SWAMI VIVEKANAND SUBHARTI UNIVERSITY
UGC Approved Meerut

Ordinance No. :- V-126-B-40

(Approved in Academic council meeting held on 11.03.2026
Proposed to be ratified in forthcoming executive council)

Evaluation Scheme and Syllabus
of
B.Sc. BOTANY
FOUR – YEAR UNDER GRADUATE PROGRAM
(AS PER NEP-2020)

Keral Verma Subharti College of Science

Swami Vivekanand
SUBHARTI UNIVERSITY
Meerut
(Effective from session 2025-26)

K. V. Subharti College of Science

PROGRAMME OBJECTIVES

1. To provide foundational and advanced knowledge of plant diversity, including algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms.
2. To develop a strong understanding of plant anatomy, morphology, physiology, and reproduction, enabling students to identify and classify plants scientifically.
3. To impart knowledge of ecology, environment, and conservation biology for addressing current ecological challenges and promoting sustainable development.
4. To understand cell biology, genetics, molecular biology, and biotechnology, forming the basis for advanced studies and research in life sciences.
5. To train students in laboratory skills, including microscopy, culturing, biochemical analysis, and modern instrumentation used in plant sciences.
6. To cultivate scientific temperament and critical thinking, enabling students to design experiments, analyze data, and interpret scientific results.
7. To introduce students to plant pathology and economic botany, highlighting the role of plants in agriculture, industry, medicine, and ecosystem services.
8. To promote field-based learning through excursions, herbarium preparation, ecological surveys, and biodiversity documentation.
9. To develop competency in bioinformatics, data analysis, and digital tools used in modern biological research.
10. To encourage problem-solving skills for addressing agricultural, environmental, and biotechnological issues relevant to society.
11. To build communication, teamwork, and scientific writing skills, necessary for academic, research, and professional careers.
12. To prepare students for diverse career pathways such as research, teaching, environmental management, agriculture, forestry, biotechnology, and higher education.

PROGRAMME OUTCOMES

1. PO1. Knowledge of Plant Diversity: Understand the classification, structure, reproduction, and evolutionary relationships of major plant groups.
2. PO2. Understanding of Plant Structure and Function: Gain in-depth knowledge of plant anatomy, morphology, physiology, and developmental biology.
3. PO3. Competence in Genetics and Molecular Biology: Explain genetic principles, heredity, molecular mechanisms, DNA technologies, and their applications in plant sciences.
4. PO4. Ecological and Environmental Awareness: Understand ecological principles, ecosystem functioning, biodiversity conservation, and environmental sustainability.
5. PO5. Skills in Laboratory Techniques: Perform experiments related to microscopy, biochemistry, physiology, plant taxonomy, and modern biological instrumentation.
6. PO6. Ability to Apply Scientific Methods: Design experiments, analyze results, interpret data, and draw meaningful scientific conclusions.
7. PO7. Knowledge of Economic and Applied Botany: Recognize the economic importance of plants in agriculture, medicine, forestry, horticulture, and industry.
8. PO8. Plant Pathology and Disease Management: Identify plant diseases, causal pathogens, and appropriate strategies for biological and eco-friendly disease control.
9. PO9. Field and Research Skills: Conduct field surveys, prepare herbarium specimens, study vegetation, and engage in basic research practices.
10. PO10. Use of Digital Tools and Bioinformatics: Utilize bioinformatics databases, software tools, and digital techniques used in modern plant research.
11. PO11. Communication and Scientific Writing: Develop effective communication skills, prepare scientific reports, presentations, and research documents.
12. PO12. Employability, Entrepreneurship, and Higher Education Preparedness: Gain competency for careers in research, education, environment, agriculture, forestry, biotechnology, and prepare for advanced studies.

CREDIT DISTRIBUTION TABLE

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT

KERAL VERMA SUBHARTI COLLEGE OF SCIENCE

Department of Life Science

B.Sc. Botany
(Session 2025-26 onwards)

		I	II	III	IV	V	VI	VII	VIII	Total
1	Major	6	6	9	15	10	14	16	4	80
2	Minor	3	3	3	3	6	6	4	4	32
3	Multi Disciplinary	3	3	3						9
4	Ability Enhancement Course	2	2	2	2					8
5	Skill Enhancement Course	3	3	3						9
6	Value Added Course	3	3							6
7	Internship					4				4
8	Research								12	12
	Total	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

K. V. Subharti College of Science

Evaluation Scheme

I YEAR

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Life Science													
Course Name - B.Sc. Botany													
Batch:2025-26							SEM:I						
S. No.	Course Type	Course Code	Course Name	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 1	BSBY-101	Cell Biology and Genetics	4		0	4	5	10	15	70	100	
2	Minor 1		To be chosen	3		0	3	5	10	15	70	100	
3	Multi Disciplinary		To be chosen	3		0	3	5	10	15	70	100	
4	Ability Enhancement Course	AEC-01	English Communication	2		0	2	5	10	15	70	100	
5	Skill Enhancement Course		To be chosen	1		3	3	5	10	15	70	100	
6	Value Added Course		To be chosen	3		0	3	5	10	15	70	100	
7	Practical I (Based on Major	BSBY-101	Cell Biology and Genetics Lab	0		4	2	5	10	15	70	100	

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	1)												
8	Qualifying	VAC-RB	Rastra bodh	2		0	2	5	5	10	30	50	Qualifying
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	**700**	

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Life Science													
Course Name - B.Sc. Botany													
Batch:2025 -26							**SEM:II**						
S. No.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**	**Remark**
				L	**T**	**P**							
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/PPT/Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**		
1	Major 2	BSBY-201	Fundamental of Botany	4		0	4	5	10	15	70	100	
2	Minor 2		To be chosen	3		0	3	5	10	15	70	100	
3	Multi Disciplinary 2		To be chosen	3		0	3	5	10	15	70	100	
4	Ability Enhancement Course 2	AEC-02	Environmental Science	2		0	2	5	10	15	70	100	
5	Skill Enhancement Course 2		To be chosen	1		3	3	5	10	15	70	100	
6	Value Added Course 2		To be chosen	3		0	3	5	10	15	70	100	
7	Practical II (Based	BSBY-201P	Introduction to Botany Lab	0		4	2	5	10	15	70	100	

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	on Major 2)												
8	Qualifying	VAC-IKS	IKS	2		0	2	5	5	10	30	50	Qualifying
TOTAL CREDITS / ASSESSMENT							**20**	**35**	**70**	**105**	**490**	**700**	

K. V. Subharti College of Science

SYLLABUS

Program type: Major 1	**Year**: First	**Semester**: First
Subject: **BOTANY**		
Course Code: BSBY-101	**Course Title**: **Cell Biology and Genetics**	

Course outcomes:

The student at the completion of the course will be able to:

1. Develop a strong foundational understanding of cellular structures, functions, and genetics, preparing them for advanced studies in life sciences, biotechnology, and medical fields.
2. Apply genetic principles and problem-solving skills to analyze inheritance patterns, enabling critical thinking in both academic and clinical contexts.
3. Strengthen laboratory skills through hands-on experiments such as microscopy, DNA extraction, PCR, and karyotyping, enhancing practical competence for research or industry roles.
4. Interpret scientific data and perform genetic analysis, making students proficient in evaluating genetic diseases, mutations, and chromosomal behavior.
5. Gain awareness of current genetic technologies like CRISPR, gene therapy, and bioinformatics, fostering innovation and ethical responsibility in modern biosciences.

Credits: 4	**Core:** Compulsory	
Max. Marks: 30+70= 100		

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit	Topics	Total No. of Lectures (Hrs)
Unit 1.	**General Introduction and Microscopy** History of cell biology- Cell theory- Prokaryotic vs. eukaryotic cells- Cell size and shape; History, Principle, operating procedure and utility of microscopy: light, phase contrast, fluorescence, SEM, TEM, Confocal microscopy	12
Unit 2.	**Cellular Architecture and Organelles** Plasma membrane structure: Cytoskeleton: microtubules, microfilaments, intermediate filaments; Size, shape, number; and structure and function of: Mitochondria, Chloroplast, Endoplasmic reticulum, Nucleus, and Golgi apparatus- Lysosomes, peroxisomes	12
Unit 3.	**Nucleus and Chromosomes** Nuclear envelope, nuclear pores, nucleoplasm, nucleolus- Chromatin: euchromatin, heterochromatin, nucleosome and solenoid structures; Classification of chromosomes on the basis of number and position of centromere; Physical structure of chromosome; Chromosome organization and packaging	12
Unit 4.	**Cell Cycle and cell division** Cell cycle phases (G_1, S, G_2, M)- Cyclins and CDKs- Mitosis and meiosis: stages, significance, and comparison; Synaptonemal complex; Apoptosis	12
Unit 5.	**Genetics, Chromosomal and Molecular Basis of Inheritance** Mendel's laws of inheritance, Multiple alleles: ABO blood groups- Lethal alleles- Gene interactions, Structure and types of chromosomes- Karyotyping, DNA structure, replication: enzymes, origin of replication- RNA types and	12

	transcription in prokaryotes & eukaryotes- Genetic code and protein synthesis, Mutations, DNA damage and repair mechanisms,	

Suggested Readings:

1. Verma, P.S. & Agarwal, V.K. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*. S. Chand Publishing, New Delhi.
2. Gupta, P.K. *Principles of Cell Biology*. Rastogi Publications, Meerut.
3. Powar, C.B. & Sindhu, K.S. *Cell Biology*. Himalaya Publishing House, Mumbai.
4. Brown, T.A. *Genetics: A Molecular Approach* (Indian Adaptation). Oxford University Press India.
5. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. *Molecular Biology of the Cell*. Garland Science (Taylor & Francis Group).
6. Karp, G. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons, USA.
7. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., & Ploegh, H. *Molecular Cell Biology*. W.H. Freeman and Company, USA.
8. Brooker, R.J. *Genetics: Analysis and Principles*. McGraw-Hill Education, New York.

Program type: Minor 1	**Year**: First	**Semester**: First
Subject: BOTANY		
Course Code: BSBY-102	**Course Title**: Plant Identification Technology	

Course outcomes:

The student at the completion of the course will be able to:

1. To gain an understanding of the history and concepts underlying various approaches to plant taxonomy andclassification.
2. To learn the major patterns of diversity among plants, and the characters and types of data used to classify plants.
3. To compare the different approaches to classification with regard to the analysis of data.
4. To become familiar with major taxa and their identifying characteristics, and to develop in depth knowledge of thecurrent taxonomy of a major plant family.
5. To discover and use diverse taxonomic resources, reference materials, herbarium collections, publications.
6. For the entrepreneur career in plants, one can establish a nursery, Start a landscaping business, Set up a farm O rRun a plantation consultancy firm

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0

Unit	**Topics**	**Total No. of Lectures (60)**

Unit-I	**Taxonomic Resources & Nomenclature** Components of taxonomy (identification, nomenclature, classification); Taxonomic resources: Taxonomic terminology and identification keys: single access and multi-access; Herbarium- functions & important herbaria, Botanical gardens, Flora. Principles and rules of Botanical Nomenclature according to ICN (ranks and names; principle of priority, binomial system; type method, author citation, valid- publication).	**12**
Unit-II	**Types of classification & Evidences** Artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series) angiosperm phylogeny group (APG IV) classification. Introduction to taxonomic evidences from palynology, cytology, phytochemistry & Molecular biology data (Protein and Nucleic acid homology).	**10**
Unit-III	**Identification and characteristics of Plant Kingdom** A study of the following divisions with emphasis on the morphological peculiarities and economic importance of Thallophyta, Bryophyta, Pteridophyta, Gymnosperm and Angiosperm.	**12**
Unit-IV	**Modern trends in Plant taxonomy**: Brief idea on Phenetics, Biometrics, Cladistics (Monophyletic, polyphyletic andparaphyletic groups; Plesiomorphy and apomorphy). GIS (Mapping of (i) Patterns(ii) Features (iii) Quantities0P02.010H11YLIP - Free Phylogenetic Software, Digital Taxonomy (e-flora), Description Language for Taxonomy – DELTAInternet directory for botany.	**13**

Suggested Readings:

1. Malik, V. *Plant Taxonomy: Principles and Practices*. Kalyani Publishers, New Delhi.

2. Singh, G. *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

3. Sharma, O.P. *Plant Taxonomy*. Tata McGraw-Hill Education, New Delhi.

4. Naik, V.N. *Taxonomy of Angiosperms*. Tata McGraw-Hill Publishing Co., New Delhi.

5. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. & Donoghue, M.J. *Plant Systematics: A Phylogenetic Approach*. Sinauer Associates, USA.

6. Simpson, M.G. *Plant Systematics*. Academic Press (Elsevier), USA.

7. Stuessy, T.F. *Plant Taxonomy: The Systematic Evaluation of Comparative Data*. Columbia University Press, USA.

8. Raven, P.H., Evert, R.F. & Eichhorn, S.E. *Biology of Plants*. W.H. Freeman and Company, USA.

Program type: Multidisciplinary 1	**Year**: First	**Semester**:	First
Subject: BOTANY			
Course Code: M-DIS-ASF	**Course Title**: **AI and Smart farming**		
Course outcomes:			

The student at the completion of the course will be able to:

1. Understand and explain the fundamentals of AI and smart farming, empowering them to contribute to the digital transformation of agriculture and food systems.

2. Gain hands-on experience with AI tools, IoT devices, and data analytics platforms, making them industry-ready for roles in agri-tech, automation, and precision agriculture.

3. Apply machine learning algorithms and data-driven approaches to solve real-world agricultural problems such as crop prediction, pest detection, and irrigation management.

4. Design and implement smart farming solutions using cloud platforms, drones, edge devices, and sensors, thereby developing practical skills valued in startups and agri-enterprises.

5. Interpret and analyze large-scale agricultural datasets (e.g., weather, soil, satellite, market data), preparing students for careers in agricultural data science and GIS-based decision-making.

6. Stay future-ready by understanding emerging technologies like robotics, blockchain, and AI-driven sustainability tools in agriculture, helping them innovate or pursue research.

7. Demonstrate ethical awareness and critical thinking about data privacy, rural digital access, and responsible AI deployment in farming, promoting socially responsible innovation.

8. Strengthen their eligibility for careers or higher studies in digital agriculture, AI in sustainability, smart rural development, and government-agri-tech collaborations (e.g., Digital India, Agristack).

Credits: 3	**Core:** Compulsory		
Max. Marks: 30+70= 100			

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0

Unit Title	Expanded Topics Covered	No. of Lectures (Hrs)
Unit-I.	**Foundations of Smart and Digital Farming, AI Fundamentals** History of agricultural revolutions; Smart farming vs precision agriculture; Agritech startups in India; Digital Twin in agriculture; Role of data and connectivity. Machine Learning, Deep Learning, NLP, and Computer Vision basics; Open-source AI tools; Transfer learning in agri-data; Generative AI potential in weather synthesis.	10
Unit –II.	**Current AI Use-Cases in Agriculture** Crop disease detection (CNN-based imaging), Yield prediction, Livestock health monitoring, Automated farm bookkeeping, Price forecasting using LLMs; Case studies.	8
Unit-III.	**Cloud Computing in Smart Farms** AWS/Azure/GCP in agriculture, Blockchain in supply chains. Soil & climate monitoring, Reinforcement learning in irrigation control.	10
Unit-IV.	**Farm Automation, Robotics, and UAVs** Autonomous tractors, AI-driven weeders, Drone spraying, Smart greenhouses, Harvesting robots, AI in aquaponics & vertical farming, Farm bots-as-a-service.	8
Unit-V.	**Future Trends, Ethical Considerations, and Policy Framework** Responsible AI in agriculture, Data ownership & digital rights of farmers, AI policy in agriculture (India & global), Carbon credit farming, Predictive governance models.	9

Suggested Readings:

1. Patel, N. R., & Mandal, D. *Precision Farming in India: Challenges and Opportunities*. Indian Council of Agricultural Research (ICAR), New Delhi.
2. Singh, A. K., & Verma, B. K. *Smart Farming Technologies for Sustainable Agriculture*. New India Publishing Agency, New Delhi.
3. Mohanraj, I., & Vijayalakshmi, M. N. *IoT and Artificial Intelligence in Agriculture*. Notion Press, Chennai.
4. Balasubramanian, R. *Emerging Technologies in Agriculture*. Agrotech Publishing Academy, Udaipur.
5. Zhang, Q. (Ed.) *Precision Agriculture Technology for Crop Farming*. CRC Press (Taylor & Francis), USA.
6. Sharma, H., & O'Brien, L. (Eds.) *Artificial Intelligence in Agriculture: Sustainable Solutions for Food and Farming*. Elsevier, UK.
7. Wolfert, S., & Sørensen, C.G. *Digital Agriculture: Transforming Agri-Food Systems*. Springer Nature, Switzerland.
8. McBratney, A., Whelan, B., & Taylor, J. *Future Farming: The Role of Automation and Robotics in Agriculture*. Burleigh Dodds Science Publishing, UK.

Program type: Skill Enhancement Course 1	**Year**: First	**Semester**: First
Subject: BOTANY		
Course Code: SEC-TH	**Course Title**: **Terrace farming and Horticulture**	

Course outcomes:

The student at the completion of the course will be able to:

1. Understand the principles and practices of terrace farming, enabling them to utilize limited urban and rural spaces for sustainable food production.
2. Identify suitable soil types, nutrient strategies, and crop combinations, making them capable of designing productive terrace or rooftop gardens.
3. Apply essential horticultural techniques such as seed sowing, grafting, pruning, organic pest control, and composting, promoting hands-on agricultural learning.
4. Plan and maintain terrace farms using eco-friendly and water-efficient methods, including drip irrigation, rainwater harvesting, and mulching techniques.
5. Evaluate and implement sustainable and entrepreneurial models of terrace farming, preparing them for start-ups, self-employment, or community-based food initiatives.
6. Demonstrate confidence in managing small-scale urban farming projects, contributing to food security, biodiversity, and green city movements.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70=100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 1-0-3

Unit Title	**Expanded Topics Covered**	**No. of Lectures (Hrs)**
Unit-I	**Introduction to Terrace Farming** Concept and history; Types of	9

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	terrace farming (step, contour, box); Suitability and advantages; Urban vs rural terrace agriculture; Scope in sustainable farming.	
Unit-II	**Soil Management and Nutrient Practices** Soil types and preparation for terraces; Soil amendments and composting; Organic vs synthetic fertilizers; Soil moisture retention; Mulching and green manures.	9
Unit-III	**Crop and Plant Selection** Seasonal vegetables, fruits, medicinal, and ornamental plants; Vertical gardening; Companion planting; Selection based on light, depth, and space availability.	9
Unit-IV	**Horticultural Techniques and Maintenance** Seed sowing and nursery raising; Grafting, pruning, budding; Pest/disease management (organic and IPM); Watering techniques (drip, sprinkler, rainwater harvesting).	9
Unit -V	**Sustainable Practices and Business Models** Roof waterproofing and safety; Organic certification basics; Farm-to-table models; Urban agri-startups; Marketing terrace produce; Case studies from India and abroad.	9

Suggested readings:

1. Randhawa, G.S. & Mukhopadhyay, A. *Floriculture in India* Allied Publishers, New Delhi.

2. **Kumar, N.** *Introduction to Horticulture* Rajalakshmi Publications, Nagercoil.

3. Saini, J.P. *Basics of Organic Farming and Horticulture* Aman Publishing House, Meerut.

4. Prasad, S. & Kumar, U. *Principles of Horticulture* Agrobios (India), Jodhpur.

5. Sharma, R.K. *Practical Manual on Vegetable Gardening* Krishna Prakashan Media (P) Ltd., Meerut.

6. Hartmann, H.T., Kester, D.E., Davies Jr., F.T., & Geneve, R.L. *Plant Propagation: Principles and Practices* Pearson Education, USA.

7. Bose, T.K., Mitra, S.K. & Sadhu, M.K. *Propagation of Horticultural Plants* Naya Udyog, Kolkata.

8. Resh, H.M. *Hydroponic Food Production* CRC Press, USA.

9. Cleveland, D.A. & Soleri, D. *Food from Dryland Gardens: An Ecological, Nutritional, and Social Approach* Center for People, Food and Environment, USA.

10. Wortman, S.E. & Lovell, S.T. *Urban Agriculture: Innovations and Practices* Springer Nature, Switzerland.

Program type: Skill Enhancement Course 1	**Year**: First	**Semester**: First
Subject: BOTANY		
Course Code: VAC-ALS	**Course Title**: AI in Life Science	
Course outcomes:		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70=100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 1-0-3		

Unit Title	**Expanded Topics Covered**	**No. of Lectures (Hrs)**
Unit-I	Introduction to Artificial Intelligence Definition, scope, and	9

	evolution of AI, Types of AI (Weak, Strong, Generative, Predictive) Machine Learning basics: supervised, unsupervised, reinforcement learning Deep learning fundamentals (ANN, CNN, RNN) Role of AI in scientific research and healthcare	
Unit-II	AI in Biological Data Analysis Biological databases (GenBank, PDB, UniProt, KEGG) Data preprocessing: normalization, cleaning, feature extraction AI tools for genomics and proteomics Sequence alignment and pattern recognition using ML Structural prediction: AlphaFold basics Applications in gene expression analysis, microarray, and NGS data.	9
Unit-III	AI in Biomedical & Healthcare Applications AI in medical imaging (X-ray, MRI, CT) – classification, segmentation * Disease prediction models (diabetes, cancer, cardiovascular diseases) AI in personalized medicine and precision therapy	9
Unit-IV	AI in Agriculture and Environmental Sciences AI for crop health monitoring, disease detection, and yield prediction Remote sensing and image-based plant phenotyping Smart farming: drones, IoT, robotics	9
Unit -V	AI in soil health analysis and nutrient profiling Climate modelling and forecasting using AI Biodiversity monitoring, wildlife tracking, ecological modelling	9

Suggested readings:

1. Goodfellow I., Bengio Y., Courville A.Deep Learning*. MIT Press; 2016.
2. Alpaydin E.*Introduction to Machine Learning*. MIT Press; 2021.
3.Charu C. Aggarwal.Neural Networks and Deep Learning*. Springer; 2018.
4. Leskovec J., Rajaraman A., Ullman J.Mining of Massive Datasets*. Cambridge University Press; 2020.
5.Xiong J., Hu X.*Essential Bioinformatics*. Cambridge University Press; 2021 (AI-integrated bioinformatics basics).
6.Bishop C.** *Pattern Recognition and Machine Learning*. Springer; 2006.
7. Baldi P., Brunak S.Bioinformatics: The Machine Learning Approach*. MIT Press; 2001 (classic ML–bioinformatics integration).
8.Mitra S., Acharya T.Data Mining: Multimedia, Soft Computing, and Bioinformatics*. Wiley; 2003.
9.Dunham M.HData Mining: Introductory and Advanced Topics*. Pearson; 2018.

Program type: Practical 1 (practical Based on major courses)	**Year**: First	**Semester**: First
Subject: BOTANY		
Course Code: BSBY-101P	**Course Title**: **Cell Biology and Genetics Lab**	
Credits: 2	**Core:** Compulsory	

Max. Marks: 30+70= 100	**Min. Passing Marks: 40**
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4	

Microscopy and Cell Structure

1. Study of prokaryotic & eukaryotic cells using temporary/permanent slides.
2. Measurement of cell size using micrometry

Cell Organelles and Staining

3. Staining of mitochondria in onion root tip
4. Observation of plastids in algae (*Spirogyra, Chlamydomonas*)
5. Staining and identification of nucleus using Feulgen stain.

Cell Division (Mitosis & Meiosis)

6. Squash preparation of mitosis in onion root tip
7. Study of meiosis stages in flower bud anthers (*Rhoeo* and *Tradescantia*)

Genetics: Mendelian Experiments

8. Study of Mendelian inheritance using pea plant models or seeds
9. Working out monohybrid and dihybrid ratios using genetic beads/simulations
10. Chi-square test for expected vs observed ratios

Human Genetics and Karyotyping

11. Genetics Exercise based on (Haemophilia, Sex-linked genes, Down's, Turner, Klinefelter symdromes and monohybrid and di-hybrid cross; Epistasis; Complementary and supplementary
12. Blood group determination (A, B, AB, O & Rh)

Drosophila and Model Organisms

13. Observation of *Drosophila melanogaster*: wild type vs mutants
14. Sex identification and culture maintenance (demo)

DNA Extraction and Estimation

15. Demonstration on DNA isolation from plant material (e.g., spinach/banana)
16. DNA estimation by diphenylamine (DPA) method |

Record/Submission

Students must maintain a **lab notebook**

Submit **at least 10 properly written records** with labeled diagrams and observation tables

Suggested readings:

1. Verma, P.S. & Agarwal, V.K. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology* S. Chand Publishing, New Delhi
2. Agarwal, B.L. *Practical Zoology: Genetics, Cell Biology, Ecology and Evolution* Pragati Prakashan, Meerut
3. Gupta, P.K. *A Textbook of Cell and Molecular Biology* Rastogi Publications, Meerut
4. Chand, S. & Mathur, M. *Practical Manual of Genetics and Cytogenetics* Krishna Prakashan Mandir, Meerut
5. Srivastava, H.S. *Practical Biotechnology and Genetics* CBS Publishers & Distributors, New Delhi
5. Rastogi, S.C. *Cell Biology* New Age International Publishers, New Delhi
6. Bruce Alberts et al. *Essential Cell Biology (with Lab Companion)* Garland Science, USA
7. Gerald Karp *Cell and Molecular Biology: Concepts and Experiments* Wiley International
8. Benjamin A. Pierce *Genetics: A Conceptual Approach (Lab Manual Edition)* Macmillan Learning, USA

9. David Freifelder *Molecular Biology* Narosa Publishing (Indian Edition available)
10. Sharma, A.K. & Agarwal, B.L. *Practical Zoology (Invertebrate & Vertebrate, with Genetics)* Pragati Prakashan, Meerut
11. Agarwal, B.L. *Genetics and Evolution (Practicals)* Pragati Prakashan, Meerut

Program type: Major 2	**Year**: First	**Semester**: Second
Subject: BOTANY		
Course Code: BSBY-201	**Course Title**: **Fundamental of Botany**	

Course outcomes:

The student at the completion of the course will be able to:

1. Understand and explain the origin and evolution of life, including key theories such as Darwinian evolution, biogenesis, and the historical development of biological diversity.
2. Classify living organisms across domains and kingdoms, gaining a foundational understanding of prokaryotic, eukaryotic, and microbial life based on established classification systems.
3. Recognize the structural and functional diversity of microorganisms and viruses, including significant bacterial groups and acellular entities like prions and viroids.
4. Identify and describe key biomolecules—carbohydrates, lipids, proteins, and nucleic acids—and explain their biological roles and molecular structures.
5. Apply principles of classical and molecular genetics**,** including Mendelian inheritance, DNA-RNA-protein relationships, and the flow of genetic information.
6. Interpret genetic variations and molecular mechanisms like mutations, transcription, and translation, preparing students for advanced studies in genetics and biotechnology.
7. Develop analytical and reasoning skills through understanding of genetic crosses, molecular biology processes, and organismal classification.
8. Build a strong conceptual base for pursuing higher studies or careers in Botany, Microbiology, Molecular Biology, Biotechnology, Agriculture, or Environmental Sciences.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Origin and Evolution of Life** Early Earth and origin of life, abiogenesis vs. biogenesis; Pasteur's experiment; germ theory of disease; major events in the history of life; origin of species (Darwinian view).	12
Unit-II	**Biological Diversity and Classification** Evolutionary history of life; Classification systems: Two-, Five-, and Three-Domain systems (Whittaker, Woese); Overview of Prokaryotes, Eukaryotes, and Archaea. Structural and functional diversity of bacteria; Special groups – Archaebacteria, Mycoplasma, Chlamydia, Rickettsia,	12

	Actinomycetes, and Cyanobacteria.	
Unit-III	**Viruses and Acellular Life Forms** General properties of viruses; structure, replication (lytic and lysogenic cycles); prions and viroids; viral diseases and their biological relevance.	12
Unit-IV	**Biomolecules – Carbohydrates, Lipids and Proteins** Classification and structure of carbohydrates (monosaccharides, oligosaccharides, polysaccharides); types and functions of lipids (fatty acids, triglycerides, phospholipids). Proteins: Amino acid structure and peptide bond formation; protein levels of structure; types and functions of nucleic acids (DNA, RNA); nucleotides and base pairing.	12
Unit-V	**Molecular Genetics & Principles of Inheritance** Structure of DNA and RNA; central dogma of molecular biology; replication, transcription, translation; genetic code; mutations and their molecular basis. Mendel's experiments and laws; monohybrid and dihybrid crosses; test cross and back cross; deviations from Mendelian ratios (incomplete dominance, codominance, epistasis).	12

Suggested readings:

1. Verma, P.S. & Agarwal, V.K. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology* S. Chand Publishing, New Delhi, **2022**, **Revised Edition**
2. Agarwal, B.L. *Cytogenetics, Evolution and Ecology* Pragati Prakashan, Meerut, **2021**, **Latest Edition**
3. S.C. Rastogi *Cell Biology* Rastogi Publications, Meerut, **2020**, **8th Edition**
4. P.K. Gupta *Genetics* Rastogi Publications, Meerut, **2023**, **12th Edition**
5. B.L. Agarwal *Practical Zoology: Genetics, Cell Biology, Ecology and Evolution* Pragati Prakashan, Meerut, **2022**, **Latest Edition**
6. Arora, M.P. & Arora, A. *Microbiology* Himalaya Publishing House, Mumbai, **2018**, **3rd Edition**
7. Campbell, N.A., Urry, L.A., Cain, M.L., et al. *Biology* Pearson Education, USA, **2020**, **12th Edition**
8. Bruce Alberts et al. *Essential Cell Biology* Garland Science, USA, **2022**, **5th Edition**
9. Benjamin A. Pierce *Genetics: A Conceptual Approach* Macmillan Learning, USA, **2022**, **7th Edition**
10. Gerald Karp *Cell and Molecular Biology: Concepts and Experiments* Wiley International, **2021**, **8th Edition**

Program type: Minor 2	**Year**: First	**Semester**: Second
	Subject: BOTANY	
Course Code: BSBY-202	**Course Title**: **Plant Nanotechnology and techniques in Botany**	

Course outcomes:

The student at the completion of the course will be able to:

1. **Understand the fundamental principles of nanotechnology** and its specific applications in

plant sciences, including synthesis and characterization of plant-based nanoparticles.
2. **Evaluate the impact of nanomaterials on plant growth and disease resistance,** enabling students to assess the efficacy and potential of nano-fertilizers and nano-pesticides in sustainable agriculture.
3. **Apply core botanical techniques** such as microscopy, microtomy, herbarium preparation, and spectrophotometry, which are essential tools for modern plant research and diagnostics.
4. **Analyze nanoparticle-plant interactions and phytotoxicity**, building the capacity to conduct biosafety assessments and interpret scientific data from lab experiments.
5. **Demonstrate awareness of the ethical, environmental, and regulatory aspects** of nanotechnology in agriculture, equipping students for responsible research and innovation in the life sciences sector.
6. **Prepare for interdisciplinary careers or research** in plant biotechnology, nano-agriculture, plant pathology, or environmental sciences through hands-on and theoretical training.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Nanotechnology Foundations in Plant Science** Definitions and scope in plant systems; Nanoparticle (NP) properties; Synthesis methods—chemical, physical, green (leaf/biomass-mediated);	9
Unit-II	Biosafety principles; Microscopy (light, SEM, TEM); Microtomy and histological staining; Electrophoresis and spectrophotometry	9
Unit-III	**NP Applications: Growth, Nutrition & Protection** Nano-fertilizers, nanopesticides; Delivery systems for agrochemicals; NP effects on germination, nutrition, stress tolerance; Phytotoxicity assessments	9
Unit-IV	**Nanomaterials for Disease Control** Antimicrobial/antifungal NPs; Nano-encapsulation and controlled release; Case studies in crop disease management	9
Unit-V	**Botanical Techniques & Instrumentation** Nanobiotechnology regulations; Environmental impact and biosafety; Ethical considerations; Future trends: green synthesis, slow-release systems, translational applications	9

Suggested readings:

1. Atkins, P., Overton, T., Rourke, J., Weller, M. & Armstrong, F. (2011-12).
2. Shriver and Atkins' Inorganic Chemistry. Oxford, UK: Oxford University Press.
3. Poole Jr.; Charles P.; Owens, Frank J. (2003), Introduction to Nanotechnology, John Wiley and Sons.
4. Malhotra, P.; Gulati, S., Novel Inorganic Solids and Nanomaterials, (2022) I.K.International Pvt Ltd.
5. Choudhary, R. & Kumar, R. (2021) *Plant Nanotechnology: Principles and Practices* **New India Publishing Agency, New Delhi**
6. Rastogi, S.C. (2020) *Cell and Molecular Biology* **Rastogi Publications, Meerut**
7. **Pragati Prakashan Editorial Board (2022)** *Botanical Techniques and Plant Tissue Culture*

Pragati Prakashan, Meerut
7. **Ghosh, A. & Chakraborty, R. (2019)** *Techniques in Molecular Biology and Plant Sciences* **University Science Press (India)**
8. **Khot, L. R., Sankaran, S., Maja, J. M., Ehsani, R., & Schuster, E. W. (2012)** *Applications of Nanomaterials in Agricultural Production and Crop Protection* **Springer**
9. Rai, M., Ribeiro, C., Mattoso, L., & Duran, N. (2015) *Nanotechnologies in Food and Agriculture* **Springer International Publishing**
10. **Albrecht, M. A., Evans, C. W., & Raston, C. L. (2006)** *Green Chemistry and the Role of Nanoparticles in Plant Systems* **Chemical Society Reviews**
11. Slater, A., Scott, N. W., & Fowler, M. R. (2008) *Plant Biotechnology: The Genetic Manipulation of Plants* **Oxford University Press**
12. Nel, A. et al. (2006) *Toxic Potential of Materials at the Nanolevel* **Science, 311(5761)**
13. Ranjan, S., Dasgupta, N., & Lichtfouse, E. (Eds.) (2019) *Nanoscience in Food and Agriculture 5: Applications and Toxicity* **Springer Nature**

Program type: Multi Disciplinary 2	**Year**: First	**Semester**: Second
Subject: BOTANY		
Course Code: M-DIS-GRP	**Course Title**: **GIS and remote sensing in Plant science**	
Course outcomes: The student at the completion of the course will be able to:		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70=100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0		

Unit Title	**Topics Covered**	**No. of Lectures (Hrs)**
Unit -I	**Fundamental of Remote Sensing** Concept and foundations of remote sensing: Basics of Remote sensing, remote sensing Art or Science process. Energy: Sources of energy, Energy radiation principle, Energy interaction in the atmosphere , Energy interactions with earth surface feature, Recording energy by sensor transmission, Reception processing, Interpretation & Analysis.	**9**
Unit -II	**Fundamental of Image interpretation** Satellite imagery interpretation, Elements of image interpretation, image interpretation strategies, interpretation keys, temporal aspect of image interpretation, interpretation techniques, methods of search in image interpretation.Steps of Image interpretation.	**9**
Unit -III	**Fundamental of G.I.S** Evolution of Geographical Information system, Concept of Geographic information systems: Introduction, Definition of GIS, Key components of GIS,	**9**
Unit -IV	Data Conceptual model of spatial information: Spatial Information and data models conceptual models of spatial information- raster and	**9**

	models vector data models, advantages and disadvantages of raster and vector data models.	
Unit -V	**Fundamental of GPS** Global positioning system (GPS): Concept of Global positioning system (GPS) and its architecture. Working procedure of GPS, Different types of Errors in GPS, Kinds of GPS, application of GPS in different applications.	**9**

Suggested readings:

1. Remote Sensing and Image interpretation: Thomas Lille sand & R.W. Keifer, John Wiley and Sons
2. Manual of Remote Sensing, Vol. 1, American Society of Photogrammetry.
3. Remote Sensing: Principles and Interpretation: F. Sabins, Freeman Publication.
4. Remote Sensing of the Environment by J.R. Jensen, Pearson Publication

Program type: Skill Enhancement Course 2	**Year**: First	**Semester**: Second

Subject: BOTANY

Course Code: SEC-HP | **Course Title**: **Hydroponics**

Course outcomes:

The student at the completion of the course will be able to:

CO1: Explain the principles and components of hydroponic systems.
CO2: Differentiate and evaluate types of hydroponic setups.
CO3: Prepare and optimize nutrient solutions.
CO4: Operate, monitor, and troubleshoot hydroponic units.
CO5: Identify and manage hydroponic crop pests, diseases, and nutrient disorders.
CO6: Apply hydroponic techniques for commercial production and economic analysis.
CO7: Demonstrate practical skills in seedling management, growth monitoring, and harvesting.
CO8: Analyze sustainability aspects and emerging technologies in hydroponics.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 1-0-3

Unit Title	**Expanded Topics Covered**	**No. of Lectures (Hrs)**
Unit-I	Hydroponics: Basic principles, Historical Perspectives Advantages/Disadvantages, Types of Hydroponics Systems: (closed and open systems techniques: Nutrient Film Technique (NFT), Deep Water Culture (DWC), Dutch Bucket and other small-scale systems), Systems layout, Strengths and weaknesses of various systems, site considerations, componentry, nutrient delivery, pumping, Principles of aeroponics.	9
Unit-II	Aerial Environmental Factors and Plant Growth: Light, Temperature, CO2, RH, Cooling Systems Controlled Environment Agriculture, Indoor Vertical Farming – Plant	9

	Factory	
Unit-III	Hydroponics Systems in leafy greens: lettuce, herbs, and microgreens, Hydroponics Systems in vine crops: tomatoes, pepper, cucumbers	9
Unit-IV	Growing Substrates for Hydroponics Marketing of the produce, Government institutes and policies related to 9protected farming	9
Unit-V	Hydroponics associated pest and diseases:Hydroponics associated pests - mites, thrips, whiteflies, leaf miners; Identification and management of diseases-bacterial, fungal and viral diseases; safety practices (Good Agricultural Practices (GAP) and Integrated Pest Management (IPM).	9

Program type: Practical II (Based on Major 2)	**Year**: First	**Semester**: Second
Subject: BOTANY		
Course Code: BSBY-201P	**Course Title**: **Introduction to Botany Lab**	

Course outcomes:

The student at the completion of the course will be able to:

1. Identify and describe key biomolecules—carbohydrates, lipids, proteins, and nucleic acids—and explain their biological roles and molecular structures.
2. Understand and explain key theories related to the origin of life, including abiogenesis and biogenesis, with reference to landmark experiments.
3. Interpret genetic variations and molecular mechanisms like mutations, transcription, and translation, preparing students for advanced studies in genetics and biotechnology.
4. Demonstrate an understanding of the structure, replication, and significance of viruses, viroids, and prions in biology and disease.
5. Use of compound and dissecting microscopes; slide preparation and staining techniques.

Credits: 2	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Unit Title	**Topics Covered**
Practical No.	**Description/Skills Developed**
1	**Microscopy Techniques** Use of compound and dissecting microscopes; slide preparation and staining techniques.
2	**Study of Pasteur's Experiment (Demonstration** Model or simulation of Pasteur's swan-neck flask experiment to demonstrate abiogenesis vs. biogenesis.
3	**Survey of Microbial Life Forms** Microscopic observation and staining (e.g., Gram staining) of bacteria, including Actinomycetes and Cyanobacteria.
4	**Cultural Techniques of Bacteria** Preparation of nutrient agar media; inoculation, incubation, and colony morphology.
5	**Observation of Special Bacterial Groups** Slide study of Archaebacteria, Mycoplasma,

	Chlamydia, Rickettsia (prepared slides or charts).
6	**Study of Viruses (Chart/Model-based)**Structure of T4 bacteriophage, TMV, and HIV; observation of lytic vs. lysogenic cycles using simulations or visuals.
7	**Detection of Carbohydrates (Qualitative Tests** Molisch's test, Benedict's test, Iodine test – identification of monosaccharides, disaccharides, and polysaccharides.
8	**Detection of Lipids** Sudan III/IV staining and paper spot test for presence of fats and oils.
9	**Detection of Proteins** Biuret and Xanthoproteic tests to detect presence of proteins.
10	**Nucleic Acid Extraction** Extraction of DNA from plant tissue (e.g., onion or banana); visualization using ethanol precipitation.
11	**Simulation of Central Dogma** Virtual lab or flowchart of DNA → RNA → Protein (transcription, translation steps).
12	**Study of DNA Structure and Base Pairing Models** Use of 3D DNA model kits; demonstration of base pairing rules and antiparallel strands.
13	**Mendelian Genetics – Simulated Crosses** Monohybrid and dihybrid cross using beads, Punnett squares, or genetics simulation tools.

II YEAR

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Life Science													
Course Name - B.Sc. Botany													
Batch:2025 -26							SEM:III						
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 3	BSBY-301	Systematic Botany	4		0	3	5	10	15	70	100	
2	Major 4	BSBY-302	Biomolecules and Metabolism	4		0	3	5	10	15	70	100	
3	Minor 3		To be chosen	3		0	3	5	10	15	70	100	
4	Multi Disciplinary 3		To be chosen	3		0	3	5	10	15	70	100	
5	Ability Enhancement Course 3 (Disaster Risk Management)	AEC-03	Disaster Risk Management	2		0	2	5	10	15	70	100	
6	Skill Enhancement Course 3		To be chosen	1		3	3	5	10	15	70	100	
7	Practical III (Based on Major 3+4)	BSBY-303P	Biomolecules and Metabolism Lab	0		4	3	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							20	35	70	105	490	700	

K. V. Subharti College of Science

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Life Science													
Course Name - B.Sc. Botany													
Batch:2025 -26							SEM:IV						
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 5	BSBY-401	Phyco-Bryology	4		0	4	5	10	15	70	100	
2	Major 6	BSBY-402	Plant Physiology	4		0	4	5	10	15	70	100	
3	Major 7	BSBY-403	Molecular Biology	4		0	4	5	10	15	70	100	
4	Minor 4		To be chosen	3		0	3	5	10	15	70	100	
5	Ability Enhancement Course 3 (Course on NCC/NSS/NGO,s/ Scout Guide / Sports)	AEC-04A/B/C/D/E	Course on NCC/ NSS/ NGO, s/ Scout Guide / Sports)	2		0	2	5	10	15	70	100	
6	Practical IV (Based on	BSBY-405P	Plant Physio	0		4	3	5	10	15	70	100	

K. V. Subharti College of Science

	Major 5+6+7)		logy Lab										
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**	

Program type: Major 3		**Year**: Second	**Semester**: Third
Subject: BOTANY			
Course Code: BSBY-301		**Course Title**: **SYSTEMATIC BOTANY**	
Course outcomes: The student at the completion of the course will be able to: 1. Understand principles of plant classification, identification, and nomenclature. 2. Use herbarium methods, taxonomic keys, and floristic documentation tools effectively. 3. Interpret and implement the International Code of Nomenclature (ICN) and taxonomic hierarchy. 4. Integrate data from palynology, cytology, 25hylogenetic25y, and molecular biology for classification. 5. Analyze angiosperm evolution and construct 25hylogenetic trees and cladograms. 6. Recognize floral and vegetative features and ecological/economic importance of selected families.			
Credits: 3		**Core:** Compulsory	
Max. Marks: 30+70= 100		**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0			

Unit Title	**Topics Covered**	**No. of Lectures (Hrs)**
Unit I	**Plant Identification, Classification & Documentation** Concepts of identification, classification, nomenclature; Biosystematics; Field inventory techniques; Functions of herbaria; Major Indian and global herbaria and botanical gardens; Virtual herbaria; E-flora projects; Floras, monographs, journals; Taxonomic keys – single access and multi-access.	9
Unit II	**Taxonomic Hierarchy & Nomenclature Principles** Concept of taxa – species, genus, family; Taxonomic hierarchy; Species concepts – taxonomic, biological, evolutionary; Botanical nomenclature (ICN): Principles and rules, ranks and names, typification, author citation, valid publication, rejection of names, principle of priority, limitations; Names of hybrids.	9
Unit III	**Systematics & Classification Systems** Systematics as an interdisciplinary science; Evidence from palynology, cytology, 25hylogenetic25y, molecular data; Contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan, Cronquist; Classification systems of Bentham & Hooker (up to series), Hutchinson (up to series); Overview of APG	9

	III system.	
Unit IV	**Phylogeny and Evolutionary Concepts** Phylogenetic concepts: primitive vs. advanced, homology and analogy, convergence and parallelism, monophyly, paraphyly, polyphyly, clades; Methods of depicting evolutionary relationships: 26hylogenetic trees, cladograms; Co-evolution of angiosperms and animals; Origin and diversification of angiosperms.	9
Unit V	**Selected Angiosperm Families – Morphological Study** Detailed floral and vegetative characteristics, economic importance, and taxonomic placement of major families: Magnoliaceae, Rosaceae, Rubiaceae, Liliaceae, Poaceae, Orchidaceae.	9

Suggested readings:

1. O. P. Sharma (2009) Plant Taxonomy, Tata Mc Grow Hill, New Delhi.
2. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi.3rdedition.
3. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
4. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant systematicsAPhylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
5. Saxena, H. O. and Brahman, M..The Flora of Orissa, CSIR Publication.
6. T. K. Bose (2009). Trees of the World, Regional Plant Resource Centre, Bhubaneswar, Odisha, India
7. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.
8. Hanes, H. H. (2009). Botany of Bihar and Orissa, Page 19 of 50
9. C. R. Mohanty (2017). Text Book of Plant Systematics, Kalynai Publisher, New Delhi.
10. M. S. Subrahmainayam (2011) Modern Plant Taxonomy, Vikash Publishing House, New Delhi
11. B. P. Pandey (2017). Taxonomy of Angiosperm. S. Chand Publication.

Program type: Major 4	**Year**: Second	**Semester**: Third
Subject: BOTANY		
Course Code: BSBY-302	**Course Title**: **BIOMOLECULES AND METABOLISM**	

Course outcomes:

The student at the completion of the course will be able to:

1. Understand the structure, classification, and functional roles of key biomolecules including carbohydrates, lipids, proteins, and nucleic acids in plant systems.
2. Comprehend enzyme mechanisms, kinetics, and regulation of metabolic pathways critical to plant physiology.
3. Analyze photosynthetic pathways and factors influencing carbon fixation and energy conversion in plants.
4. Interpret mitochondrial respiration, electron transport chain, and ATP synthesis mechanisms, linking structure with function.
4. Evaluate lipid and nitrogen metabolism and their physiological significance in plant growth, development, and stress responses.

Credits: 3	**Core:** Compulsory

Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0		
Unit Title	**Topics Covered**	**No. of Lectures (Hrs)**
Unit I	**Biomolecules: Structure and Function** Types and significance of chemical bonds Structure and properties of water, pH and buffers Carbohydrates: Classification, structure, and functions of mono-, di-, oligo-, and polysaccharides Lipids: Storage and structural lipids, fatty acids, triacylglycerols, essential fatty acids Proteins: Amino acids, peptide bonds, protein structure (primary to quaternary), isoelectric point, denaturation, biological roles Nucleic acids: Structure of bases, nucleotides, DNA (A, B, Z forms), types of RNA, structure of tRNA	**9**
Unit II	**Enzymes and Metabolic Regulation** Enzyme structure: holoenzyme, apoenzyme, cofactors, coenzymes, prosthetic groups Classification and properties; active site and substrate specificity Mechanism of enzyme action: activation energy, lock-and-key, induced-fit models Michaelis–Menten kinetics, enzyme inhibition, factors influencing activity Concept of metabolism: anabolic & catabolic pathways, regulatory enzymes (allosteric control, covalent modulation, isozymes)	**9**
Unit III	**Photosynthesis and Carbon Assimilation** Photosynthetic pigments and their roles Antenna molecules, reaction centers, PSI & PSII Light-dependent reactions, photochemical events, electron transport, Q-cycle Carbon fixation: C3, C4, CAM pathways Photorespiration and factors affecting CO_2 assimilation	**9**
Unit IV	**Respiration and ATP Synthesis** Glycolysis, oxidative pentose phosphate pathway, fate of pyruvate Pyruvate dehydrogenase complex (PDH), NADH shuttle TCA cycle: amphibolic and anaplerotic roles, regulation Mitochondrial electron transport chain, oxidative phosphorylation ATP synthesis: substrate-level & chemiosmotic mechanisms ATP synthase, Boyer's model, Racker's & Jagendorf's experiments, uncouplers	**9**
Unit V	**Lipid and Nitrogen Metabolism** Lipid metabolism: triglyceride synthesis and breakdown, β-oxidation, α-oxidation, glyoxylate cycle, gluconeogenesis and lipid mobilization during seed germination Nitrogen metabolism: nitrate assimilation, biological nitrogen fixation (legumes and non-legumes), physiology and biochemistry of fixation, ammonia assimilation, transamination Signal transduction pathways: calcium, phospholipids, cGMP, nitric oxide	**9**

Suggested readings:
1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
4. A. C. Sahoo (2018). Outlines of Plant Metabolism, Kalynai Publishers, New Delhi.
5. V. B. Rastogi (2016). Introductory Cytology, KedarNath & RamNath, Meerut
6. P. K. Gupta (2017). Biomolecules and Cell Biology, Rastogi Publication, Meerut. Reference Books: 1. K. Sahoo (2017) Biomolecules and Cell Biology, Kalynai Publishers, New Delhi.
7. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
8. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
9. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
10. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Program type: Minor 3	**Year**: Second	**Semester**: Third
Subject: BOTANY		
Course Code: BSBY-303	**Course Title**: **Ethnobotany- Traditional Knowledge of Plants**	
Course outcomes: The student at the completion of the course will be able to:		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0		

Unit Title	**Topics Covered**	**No. of Lectures (Hrs)**
Unit-I	Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.	**9**
Unit-II	Role of ethnobotany in modern Medicine Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.	**9**

Unit-III	Methodology of Ethnobotanical studies a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina*, *Trichopus zeylanicus*, *Artemisia,Withania*.	**9**
Unit-IV	Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).	**9**
Unit-V	Ethnobotany and legal aspects Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.	**9**

Program type: Multi Disciplinary 3	**Year**: Second	**Semester**: Third
Subject: BOTANY		
Course Code:M-DIS-AS	**Course Title**: **Agroecology and sustainable agriculture**	
Course outcomes: The student at the completion of the course will be able to:		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0		

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Introduction to Agroecology** Definition and scope of Agroecology, Industrial vs traditional farming, Components of agroecosystems Energy & nutrient flow in farming	9
Unit-II	**Soil, Water & Nutrient Management** Soil types and health indicators; Composting, vermicompost; Water-saving techniques, Biofertilizers and nutrient cycles	9
Unit-III	**Crop Diversity & Agroecosystem** Design Crop rotation and intercropping; Polyculture and agroforestry, Livestock in farming, Home and community gardens	9
Unit-IV	**Pest & Disease Management** Ecological pest control, Biological pest control agents, Integrated Pest Management (IPM), Neem and natural pesticides	9
Unit-V	**Agriculture, Society, Policy and Smart Agriculture** Role of farmers in food systems, Organic farming standards, Sustainable agriculture movements, Policies for rural and climate resilience	9

	Smart Agriculture: Concepts of smart farming, precision agriculture, and the need for technology in modern agriculture Smart farming of Strawberries, Lemongrass, Microgreens, Mushrooms	

Program type: Skill Enhancement Course 3	**Year**: Second	**Semester**: Third
Subject: BOTANY		
Course Code: SEC-FNP	**Course Title**: **Fragrant Flora- Botanical sources of Natural Perfumes**	

Course outcomes:

The student at the completion of the course will be able to:

CO1: Identify major aromatic plants and their botanical characteristics.
CO2: Explain the biochemical basis of fragrance in different plant species.
CO3: Describe traditional and modern extraction techniques for natural perfumes.
CO4: Evaluate the quality and applications of essential oils derived from fragrant flora.
CO5: Assess sustainable cultivation and conservation practices for aromatic plants.
CO6: Apply botanical and chemical knowledge to develop simple natural fragrance formulations.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 1-0-3

Unit Title	Expanded Topics Covered	No. of Lectures (Hrs)
Unit-I	**Introduction to Natural Perfumes & Aromatic Plants** Definition and scope of natural perfumes - Historical and cultural relevance (Egypt, India, Arabia, etc.) - Overview of aromatic plant taxonomy and nomenclature Important aromatic plants of India with their systematics, geographical distribution and uses. Introduction and historical background of aromatic plants. Aromatic and cosmetic products. Raw material for perfumes etc.	**9**
Unit-II	**Botanical Raw Materials & Extraction Techniques** - Sources: Rose, Jasmine, Vetiver, Sandalwood, Patchouli, Lavender, Citrus, Spices - Extraction methods: Steam distillation, Enfleurage, CO_2 extraction, Solvent & maceration - Demonstrations or labs on extraction	**9**
Unit-III	**Cosmetics and Fragrance** Cosmetic Industries. Major, minor and less known aromatic plants of India. Taxonomic descriptions and uses of important aromatic plants – citronella, davana, damask rose, geranium, khus grass, large cardamom, lavender, lemon grass, mentha, holy basil, patchouli, rosemary Palmarosa, vetiver, artemisia, eucalyptus, thyme, marjoram and	**9**

	oreganum. Aromatic spices - clove, cinnamon, nutmeg, ajwain, dill, celery, tamarind, garcinia, curryleaf and saffron.	
Unit-IV	- **Phytochemistry and Quality Control** Chemical constituents: Terpenes, alcohols, esters, phenols, ketones - Fragrance pyramid: Top, middle, base notes - Techniques: GC-MS, TLC, safety protocols (IFRA, allergen testing)	9
Unit-V	**Olfactory Training & Fragrance Formulation** Olfactory system & training methods - Perfume classification: Floral, Woody, Oriental, Citrus, Gourmand, Green - Creating natural accords (top-middle-base blending)	9

Program type: Practical III (Based on Major 3+4)	**Year**: Second	**Semester**: Third
Subject: BOTANY		
Course Code: BSBY-304P	**Course Title**: **Biomolecules and Metabolism Lab**	
Credits: 4	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0		
Topics Covered		
Qualitative Analysis of Amino acids and Proteins Amino acids- (Tyrosine, Tryptophan, Histidine, Arginine, Cysteine, Cystine, Proline and Methionine) (single components only need to be given). Xanthoproteic test, Biuret test, Folin's test, Millon's test, Morners test, Hopkin-Cole or Glyoxalic acid test, Ehrlich's test, Sodium nitroprusside test, Basic Lead acetate test, Test for Methionine, Aldehyde test, Sakaguchi test and Isatin test Proteins-Ovalbumin and Casein. Tests- Solubility test, Biuret test, Xanthoproteic test, Folin's test, Picric acid test, , Heat denaturation, TCA precipitation, Metal precipitation, Alcohol precipitation and Hellar's- nitric acid test. **Chromatographic Techniques** Demonstration of different types of paper chromatography. Separation and identification of amino acid mixture by Paper chromatography, Thin Layer Chromatography, Extraction and quantification of total lipids. Separation of lipids by TLC. **Electrophoresis Technique (Demonstration)** Demonstration of Native PAGE.Demonstration of Agarose gel electrophoresis		

Program type: Major 5	**Year**: Second	**Semester**: Fourth

Subject: BOTANY	
Course Code: BSBY-401	**Course Title**: **PHYCO-BRYOLOGY**

Course outcomes:

The student at the completion of the course will be able to:

1. Understand conceptual clarity on the evolutionary origins, systematic classification, and ecological significance of bryophytes and algal groups.
2. To identify and compare key genera of bryophytes (*Riccia*, *Marchantia*, *Anthoceros*, *Funaria*, etc.) and algae (*Nostoc*, *Vaucheria*, *Chlamydomonas*, *Fucus*, *Polysiphonia*, etc.) based on morphological, structural, and reproductive traits.
3. To understand and apply traditional and modern taxonomic frameworks including those by Fritsch and Lee, and appreciate the contributions of eminent phycologists.
4. To evaluate the ecological, environmental, biotechnological, and industrial importance of algae and bryophytes, especially in relation to carbon fixation, nitrogen cycling, and phytoremediation.
5. The course will help students build essential hands-on skills related to field identification, collection, preservation, and documentation of lower plant groups.
6. To interpret life cycle patterns and evolutionary adaptations of algae and bryophytes in the context of land colonization and thallus organization.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit I –	**Bryophytes: General Characteristics and Classification** Definition and scope of Bryology; General characteristics of Bryophytes; Theories on the origin of bryophytes; Adaptations to terrestrial habitat and ecological significance; Range of thallus organization: From simple thalloid forms to leafy gametophytes; Systematic position and classification of bryophytes up to family level; Comparative account of three major classes: Hepaticopsida, Anthocerotopsida, and Bryopsida	**12**
Unit II –	**Bryophytes: Type Studies and Reproductive Strategies** Morphology, anatomy, and reproductive structures (excluding developmental stages) of the following representative genera: *Riccia*, *Marchantia*, *Pellia*, *Porella*, *Anthoceros*, *Sphagnum*, *Funaria* Comparison of reproductive and structural features across the genera; Reproduction in bryophytes; Evolutionary trends in bryophytes: progressive elaboration of sporophyte, internal differentiation of tissues, and transition toward vascular plants; Ecological and economic importance of bryophytes with special reference to *Sphagnum* in peat formation, water retention, and bioindicator roles	**12**
Unit III	**– Algae: Fundamental Concepts and Systematics** General characteristics of algae and diversity in habitat (aquatic, terrestrial, symbiotic); Ecological distribution and significance of algal blooms and primary productivity; Range of thallus organization in algae Algal cell structure: cell wall composition, types and roles of pigments (chlorophylls, carotenoids,	**12**

	phycobilins), reserve food materials, types of flagella; Reproduction in algae: Classification of algae; Contributions of renowned Indian and international phycologists: F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar; Economic Importance of Algae	
Unit IV	**Cyanophyta and Xanthophyta Structural and Reproductive Insights** Ecology and occurrence in diverse habitats; Thallus organization (unicellular to filamentous forms); Cell structure including heterocysts and akinetes; Reproduction and life cycle of *Nostoc*; Role in nitrogen fixation and ecological succession **Xanthophyta (Yellow-green algae)**: Habitat and general structure; Unique pigments and storage products; Cell structure and reproduction; Morphology and life cycle of *Vaucheria*	**12**
Unit V –	**Green, Brown, and Red Algae (Chlorophyta, Charophyta, Phaeophyta, Rhodophyta)Chlorophyta**: Occurrence and ecological distribution; Range of thallus organization; Cell structure and pigmentation; Reproduction and life cycles of: *Chlamydomonas*, *Volvox*, *Oedogonium* **Charophyta**: Advanced features linking algae and bryophytes; Morphology and life cycles of *Coleochaete* and *Chara* Evolutionary significance of *Prochloron* as a link between prokaryotes and chloroplast evolution **Phaeophyta (Brown Algae)**: Marine habitat and ecological dominance; Thallus complexity and holdfasts; Cell structure and reserve food; Reproductive cycle and morphology of *Ectocarpus*, *Fucus* **Rhodophyta (Red Algae)**: Deep sea adaptations and pigmentation (phycoerythrin); Morphology and reproduction of *Polysiphonia*; Significance in coral reef formation and agar production	**12**

Suggested readings:

1. P. R. Vasista (2017) Botany for Degree student, Bryophyta, S. Chand Publication, New Delhi.
2. Singh, Pandey and Jain (2017). Archegoniate, Rastogi Publication, Meerut.
3. B. S. Acharya (2017), Archegoniate, Kalynai Publishers, New Delhi.
4. P. R. Vasista (2017) Botany for Degree student, Algae, S. Chand Publication, New Delhi.
5. B. K. Mishra (2018)Microbiology and Phycology, Kalynai Publishers, New Delhi.
6. Srivastava, H N, 2003. Algae. Pradeep Publication, Jalandhar, India.
7. Graham, L. E., Graham, J. M., & Wilcox, L. W. (2009). *Algae* (2nd ed.). Publisher: Pearson Education.

8. Sze, P. (1998). *A Biology of the Algae* (3rd ed.). Publisher: WCB/McGraw-Hill.
9. Bellinger, E. G., & Sigee, D. C. (2015). *Freshwater Algae: Identification and Use as Bioindicators* (2nd ed.). Publisher: Wiley-Blackwell.
10. Round, F. E. (1981). *The Ecology of Algae*. Publisher: Cambridge University Press.
11. Goffinet, B., & Shaw, A. J. (2009). *Bryophyte Biology* (2nd ed.). Publisher: Cambridge

University Press.
12. Ranker, T. A., & Haufler, C. H. (2008). *Biology and Evolution of Ferns and Lycophytes*. Publisher: Cambridge University Press.
13. Chopra, R. N., & Kumar, P. K. (1988). *Morphology of Bryophytes*. Publisher: Wiley Eastern Limited.
14. Simpson, M. G. (2022). *Plant Systematics* (3rd ed.). Publisher: Academic Press (Elsevier).

Program type: Major 6	**Year**: Second	**Semester**: Fourth
Subject: BOTANY		
Course Code: BSBY-402	**Course Title**: **PLANT PHYSIOLOGY**	

Course outcomes:

The student at the completion of the course will be able to:

1. Understand the concepts of water potential, transpiration, root water uptake, and mechanisms like stomatal movement and guttation, essential for plant survival and function.
2. Explain the transport of water, minerals, and organic solutes (sugars) through xylem and phloem, and grasp nutrient uptake processes at the cellular level.
3. Recognize the significance of macro- and micronutrients, identify deficiency symptoms, and assess the role of chelators and nutrient dynamics in plant metabolism.
4. Gain insights into the discovery, structure, bioassay, and physiological roles of phytohormones including auxin, gibberellin, cytokinin, ethylene, ABA, brassinosteroids, and jasmonates.
5. Understand photoperiodism, the florigen concept, seed dormancy, and the molecular role of phytochromes in regulating plant growth under different light conditions.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit I:	**Plant-Water Relations & Transport Mechanisms** Water potential and components - Root water absorption and aquaporins - Pathways of water movement: symplast, apoplast, transmembrane - Root pressure and guttation - Ascent of sap: cohesion-tension theory - Transpiration and influencing factors - Anti-transpirants - Mechanism of stomatal movement	12
Unit II:	**Translocation & Nutrient Dynamics** Phloem as sugar translocation tissue (experimental evidence) - Pressure-Flow Model - Phloem loading and unloading - Source–sink relationship - Essential and beneficial elements: macro and micronutrients - Criteria of essentiality and deficiency symptoms - Chelating agents and roles of elements	12
Unit III:	**Nutrient Uptake Mechanisms** Soil as nutrient reservoir - Ion transport across membranes - Passive and active absorption - Role of electrochemical gradient - Facilitated diffusion and ATP involvement - Carrier systems: uniport, symport, antiport - Proton ATPase pump and ion flux	12

Unit IV:	**Growth Regulators in Plants** Discovery, chemical nature, and bioassay - Physiological roles of: Auxin, Gibberellins, Cytokinins, Abscisic acid, Ethylene - Brassinosteroids and Jasmonic acid	12
Unit V:	**Flowering Physiology & Light Responses** - Photoperiodism and flowering stimulus - Florigen concept and vernalization - Seed dormancy and germination control - Phytochrome: discovery and chemical nature - Role in photomorphogenesis - Low energy and high irradiance responses (LER & HIR) - Mode of phytochrome action	12

Suggested readings:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. NarosaPublishing House, New Delhi.
4. Salisbury, F. B. and Ross, C. W. Plant Physiology Wadsworth Publishing Company, California 5. A. C. Sahoo (2018). Outlines of Plant Physiology Kalynai Publishers, New Delhi.
6. N. K.. Srivatava (2017). Plant Physiology, Rastogi Publications, Meerut.
7. Pandey and Sinha (2011). Plant Physiology, Vikash Publishing House, New Delhi

Program type: Major 7	**Year**: Second	**Semester**: Fourth
Subject: BOTANY		
Course Code: BSBY-403	**Course Title**: **MOLECULAR BIOLOGY**	

Course outcomes:

The student at the completion of the course will be able to:

1. Comprehend the structure, function, and organization of DNA and RNA across prokaryotes, eukaryotes, and organelles.
2. Illustrate the processes of replication, transcription, and translation with associated enzymes and regulatory elements.
3. Compare prokaryotic and eukaryotic gene regulatory mechanisms, including operon models, transcription factors, and gene silencing.
4. Understand splicing, editing, and transport of mRNA, and relate them to gene expression control.
5. Demonstrate understanding of genetic code translation, fidelity mechanisms, and post-translational modifications.
6. Analyze foundational experiments (e.g., Griffith's, Hershey-Chase, Kornberg's) that established modern molecular genetics.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit I	**Introduction to Genetic Material** Historical perspective of nucleic	12

	acids as genetic material; Griffith's, Avery-MacLeod-McCarty, Hershey & Chase experiments; Types of genetic material; Denaturation & renaturation; Cot curves; DNA organization in Prokaryotes, Viruses, Eukaryotes; RNA structure and Fraenkel-Conrat's experiment; Organelle DNA (mitochondrial & chloroplast); Chromatin structure: Nucleosome, Euchromatin, Heterochromatin (Constitutive & Facultative).	
Unit II	**DNA Replication and Genetic Code** Chemistry of DNA synthesis (Kornberg's discovery); DNA replication principles (bidirectional, semi-conservative, semi-discontinuous); Models of replication (rolling circle, θ-mode, linear ds-DNA); Replication of 5' end; Enzymes in replication; Central Dogma; Adaptor hypothesis; Discovery of mRNA; Genetic code: deciphering & features.	12
Unit III	**RNA Processing and Modification** Split genes; Introns and exons; Splicing mechanisms (spliceosome, Group I & II introns); Eukaryotic mRNA processing (5' cap, 3' poly-A tail); Alternative splicing; RNA editing; mRNA transport; Exon shuffling; Ribozymes.	12
Unit IV	**Transcription and Gene Regulation** Mechanism of transcription in prokaryotes and eukaryotes; Regulation of transcription: Operon model (lac and trp operons); Transcription factors in eukaryotes; Heat shock proteins; Hormonal regulation (steroids and peptides); Gene silencing mechanisms.	12
Unit V	**Protein Synthesis and Post-Translational Events** Ribosome structure and assembly (prokaryotes and eukaryotes); Charging of tRNA; Role of aminoacyl tRNA synthetases; Steps of protein synthesis – initiation, elongation, termination; Fidelity and inhibitors of translation; Post-translational modifications of proteins.	12

Suggested readings:

1. P. K. Gupta (2017). Molecular Biology, Rastogi Publication, Meerut. Reference Books:
2. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). MolecularBiology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
3. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc.,U.S.A. 5th edition.
4. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. BenjaminCummings.U.S.A. 9th edition. Page 16 of 50
5. Sheelar and Bianchi (2009) Molecular Biology of the Cell, Willey Publisher, New Delhi
6. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to GeneticAnalysis. W.H. Freeman and Co., U.S.A. 10th edition.
7. Bruce Alberts et al. 2014. Molecular Biology of the cell Garland Science. 6 th Edition
8. C. B. Power (2017) Cell Biology, Himalaya Publishing House, New Delhi
9. AC. Sahu (2017). Essentials of Molecular Biology, Kalynai Publishers, New Delhi.

Program type: Minor 4	**Year**: Second	**Semester**: Fourth
Subject: BOTANY		

Course Code: BSBY-404	**Course Title**: **Bio-fertilizer and Organic Farming**

Course outcomes:

The student at the completion of the course will be able to:

CO1: Explain the principles of organic farming and the role of bio-fertilizers in sustainable agriculture.
CO2: Identify and describe various types of bio-fertilizers, their microbial components, and mechanisms of action.
CO3:Demonstrate skills in preparation, handling, and application of major bio-fertilizers (Rhizobium, Azotobacter, PSB, etc.).
CO4: Evaluate soil health parameters and understand nutrient cycling under organic farming systems.
CO5: Assess the benefits, limitations, and field performance of bio-fertilizers through practical case studies.
CO6: Apply organic farming practices for improving crop productivity, soil fertility, and environmental sustainability.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.	**9**
Unit-II	Azospirillum: isolation and mass multiplication, Azotobacter: classification, characteristics – crop response to Azotobacter inoculums, maintenance and mass multiplication.	**9**
Unit-III	Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.	**9**
Unit-IV	Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.	**9**
Unit-V	Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.	**9**

Suggested Readings:

1.Mahendra Rai, (2006). Hand book of Microbial Biofertilizers. CRC Press.
2. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
3. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
4. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay _Publication, New Delhi.
5. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.

6. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New -Delhi.
7. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic. Farming Akta Prakashan, Nadiad
8. Pravin Chandra Dwivedi.(2008). Biofertilizers. Pointer Publishers.

Program type: Practical IV (Based on Major 5+6+7)	**Year**: Second	**Semester**: Fourth

Subject: BOTANY

Course Code: BSBY-405P	**Course Title**: **Plant Physiology Lab**

Course outcomes:

The student at the completion of the course will be able to:

1. Comprehend the structure, function, and organization of DNA and RNA across prokaryotes, eukaryotes, and organelles.
2. Illustrate the processes of replication, transcription, and translation with associated enzymes and regulatory elements.
3. Compare prokaryotic and eukaryotic gene regulatory mechanisms, including operon models, transcription factors, and gene silencing.
4. Understand splicing, editing, and transport of mRNA, and relate them to gene expression control.
5. Demonstrate understanding of genetic code translation, fidelity mechanisms, and post-translational modifications.
6. Analyze foundational experiments (e.g., Griffith's, Hershey-Chase, Kornberg's) that established modern molecular genetics.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Topics Covered

Practical:

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3.Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the induction of amylase activity in germinating barley grains
8. To demonstrate suction due to transpiration.

Suggested readings:

1. R. K. Sinha, (2015). Modern Plant Physiology, Narosa Publishing House, New Delhi.
2. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
3. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development.Sinauer Associates Inc. USA. 6th edition.
4. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual.

NarosaPublishing House, New Delhi. 5
5. Salisbury, F. B. and Ross, C. W. Plant Physiology Wadsworth Publishing Company, California 6.
A. C. Sahoo (2018). Outlines of Plant Physiology Kalynai Publishers, New Delhi.
7. N. K.. Srivatava (2017). Plant Physiology, Rastogi Publications, Meerut.
8. Pandey and Sinha (2011). Plant Physiology, Vikash Publishing House, New Delhi

III YEAR

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Life Science														
Course Name - B.Sc. Botany														
Batch:2025 -26							**SEM:V**							
S.No.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**Credits**		**Internal Assessment**		**External Assessment**	**Total**	**Remark**	
				L	**T**	**P**								
THEORY and PRACTICAL SUBJECTS								**Attendance (5)**	**quiz/ PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**			
1	Major 8	BSBY-501	Pteridophytes, Gymnosperm and Paleobotany	4		0	4	5	10	15	70	100		
2	Major 9	BSBY-502	Plant morphology and anatomy	4		0	4	5	10	15	70	100		
3	Minor 5		To be chosen	3		0	3	5	10	15	70	100		
4	Minor 6		To be chosen	3		0	3	5	10	15	70	100		
5	Internship	BSBY-506I	Internship	2		0	4	5	10	15	70	100		
6	Practical V (Based on Major 8+9)	BSBY-503P	Plant morphology and anatomy Lab			4	2	5	10	15	70	100		
TOTAL CREDITS / ASSESSMENT							**20**	**30**	**60**	**90**	**420**	**600**		

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SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Life Science													
Course Name - B.Sc. Botany													
Batch:2025 -26							SEM:VI						
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment		External Assessment	Total	Remark
				L	T	P							
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)	End Sem Exam (70)		
1	Major 10	BSBY-601	Taxonomy of Angiosperm and Economic Botany	4		0	4	5	10	15	70	100	
2	Major 11	BSBY-602	Ecology	4		0	4	5	10	15	70	100	
3	Major 12	BSBY-603	Reproductive Biology and Embryology	4		0	4	5	10	15	70	100	
4	Minor 7		To be chosen	3		0	3	5	10	15	70	100	
5	Minor 8		To be chosen	3		0	3	5	10	15	70	100	
6	Practical VI (Based on Major 10+11+12)	BSBY-604P	Taxonomy of Angiosperm and Economic Botany Lab	0		4	2	5	10	15	70	100	
TOTAL CREDITS / ASSESSMENT							20	30	60	90	420	60	

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Program type: Major 8	**Year**: Third	**Semester**: Fifth
Subject: BOTANY		
Course Code: BSBY-501	**Course Title**: **PTERIDOPHYTES, GYMNOSPERM AND PALEOBOTANY**	

Course outcomes:

The student at the completion of the course will be able to:

1. Develop a comprehensive understanding of the morphology, anatomy, reproduction, and evolutionary significance of Pteridophytes and Gymnosperms.
2. Identify and classify key genera like *Psilotum*, *Selaginella*, *Equisetum*, *Cycas*, and *Pinus* based on diagnostic characters.
3. Grasp the concepts of apogamy, apospory, heterospory, seed habit, telome theory, and stele evolution to interpret plant evolution.
4. Understand fossilization processes, types of plant fossils, and their significance through the study of fossil genera like *Rhynia* and *Williamsonia*.
5. Appreciate the contributions of Indian palaeobotanists and understand the ecological, medicinal, and industrial applications of Pteridophytes and Gymnosperms.

Credits: 4	**Core:** Compulsory
Max. Marks: 25+75= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit I	**Introduction to Pteridophytes** General characteristics and origin of Pteridophytes; Evolution of land habit; Recent classification (up to family); Distinguishing features from Bryophytes and Gymnosperms; Alternation of generations; Ecological roles of Pteridophytes.	12
Unit II	**Representative Pteridophytes** Detailed morphology, anatomy, reproduction of *Psilotum*, *Selaginella*, *Equisetum*, and *Pteris*; Apogamy and apospory; Heterospory and seed habit; Telome theory; Evolution of stele (stellar evolution); Economic and medicinal importance.	12
Unit III	**Gymnosperms: Structure, Reproduction & Significance** General characteristics and classification (up to family); Morphology, anatomy, and reproduction of *Cycas*, *Pinus*, *Ginkgo*, and *Gnetum* (developmental stages not included); Double fertilization in *Ephedra*; Ecological and economic importance of gymnosperms.	12
Unit IV	**Fundamentals of Palaeobotany** Introduction and history of palaeobotany; Geological time scale; Contributions of Indian palaeobotanists (e.g., Birbal Sahni, S. N. Dixit, D. D. Pant); Fossilization processes (permineralization, compression, impression, petrifaction, coal balls, amber preservation); Types of fossils (compression, impression, petrified, cast and mold fossils); Methods of fossil study: peel technique, thin sectioning, acid maceration, SEM, and X-ray tomography.	12

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Unit V	**Fossil Pteridophytes and Gymnosperms** Morphology, anatomy, and evolutionary significance of *Rhynia*, *Calamites*, *Lepidodendron*, *Lyginopteris*, *Cycadeoidea*, and *Williamsonia*; Comparative accounts of Cycadofilicales, Cordaitales, and Bennettitales; Affinities of fossil taxa with living groups; Significance of fossil discoveries in plant evolutionary biology.	12

Suggested readings:

1. P. R. Vasista (2017) Botany for Degree student, Bryophyta, S. Chand Publication, New Delhi.
2. Singh, Pandey and Jain (2017). Archegoniate, Rastogi Publication, Meerut.
3. B. S. Acharya (2017), Archegoniate, Kalynai Publishers, New Delhi.
4. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. New Delhi, India.
5. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers,New Delhi, India.
6. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

Program type: Major 9	**Year**: Third	**Semester**: Fifth
Subject: BOTANY		
Course Code: BSBY-502	**Course Title**: **PLANT MORPHOLOGY AND ANATOMY**	

Course outcomes:

The student at the completion of the course will be able to:

1. Understanding the main features in Angiosperm evolution.
2. Ability to identify, classify and describe a plant in scientific terms, thereby, Identification of plants using dichotomous keys.
3. Develop a comprehensive understanding of the morphology and modifications of root, stem, leaf, flowers, and fruits, enabling accurate identification and classification of angiosperms.
4. Understand the structure and function of plant tissues and their role in growth, differentiation, and physiological processes relevant to systematics, pharmacognosy, and forensic botany.
5. Analyze the internal organization of plant organs (root, stem, and leaf), including primary and secondary growth, vascular cambium activity, and wood anatomy.
6. Examine anatomical adaptations in different plant groups such as xerophytes and hydrophytes, and evaluate structural responses to environmental conditions.
7. Gain practical knowledge of secretory structures and protective systems in plants, enhancing the understanding of plant-environment interactions and industrial applications.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit I	**Plant Morphology** Morphology of root, stem, and leaf; Their modifications for various functions; Types of inflorescence; Flower structure and variations; Types of fruits; Floral diagram and floral	12

	formula.	
Unit II	**Fundamentals of Plant Anatomy** Introduction and scope of plant anatomy; Applications in systematics, forensics and pharmacognosy; Classification of tissues – simple and complex; Tracheary and sieve elements; Pits, plasmodesmata; Transfer cells; Adcrustation and incrustation; Ergastic substances.	12
Unit III	**Anatomy of Stem and Leaf** Shoot apex organization: Apical cell theory, Histogen theory, Tunica Corpus theory, cyto-histological zonation; Types of vascular bundles; Anatomy of dicot and monocot stems; Vascular cambium: structure, function, seasonal activity; Normal and anomalous secondary growth in stem; Anatomy of dicot and monocot leaves; Kranz anatomy.	12
Unit IV	**Anatomy of Root and Wood** Root apex organization: Histogen and Korper-Kappe theory; Quiescent centre and root cap; Anatomy of dicot and monocot roots; Endodermis, exodermis; Origin of lateral roots; Secondary growth in roots; Wood: axial and radial elements, types of rays and axial parenchyma, sapwood and heartwood, reaction wood, dendrochronology, tyloses; Periderm: development, rhytidome and lenticels.	12
Unit V	**Adaptive and Secretory Systems** Epidermal tissue system, cuticle, epicuticular waxes; Trichomes (glandular and non-glandular); Classification of stomata; Anatomical adaptations in xerophytes and hydrophytes; Secretory structures – hydathodes, cavities, lithocysts, laticifers.	12

Suggested readings:

1. Singh, Pandey and Jain (2017). Anatomy of Angiosperms, Rastogi Publication, Meerut.

Reference Books:

2. Eames and Mc Daniels ( ). An introduction to plant anatomy, Tata Mc Grow Hills, New Delhi
3. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
4. M. S. Tayal (2012) Rajpal and Sons, New Delhi 4. B. K. Mishra (2017). Anatomy of Angiosperms, Kalynai Publishers, New Delhi.
5. B. P. Pandey (2017) Plant Anatomy, S. Chand Publication, New Delhi.
6. Coutler E. G. , 1969. Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London. 4. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA
7. Eames A. J. - Morphology of Angiosperms - Mc Graw Hill, New York.
8. Esau, K. 1990. Plant Anatomy, Wiley Eastern Pvt Ltd New Delhi
9. Evert, R.F. (2006) Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
10. Fahn, A.1992. Plant Anatomy, Pergamon Press, USA
11. Pandey, B. P., 1997. Plant Anatomy, S.Chand and Co. New Delhi

Program type: Minor 5	**Year**: Third	**Semester**: Fifth
Subject: BOTANY		
Course Code: BSBY-503	**Course Title**: **Bio-remediation**	

Course outcomes: The student at the completion of the course will be able to:		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0		

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	Bioremediation: Definition and scope, Historical development and importance; Types of bioremediation: In-situ and ex situ bioremediation; bioremediation monitoring; microbial metabolism, factors influencing metabolism, ground water and soil remediation - case studies; Advantages and limitations	**9**
Unit-II	Metabolic pathways of pollutant degradation; Aerobic vs anaerobic degradation; Role of Plants, bacteria, fungi, nematode and archaea, Bioaugmentation and biostimulation, Role of Enzymes in bioremediation (oxidoreductases, dehalogenases, etc.)	**9**
Unit-III	Forms of pollutants and their bioremediation methods: Petroleum hydrocarbons, Heavy metals and radionuclides, Pesticides and herbicides, Plastics and e-waste, Organic solvents and dyes. Genetic engineering applications for phytoremediation	**9**
Unit-III	Different strategies of remediation: Phytoremediation, mycoremediation, vermiremediation, bacterioremediation, Phycoremediation;	**9**
Unit-IV	Bioreactors and land farming, Composting and biosparging, Constructed wetlands, Genetically engineered microbes in bioremediation	**9**
Unit-V	Biosafety, bioethics, and regulatory policies, Monitoring and risk assessment, Nanotechnology in bioremediation, Emerging trends (synthetic biology, CRISPR for microbes)	**9**

Program type: Minor 6	**Year**: Third	**Semester**: Fifth
Subject: BOTANY		
Course Code: BSBY-504	**Course Title**: **Microbial enzyme production and industrial application**	
Course outcomes: The student at the completion of the course will be able to:		

CO1: Understand the fundamentals of microbial enzymes, their types, properties, and significance in biological systems.
CO2: Explain various microbial enzyme production methods, optimization strategies, and fermentation techniques.
CO3: Analyze enzyme purification, characterization, and stability parameters for industrial applicability.
CO4: Evaluate large-scale enzyme production processes and bioprocess engineering principles.
CO5: Discuss industrial applications of microbial enzymes in food, pharmaceutical, textile, agriculture, and environmental sectors.
CO6: Develop problem-solving skills for improving enzyme yield, activity, and process efficiency in industrial settings.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	Introduction to Microbial Enzymes: Enzymes: Definition, classification (IUB system), and properties, Microorganisms as a source of industrial enzymes (bacteria, fungi, actinomycetes), Advantages of microbial enzymes over plant and animal enzymes, Primary and secondary screening of enzyme-producing microbes.	**9**
Unit-II	Enzyme Production and Fermentation Strategies, Submerged fermentation (SmF) and solid-state fermentation (SSF), Media formulation and optimization for enzyme production, recovery and purification of enzymes, Use of immobilized cells and enzymes in production.	**9**
Unit-III	Characterization and Kinetics of Enzymes, Determination of enzyme activity, units, and specific activity, Enzyme kinetics: Michaelis-Menten equation, Km and Vmax, Factors affecting enzyme activity: pH, temperature, inhibitors, Thermostability and halo stability of microbial enzymes.	**9**
Unit-IV	Applications of Microbial Enzymes, Industrial applications: Food industry: Amylase, protease, lipase, lactase, Detergent industry: Alkaline proteases, cellulases, Textile industry	**9**
	Applications of Microbial Enzymes Laccase, cellulase, Pharmaceuticals: Streptokinase, penicillinase, Environmental: Ligninase, peroxidases in bioremediation, Recent advances: Recombinant enzyme technology, metagenomic enzymes.	**9**

Program type: Practical V (Based on Major 8+9)	**Year**: Third	**Semester**: Fifth
Subject: BOTANY		
Course Code: BSBY-505	**Course Title**: **Plant morphology and anatomy Lab**	

Course outcomes:

The student at the completion of the course will be able to:

1. Prepare permanent slides, temporary stain mounts, macerations and museum specimens (Creating)
2. Gain the knowledge about apical meristem of root, shoot and vascular system (Understanding)
3. Apprehend the ideas of the distribution and types of tissues (Understanding)
4. Gain an understanding on secondary growth and wood anatomy in plants (Applying)
5. Scrutinize the different aspects of plant adaptations (Analyzing) 6. Estimate the importance of plant secretory systems (Evaluating)

Credits: 2	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Topics Covered

Practical:

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements- tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart-and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot.- primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.

Program type: Major 10	**Year**: Third	**Semester**: Sixth
Subject: BOTANY		
Course Code: BSBY-601	**Course Title**: **Taxonomy of Angiosperm and Economic Botany**	

Course outcomes:

The student at the completion of the course will be able to:

CO1: Explain principles of plant classification, nomenclature, and identification of angiosperms.

CO2: Distinguish major angiosperm families based on diagnostic morphological and anatomical

characters.
CO3: Apply keys, herbarium techniques, and field methods for identifying and documenting flowering plants.
CO4: Analyze phylogenetic relationships among angiosperms using modern taxonomic approaches (APG system).
CO5: Describe economically important plants and their contributions in food, medicine, fibre, oil, and industry.
CO6: Evaluate the role of plant resources in agriculture, environment, and sustainable economic development.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	1. History of plant Taxonomy. 2. International Code of Botanical Nomenclature (ICBN). Salient feature, important rules and recommendation, Binomial nomenclature, botanical gardens and herbaria. 3. Taxonomic evidences: Morphology, Plant anatomy, Palynology, Embryology, Cytology, Phytochemistry, Genome analysis and DNA hybridization technique in relation to taxonomy, numerical taxonomy, serotaxonomy.	**12**
Unit-II	The species concept: Taxonomic hierarchy, species, genus, family and other categories, Principles used in assessing relationship, delimitation of taxa and attribution of rank. Variation and specialization in plants. 5. Phylogenetic systems of classification: Hutchinson, Cronquist, Takhtajan and Dahlgren. Outlines, merits and demerits. 6. Basic knowledge of phylocode and A P G system.	**12**
Unit-III	Range of floral structure and phylogeny in: I. Dicotyledons: a. Magnoliidae with special reference to Magnoliaceae, Lauraceae, Piperaceae, b. Hamamelidae with special reference to Moraceae, Juglandaceae and Casuarinaceae, c.Caryophyllidae with special reference to Cactaceae, Chenopodiaceae and Polygonaceae, d. Dilleniidae with special reference to Tiliaceae, Sterculiaceae, Violaceae, e. Rosidae with special reference to Lythraceae, Combretaceae, f. Asteridae with special reference to Boraginaceae, Scrophulariaceae, Bignoniaceae	**12**
Unit-IV	II.Monocotyledons: a. Alismatidae, b. Commelinidae with special reference to Commelinaceae and Zingiberaceae, c. Arecidae with special reference to Araceae, d.Liliidae with special reference to Amaryllidaceae 8. Cradle of flowering plants.	**12**
Unit-V	Economic Botany: 12. Botanical names, families, Plant part(s) used and uses of the important plants belonging to following categories: λ Fiber plants λ Spices and condiments Beverages λ Medicinal plants λ Non-wood plant products (NWPPs): rubber, dyes, resin, gums etc.	**12**

Program type: Major 11	**Year**: Third	**Semester**: Sixth
Subject: BOTANY		
Course Code: BSBY-602	**Course Title**: **Ecology**	

Course outcomes:

The student at the completion of the course will be able to:

1. Recollect the concepts of ecology of individual, population, community and ecosystem (Remembering)
2. Perceive the basic knowledge of biotic and abiotic factors of environment their interaction, ecosystem and its functional aspects (Understanding)
3. Inspect the ideas on ecosystem and its functional aspects (Analyzing)
4. Utilize the concepts of population dynamics and community succession in understanding the composition of a particular area (Applying)
5. Check their knowledge on phytogeography (Evaluating)

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Introduction and Soil** Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.	**12**
Unit-II	**Water, Light, temperature, wind and fire** Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. Variations; adaptations of plants to their variation.	**12**
Unit-III	**Biotic interaction** Host-Pathogen interaction Module VI: Population ecology (4 Hrs) Characteristics and Dynamics. Ecological Speciation	**12**
Unit-IV	**Plant communities and Ecosystems** Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. Ecosystem Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.	**12**
Unit-V	**Functional aspects of ecosystem and Phytogeography** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus. Phytogeography Principles; Continental drift; Theory of tolerance; Endemism;	**12**

	Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation	

Program type: Major 12	**Year**: Third	**Semester**: Sixth
Subject: BOTANY		
Course Code: BSBY-603	**Course Title**: **Reproductive Biology and Embryology**	

Course outcomes:

The student at the completion of the course will be able to:

1. Define and tell the basic ideas of anther, ovule, endosperm, embryo and seed (Remembering)
2. Demonstrate and explain concepts of pollen biology, pollination and fertilization, self-incompatibility (Understanding).
3. Plan and develop protocols for studying pollination, fertilization and embryogenesis (Applying)
4. Categorize and distinguish different reproductive mechanisms in Angiosperm (Analyzing)
5. Compare and evaluate methods of pollination and self-incompatibility in plants (Evaluating)
6. Design and improve protocols for transformation (Creating)

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Introduction and Anther** History and Scope of embryology Typical Angiosperm Flower Structure of stamen Microsporogensis Microgametogenesis Dehiscence	**12**
Unit-II	**Ovule and Embyogeny** Structure of carpel Types of Ovule Megasporogenesis, Megagametogenesis (monosporic, bisporic and tetrasporic types). Structure of typical embryosac, (Polygonum, Allium and Adoxa type)	**12**
Unit-III	**Pollination and Fertilization** Pollination, Pollen tube entry (Types) Syngamy and triple fusion, Double fertilization Development of Endosperm	**12**
Unit-IV	**post-fertilization** Types of endosperm Haustoria Functions of suspensors and synergids, Apomixis Polyembryony. Fruit-development and maturation	**12**
Unit-V	**Palynology** Pollen- pistil interaction, Compatibility and incompatibility Types of Pollen production and dispersion in time and space, Pollen/spore morphology and its role in taxonomy, Pollen allergy.	**12**

Suggested readings:

1. Bhojwani, S.S. and Bhatnagar SP 2004 The Embryology of Angiosperms, Vikas Publishing House

2. Davis C.L. 1965. Systematic Embryology of Angiosperms. John Wiley, New York.
3. Eames M.S 1960. Morphology of Angiosperms Mc Graw Hill New York.
4. Erdtman G 1952. Pollen Morphology and plant Taxonomy Part I. Almiquist & Wicksell Stockholm
5. Erdtman G 1969. Hand Book of Palynology. National Botanical Gardens Publication, Lucknow
6. Johri BD 1984 (ed.) Embryology of Angiosperms Springer Verlag, Berlin.
7. Johri, B.M. 1984 Embryology of Angiosperms, Springer-Verlag, Netherlands.
8. Maheswari P. 1985. Introduction to Embryology of Angiosperms Mac Graw Hill, New York. House (P) Ltd.
9. Nair P .K .K Pollen Morphology of Angiosperms Scholar Pub: House, Lucknow
10. Raghavan, V. 1997 Molecular embryology of flowering plants. Cambridge, University Press.
11) Raghavan, V. 2000 Developmental Biology of Flowering plants, Springer, Netherlands. 12) Shivanna, K.R. 2003 Pollen Biology and Biotechnology, Science Publishers.

Program type: Minor 7	**Year**: Third	**Semester**: Sixth
Subject: BOTANY		
Course Code: BSBY-604	**Course Title**: **Pharmacognosy and Herbal Drug Technology**	
Course outcomes: The student at the completion of the course will be able to:		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0		

Unit	Topics Covered	No. of Lectures (Hrs)
Unit-I	Herbs as raw materials; Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation. Source of Herbs Selection, identification and authentication of herbal materials Processing of herbal raw material. Biodynamic Agriculture: Good agricultural practices in cultivation of medicinal plants including Organic farming. Pest and Pest management in medicinal plants: Biopesticides/Bioinsecticides.	**9**
Unit-II	Study of following herbs as health food: Ginger, Fenugreek, Garlic, Amla, Neem, Ashwagandha, Giloy, Harjod, Munga. Herbal-Drug and Herb-Food Interactions: General introduction to interaction and classification.	**9**
Unit-III	Herbal Cosmetics Sources and description of raw materials of herbal origin used via, fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants in products such as skin care, hair care and oral hygiene products.	**9**

Unit-IV	Evaluation of Drugs WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs. Patenting and Regulatory requirements of natural products:	**9**
Unit-V	Definition of the terms: Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy, Patenting aspects of Traditional Knowledge and Natural Products. Case study of Curcuma & Neem.	**9**

Suggested readings:

1. Agarwal, S.S. and Paridhavi, M., "Herbal Drug Technology" Universities Press (India) Private Limited, 2007.
2. Wallis, T.E., "Textbook of Pharmacognosy" 5th Edition, CBS Publishers and Distributors, 1985.
3. Evans, W.C., "Trease and Evans Pharmacognosy" 15th Edition, Elsevier Health Sciences, 2001.
4. Lanza, R.P. and Atala, A., "Methods of Tissue Engineering" Elsevier Publications, 2006.
5. Daniel, M., "Herbal Technology: Concepts and Advances" Satish Serial Publishing House, 2008.

Program type: Minor 8	**Year**: Third	**Semester**: Sixth

Subject: BOTANY

Course Code: BSBY-605	**Course Title**: **Commercial Botany**

Course outcomes:

The student at the completion of the course will be able to:

CO1: Understand the economic importance of major plant groups used in food, fibre, medicine, timber, and industry.
CO2: Identify and classify commercially important plant species based on their botanical characteristics.
CO3: Explain the cultivation, processing, and utilization techniques of key commercial crops.
CO4: Analyze the role of plants in pharmaceuticals, nutraceuticals, cosmetics, and other industrial sectors.
CO5:Apply botanical knowledge in sustainable resource management and development of plant-based industries.
CO6: Demonstrate basic skills in evaluating plant products, quality parameters, and market potential.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0

Unit	Topics Covered	No. of Lectures (Hrs)
Unit-I	Origin of Cultivated Plants (6 lectures) Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.	**9**
Unit-II	Cereals: Wheat and Rice (origin, morphology, processing &	**9**

	uses); Brief account of millets. Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem. Sources of sugars and starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.	
Unit-III	Spices: Listing of important spices, their family and part used. Economic importance with special reference to fennel, saffron, clove and black pepper	**9**
Unit-IV	Beverages (4 lectures) Tea, Coffee (morphology, processing & uses) Sources of oils and fats (10 lectures) General description, classification, extraction, their uses and health implications groundnut, coconut, linseed, soybean, mustard and coconut (Botanical name, family & uses). Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.	**9**
Unit-V	Natural Rubber: Para-rubber: tapping, processing and uses. Medicinal plants: Listing of important medicinal plants of Jharkhand. Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*; Tobacco (Morphology, processing, uses and health hazards). Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers; Cotton, Coir and Jute (morphology, extraction and uses).	**9**

Suggested readings:

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett _Publishers.

Program type: Practical VI (Based on Major 10+11+12)	**Year**: Third	**Semester**: Sixth
Subject: BOTANY		
Course Code: BSBY-606P	**Course Title**: **Taxonomy of Angiosperms and Economic Botany Lab**	

Course outcomes:

The student at the completion of the course will be able to:

1. Outline the identification, classification and nomenclature of plants as well as explain taxonomic identification and hierarchy (Understanding)
2. Demonstrate the applied aspects of plant taxonomy (Understanding)
3. Interpret botanical nomenclature and classification and also compare biometrics, numerical taxonomy and cladistics (Understanding)

4. Recollect the morphology and anatomy of various economically important plants (Remembering)
5. Explain the economic importance of crop plants (Understanding)
6. Execute various micro-chemical tests of cereals, legumes, sugars and starches (Applying)
7. Able to carry out qualitative and quantitative checking of crop plant products (Evaluating)

Credits: 2	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4

Topics Covered

Practicals:

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae –Brassica, Alyssum / Iberis; Asteraceae - CO6 H H H Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax; Solanaceae - Solanum nigrum, Withania; Lamiaceae -Salvia, Ocimum, Liliaceae Asphodelus / Lilium / Allium.
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Cereals: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro -chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).

3. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).

4. Sugars & Starches: Sugarcane (habit sketch; cane juice-micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).

5. Spices: Black pepper, Fennel and Clove (habit and sections).

6. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).

7. Oils & Fats: Coconut-T.S. Nut, Mustard–plant specimen, seeds; tests for fats in crushedseeds.

8. Essential oil-yielding plants: Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus (specimens/photographs).

9. Rubber: specimen, photograph/model of tapping, samples of rubber products.

10. Drug-yielding plants: Specimens of Digitalis, Papaver and Cannabis.

11. Tobacco: specimen and products of Tobacco.

12. Woods: Tectona, Pinus: Specimen, Section of young stem.

13. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

IV YEAR

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT														
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE														
Department of Life Science														
Course Name - B.Sc. Botany														
Batch:2025 -26							SEM:VII							
S. No.	Course Type	Course Code	Course	Teaching Load			Credits		Internal Assessment			External Assessment	Total	Remark
				L	T	P								
THEORY and PRACTICAL SUBJECTS								Attendance (5)	quiz/PPT/Assignment (10)	Mid Sem Test (15)		End Sem Exam (70)		
1	Major 13	BSBY-701	Bioethics, Biosafety and IPR	4		0	4	5	10	15		70	100	
2	Major 14	BSBY-702	Computational biology and bioinformatics in research	4		0	4	5	10	15		70	100	
3	Major 15	BSBY-704	Plant Tissue Culture	4		0	4	5	10	15		70	100	
4	Minor 9		To be chosen	3		0	4	5	10	15		70	100	
5	Practical VII (Based on Major (13+14)	BSBY-703P	Plant Tissue Culture Lab	0		4	2	5	10	15		70	100	
6	Practical VIII (Based on	BSBY-706P	Computational biology and	0		4	2	5	10	15		70	100	

K. V. Subharti College of Science

	Major 15)		bioinformatics in research Lab									
TOTAL CREDITS / ASSESSMENT						**20**	**30**	**60**	**90**	**420**	**600**	

SWAMI VIVEKANAD SUBHARTI UNIVERSITY MEERUT													
KERAL VERMA SUBHARTI COLLEGE OF SCIENCE													
Department of Life Science													
Course Name - B.Sc. Botany													
Batch:2025-26						**SEM:VIII**							
S.No.	**Course Type**	**Course Code**	**Course**	**Teaching Load**			**CREDITS**	**Internal Assessment**			**External Assessment**	**Total**	**Remark**
	THEORY and PRACTICAL SUBJECTS			**L**	**T**	**P**		**Attendance (5)**	**Quiz/PPT/ Assignment (10)**	**Mid Sem Test (15)**	**End Sem Exam (70)**		
1	Major 16	BSBY-801	Research Methodology in Botany	4		0	4	5	10	15	70	100	
2	Minor 10		To be chosen	3		0	4	5	10	15	70	100	
4	Research Project / Dissertation	BSBY-803R	Research Project / Dissertation	2		0	12				300	300	
TOTAL CREDITS / ASSESSMENT							**20**	**60**			**440**	**500**	

K. V. Subharti College of Science

Program type: Major 13	**Year**: Fourth	**Semester**: Seventh
Subject: BOTANY		
Course Code: BSBY-701	**Course Title**: **Bioethics, Biosafety and IPR**	

Course outcomes:

The student at the completion of the course will be able to:

1. Outline the identification, classification and nomenclature of plants as well as explain taxonomic identification and hierarchy (Understanding)
2. Demonstrate the applied aspects of plant taxonomy (Understanding)
3. Interpret botanical nomenclature and classification and also compare biometrics, numerical taxonomy and cladistics (Understanding)
4. Recollect the morphology and anatomy of various economically important plants (Remembering)
5. Explain the economic importance of crop plants (Understanding)
6. Execute various micro-chemical tests of cereals, legumes, sugars and starches (Applying)
7. Able to carry out qualitative and quantitative checking of crop plant products (Evaluating)

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Introduction to IPR and Patent Laws** - Ownership of tangible and intellectual property - Requirements of patentability: subject matter, novelty, non-obviousness - Indian Patent Law overview - WTO and TRIPS agreement - Patent Cooperation Treaty (PCT) - Public domain vs. patentable matter - Legal protection of intellectual/industrial property	12
Unit-II	**Patent Laws in Biotechnology & Litigation** - Patenting in biotechnology: scope and challenges - Ethical and economic considerations - Patent infringement, revocation, compulsory licensing - Disclosure requirements - Collaborative and competitive research - Patent litigation: procedural and substantive aspects - Budapest Treaty - Recent developments in patent systems	12
Unit-III	**Biosafety & Regulatory Frameworks** - Introduction to biosafety - Health hazards in biotechnology - The Cartagena Protocol on Biosafety - Containment levels (BSL 1–4) - GLP (Good Laboratory Practices) - GMP (Good Manufacturing Practices)	12
Unit-IV	**Bioethics & Bioterrorism** Necessity and importance of bioethics - National and international bioethical paradigms - Ethical issues in molecular biology & biotechnology -	12

	Social and ethical implications of biological weapons - Concept of bioterrorism and its prevention	
Unit-V	**Contemporary Topics and Case Studies** - Case studies: Indian and global patent disputes (e.g., Bt cotton, CRISPR, turmeric, basmati rice) - IPR in the digital age: AI-generated inventions, software patents - Role of AI and data science in patent analytics - Career prospects in IPR, patent law, biotech policy & biosafety auditing	12

Suggested readings:

1. Gupta, P.K. (2004). Elements of Biotechnology. India: Meerut Rastogi Publications.
2. Subbaram. (2003). What everyone should know about patents? Hyderabad: NPharma book Syndicate.
3. Watal, J. (2001). Intellectual Property rights in the WTO and Developing countries. New Delhi: Oxford University Press.
4. Intellectual Property Bulletin.
5. Sateesh, M. K. (2010). Bioethics and Biosafety. New Delhi: I. K. International Pvt Ltd.
6. Krishna, S.V. (2007). Bioethics and Biosafety in Biotechnology. New Delhi: New age international publishers.

Program type: Major 14	**Year**: Fourth	**Semester**: Seventh
Subject: BOTANY		
Course Code: BSBY-702	**Course Title**: **Computational biology and bioinformatics in research**	

Course outcomes:

The student at the completion of the course will be able to:

CO1: Apply computational tools** to analyze biological datasets, including sequences, structures, and omics data.

CO2:Interpret biological patterns** using bioinformatics algorithms such as alignment, BLAST, molecular modeling, and phylogenetics.

CO3:Perform data-driven research** by integrating statistical, computational, and biological approaches.

CO4:Design and execute workflows** for genome analysis, protein structure prediction, and molecular simulations.

CO5:Use programming and databases** (NCBI, UniProt, PDB) to retrieve, manage, and analyze biological information.

CO6:Develop problem-solving skills** for research in systems biology, drug discovery, and precision medicine.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0		
Unit Title	**Topics Covered**	**No. of Lectures (Hrs)**
Unit-I	**Introduction to Computational Biology and Bioinformatics** Nature and scope of Computational Biology and Bioinformatics, Basic algorithms in Computational Biology, Introduction to sequence alignment (only general ideas, not algorithm) - Local and global, pair wise and multiple, BLAST.	
Unit-II	**Cell Energetics** Laws of Thermodynamics, Photosynthesis, Anaerobic & aerobic respiration, Structure and function of mitochondria, respiratory pathways: Glycolysis, Kreb's Cycle, Electron transport chain.	
Unit-III	**Chromosome-Genome-Genes-Databases** Bio-molecules- DNA, RNA, Protein and amino acids, Chargaff's Rules, Codon bias, GC content. Central Dogma: Replication, Transcription, Translation, Post transcriptional & post translational modifications, RNA processing, RNA splicing and RNA editing. Sense/coding and anti-sense/template strands, Genetic code, wobble hypothesis. Introduction to DNA and Protein sequencing, Human Genome Project, Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, Gene Bank, DDBJ; Secondary nucleotide sequence databases.	
Unit-IV	**Proteins and Databases** Protein structure and function, Protein Primary structure, Amino acid residues, Secondary, Tertiary, Quaternary Structure of Protein, Protein sequence databases- SwissProt/ TrEMBL, PIR, Sequence motif databases -Pfam, PROSITE, Protein structure databases, Protein Data Bank-SCOP, CATH, KEGG, Chembank, Sequence, structure and function relationship.	
Unit-V	**Databases & Online tools** Databases - NCBI, EMBL, DDBJ, Genbank, Pubmed, Patent databases, TAIR, PDB, ATIDB). Online tools - BLAST, ORF finder, Primer3, protein motif and structure prediction tools; Vector NTI, DNASTAR. Bioinformatics in genome sequencing and annotation. Fundamentals of computer programming. Programming in PERL. Introduction to in silico drug design and molecular modeling.	

Suggested readings:

1. Attwood TK and Parry-Smith DJ (2004) Introduction to Bioinformatics, Pearson Education (Singapore) Pvt. Ltd.
2. David Edwards (Ed.) (2007) Plant Bioinformatics: Methods and Protocols, Humana Press, New Jersey, USA.
3. Kulas JT (2008) SPSS Essential: Managing and Analyzing Social Science Data. John Wiley & Sons, New York.
4. Pagano M, Gauvreau K (2007) Principles of Biostatistics. Thomson India Edition, New Delhi.
5. Randal Schwartz, Tom Phoenix and Brian d Foy (2005) Learning Perl (4th edition), O'Reilly &

Associates, ISBN: 0-596-10105-8.
6. Rex A. Dwyer (2004) Genomic Perl: From Bioinformatics Basics to Working Code, Cambridge University Press, 1st South Asian Edition.
7. Rosenkrantz WA (2009) Introduction to Probability and Statistics for Science, Engineering and Finance. CRC Press, Boca Raton.
8. Becker, W. M., Kleinsmith, L. J., Hardin, J., & Raasch, J. (2003). The world of the cell (Vol. 6). San Francisco: Benjamin Cummings.
9. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2002). Biochemistry,;
10. W. H. Claverie,J.,M., Notredame,C.(2003).Bioinformatics: A Beginner's Guide. Wiley India Pvt. Limited.
11. Devasena, T. (2012). Cell Biology. Published by Oxford University Press.
12. Fall, C.P., Marland, E.S., Wagner, J.M., Tyson, J.J.(2002). Computational Cell Biology. Springer.
13. Hausman, R. E., & Cooper, G. M. (2004). The cell: a molecular approach.ASM, Washington, DC.
14. Karp, G. (2009). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons.

Program type: Major 15	**Year**: Fourth	**Semester**: Seventh
Subject: BOTANY		
Course Code: BSBY-704	**Course Title**: **Plant Tissue Culture**	

Course outcomes:
The student at the completion of the course will be able to:
CO1: Understand the fundamental principles and historical developments of plant tissue culture.
CO2: Demonstrate aseptic techniques and prepare culture media for various plant tissues.
CO3: Apply micropropagation methods for the rapid multiplication of economically important plants.
CO4: Explain and perform callus induction, somatic embryogenesis, and organogenesis.
CO5: Analyze factors affecting in vitro plant growth and development, including hormones and environmental conditions.
CO6: Utilize tissue culture techniques for plant improvement, conservation, and secondary metabolite production.

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Brief history of tissue culture** History of plant tissue culture, Concepts of cell differentiation and totipotency; pathways for in vitro regeneration: organogenesis, somatic and gametic embryogenesis; protoplast isolation, culture and regeneration; somatic hybridization; Applications: micropropagation, embryo rescue, synseed production, somaclonal and androclonal	**12**

	variations, cryopreservation and germplasm storage. Principles, methods and applications of plant tissue culture	
Unit-II	**Tissue culture lab and media** Characteristics of Plant tissue culture laboratory, Media composition Selection of media, Media preparation	**12**
Unit-III	**Micropropagation** Selection of suitable material and Stock plant selection c. Parts of plant, d. Size of explants, e. Avoid diseased tissue.	**12**
Unit-IV	**Organ Culture** Meristem culture, Callus culture, Anther culture, Embryo culture, Ovary culture, Ovule culture, Pollen culture	**12**
Unit-V	**Benefits of plant tissue culture** Rapid multiplication of clones, Genetic uniformity, Aseptic condition, Controlled environment	**12**

Suggested readings:

1. H. S. Chawla (2010). Introduction to Plant Biotechnology.Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
4. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
5. Y. P. S. Bajaj Series, Springer Verlag
6. B. D. Singh (2018). Plant Biotechnology Kalynai Publishers, New Delhi.
7. P. K. Gupta (2017). Plant Biotechnology, Rastogi Publication, Meerut.
8. R. C. Dubey (2017). Advanced Biotechnology, S, Chand Publication, New Delhi

Program type: Minor 9	**Year**: Fourth	**Semester**: Seventh
Subject: BOTANY		
Course Code: BSBY-705	**Course Title**: **Literature review and Scientific writing**	

Course outcomes:

The student at the completion of the course will be able to:

CO1: Identify, search, and retrieve relevant scientific literature using appropriate databases and keywords.

CO2: Critically evaluate scientific articles for quality, validity, and relevance.

CO3: Organize and synthesize reviewed literature to develop coherent arguments and research gaps.

CO4: Prepare structured scientific documents including review papers, reports, and research proposals.

CO5: Apply appropriate scientific writing styles, referencing formats, and ethical guidelines (plagiarism, citation, paraphrasing).

CO6: Communicate scientific information effectively with clarity, accuracy, and logical flow.		
Credits: 3	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0		
Unit	**Topics Covered**	**No. of Lectures (Hrs)**
Unit-I	Introduction to Literature Review, Purpose and importance of literature review, Types of literature: primary, secondary, tertiary sources, Review types: narrative vs systematic vs. meta-analysis, identifying research gaps and formulating review questions.	**9**
Unit-II	Searching and Managing Scientific Literature**,** Use of online databases: PubMed, Scopus, Google Scholar, Web of Science**,** Use of keywords,	**9**
Unit-III	Boolean operators, filters**,** Reference management tools: Mendeley, Zotero, EndNote (basic introduction)**,** Organizing and storing references	**9**
Unit-IV	. Principles of Scientific Writing, Structure of a scientific paper: IMRAD (Introduction, Methods, Results, Discussion), Writing styles: clarity, conciseness, coherence, Common errors and how to avoid them, Writing summaries, abstracts, and keywords	**9**
Unit-V	Referencing and Plagiarism: Citation styles: APA, MLA, Vancouver, Chicago (overview), Paraphrasing and quoting, Avoiding plagiarism: use of plagiarism detection tools, Ethical issues in scientific writing and publication	**9**

Program type: Practical VII (Based on Major (13+14)	**Year**: Fourth	**Semester**: Seventh
Subject: BOTANY		
Course Code: BSBY-703P	**Course Title**: **Plant Tissue Culture Lab**	
Credits: 2	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4		
Unit Title	**Topics Covered**	**No. of Lectures (Hrs)**
Practicals: 1. (a) Preparation of MS medium. (b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura, Brassica* etc. 2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.		

3. Isolation of protoplasts. 4. Construction of restriction map of circular and linear DNA from the data provided. 5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs. 7. Isolation of plasmid DNA. 8. Restriction digestion and gel electrophoresis of plasmid DNA.
Suggested readings: 1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands. 2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington. 3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition. 4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition. 5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

Program type: Practical VIII (Based on Major (13+14)	**Year**: Fourth	**Semester**: Seventh
Subject: BOTANY		
Course Code: BSBY-706P	**Course Title**: **Computational biology and bioinformatics in research Lab**	
Credits: 2	**Core:** Compulsory	
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 0-0-4		
Topics Covered		
Practical: 1. Laboratory safety guidelines, equipment handling, Preparation of buffers, reagents and media: simple media, special media. 2. Basic experimental concepts in Microbiology, 3. Sterilization: dry heat, moist heat, Radiation, chemical treatment, Isolation of bacteria from different samples: soil, water and air, 4. Microscopic examination of bacteria by simple and differential staining, bacterial colony characterization, 5. Biochemical characterization of bacterial colonies, Antibiotic sensitivity test, Bacterial growth curve.		

6. Decontamination of microbial culture
7. Differential staining of blood, Blood typing, chromosome preparation: mitosis –Onion root tip
8. Facilitating access from various Bioinformatics databases: NCBI, PDB, SWISS PROT, Pfam etc., and pairwise sequence alignment using BLAST.
9. Database creation and management using PHP-MySQL,
10. Writing programs using python features including functions, string handling as well as object oriented features, Data analysis using R package.
10. Experiments in basic bioinformatics tools

Suggested readings:

1. Aneja K.R. (2014). Laboratory manual of Microbiology and Biotechnology, Medtec
2. Claverie, J. M., & Notredame, C. (2011). Bioinformatics for dummies. John Wiley & Sons.
3. Jayaraman, J. (1981). Laboratory manual in biochemistry. Wiley Eastern
4. Miller, J. H. (1992). Experiments in molecular genetics.
5. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: a laboratory manual. 13 MSc Syllabus Final ver_15/2/2018
6.Winfrey, M. R., Rott, M. A., & Wortman, A. T. (1997). Unraveling DNA: Molecular biology for the laboratory (pp. 73-80). New York (NY): Prentice-Hall.
7. Carey, V. J., Huber, W., Irizarry, R. A., & Dudoit, S. (2005). Bioinformatics and computational biology solutions using R and Bioconductor (Vol. 746718470). R. Gentleman (Ed.). New York: Springer.

Program type: Major 16	**Year**: Fourth	**Semester**: Eight
Subject: BOTANY		
Course Code: BSBY-801	**Course Title**: **Research Methodology in Botany**	

Course outcomes:

The student at the completion of the course will be able to:

CO1:Demonstrate understanding of fundamental research concepts, principles, and ethics relevant to botanical research.
CO2: Identify research problems, formulate hypotheses, and design appropriate experimental approaches in botany.
CO3: Apply suitable qualitative and quantitative research methods for data collection, analysis, and interpretation in plant sciences.
CO4: Use laboratory, field-based, and computational tools to conduct systematic botanical investigations.
CO5: Critically review scientific literature and synthesize information to develop research proposals.
CO6: Prepare scientific reports, research papers, and presentations following standard academic formats..

Credits: 4	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 4-1-0

Unit Title	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Research Problem 1** Its importance, aims and objectives, literature collection, Methodology (Experimental design / Field data collection). Data presentation and interpretation.	**12**
Unit-II	**Research Problem 2**Drawing conclusions. Scientific paper writing – Manuscript preparation and presentation Research Journals, Impact Factor and paper citation index Statistical methods in Biology: Mean, Variance, Standard deviation, Standard error, Chisquare and 't'– test	**12**
Unit-III	**Culture of Algae** Media and isolation of pure cultures Culture and preservation of Fungi Plant tissue culture methods. Genetic transformation methods (Agrobacterium-mediated and microprojectile / Biolistic methods). Herbarium techniques	**12**
Unit-IV	**Plant Micro technique** Fixatives and staining (single and double). Fixation for histological and histochemical study. Microtomy. Histochemical methods in Pharmacognosy and Forensic Botany. Organoleptic evaluation of market drugs. Preparation of Cytological slides for study of Mitosis and Meiosis Principles of Microscopy (Light microscope, phase contrast, Electron Microscope (SEM & TEM) and Fluorescence microscope).	**12**
Unit-V	Methods of expressing concentration: Physical and chemical methods. Soxhlet extraction, Column chromatography, TLC, High pressure liquid Chromatography (HPLC), Electrophoresis and ELISA. Principles of Fluorescence, UV, Visible, NMR and Atomic Absorption Spectroscopy and Autoradiography. Basic concepts of Recombinant DNA technology. Gene cloning, DNA fingerprinting technique, Polymerase Chain Reaction and Southern blotting.	**12**

Suggested readings:

1. P.N. Arora and P.K. Malhan (1998). Biostatistics. Himalaya Publishing Bombay.
2. P.S.G. Kumar (2004). Research methods and statistical techniques. B.R. publishing Academy, Udaypur.
3. G.B.N. Chainy, G. Mishra and P.K. Mohanty (2004) Basic Biostatistics. Kalyani Publisher.
4. N. Gurumani (2006). Research Methodology for Biological Sciences. MJP Publishing, Chennai.
5. C.R. Kothari (2004). Research Methodology- Methods and Techniques, New Age Publ. Wiley Eastern, 1985.
6. Dawson, Catherina (2002). Practical Res. Methods. New Delhi. UBS Publ.

7. Kumar Ranjit (2005). Res. Methodology. A step by step Guide for Beginners. Singapore, Pearson Education.

Program type: Minor 10	**Year**: Fourth	**Semester**: Eight
Subject: BOTANY		
Course Code: BSBY-802	**Course Title**: **Thrust Area of Botany**	

Course outcomes:

The student at the completion of the course will be able to:

CO1: Understand the major thrust areas of modern Botany, including plant diversity, ecology, physiology, biotechnology, and molecular biology.

CO2: Explain the significance of emerging research domains such as plant genomics, climate-resilient crops, phytoremediation, and conservation biology.

CO3: Demonstrate the ability to relate botanical concepts to real-world applications in agriculture, environment, industry, and healthcare.

CO4: Analyze current scientific challenges and technological advancements within the core and emerging areas of plant sciences.

CO5: Develop skill-based competencies in experimental, analytical, and computational tools relevant to advanced Botanical research.

CO6:Evaluate global trends and future prospects of Botany for sustainable development, biodiversity conservation, and biotechnological innovations.

Credits: 3	**Core:** Compulsory
Max. Marks: 30+70= 100	**Min. Passing Marks: 40**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P:** 3-1-0

Unit	Topics Covered	No. of Lectures (Hrs)
Unit-I	**Plant Biotechnology & Genetic Engineering** CRISPR-Cas & genome editing in plants; Plant transformation techniques (*Agrobacterium, biolistics*; Marker-assisted breeding; GMO biosafety	9
Unit-II	**Climate Resilience & Stress Physiology** Mechanisms of drought, salinity & heat tolerances; Osmoprotectants & antioxidant responses; Phenotyping for stress tolerance; Carbon sequestration by plants	9
Unit-III	**Phytomedicine & Ethnobotany** Phytochemical screening methods; Bioactive compounds & their biosynthesis; Traditional knowledge systems & documentation; Conservation of medicinal plants	9

Unit-IV	**Plant–Microbe Interactions & Environmental Applications** Mycorrhizae, rhizobia & endophytes; Biofertilizers & plant growth promotion;	9
Unit-V	**Plant–Microbe Interactions & Environmental Applications** Phytoremediation & mycoremediation strategies; Biocontrol agents in plant health	9