	-	1	3	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Practical assignment	Home Assignment	Quiz	Viva	Written Test/MCQ	
CO1	x	x	x	x	x	x
CO2	x	x	x	x	x	x
CO3	x	x	-	x	x	x
CO4	x	-	-	x	x	x
CO5	x	x	-	-	-	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Lab involvement	Practical Assignment	Viva	Record	Lab Test	
CO1	x	x	x	-	x	x
CO2	x	x	x	x	x	x
CO3	x	x	x	x	x	x
CO4	x	x	x		x	x
CO5	x	x	-	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: History and Systems of Plant Classification (4 Hrs)				
Historical background of classification - Major systems of Angiosperm classification- Artificial, Natural and Phylogenetic systems. Significance of plant taxonomy (Self-study).	1.1	1	0	Lecture/ Demonstration
Critical analysis of classifications proposed by (i) Linnaeus (ii) Bentham & Hooker (Self-study), (iii) Engler & Prantl (iv) Bessey and (vi) APG.	1.2	1	4	Lecture/ Demonstration
Module 2: Botanical Nomenclature (3 Hrs)				
Brief history of ICN (formerly ICBN)	2.1	2	1	Lecture/ Demonstration
Principles, rules and recommendations: rule of priority, typification, author citation, retention, rejection and changing of names, effective and valid publication.	2.2	2	2	Lecture/ Demonstration
Module 3: Concepts of Taxonomic Hierarchy (3 Hrs)				
Concept of taxon, Species/Genus/Family and other categories;	3.1	2	1	Lecture/ Demonstration
species concept and intra specific categories - subspecies, varieties and forms.	3.2	2	2	Lecture/ Demonstration
Module 4 Data sources of Taxonomy (3 Hrs)				
Concepts of character. Sources of taxonomic characters - Anatomy, Cytology, Phytochemistry and molecular biology.	4.1	3	3	Lecture/ Demonstration
Module 5: Synthetic approaches to the Systematics of Angiosperms (3 Hrs)				
Chemotaxonomy, molecular taxonomy, basic concepts of genome analysis – bar coding.	5.1	3	3	Lecture/ Demonstration
Module 6: Concept and Principles of Assessing Relationships (2 Hrs)				
Phenetic - Numerical Taxonomy - principles and methods; Phenogram. Cladistic - Principles and methods. Phylogenetic tree – Cladogram.	6.1	4	2	Lecture/ Demonstration
Module 7 Tools of Taxonomy (3 Hrs)				
Construction of taxonomic keys – indented and bracketed – their utilization.	7.1	5	1	Lecture/ Demonstration
Floras/Taxonomic literature, field study and GIS, Herbarium.	7.2	5	2	Lecture/ Demonstration

Module 8 Angiosperm diversity of Kerala (22Hrs)				
Study of the following families (Bentham & Hooker) in detail with special reference to their salient features, interrelationships, evolutionary trends and economic significance. 1. Rununculaceae, 2. Polygalaceae, 3. Clusiaceae 4. Tiliaceae, 5. Geraniaceae, 6. Vitaceae, 7. Sapindaceae, 8. Rosaceae, 9. Melastomaceae, 10. Aizoaceae, 11. Campanulaceae, 12. Myrsinaceae, 13. Oleaceae, 14. Asclepiadaceae, 15. Boraginaceae, 16. Scrophulariaceae, 17. Verbenaceae, 18. Amaranthaceae, 19. Polygonaceae, 20. Loranthaceae, 21. Orchidaceae, 22. Commelinaceae 23. Zingiberaceae, 24. Araceae, 25. Cyperaceae,	8.1	5	22	Lecture/ Demonstration / Seminar

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 9: Angiosperm Morphology and Taxonomy Practical (30 Hrs)				
Dissect and describe at least one member from each family with diagnostics and sketches of flower LS, floral diagram and construct the floral formula.	9.1	5	25	Demonstration/ Hands on training
Construction of comparison charts and preparation of dichotomous keys.	9.2	5	1	Demonstration/ Hands on training
Use of floras (Flora of the Presidency of Madras) in the identification of plant specimens up to species level.	9.3	5	2	Demonstration/ Hands on training
Workout nomenclatural problems regarding priority and author citations.	9.4	2	1	Demonstration/ Hands on training
Familiarize with all the economically/ethnobotanically/ medicinally important plants of the families mentioned in the syllabus.	9.5	5	1	Demonstration/ Hands on training
A field study preferably of one week duration under the guidance and supervision of teachers.	9.6	5	-	Demonstration/ Hands on training
Preparation of a minimum of 20 herbarium sheets of the members of the families mentioned in the syllabus along with supporting field book.	9.7	5	-	Demonstration/ Hands on training
Module 10: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Reference

1. Cronquist A. An integrated system of classification of flowering plants. Columbia University Press.
2. Cronquist A. Evolution and classification of flowering plants. Thomas & Nelson Co.
3. Gamble J S. Flora of the Presidency of Madras. (Vol.I – III).
4. Heywood V H, Moore D M (Eds). Current concepts in Plant taxonomy.
5. Hooker J D. The flora of British India (Vol.I – VII).
6. Jain S K. Dictionary of Indian Folk medicine and Ethnobotany.
7. Jain, S K. (Eds), Manual of Ethnobotany. Scientific Publishers, India, Jodhpur.

8. Paye G D. Cultural Uses of Plants: A Guide to Learning about Ethnobotany. The New York, Botanical Garden Press.
9. Radiford A E. Fundamentals of plant systematics. Harper & Row.
10. Rendle A E. Classification of flowering plants. Vikas Co.
11. Saxena, N B and Saxena S, Plant Taxonomy. Pragati Prakashan Educational Publishers, Meerut.
12. Sharma, O P. Plant Taxonomy. Second Edition. McGraw Hill Education (India) Private Limited, New Delhi.
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14. Stace C A. Plant Taxonomy and Biosystematics (II Edn). CBS Publ.
15. Takhtajan A L. Diversity and Classification of Flowering Plants. Columbia Univ. Press.
16. Verma, B K. Introduction to Taxonomy of Angiosperms. PHI Learning Private Limited, New Delhi.
17. Woodland D W. Contemporary Plant Systematics. Prentice Hall.

Course designed by: Dr. Salvy Thomas

SBU24BO8PRJ400: PROJECT

Type of Course	Major		
Course Level	400-499		
Credit	12		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Write a literature review of the topic of research to identify knowledge gap or problem.	E
CO2	Define the scientific problem and state the hypothesis.	U
CO3	Design the experiment and identify the relevant variables associated with it.	A
CO4	Collect and collate data to arrive at valid conclusions.	A
CO5	Write a coherent thesis and communicate the major findings to the scholarly community.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	-	-	2	-	1	2	1	1	1	1
CO2	-	-	-	-	1	1	-	-	-	-
CO3	-	-	1	-	2	2	1	1	-	2
CO4	-	-	1	-	2	2	1	1	-	2
CO5	-	-	1	-	2	1	1	1	-	1

Rubrics for Assessment Tools

Each course contains specific assessment tools. However, the faculty teaching the course has the freedom to alter these tools according to the course requirements, with prior permission from the respective Board of Studies.

Rubrics for Assignment/Home Assignment

Criteria	Level 1	Level 2	Level 3
Level of Content	Many relevant aspects regarding the topic are missing	Some aspects are missing	All aspects regarding the topic are covered
Organization	Writing lacks logical organization. It shows some coherence but ideas lack unity.	Writing is impartially coherent and medium level of logical organization.	Writing is coherent and logically organized. Overall unity of ideas is present.
Reference	Lack clarity of sources and are unauthentic	Sources are listed properly but many are unauthentic	Enough reference and all the sources are authentic

Rubrics for Viva

Criteria	Level 1	Level 2	Level 3
Clarity in the understanding concepts	Only superficial knowledge in most of the topics	Adequate understanding in most of the topics, but fails to elaborate	Good understanding with explanation ability
Communication skills	Struggle to communicate the concepts	Limitations in concept clarity, proper vocabulary and articulation	Concept clarity, proper vocabulary and perfect articulation

Rubrics for Lab involvement/Practical Skill Observation

Criteria	Level 1	Level 2	Level 3
General Lab Practice	Unaware of general lab practices	Some laxity in good lab practices	Aware of good lab practice
Lab procedure	Error in lab procedure	Followed the lab procedure with minimum errors	Well followed the lab procedure

Rubrics for Record

Criteria	Level 1	Level 2	Level 3
Diagram	Incomplete records	Complete records but with errors in labelling and captions	Complete record with proper labelling and captions /Legends
Punctuality	Delay in timely submission of record sheets	Submission of records on the ensuing day of lab work	Submission on the day of lab work

Rubrics for Field Report

Criteria	Level 1	Level 2	Level 3	Level 4
Writing Skills	Language is very poor	Able to communicate to a certain extent	Able to communicate but lacks proper usage of terminologies	Able to communicate with proper scientific terminologies
Knowledge/ Understanding about the subject	Knowledge about the subject of presentation is not up to the mark.	Knowledge about the subject is fairly good but not exhibited through report.	Knowledge about the subject is good and tried to exhibit it to a certain extent.	Sound understanding about the subject and communicated it well.
Diagrams/ Photographs	Diagrams/ Photographs lack clarity.	Diagrams without labelling or Photographs without captions	Diagrams with proper labelling or Photographs with captions of any two groups	Diagrams with proper labelling or Photographs with captions of any three or more groups

Rubrics for Seminar

Criteria	Level 1	Level 2	Level 3
Content	Many relevant aspects regarding the topic are missing	Some aspects are missing	All aspects regarding the topic are covered
Presentation	Struggle to communicate the concepts and unable to follow logical sequence	Presented the topic in a logical order but issues in communication	Communicated properly and followed a logical sequence
Interaction	Unable to answer all the questions	Able to address only few questions and lack clarity in answering	Explained all the questions with clarity

Rubrics for Quiz

Criteria	Level 1	Level 2	Level 3
Content	Many relevant aspects regarding the topic are missing	Some aspects are missing	All aspects regarding the topic are covered
Presentation	Struggle to communicate the concepts and unable to follow logical sequence	Presented the topic in a logical order but issues in communication	Communicated properly and followed a logical sequence
Interaction	Unable to answer all the questions	Able to address only few questions and lack clarity in answering	Explained all the questions with clarity

Rubrics for Oral Presentation

Criteria (% of marks)	Level 1	Level 2	Level 3	Level 4

Presentation Skill (50%)	Demonstrates little to no skill mastery, with frequent errors.	Demonstrates basic mastery of the skill but with some errors or inefficiencies.	Demonstrates proficient mastery of the skill, performing it accurately and effectively.	Demonstrates exceptional mastery of the skill, performing it flawlessly and efficiently.
Content delivery (50%)	Not well prepared and struggles to complete the task within the allotted time	Completes the presentation, but with some inefficiencies or delays with content and time.	The content is well-prepared but lacks clarity. Completes the presentation in time	Well prepared and present the content with clarity. Completes the presentation efficiently and within the allocated time.

Rubrics for In-class discussion or debates

Criteria	Level 1	Level 2	Level 3	Level 4
Contribution (25%)	Rarely contributes ideas or fails to contribute to the discussion.	Occasionally contributes ideas, but they are not always relevant or insightful.	Regularly contributes relevant and meaningful ideas, enriching the discussion.	Consistently contributes insightful and thought-provoking ideas, enhancing the discussion and guiding it forward.
Active Listening (25%)	Demonstrates poor listening skills, frequently appearing distracted or disinterested.	Demonstrates some listening skills but may appear distracted or disengaged at times.	Demonstrates good listening skills, engaging with speakers and responding appropriately to their points.	Demonstrates exceptional listening skills, actively engaging with speakers and responding thoughtfully to their points.
Collaboration (25%)	Fails to collaborate effectively with peers, often interrupting or disregarding their contributions.	Demonstrates some collaboration with peers but may dominate the discussion or dismiss others' ideas.	Collaborates well with peers, respecting their ideas and contributing positively to group dynamics.	Collaborates effectively with peers, building on their ideas and fostering a supportive discussion environment.
Communication (25%)	Struggles to communicate ideas clearly, making it difficult for others to understand.	Communicates ideas but may use unclear or inappropriate language, hindering understanding.	Communicates ideas clearly, though may occasionally struggle to express thoughts coherently.	Communicates ideas clearly and articulately, using appropriate language and effectively expressing thoughts.

Appendix

SHORT TERM COURSES

The main objective of the short term courses offered by the college is to supplement the students with various skills and technical know-how outside the structured academic curriculum, to produce quality citizens who are academically proficient, self-reliant and socially committed. The courses have compulsory components and optional components that equip the students to attain various programme objectives envisaged by the Vision and Mission statements of the college.

All Short-Term Courses (STCs) are coordinated by the Department of Short Term Courses, headed by a Director and is supervised by a Vice Principal nominated by the Principal. Each component of the STC is coordinated and managed by a Faculty Convener. The Advisory Board of the Department consists of the Vice-Principals, Director of the Short Term Courses and the various Conveners.

In case of any grievances, students can approach the Grievance Redressal Cell of the STC which consists of the Vice-Principal in Charge, Director and the concerned Convener. If the student feels that the issue was not adequately addressed, he/she can approach the Grievance Redressal Cell of the college. The grading pattern for all courses will be the same as in the UG regulations 2024. The courses offered by the department are given in the following table.

	Name	Semesters	Type	Credit
1	Value Education	I to VI	Compulsory	3
2	Basic Life Support System and Disaster Management (BLS & DM)	I	Compulsory	1
3	Social Awareness Course (SAC)	I and II	Compulsory	2
4	Skill Development Courses (SDC)	II and III	Optional	2
5	Finishing School	III and IV	Compulsory	1
6	Virtual Lab Experiments	V	Optional	1

REGULATIONS FOR SHORT TERM COURSES

VALUE EDUCATION

Value Education is a compulsory extra credit course with three (3) credits for all the students admitted to the undergraduate programmes.

Duration

The duration of the course shall be three academic years (six semesters). There shall be minimum 60 hours spread over three years with 20 hours every academic year.

Evaluation

The evaluation of each course shall contain two parts.

i. Continuous evaluation (every year)
ii. Final evaluation (every year)

There shall be a maximum of 50 marks comprising of forty (40) marks for final evaluation and ten (10) marks for continuous evaluation.

Continuous Evaluation

Component	Marks
Assignment	5
Attendance	5
Total	10

1. **Assignment**

The students shall submit at least one assignment in every year. The marks for assignment is five (5).

2. **Attendance**

The minimum requirement of aggregate attendance during a year for appearing the final examination shall be 75%.

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Final evaluation

Final evaluation shall be conducted by the course coordinator at the end of every year.

There shall be an annual written examination of one and a half hours (1½) duration with a maximum forty marks (40), every year.

The question paper shall be strictly on the basis of model question paper set by the Expert Committee.

A question paper consists of short answer type, short essay type and long essay type questions.

The total marks of the course (three years combined) shall be one hundred and fifty (150).

Award of certificate

A separate minimum 30% marks each for continuous evaluation and final evaluation and an aggregate minimum of 35% are required for a pass in the course.

If a student does not acquire minimum marks in first and second years, he/she can continue the course.

The student shall be eligible to get certificate only after completing the course with D Grade. On successful completion of the course, the grade awarded will be indicated in the Mark cum Grade Card.

The grading pattern will be the same as in UG Regulations 2024.

The course shall be completed during the tenure of the programme.

BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

- The main objective of this course is to provide intensive training on Basic Life Support System and Disaster Management with the help of professional trainers and adequate numbers of mannequins and kits for imparting the training to students.
- This course is compulsory for all the undergraduate students of this college and has one (1) credit.
- The course on BLS & DM shall be conducted by a nodal centre created in the College.
- Each student shall undergo five (5) hours of hands-on training in BLS & DM organised by the Centre for BLS & DM.
- After the completion of the training, the skills acquired shall be evaluated using an offline/online test and grades shall be awarded.

- Nodal Centre for BLS & DM shall conduct an online test and publish the results.
- Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch.
- The grading of the course is as per the grading pattern in UG Regulations 2024.

SOCIAL AWARENESS COURSE (SAC)

- The aim of SAC is to make students aware of the problems that different societies and communities face on a day-to-day basis and to be conscious of the difficulties and hardships of society.
- This is a compulsory course with two (2) credits.
- Social Awareness Course shall be conducted by a nodal centre consisting of the convenor, other faculty members nominated by the Principal.
- The centre shall identify the areas where the students can serve the society through the course.
- During the first semester itself, the centre shall organise activities to sensitize the students about the significance and relevance of Social Awareness and publish a list of different areas where they can work as volunteers.
- The centre shall allot students to various areas based on their preference.
- Students shall carry out the voluntary work allotted to them after the regular class hours/weekends/holidays falling in the first and second semesters and the summer vacation following the second semester.
- Evaluation of the SAC activity shall be based on the hours of work put in by a student. A minimum of 50 hours of social work (corresponding to 50 marks) is required for the successful completion of the course. Every additional work beyond the minimum 50 hours shall fetch five (5) marks per hour. Maximum marks shall be 100.
- Students who donate blood during the first year shall be given 10 marks on production of the certificate from the medical officer. However, marks earned through blood donation shall not be counted for a pass in the course. Mark for blood donation shall be awarded only once during the SAC.
- Two credits shall be awarded to students who complete the requirements of SAC.
- The grading will be as per the grading pattern in the UG Regulations 2024.
- Students who could not complete the requirements of the SAC shall appear for the same with the next batch.
- The Director of Short-Term Courses and Convenor of SAC has the right to exclude students who are physically challenged from SAC, if requested.

SKILL DEVELOPMENT COURSES (SDC)

- This is a compulsory component of STC with two (2) credits.
- SDC's shall be completed within the first four semesters of the programme.
- Depending on the nature of the course, there will be a theory component and a skill development component.
- The credit will be awarded only if the student gets a D grade (35% marks) and above.
- A student can do a maximum of three skill Development Courses according to his/her choice, but pass in at least one course is compulsory.
- The Convenor of SDC will coordinate the course.
- The Head of the Department concerned in consultation with the faculty members may prepare a syllabus for the SDC, which will be approved by the Board of Studies concerned.

Evaluation of SDC

The evaluation the course shall be done internally and contain two parts.

i. Continuous evaluation
ii. Final evaluation

Both continuous evaluation and final evaluation shall be carried out using indirect grading. The marks for continuous evaluation is twenty (20) and that of the final evaluation is eighty (80).

Continuous evaluation

The components of the continuous evaluation and their marks are as below.

For all courses, without practical

There are two components for continuous evaluation, which include attendance and assignment. All the components of the continuous evaluation are mandatory.

Component	Marks
Attendance	5
Assignments	15
Total	**20**

Marks for attendance

Minimum 75% attendance is compulsory for attending the final examination.

% of Attendance	Marks
90 and above	5
85 - 89	4
80 – 84	3
76 – 79	2
75	1

(Decimals shall be rounded mathematically to the nearest whole number)

For all courses with practical

The components for continuous evaluation of courses with practical are given below.

Component	Marks
Attendance	5
Lab/skill work involvement	15
Total	**20**

Assignments

At least one assignment shall be submitted for the course.

Final evaluation

The final evaluation of theory and practical courses shall be conducted by the office of the Controller of Examinations. It can be in the form of 80 marks written examination or 80 marks project/practical examination or 80 marks written and project/practical examination combined, as decided by the Board of Studies concerned.

FINISHING SCHOOL

- It is a compulsory course with one (1) credit.
- The course provides compulsory training for all under graduate students of this college.
- The training is to help students develop their soft skills and interview skills.
- The training shall impart soft skills comprising of language skills, personal presentation and grooming, table manners, resume preparation, group discussion techniques, and interview skills among the undergraduate students.
- This course shall be conducted during the third and fourth semesters for all the undergraduate students.
- There will be a total of 20 contact hours which shall be handled by a team of professional members/faculty. In addition, a one-day outbound training session by a team of professional trainers that touches on the aspects of creativity, problem solving and team building shall also be organized.
- The students shall be assessed on the basis of the components given below.

Component	Marks
Attendance	5
Aptitude Test	10
Assignments	10
Group discussion	10
Interview	15
Total	**50**

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

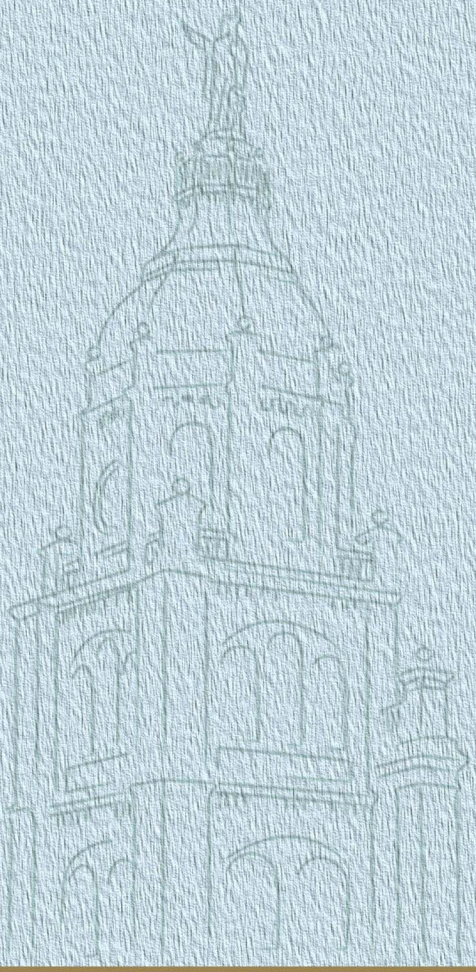
% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Grades will be awarded as per grading pattern in UG Regulations 2024.

VIRTUAL LAB EXPERIMENTS

- This is an optional course with one (1) credit.
- The main aim of the Virtual Lab Experiments is to provide remote-access to simulation-based Labs in various disciplines of Sciences which enthuse students to conduct experiments by arousing their curiosity.
- The Convenor will coordinate the Virtual Lab component and he may use the services available in different virtual lab platforms after the approval of the advisory body.
- Students have to do at least 36 hours of experiments and they get a maximum of one credit for this.
- Convenor and the mentor of the student shall oversee the progress and assign grades as per the grading pattern in UG Regulations 2024 after the completion of the programme.



St Berchmans College

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