
COURSES OF STUDY

M.Sc. in BOTANY

For The Session: 2025-2027

(Effective from the Academic Session, 2025-2026)

Choice-Based Credit System (CBCS)



**BERHAMPUR UNIVERSITY
BHANJA BIHAR
BERHAMPUR – 760 007 (GANJAM)
ODISHA**

2025

A Brief Profile of the Department

The Department of Botany was established in 1969 and was founded by the late Prof. Harihar Pattnaik, a renowned algologist. Since its inception, the department has grown appreciably not only in terms of student and faculty strength but also in the introduction of new courses, specializations, and broadening research activities. The Government agencies fund the department through research grants from CSIR, UGC, DBT, DAE, MoEF &CC, SERB, ANRF, DST, Govt of India. the Government of India, OFSD, the S & T Department, and the Government of Odisha.

Program Outcome: M.Sc. in Botany

M.Sc. in Botany is a two-year regular course, offered by the PG Department of Botany, Berhampur University. The present syllabus covers different components of theory and practical, as well as project work, field study, and seminar presentations, which will help the students to have in-depth knowledge of advanced Botany. During and after the completion of this course, students are expected to know Microbiology, different lower (Cryptogams) and higher plants (Phanerogams) diversity, their anatomy, physiology, biochemistry, biostatistics, reproductive biology, genetics, evolutionary history and Paleobotany, etc. The students can learn about the origin and history of different cultivated plants, their economic importance, utilization and conservation of natural resources, and different renewable and nonrenewable energy sources. The course curriculum is designed to introduce the students to sensory biology and stress physiology, along with hands-on training on the theory and practical aspects of different instruments, including microbial and plant tissue culture. The course also encompasses an enriched knowledge of Ecology, environmental pollution and different Environment laws. After completion of this course, students are expected to have practical knowledge on how to handle and operate basic instruments for their experimental purposes. They might have a basic idea of experimental designing, project handling and writing their project reports, which may be beneficial for them in the future and improve their capability to write notes and research articles for different scientific journals. The degree of M.Sc. Botany may open their path into academia/research career at the national and international level as a scientist, as a teaching faculty or as a scholar or into different administrative positions.

Course Outcome

After successful completion of this course, students will be able to understand, the cell structures function of cells, the fundamental unit of life along with molecules present in cells, the concepts in prokaryotic, eukaryotic, and viral genetics, the central dogma of molecular biology (replication, transcription, and translation), the types of mutation, gene regulation and transposable element, the diversity of lower cryptogams (Cyanobacteria, Algae, Bacteria, and Viruses), the collection and study of Cyanobacteria, algae, fungi, bacteria from different natural sources, their identification up to generic

level. After completion of the course, the students will be familiar with various physiological aspects involved in plant development, the role of enzymes in it, and the mechanisms of photosynthesis, respiration, nitrogen, and lipid metabolism. Identification of genus and species of locally available wild plants, preparation of botanical keys at the generic level by locating key characters, knowledge of at least 10 medicinal plant species locally available of flowering plants, secondary metabolites and its use in taxonomy, development of plant reproductive parts i.e. male, female gametophytes and fruits. Sterilization techniques for media as well as for explants and their culture, anther culture, pollen culture, micropropagation, embryo rescue technique, somaclonal variation, isolation of plant protoplasts and their fusion techniques, tissue culture of important horticultural and medicinal plants, etc. The students will also learn microbial isolation and pure culture techniques. The students will learn different aspects in Ecology, environmental problems and their mitigation rules along with different Environment laws.

Course curriculum

The Post Graduate (M.Sc.) curriculum in Botany is of two-year duration in a choice-based credit system (CBCS) and a total of 94 Credits and 2100 marks. The system of examination is of a semester pattern. There are four semesters, each core/elective theory paper carries 4 credits (100 marks), each practical/lab work paper carries 6 credits (100 marks), and the dissertation carries 12 credits (200 marks). All the theory papers have 30 marks for internal evaluation and 70 marks for the end-term examination. There are six core papers (five theory and one practical) in the first semester. In the second semester, five core papers (four theory and one practical/lab.work), and one add-on vocational paper (non-credit). In the third semester, there is one core theory paper, one practical paper, one elective paper (interdisciplinary theory paper open to students the other departments), two elective theory papers, and one add-on vocational paper (non-credit). In the fourth semester, there will be one core theory paper, one student activity paper (seminar & field study) and one elective (Theory) paper and a dissertation/project work.

BOTA C403: Students have to present their seminar on a subject relevant to the topic in biological sciences and submit their Field Study/ Industrial Visit/Scientific Visit report. The Field Study/ Industrial Visit/Scientific Visit report will be examined by a board of examiners, consisting of faculty members of the department and one external member from outside. **Dissertation/Project Work (BOTA D404):** Students have to do their project work on a particular problem related to Botany/Biosciences under the supervision of one of the faculty members of the Post Graduate Department of Botany or from any reputed Universities/Institutes/Organizations for their M.Sc. dissertation/thesis.

Core Research Areas

The faculty members of the department work on all current topics in Botany, ranging from Algal Biotechnology, Pharmaceutical Microbiology, Ethnobotany, Biochemistry, Bioinformatics & Computational Biology, and Plant Molecular Biology etc.

Semester: I/II/III/IV - Credit: 94; Core 16; Elective: 04; Value added course: 02; Add on: 01

Course Structure of M.Sc. in Botany								
Sem.	Course No.	Paper Name	Credit	Type (Core/Elective)	Mid* Term Marks	End term Marks	Total (Marks)	
I	BOTA C101	Microbiology	4	Core	30	70	100	
	BOTA C102	Lower Plant Diversity and Paleobotany	4	Core	30	70	100	
	BOTA C103	Cell Biology and Evolution	4	Core	30	70	100	
	BOTA C104	Genetics and Molecular Biology	4	Core	30	70	100	
	BOTA C105	Indian Knowledge System	4	Core	30	70	100	
	BOTA P106	Practical/lab. work	6	Core	-	-	100	
Total Credits/core/electives (26/06/00) Total marks: 600								
II	BOTA C201	Plant Taxonomy and Economic Botany	4	Core	30	70	100	
	BOTA C202	Plant Physiology and Metabolism	4	Core	30	70	100	
	BOTA C203	Biochemistry	4	Core	30	70	100	
	BOTA C204	Environmental Biology and Biostatistics	4	Core	30	70	100	
	BOTA P205	Practical/ lab. work	6	Core	-	-	100	
	BOTA VAC206	Organic Farming	-	NC	-	-	Grade	
Total Credits/core/electives (22/05/00) Total marks: 500								
III	BOTA C301	Plant Embryology and Anatomy	4	Core	30	70	100	
	Or	BOTA E302(A)	(A) Molecular Plant Pathology and Immunology	4	Elective	30	70	100
		BOTA E302(B)	(B) Natural Resources, Conservation and Utilization	4	Elective	30	70	100
	Or	BOTA E303(A)	(A) Computational Biology and Bioinformatics	4	Elective	30	70	100
		BOTA E303(B)	(B) Plant molecular biology and Stress Biology	4	Elective	30	70	100

	BOTA P304	Practical/Lab. work	6	Core	-	-	100
	BOTA CT300	Inter-Disciplinary Elective#	4	CBCT Elective	30	70	100
	BOTA VAC305	Nursery and Horticulture Techniques	-	NC	-	-	Grade
Total Credits/core/electives (22/02/03) Total marks: 500							
IV	BOTA C401	Plant Biotechnology	4	Core	30	70	100
	BOTA E402 (A)	Microbial and Molecular Techniques	4	Elective	30	70	100
	Or BOTAE402 (B)	Molecular Stress Biology and Biotechnology of Cyanobacteria	4	Elective	30	70	100
	BOTA C403	Field Study & Seminar	4	Core	-	100	100
	BOTA D404	Dissertation (Project Work)	12	Core	-	-	200
	BOTA AC405	Cultural Heritage of Ganjam	-	NC	-	-	Grade
Total Credits/core/electives (24/03/01) Total marks: 500							
			Total Credit: 94				Total Marks: 2100

* (30 marks) = 5 Marks (Assignment/MCQ/ Quiz) + 5 Marks (Students Attendance) + 20 marks (Subject)

** = All PG Students are required to complete one SWAYAM-NPTEL Course (minimum 02 Credits) on or before completion of the 3rd Semester. The course to be opted by the students shall be finalized by the Departmental Nodal Officer and the Course Coordinator of SWAYAM. The course credit shall be included in the 3rd Semester Grade sheet.

***= Optional Summer internship (02-04 weeks) during/after the second semester (during summer vacation)

= Students have to choose one of the following courses except 'BOTA-CT-300'

BOTA-CT-300: Economic Botany (Offered by Dept. of Botany)

BIOT-CT-300: Biotechnology in Human Welfare (Offered by Dept. of Biotechnology)

ENVS-CT-300: Population and Environmental Issues (Offered by Dept. of Environment Studies)

MARB-CT-300: Environmental Impact Assessment and Management plans (Offered by Dept. of Marine Science)

ZOOL-CT-300: Human Health & Nutrition (Offered by Dept. of Zoology)

Value-added course: BOTA- VAC-206; BOTA- VAC-305

Add On Course (AC): BOTA-AC-405: Cultural Heritage of South Odisha

Code Used: BOTA- Botany, C- Core, P- Practical, D- Dissertation, CT- Choice Based Credit Transfer), VAC- Value Added Course, AC- Add-on Course, NC- Non-Credit

*3rd-semester students can opt for two elective courses BOTA E302 (A) or (B), BOTA E303 (A) or (B) and one CBCT course offered by other departments. Other department students can opt for BOTA CT300.

** 4th-semester students can opt for one elective course BOTA E402 (A) or BOTA E402 (B)

DETAILS OF SYLLABUS

SEMESTER: I**Semester: I Course No: BOTA C101****Course Name: Microbiology****Credits: 4****Core/Elective: Core****Course details**

Chapter	Contents	Hours/ lectures
Unit- I	History and scope of Microbiology , Microbial evolution, classification of microorganisms, five kingdom classification, three domain classification; modern approaches in microbial taxonomy, ribosomal RNA sequencing; Bergy's manual of bacterial classification, the role of bacteria and archaea in human health, medicine, agriculture, and industry.	16
Unit- II	Bacteria and Archaea: Cell structure; nutrition; reproduction; Bacterial genetics: conjugation, transduction, and transformation, sex-duction, mapping of genes by interrupted mating; plasmid; episome; microbial growth & methods of microbial growth measurements; bacterial toxin. General features and pathogenicity of Mycoplasma, Rickettsia, and Spirochetes.	16
Unit- III	Cyanobacteria: Classification, cell structure, nutrition, reproduction, cellular differentiation, akinetes, and its function, heterocyst (heterocyte) and its function, cyanotoxin; the role of cyanobacteria in human health, medicine, agriculture, bioenergy, and industry. General Characteristics and Evolutionary Significance of Prochlorophyceae,	16
Unit- IV	Virus: General properties; structure, purification, cultivation, principle of viral taxonomy, classification, one-step growth experiment, Phage and its life cycle, RNA phages, DNA viruses, RNA viruses; viroid and prions; structure, transmission, and replication of plant virus (TMV) and animal viruses (HIV); Economic importance of virus	16
Total		64

Referred Textbooks/materials/ research articles:

1. Microbiology by Prescott, L. M., Harley, J. P. and Klen, D. A, Tata McGraw-Hill, New York.
2. Microbiology by Pelczar, Jr., M. J., Chan E.C.S. and Krieg, N. R, Tata McGraw-Hill, New Delhi.
3. General Microbiology by Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., and Painter, P.R. The McMillan Press Ltd.
4. Brook Biology of Microorganisms by Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall.
5. Microbial Genetics by Maloy, S.R., Cronan, J.E.Jr., and Friefelder, D. Jones and Bartlett Publishers.
6. Phycology by R.E. Lee, Cambridge University Press (for Cyanobacteria)

Semester: I Course No: BOTA C102		
Course Name: Lower Plant Diversity and Paleobotany		
Credits: 4		Core/Elective: Core
Course details		
Chapter	Contents	Hours/ lectures
Unit- I	Algae: Distribution (terrestrial, freshwater, marine); thallus organization; cell structure; criteria for classification of algae; pigments, reserve food, flagella, reproduction (vegetative, asexual, sexual). Salient features of Glaucophyta, Rhodophyta, Euglenophyta, Phaeophyta, Bacillariophyta, Xanthophyta, Chlorophyta, and Charophyta; algal blooms and toxins; economic importance of algae; algae as biofertilizer, food, feed and industrial uses.	16
Unit- II	Fungi: General characters of fungi; recent trends in classification; phylogeny of fungi; cell ultra-structure, unicellular and multicellular organization; substrate relationship in fungi; nutrition, reproduction; heterothallism; heterokaryosis; parasexuality; general account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina; Economic importance of Fungi i.e. medicine, food, industry, and disease, General account of lichen, Mycorrhizae and their economic importance.	16
Unit- III	Bryophyta: Classification; theories of origin (algal and pteridophyte), Phylogenetic relationships among Bryophytes; distribution, morphology, structure, reproduction and life cycles and general account of Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales; Ecological importance; Evolution of gametophytes and sporophytes in bryophytes. Pteridophyta: Morphology, anatomy and reproduction; classification; evolution of stele; heterospory and origin of seed habit. General account of Psilopsida, Lycopsida; Sphenopsida, and Pteropsida.	16
Unit- IV	Gymnosperms: General characteristic features of Gymnosperms, Classification of Gymnosperms and their distribution in India. General account of Cycadales, Coniferales, Ephedrales, and Gnetales. Paleobotany: Geological time scale, origin, and evolutionary evidences (eras, periods and epochs). Types of fossils, processes of fossilization, role of fossils in evolution. Brief account of fossil Pteridophytes and Gymnosperms. Cycadeoidales, Pentoxylales, Medullosales and Glosspteriodales.	16
Total		64

Referred Text books:

1. R.E. Lee R.E. 2005, Introduction to Phycology, Cambridge University Press
2. Algae by L.E. Graham and L. W. Wilcox Prentice Hall
3. Introductory Phycology by Kumar, H. D. (1988), East-West Press, New Delhi.
4. Bryophyta by B.R. Vasista, S. Chand Publication
5. Bryophyta by N. S., Parihar, Central Book Depot, Allahabad.
6. Gymnosperms by Bhatnagar, S. P. and Moitra, A., New Age International, New Delhi.
7. Biology and Morphology of Pteridophytes by Parihar, N. S., Central Book Depot, Allahabad.
8. Gymnosperms: Structure and Evolution by Chamberlin, C. J., Dover Publications, New York.
9. Introductory Mycology by Alexopoulos, C. J., Mims, C. W. and Blackwel, M., John Wiley, New York.

10. An Introduction to Mycology by Mehrotra, R. S. and Aneja, R. S., New Age International, New Delhi.

Semester: I Course No: BOTA C103		
Course Name: Cell Biology and Evolution		
Credits: 4		Core/Elective: Core
Course details		
Chapter	Contents	Hours/lectures
Unit- I	Structural organization of the plant cell and its function: Structure and functions of the cell wall, plasma membrane, ion carriers, channels and pumps, receptors, chloroplast, mitochondria, peroxisome, endoplasmic reticulum, ribosome, lysosome, vacuole, nuclear pore, and nucleolus. Cell shape and motility: cytoskeleton organization, role of microtubules and microfilaments in flagella and other moments.	16
Unit- II	Cell cycle: Mitosis, meiosis, DNA synthesis in cell cycle, regulation of cell cycle: role of cyclins and cyclin-dependent kinases; cytokinesis and cell plate formation; cell surface receptors, G-protein coupled receptors, signal transduction pathways, secondary messengers, regulation of signaling pathways.	16
Unit- III	Structure and organization of eukaryotic chromosomes: Chromatin - heterochromatin and euchromatin, special types of chromosomes, chromosome morphology, karyotype, chromosome banding, sex chromosomes, sex determination in plants, dosage compensation, B-chromosomes, Chromosome organization, DNA packing, Nucleosome, Nuclear DNA content, C-value paradox, satellite-DNA, cot-curve, unique and repetitive DNA, Junk DNA and ENCODE project, <i>In situ</i> hybridization concept and techniques, FISH and GISH.	16
Unit- IV	Evolution: Lamarckism; Darwinism-concepts of variation, adaptation, struggle, fitness, and natural selection. Neo-Darwinism, synthetic theory of evolution, genetic polymorphism, gene pool, gene frequency; Hardy-Weinberg Law, Origin of new genes and proteins; molecular evolution, epigenetics, and adaptive evolution.	16
Total		64

Referred Textbooks:

1. Cell Biology by De-Robertis Saunders, Singapore.
2. Reproduction in eukaryotic cells, Prescott DM, Academic Press.
3. Developmental Biology, Gilbert SF, Sinauer Assoc. Inc.
4. Cell in Development and Inheritance, Wilson EB, McMillan, New York.
5. Molecular Biology of Cells, Alberts B et al.
6. The Cell: A molecular approach by Cooper G. M., ASM Press, Washington, D. C., USA.
7. Essentials of Molecular Biology by Malacinski, G. M and Feidfelder, D Ed. Jones and Bartel, London.
8. Gene IX or X by Lewine, B., Person-Prentice Hall, London.

Semester: I, Course No: BOTA C104**Course Name: Genetics and Molecular Biology****Credits: 4****Core/Elective: Core****Course details**

Chapter	Contents	Hours
Unit- I	Genetics I: Mendelism and deviation of Mendelian ratios, epistasis, linkage and crossing over, sex-linked inheritance, three-point test cross and chromosome mapping, Extra chromosomal inheritance, mitochondrial and chloroplast genome.	16
Unit- II	Genetics II: Structural chromosome aberrations: duplication, deficiency, inversion, and translocations heterozygotes; Numerical chromosome aberrations: aneuploids: trisomics and monosomics; euploids: autopolyploids, allopolyploids, segmental allopolyploid, role polyploidy in speciation with reference to <i>Triticum</i> and <i>Brassica</i> .	16
Unit- III	Molecular genetics: Prokaryotic and eukaryotic DNA replication: DNA polymerases, replisome, replicon, primase, telomerase. RNA transcription: mRNA, tRNA, rRNA, siRNA, miRNA, RNAi, RNA polymerases, RNA-processing: RNA splicing, spliceosome, RNA editing. Deciphering the genetic code. Protein translation, post-translational modifications, and protein targeting. Regulation of gene expression in prokaryotes and eukaryotes; Fine structure of gene, cis-trans test.	16
Unit- IV	Mutagenesis, DNA damage, and repair: Spontaneous and induced mutations, physical and chemical mutagens, the molecular basis of mutations, transposable elements in prokaryotes and eukaryotes, mutations induced by transposons, site-directed mutagenesis, DNA damage, and repair mechanisms. Environmental mutagenesis and genetic toxicology	16
Total		64

Referred Text books:

1. Genetics: A Conceptual Approach by Pierce, B. A., W. H. Freeman, New York.
2. Principles of Genetics by Simmons, M.J., Snustad, D.P., Tamarin, R.H.
3. Molecular Biology of the Gene by J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, the Benjamin / Cummings Pub. Co. Inc., California.
4. Genomes by T.A. Brown.
5. Molecular Cell Biology by J. Darnell, H. Lodish and D. Baltimore, Scientific American Books Inc USA 1994.
6. Gene IX by Benjamin Lewin, Oxford University Press, U.K.
7. Molecular Biology of the Cell by B. Alberts, D. Bray, J. Lewis, M. Raff. K. Roberts, and J.D. Watson, Garland Publishing Inc., New York.
8. The Cell: A molecular approach by Cooper G. M., ASM Press, Washington, D. C., USA.

Semester: I, Course No: BOTA C105**Course Name: Indian Knowledge System****Credits: 4****Core/Elective: Core****Course details**

Chapter	Contents	Hours/ lectures
Unit- I	Microbiology in Indian Vedic Knowledge: Sukshmjeevanu in Vedas (The concept of microbes by Rishi Kanva; discoveries of Rishi Kanva and his descendants Atri, Yamadagnni, and Agasti against microbial infection described in Atharvaveda).	16
Unit- II	Indian Knowledge System on Concept of origin of life: Ancient Science of India 10: Primary Concept on Origin of Life: Origin of Life-concept in Manusmriti	16
Unit- III	Indian Knowledge System on Plant Morphology: Description of plant morphology in <i>Samhita</i> - Charak (1st Century AD); Susruta (600 BC); Parasar (1st Century BC or AD); Study of plants in <i>Nighantu</i> Period in India (In <i>Rajanighantu</i> , In <i>Dhanvantarinighantu</i> , In <i>Nighantushesha</i> , In <i>Bhavprakashnighantu</i>); Indian Traditional Ayurvedic System of Medicine and Nutritional Supplementation:	16
Unit- IV	Indian Knowledge System on medicinal plants before Theophrastus: Ancient Indian rishi's (Sages) knowledge of botany and medicinal plants since Vedic period: Study of plants in Vedic period (2500 BC to 600 BC) in India; study of plants in <i>Samhita</i> period (900 – 600 BC) in India (The <i>Charaka Samhita</i> , The <i>Sushruta Samhita</i>)	16
Total		64

References

1. Kuhad U, Goel G, Maurya, PK, Ramesh Kuhad C 2021. Sukshmjeevanu in Vedas: The Forgotten Past of Microbiology in Indian Vedic Knowledge, Indian journal of Microbiology, 61: 108-110.
2. Padhy S 1999. Ancient Science of India 10: Primary Concept on Origin of Life-A Review, Anthropologist, 54(1-3): 1-6 (2023)
3. Balkrishna A, Mishra R.K, Srivastava A, Joshi B, Marde R and Prajapati UP. 2019. Ancient Indian rishi's (Sages) knowledge of botany and medicinal plants since Vedic period was much older than the period of Theophrastus, A case study-who was the actual father of botany? International Journal of Unani and Integrative Medicine 3(3): 40-44.
4. Pandey M. M., Rastogi S, and Rawat A. K. S. 2013. Indian Traditional Ayurvedic System of Medicine and Nutritional Supplementation. Evid Based Complement Alternat Med.: 376327.

Semester: I, Course No: BOTA P106**Course Name: Practical/Lab. work****Credits: 6****Core/Elective: Core****Course details**

Chapter	Contents	Hours
Microbiology, Lower plant diversity,	1. Laboratory Protocol, general rules and regulations for laboratory safety.	100

Cell Biology, Genetics and Molecular Biology	<ol style="list-style-type: none"> 2. Bacterial staining (simple staining, negative staining, Gram staining, and acid-fast staining, spore and capsule staining) 3. Microbial pure culture techniques (Streak plate methods, Pour plate methods); sub-culturing techniques. 4. Microscopic measurement of microorganisms (Micrometry). 5. Measurements of cultural characteristics of microorganisms. 6. Measurement of growth microorganisms (microbial cells counting, CFU counting, spectrophotometric/colorimetric analysis, etc.) 7. Collection, identification of cyanobacteria, micro and macroalgae, preparation of permanent slides of cyanobacteria, and microalgae. Preservation, and preparation of herbarium macroalgae. 8. Microscopic Study of morphology and reproductive structures of fungi, bryophytes and pteridophytes belonging to different classes using permanent prepared slides and preserved specimens. 9. Study of vegetative and reproductive structure of Gymnosperms and Fossils using different collected specimen. 10. Squashing techniques for the study of mitosis and meiosis in onion root tip and flower bud; Microscopic analysis of different stages of cell division and microphotography. 11. Mitotic index of dividing cells of <i>Allium cepa</i> root tips. 12. Comparative karyotypic analysis of two species of a genus. 13. Isolation of plant DNA and quantification of extracted DNA by spectrophotometric method 14. Chromosome mapping through two and three point test cross 	
Total		100

Referred books/manual/Monographs

1. Microbiology A Laboratory Manual by Cappuccion, J.G., and Sherman, N., Addison Wesley
2. Microbiological Applications (A Laboratory Manual in General Microbiology) by Benson, H.J., W.C.B., Wim C. Brown Publishers
3. Practical Botany, Vol. 2 by S.C. Santra, NCBA publication
4. Handbook of Microbial Technology by Yadav, A.K. and Mowade, S.M.
5. Algal culture techniques by Andersen
6. Manuals of Phycology by Smith

SEMESTER: II**Semester: II, Course No: BOTA C201****Course Name: Plant Taxonomy and Economic Botany****Credits: 4****Core/Elective: Core****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Taxonomic Structure: Taxonomic hierarchy; Concept of species, genus and family; International Code of Nomenclature for Algae, Fungi and Plants (ICN): priority, effective and valid publications, author citation, type concept. Taxonomic Tools: Field and Herbarium techniques; Floras and Botanical Gardens, Computer and Taxonomy.	16

	Taxonomic Evidence: Morphology, anatomy, palynology, embryology, cytology, phytochemistry, and serology.	
Unit- II	Systems of Angiosperm Classification: Artificial, natural and phylogenetic systems, relative merits and demerits of major systems of classification (Bentham and Hooker, Engler and Prantle, Hutchinson and Takhtajan). Phylogenetic tree and Cladistics, Angiosperm Phylogeny Groups (APG)	16
Unit- III	Angiosperm Families: Floral structure and phylogenetic relationship among the taxa under the following orders: Liliflorales, Scitaminae, Orchidales, Ranales, Rosales, Tubiflorae, Malvales, Asterales and Rubiales.	16
Unit- IV	Economic Botany: Origin, cultivation, production, and use of: Cereals (wheat, rice, maize, sorghum and millet), pulses, spices, oil-yielding plants, and fruit-yielding plants. Important medicinal and aromatic plants: Sarpagandha, Cinchona, Nux-Vomica etc.; Narcotics: Cannabis, Datura, Gloriosa, Pyrethrum and opium.	16
Total		64

Referred Textbooks/articles:

1. Principles of Angiosperms Taxonomy by Davis, P. H. and Heywood, V. H., Robert E. Kreiger, New York.
2. Current Concepts in Plant Taxonomy by Heywood, V. H. and Moore, D. M., Academic press, London.
3. Principles and Methods Plant Biosystematics by Solbrig, O. T., MacMillan, London.
4. Plant taxonomy and Biosystematics by Stace, C. A., Edward Arnold, London.
5. Diversity and Classification of Flowering Plants by Takhtajan, A. L. Columbia University Press, NY.
6. Contemporary Plant Systematics by Woodland, D. W. Prentice-Hall, New Jersey, USA
7. Economic Botany by B.P. Pandey. S. Chand & Co. Ltd.
8. Economic Botany: S. L. Kochhar, Cambridge University Press
9. Economic Botany- Principle & Practices: G.E. Wickens, Kluwer Academic Publishers
10. Economic Botany & Ethnobotany: Afroz Alam, Willey

Semester: II, Course No: BOTA C202**Course Name: Plant Physiology and Metabolism****Credits: 4****Core/Elective: Core****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Membrane transport and translocation of water and solutes: Plant water relation, mechanism of water transport through xylem, phloem loading and unloading, passive and active solute transport, membrane transport proteins. Photosynthesis: Light harvesting complex, structure and chemistry, Photolysis of water and Hill Reaction, Photo-phosphorylation, CO ₂ -fixation, C ₃ and C ₄ and CAM pathways, photorespiration.	16
Unit- II	Respiration: Glycolysis, Fermentation, TCA cycle, pentose phosphate pathways, mitochondrial electron transport and ATP synthesis, alternate oxidase, Glyoxylate Cycle. Lipid metabolism: fatty acid biosynthesis, synthesis of membrane lipids, storage lipids and their catabolism.	16
Unit- III	Nitrogen metabolism: Biological nitrogen fixation, symbiotic and symbiotic nitrogen fixation, nodule formation, nod and <i>nif</i> genes, their regulation and function, mechanism of nitrate uptake and reduction, ammonium transport and assimilation.	16

Unit- IV	Stress Physiology: Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress. Oxidative metabolism: reactive oxygen species (ROS), antioxidants, antioxidant enzymes: catalase, peroxidases, superoxide dismutase, glutathione transferase, glutathione reductase, <i>Halliwell-Asada cycle</i> . Physiology of aging and senescence, influence of hormones and environmental factors on senescence. Programmed cell death.	16
Total		64

Referred Textbooks:

1. Plant Physiology by Taiz & Zeiger, Sinauer Publications
2. Biochemistry and Molecular Biology of Plants by Buchachnanan, B. B., Grissem, W. and Jones, R. L. J., American Society of Plant Physiologists, Rockville, USA.
3. Plant Physiology by Devlin, R. N. and Witham, F. H., CBS Publishers, Delhi.
4. Plant Physiology by Salisbury, F. B. and Ross, C. W., Wordsworth Publication California, USA

Semester: II, Course No: BOTA C203

Course Name: Biochemistry

Credits: 4

Core/Elective: Core

Course details

Chapter	Contents	Hours/ Lectures
Unit- I	Basics of Biochemistry: Structure of atoms, molecules, chemical bonds, stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding and hydrophobic interactions). Principle of biophysical chemistry and bioenergetics: pH, buffer, reaction kinetics, thermodynamics, colligative properties, couples reactions, group transfer, biological energy transfer.	16
Unit- II	Biomolecules: Composition, structure, and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Confirmation and stability of protein (Ramachandra plot, secondary, tertiary and quaternary structure; domains, motif, and fold). Confirmation and stability of nucleic acids (A-, B-, Z- DNA, RNA); phenols and terpenes.	16
Unit- III	Plant enzymes and coenzymes: Nomenclature and classification of enzymes and coenzymes: Distribution of enzymes in plant, structure and function of Isozymes. Enzyme kinetics, mechanism of enzyme action and its regulation. Factors affecting enzyme action. Antioxidants: Structure and functions of ascorbic acid, glutathione, tocopherol, carotenoids, etc.	16
Unit- IV	Phytochromes and Phytohormones: Structure, function, and mechanisms of action of phytochromes and phototropins; Phytohormones: Plant growth regulators, structure and function, ethylene, abscisic acid, brassino-steroids, polyamines, jasmonic acid.	16
Total		64

Referred Text books:

1. Lehninger Principle of Biochemistry by Nelson and Cox
2. Advanced Biochemistry by Voet and Voet
3. Principle of Biochemistry by Stryer

4. Biochemistry by Mathews, C. K., Van Holde, K. E. and Ahern, K. G., Addison-Wesley Publishing Company, San Francisco, USA.
5. Genes VH, B. Lewin, Oxford University Press.
6. Proteins – Structure and Molecular Properties, TE Creighton, WH Freeman and Company.
7. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New
8. Fundamentals of Biostatistics by Veer Bala Rastogi
9. Fundamentals of Biostatistics by Bernard Roser
- 10.

Semester: II Course No: BOTA C204		
Course Name: Environmental Biology and Biostatistics		
Credits: 4 Core/Elective: Core		
Course details		
	Contents	Hours/ Lectures
Unit- I	Ecosystems: Biotic and abiotic components, trophic level, food chain, food web and ecological pyramid; aquatic and terrestrial ecosystems, Forest ecosystems. Ecological adaptations, Energy flow in the ecosystem: primary and secondary production, decomposition, energy dynamics, ecological efficiencies, concept of energy subsidy, universal energy flow, The Gaia hypothesis, Biogeochemical cycle, Ecological succession	16
Unit- II	Community ecology: Population interactions (population density, natality, mortality, population age structure, carrying capacity). structural analysis of communities, inter- and intra-specific competitions, Mutualism and commensalism, predation, parasitism, amensalism, competition and coexistence, Habitat and ecological niche. Biodiversity (Types and importance, its conservation)	16
Unit- III	Environmental Pollution and Law: Air pollution, water pollution, terrestrial/soil pollution, noise pollution, and radiation pollution. Global warming and climate change; Greenhouse gases (GHG), Ozone layer depletion, and consequences of climate change. Environmental education and awareness The Forest (Conservation) Act, 1980; The Wildlife (Protection) Act, 1972: The Indian Biological Diversity Act 2002, Convention on Climate Change 1992 – Kyoto Protocol 1997, Johannesburg Convention 2002	16
Unit-IV	Biostatistics: Frequency distribution, cumulative and relative frequency. Measurement of central tendency and dispersion, mean, median and mode, mean deviations, variance and standard deviation, coefficient of variation, errors. Comparison of means: Students 't-test and paired t-test, Analysis of variance (ANOVA), Chi-square (χ^2) test, 2 x 2 contingency table and association analysis as applied to biological experimental data. Simple correlation and linear regression analysis.	16
Total		64

Referred Textbooks:

1. Concepts of Ecology by Kormondy, E. J., Prentice-Hall India, New Delhi.
2. Fundamentals of Ecology by Odum, E. P. Saunders, Philadelphia, USA.
3. Ecology and Field Biology by Smith, R. L. Harper Collins, New York.
4. Ecology by Subrahmanyam, N. S. and Sambamurty, A. V. S. S. New Delhi
5. Introductory Practical Biostatistics by Misra, B.N. and M.K. Misra

Semester: II Course No: BOTA P205		
Course Name: Practical /Lab. work		
Credits: 6		Core/Elective: Core
Course details		
Chapter	Contents	Hours
Plant Systematics, Plant Physiology, Biochemistry, Environmental biology, Biostatistics	1. Description and identification of Angiosperms at family, genus, and species levels using Floras. 2. Herbarium techniques. 3. Determination of Transpiration and Absorption ratios. 4. Measurement of rate of photosynthesis 5. Preparation of Buffers. 6. Quantitative estimation of Protein (Lowry methods/Bradford Method), Sugars (Anthrone Methods), Lipids (Bligh and Dryer Method). 7. Quantitative estimation of Amino acids (Ninhydrine methods) 8. Spectrophotometric analysis of different enzymes (CAT, APX, GR, SOD) 9. Estimation of pigments (chlorophylls and carotenoids) from plant and algal materials. 10. Estimation Dissolved oxygen (DO) water samples by Winkler's method 11. Physico-chemical analysis of water and soil (pH, chloride, phosphate, nitrogen, potassium) 12. Determination of primary productivity of water samples. 13. Determination of minimum size and number of quadrants required for reliable estimates of biomass in grassland 14. Determination of frequency, density of a species of a grassland community. 15. Calculation of Important Value Index (IVI) of grassland ecosystem. 16. Measurement of Central Tendency 17. Measurement of dispersion 18. Students's T test 19. X^2 (chi-square) distribution	100
Total		100

Referred practical books/manuals

- Biochemical Methods by Pingoud, Urbanke, Hoggett and Jeltsch, Willey-VCH
- Experimental biochemistry by Switze, R.L. and Garrity, L.F., Freeman and Company, New York
- Analytical Biochemistry and Separation Techniques by Palanivelu, P
- Biochemical calculations, by Segel
- Phytochemicals Techniques by N. Raaman
- Phytochemicals methods by Harborne, J.G, Springer
- Practical Biochemistry: Principles and Techniques by Wilson and Walker
- Plant reproduction by T. Pullaiah, K. Lakshminarayana, B. Hanumanta Rao
- Udbhida Sangraha (In Odia) by M.K. Misra
- Flora of Odisha by Saxena, H.o & M. Brahmam

Semester: II, Course No: BOTA VAC206**Add on Course Name: Organic Farming****Credits: NC****Non Credit****Course details**

Chapter	Contents	Hours
Unit- I	Introduction to Organic Farming: Introduction; Need of Organic Farming; Benefits of Organic Farming; Social aspects of Organic Farming; Market aspects of Organic Farming	08
Unit- II	Organic Fertilizers: Need of Organic Fertilizer; Benefits of Organic Fertilizer; Preparation of Organic Fertilizer; Demonstration & land preparation. Plant Nutrients: Name of plant Nutrients; Functions of Nutrients in plant growth and Development Sources of nutrients for Organic Agriculture: Organic Manure: Rural compost, City compost, Oil cakes, Animal wastes, Green Manure with Leguminous crops in crop rotation. In-situ incorporation of crop residues	08
Unit- III	Biofertilizers and their method of use: Need and Benefits of Microorganism, Management of Microorganism, mechanism of action in increasing soil fertility Preparation of vermin compost: Pit construction; Raw materials; Availability of specific species of earth worm; Method of preparation; Quality improvement of finished vermicompost	08
Unit- IV	Plant Protection Measures: Integrated pest & disease management techniques, Organic pesticides, bio-pesticides. Inorganic pesticides, disadvantages of their use. Seed, seedling and soil Treatment measures. Feasibility of complete dependence on organic sources. Good Harvesting Practices; Storage; Transportation; Supply Chain.	08
Total		32

Referred Textbooks:

1. Basics of Organic Farming by Bansal and Mamta, CBS publication
2. A text book of Modern Organic Farming
3. Principles of Organic Farming: Textbook (By P. L. Maliwal)

SEMESTER: III**Semester: III, Course No: BOTA C301****Course Name: Plant Embryology and Anatomy****Credits: 4****Core/Elective: Core**

Chapter	Contents	Hours/ Lectures
Unit- I	Male and female gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development, and gene expression; male sterility, sperm dimorphism, and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos. Female gametophyte: Ovule development, megasporogenesis; organization of the embryo sac, structure of the embryo sac cell.	16
Unit- II	Pollination, Pollen-pistil interaction, and fertilization: Floral characteristics, pollination mechanisms, and vectors, breeding system; commercial considerations, the structure of the pistil, pollen stigma interactions, sporophyte and gametophytic self-incompatibility (cytological, biochemical and molecular aspects), double fertilization, <i>in vitro</i> fertilization.	16

Unit- III	Seed development and fruit ripening: Endosperm development during early, maturation and desiccation stages, embryogenesis, ultra-structure; cell lineages during late embryo development; storage proteins of endosperm and embryo; polyembryony, apomixis; embryo culture, dynamics of fruit growth and ripening; Latent life-dormancy; Importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy.	16
Unit- IV	Plant Anatomy: Tissue and tissue system; Meristematic tissue, distribution of mechanical tissues, apical meristem, Root-shoot transition, shoot-root development, leaf development and phyllotaxy, transition to flowering. Nature and need of secondary growth, Normal secondary growth in dicot stem, Anomalous secondary growth in dicot and monocot stem (adaptive and non-adaptive),	16
Total		64

Referred Text books:

1. Seed: physiology of Development and Germination by Bewley, J. D. and Black, M. Plenum, New York.
2. The Embryology of Angiosperms by Bhojwani, S. S. and Bhatnagar, S. P., Vikas Publishing House, New Delhi.
3. Molecular Embryology of Flowering Plant by Raghavan, V. Cambridge University Press, Cambridge.
4. Developmental Biology of Flowering Plants by Raghavan, V., Springer-Verlag, New York.
5. Plant Anatomy by B.P. Pandey. S. Chand & Co. Ltd.
6. Anatomy of Angiosperms by B.K. Mishra and N. Dash, Kalyani Publishers.
7. Plant Reproduction by T.Pullaiah, K. Lakshminarayana & B. Hanumantha Rao, Scientific Publisher, P.O.Box91
8. An introduction to Embryology of Angiosperms by P. Maheswari, Suvjeet Publications.

Semester: III, Course No: BOTA E302(A)

Course Name: Plant Pathology and Immunology

Credits: 4

Core/Elective: Elective

Chapter	Contents	Hours/ Lectures
Unit- I	Phytopathology: Plant disease symptoms, modes of infection and dissemination; altered metabolism of plants under biotic and abiotic stresses; host-parasite relationship, disease triangle, disease cycle and stages of disease development, molecular mechanism of pathogenesis, recognition phenomenon, penetration and invasion.	16
Unit- II	Host resistance: Primary disease determinant; enzymes and toxins in relation to plant diseases; host defense mechanism, molecular mechanism of resistance; phytoalexins, PR proteins, antiviral proteins, SAR, HR and active oxygen radicals	16
Unit- III	Immune system: Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions	16

Referred Textbooks:

1. An Advance Text book and Biodiversity: Principles and Practice by K.V. Krishnamurthy, Oxford & IBH publication, New Delhi.
2. Plants, Genes and Agriculture by Conway, G. and Barbier, E., Jones and Bartlett, Boston, USA.
3. Tropical Botanical Gardens Their role in Conservation and Development by Heywood, V. H. and Wyse Jackson, P. S., Academic press, San Diego, USA.
4. Understanding Biodiversity: Life sustainability and Equity by Kothari, A, Orient Longman, New York.
5. Biodiversity and its Conservation in India by Negi, S. S. Indus Publishing Company, New Delhi.
6. Evolution of Crop Plants by Simmonds, N. W., Longman, New York.

Semester: IV, Course No: BOTA E303(A)**Course Name: Computational Biology and Bioinformatics****Credits: 4****Core/Elective: Elective****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Introductory Bioinformatics: Introduction to Bioinformatics, Introduction to data structures and database concepts, Biological sequence analysis and information retrieval, pairwise and multiple sequence alignment: BLAST, FASTA, Phylogenetic analysis.	16
Unit- II	Basics of Molecular Modelling: Introduction to Molecular Modelling and its Applications. Biomolecular modeling problems: protein folding, protein misfolding. Basic concepts of quantum mechanics, <i>ab initio</i> structure prediction. Molecular mechanisms, energy calculations, Bond stretch, Angle bending, torsional terms, Electrostatic interaction- van der Waals interactions. Molecular modeling in drug discovery.	16
Unit- III	Structure-Based Drug Designing: Structure-based drug designing: 3D pharmacophores, molecular docking, De novo Ligand design, 3D database searching and virtual screening, Mechanism of drug absorption, distribution, metabolism, and excretion: ADME process; Drug toxicity evaluation, Pharmacokinetics.	16
Unit- IV	Molecular Dynamics and Simulations: Introduction to molecular dynamics and simulations; Monte Carlo simulation of biomolecules. Comparative modelling of protein: by homology modeling, validation of protein models – Ramachandran plot, threading, and <i>ab initio</i> modeling.	16
Total		64

Referred Textbooks:

1. Molecular Modelling: Principles & Applications. By Andrew R. Leach, Pearson (Prentice Hall) 2nd Edition 2001.
2. Bioinformatics: A practical guide to the analysis of genes and proteins. By AD Baxevanis and BFF Ouellette (Wiley-Liss) 3 rd Edition 2005.
3. Guidebook on Molecular Modeling in Drug Design- N. Claude Cohen, 1996. Elsevier
4. Molecular Modeling Basics- Jan H. Jensen, 2010. CRC Press.
5. Computational Chemistry and Molecular Modeling, Principles and Applications- K. I. Ramachandran, G. Deepa, K. Namboori, 2008
6. Textbook of Drug Design and Discovery, 5th Edition- Kristian Stromgaard, Povl Krogsgaard-Larsen, Ulf Madsen, 2016. CRC Press.

Semester: IV, Course No: BOTA E303(B)**Course Name: Plant molecular biology and Stress Biology****Credits: 4 Core/Elective: Elective****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Light and Hormone Signal Transduction in Plants: Diversity of sensory receptors and their evolutionary significance; Two-component sensor-regulator system; Light- and hormone-regulated signaling. Gene Regulatory Networks Controlling Flower Development.	64
Unit- II	Molecular Breeding and IPR-related Issues: Molecular markers; Marker-assisted breeding (MAB) and molecular-assisted selection (MAS); IPR-trademarks, copy rights, patents, and geographical indicators.	64
Unit- III	Introduction to Stress Biology: Abiotic Stresses in plants; Comprehensive molecular changes caused by abiotic stresses in plants. Management of damage due to abiotic stress. Biotic Stresses in plants; Bacterial, Fungal and viral Pathogenicity; Biotrophs, necrotrophs and protein secretion systems of plant pathogenic bacteria. Viral gene functions, virus-host and virus-vector interactions; RNA interference and viruses; viral satellites.	64
Unit- IV	Signalling in Plant Disease: Genetic dissection of resistance pathways; resistance proteins as signalling molecules; Role of hormones in resistance.	64
Total		64

Referred Textbooks:

1. Signal Transduction in Plants; P. Aducci; Molecular and Cell Biology Updates, Birkhäuser Basel
2. Signal Transduction; Ijsbrand M. Kramer; Academic Press; Elsevier
3. Molecular Plant Breeding; Yunbi Xu; CABI Digital Library
4. Text Book of Intellectual Property Rights; N K Acharya; Asia Law House
5. Plant Stress Biology; Bhoopander Giri, Mahaveer Prasad Sharma; Springer

Semester: III, Course No: BOTA CT300**Course Name: Economic Botany****Credits: 4 Core/Elective: Interdisciplinary Elective****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Origin, history, domestication, botany, cultivation, production, and use of: Cereals (Wheat, rice, maize, sorghum, pearl millet, and minor millets) and Pulses.	16
Unit- II	Origin, distribution, cultivation, production, and utilization of economic plants of following groups such as Plant of agro-forestry importance: Teak, Sal Acacia, Sesbania, Neem, etc. Fibers: cotton, silk cotton, jute, sunn hemp. Oilseeds: Groundnut, sesame, castor, rape seed, mustard, sunflower, safflower, niger, oil palm, coconut and linseed.	16
Unit- III	Origin, distribution, classification, production and utilization of Fruits: mango, banana, citrus, guava, grapes and other Indigenous fruits; apple, plum, pear, peach, cashew nut, and walnut; Vegetables: tomato, brinjal, okra, cucumber, cole crops, gourds etc.	16
Unit- IV	Important medicinal and aromatic plants: Sarpagandha, Belladonna, Cinchona, Nux-Vomica, Vinca, Mentha and Glycyrrhiza, Plantago etc.; Narcotics: Cannabis, Datura, Gloriosa, Pyrethrum and opium. Important	16

	Spices and condiments Ginger, Garlic, Cinnamon, Cardamom, Cumin, Foeniculum, etc.	
Total		64

Referred Textbooks:

1. Economic Botany by B.P. Pandey. S. Chand & Co. Ltd.
2. Economic Botany: S. L. Kochhar, Cambridge University Press
3. Economic Botany- Principle & Practices: G.E. Wickens, Kluwer Academic Publishers
4. Economic Botany & Ethnobotany: AfrozAlam, Willey

Semester: III, Course No: BOTA P304**Course Name: Practical /Lab work****Credits: 6****Core/Elective: Core****Course details**

Chapter	Contents	Hours
Plant Embryology and Anatomy, Bioinformatics, Natural Resources	<ol style="list-style-type: none"> 1. Microscopic observation various microsporangium (T.S & L.S.), Microspore tetrad, Pollen structure 2. Pollen counting and viability; staining of pollen tube 3. Microscopic study of ovules (T.S. & L.S.), Ovaries (T.S. & L.S.), structure of embryo sac organisation, types of endosperm etc. 4. Microscopic observation of Primary and Secretory tissue systems, Ecological anatomy, wood anatomy, preparation of permanent slides. 5. Pair wise and multiple sequence alignment by using EMBL-EBI and/or ClustalW2 tools. 6. Phylogenetic analysis of proteins and genes using PHYLIP and /or Phylogenetic analysis using parsimony (PAUP) or any other analytical tools. 7. Protein Structure visualization and Homology modelling of proteins through PyMol, VMD and Swiss-PDBV. 8. Docking of small molecules to protein binding sites by AutoDock-Vina and MGL Tools or protein-protein docking through online modes. 9. Protein structure predictions via online servers like I-TASSER, Phyre2, QUARK, PredictProtein. 10. Molecular Dynamics simulation of small protein and water complex by AMBER/GROMACS. 11. Study of different plant diseases, isolation of microbes from diseased plant parts and isolation of microbes (Human flora). 12. Immunodiagnosics (demonstration using commercial kits). 13. Preparation of a short list of the ten most important sources of firewood and timber in the locality. Give their local names, scientific names, and families to which they belong. Mention their characters. 14. Study of biodiversity and important flora of Odisha and India through field trips. 15. Study of different plant disease and isolation of microbes from diseased plant part. 16. Isolation of microbes from normal 	100
Total		100

Referred to practical books/ manuals/monographs

1. A Practical Guide for Basic Bioinformatics and Biostatistics by Pallavi Pandey & Pooja Tiwari. Notion Press; First edition (2017), ISBN- 13: 978-1946822260.

Semester: III, Course No: BOTA VAC305**Add on Course Name: Nursery and Horticulture Techniques****Credits: NC****Non Credit****Course details**

Chapter	Contents	Hours
Unit- I	Introduction to Nursery: Plant nursery: Definition, importance; Basic facilities for a nursery; layout and components of a good nursery. Nursery beds, types, their merits and demerits; precautions to be taken during preparation. Brief account of growing media; nursery tools and implements. Containers for plant nursery, Brief account of plant propagation structures.	08
Unit- II	Introduction to Horticulture: Horticulture: Definition, importance of horticulture in terms of economy, production, employment generation, environmental protection and human resource development. Fruit and vegetable zones of India and Odisha. Export scenario and scope for Horticulture in India. Classification of horticultural crops based on soil and climatic requirements	08
Unit- III	Introduction to Vegetable crops: Importance of vegetable cultivation in India and Odisha. Classification and Nutritive value of vegetables Importance, morphology and taxonomy, varieties, climate and soil, seeds and sowing, manuring, irrigation, intercultural operations, diseases and their control, harvesting and yield of following crops: Cultivation of (a) Brinjal(b) Tomato(c) Capsicum (d) Spinach (c) Coriander and (d) Mentha	08
Unit- IV	Introduction to Fruit crops: Importance of fruit growing in India and Odisha. Nutritive value of fruits. Origin, history, distribution, area and production, uses and composition, varieties, soil and climatic requirements, propagation, planting, training and pruning, manuring and fertilizer application, irrigation, intercropping, harvesting and yield, diseases and pests of the following tropical fruit crops: (a) Mango (b) Guava and (c) Papaya	08
Total		32

Referred Text books:

1. Nursery Management of Fruit Crops in India
2. Plant Propagation and Nursery Management

SEMESTER: IV**Semester: IV, Course No: BOTA C401****Course Name: Plant Biotechnology****Credits: 4****Core/Elective: Core****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Plant nutrition, plant cell and tissue culture: General introduction, history, scope, concept of cellular differentiation, totipotency. Plant micro and macronutrients, vitamins and growth hormones (auxins, gibberellins,	16

	cytokinins): physiological effects and mechanism of action, Media for plant tissue culture. Fundamental aspects of morphogenesis, micropropagation techniques, organogenesis somatic embryogenesis, androgenesis, gynogenesis and adaptive embryogenesis.	
Unit- II	Protoplasm culture: Somatic hybridization, protoplast isolation, fusion and culture, hybrid selection and regeneration. Possibilities, achievements and limitations of protoplasm research. Applications of plant tissue culture: clonal propagation, artificial seed production of hybrids, somaclones, production of secondary metabolites/natural products, cryopreservation and germplasm storage.	16
Unit- III	Plant genomics: Introduction to plant genomics, functional genomics, transcriptomics and proteomics, comparative genomics, organelle genomes (Mitochondria and Chloroplast). Study of Genome: shotgun approach, clone contig approach, chromosome walking and jumping, c-DNA, genome and gene libraries. Analysis of genome: DNA fingerprinting techniques: RFLP, RAPD, AFLP, SSR, SNP, DNA microarray. Expressed sequence tags (ESTs).	16
Unit- IV	Recombinant DNA, Transgenic and genome editing technologies: Methods of R-DNA technology and genetic manipulation; restriction endonucleases, vectors: plasmid, cosmid, BAC, YAC, <i>Agrobacterium</i> - the natural genetic engineer of Ti and Ri plasmid, mechanism T-DNA transfer to plant; Insect-, pathogen- and herbicide-resistant plants, stress-tolerant plant; Genome and gene editing (CRISPR Cas-9) technologies for plant improvement. Regulatory, biosafety, and ethical issues relating to transgenic and gene-editing.	16
Total		64

Referred Textbooks:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Glick, B. R. and Pasternak, ASM Press, Washington, D. C., USA.
2. Plants from Test Tube: An Introduction to Micropropagation by Kyte, L. and Kleyn, J. 3rd Ed. Timber press, Portland, USA.
3. Plant Cell and Tissue Culture Vol VI by Pollard, W. J. and Walker, Humana press Clifton, USA.
4. Gene Cloning and DNA Analysis by Brown T. A. Blackwell Science, London.
5. Biotechnology and Plant Genetic Resources by Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J., Conservation and Use, CAB International, Oxon UK
6. Practical Applications of Plant Molecular Biology by Henry, R. J., Chapman & Hall, London, UK
7. Proteomics in Functional Genomics by Jolles, O. and Jornvall, H. (eds). Birkhauser Verlag, Basel, Switzerland.

Semester: IV, Course No: BOTA E402 (A)**Course Name: Microbial and Molecular techniques****Credits: 4****Core/Elective: Elective****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Techniques of microbial culture: Preparation of solid and liquid media for algae, fungi and bacteria, pure culture isolation, maintenance and storage of microbes, culture characteristics, fixation and staining, cytophotometry and flow cytometry	16

Unit- II	Chromatographic techniques: Principles of chromatography (Adsorption and Partition chromatography), Planar chromatography (Paper and Thin-layer chromatography), Column chromatography (Gas chromatography, Gel exclusion/permeation chromatography, Ion exchange chromatography, Affinity chromatography, HPLC)	16
Unit- III	Molecular Techniques: Sequencing of Proteins and nucleic acids; Southern, Northern and Southern and Western blotting techniques; Methods for measuring nucleic acid and protein interactions. Polymerase chain reaction (PCR), RT-PCR.	16
Unit- IV	Electrophoretic techniques: General principles, support media, electrophoresis of proteins (SDS-PAGE, native gels, gradient gels, isoelectric focusing gels and two-dimensional gels), electrophoresis of nucleic acids (Agarose, pulse-field and sequencing gels).	16
Total		64

Referred Textbooks:

1. Wilson, K. and Walker, J., (1994) Practical Biochemistry: Principles and Techniques 4th ed. Cambridge University Press.
2. Instrumental methods of analysis by Willard *et al.*
3. Practical Biochemistry: Principles and Techniques by Wilson and Walker
4. Principles and Techniques of Biochemistry and Molecular Biology by Wilson and Walker
5. Laboratory Manual of Biotechnology by S. K. Bhatnagar and Deepika Abrol, S. Chand & Co.

Semester IV: Course No: BOTA E402 (B)**Course Name: Molecular Stress Biology and Biotechnology of Cyanobacteria****Credits: 4****Core/Elective: Elective****Course details**

Chapter	Contents	Hours/ Lectures
Unit- I	Ecology of cyanobacteria: Molecular ecology (Model organisms e.g., <i>Synechocystis</i> sp. PCC 6803, <i>Anabaena</i> sp. PCC 7120 (c) environmental genomics, metagenomics and phylogeny of cyanobacteria across environmental gradients; Nutraceuticals: Cyanobacteria as a source of antioxidants, biomolecules, <i>Spirulina</i> spp. as a model for desired nutraceuticals	16
Unit- II	Cyanobacterial light-harvesting complex: Phycobiliproteins, Carotenoids and xanthophylls, structure and regulation of light-harvesting genes, light-harvesting proteins of cyanobacteria <i>vis-à-vis</i> light-harvesting complex of higher plants	16
Unit- III	Cyanobacterial responses towards abiotic stresses: Salinity, ultraviolet radiation, temperature, herbicides inhibiting PSI and PSII, desiccation and heavy metals; Signal transduction under abiotic stress (SOS pathway).	16
Unit- IV	Gene mining from cyanobacteria: Cyanobacteria as a source of stress-tolerant genes for the development of stress-tolerant crops using gene pyramiding technology (b) Targeted genetic modifications in cyanobacteria Cyanobacteria and green chemistry: Genetic engineering for the production of biofuels (biodiesel, hydrogen production), bioplastics, nanomaterials (nanotechnologies)	16
Total		64

Referred Textbooks/Suggested readings

1. **Bryant** DA (1995) The Molecular Biology of Cyanobacteria, Kluwer Academic Publisher, Berlin.
2. **Whitton** BA, **Potts** M (2000) Ecology of Cyanobacteria - Their diversity in Time and Space, Kluwer Academic Publishers, Berlin.
3. Chavvat F, Chavvat CC (2013) Advances in Botanical Research Vol 65 Genomics of Cyanobacteria, Elsevier.
4. Sarma TA (2012) Handbook of Cyanobacteria, 1st edition, CRC press, Boca Raton, USA.
5. Larkman WD, Douglass E, Raven JA, Photosynthesis in Algae, Kluwer Academic Publishers, Berlin.

Semester: IV, Course No: BOTA C403**Course Name: Seminar and Field Study/Scientific visit****Credits: 4** **Core/Elective: Core****Seminar Presentation and Field Study:**

The student seminar presentation carries 50 marks, and the field study report also carries 50 marks. Students must present at least one seminar before the final Examination during the 4th semester. Students must submit a detailed field study/scientific visit/field survey report. **The Seminar and report of the field study/scientific visit report will be examined by board examiners consisting of departmental faculty members and one external examiner from outside, duly approved by the authority**

Semester: IV, Course No: BOTA D404**Course Name: Dissertation****Credits: 12** **Core/Elective: Core****DISSERTATION/PROJECT WORK**

Students have to do their project work on a particular problem related to Botany/Biosciences under the supervision of one of the faculty members of the Post Graduate Department of Botany or from any reputed Universities/Institutes/Organizations duly approved by the Head of the Department for their M.Sc. dissertation/thesis. Students in advance may contact the respective researchers/scientists from around the country to carry out the work for the project, much before the start of the 4th Semester (Mid of the 3rd semester), to avail sufficient time for the planning and execution of the project work. The dissertation carries 200 marks (12 credits). The dissertation will be examined jointly by both internal (supervisor) and external examiners. Students have to present their Dissertation/thesis work with Power Point presentation before the board of examiners, consisting of the department faculty members and an external examiner from outside, duly approved by the authority.

The dissertation must be certified with a **Turnitin Plagiarism/similarity index certificate, signed by the Internal supervisor and the candidate. The UGC-2019 plagiarism rules are recommended by Berhampur University 2019-2020 before acceptance of the M.Sc. dissertation for evaluation.**

Format of M.Sc. Dissertation:

1. Title Page
2. Declaration certificate from the Candidate
3. Certificate from the supervisor
4. Plagiarism certificate, signed by the supervisor and the candidate
5. Abstract/summary/
6. Introduction
7. Materials and Methods
8. Results

9. Discussion
10. Conclusion
11. References

Semester: IV, Course No: VAC		
Course Name: Cultural Heritage of Ganjam		
Credits: NC		Core/Elective: Non Credit
Course details		
Chapter	Contents	Hours
Unit- I	Kabi Samrat Upendra Bhanja: Life and Literary works	08
Unit- II	Other Literatures of Ganjam	08
Unit- III	Cultural Heritage of Ganjam	08
Unit- IV	Folk Tradition of Ganjam	08
Total		32

CBCT papers is interdisciplinary

Botany students can choose any of the under-mentioned courses offered by other departments of BU

Semester: III, Course No: BIOT CT-300		
Course Name: Biotechnology in Human Welfare		
Credits: 4		Core/Elective: Interdisciplinary
Chapter	Contents	Hours
Unit- I Basic Concepts of Biotechnology	Basic Concepts of Biotechnology and its applications, Recombinant DNA technology; gene cloning, human genome project, Tools of Bioinformatics.	10
Unit- II Agricultural and Environmental Biotechnology:	Application in Breeding, Nitrogen fixation, Transfer of pest resistance genes to plants, Interaction between plants and microbes, Qualitative improvement of livestock. Crop plant genome project. Chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers	10
Unit- III Medical and Pharmaceutical Biotechnology	Development of therapeutic agents, recombinant live vaccines, gene therapy, Diagnostics; Principle of DNA fingerprinting, Stem cell Biology, Ethical issues in Biotechnology research	10
Unit- IV Industrial Biotechnology	Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.	10
Total		40

Referred Textbooks:

1. John E. Smith. Biotechnology (2009), 5th Edition, Cambridge University Press.
2. Ignacimuthu Biotechnology: An Introduction (2012) 2nd Edition, Narosa Publishing House Ltd., India

Semester: III, Course No: ENVS CT-300**Course Name: Population and Environmental Issues****Credits: 4****Core/Elective: Interdisciplinary**

Chapter	Contents	Hours
Unit 1: Demographic Overview	Introduction, History of human population growth, The demographic transition: India and World; Projections of population growth, Effects of human population growth, Unsustainable lifestyle – increased consumerism	12
Unit-2: Energy Crisis	Energy Crisis: Background, Possible causes (Energy demand and consumption, Production capacity and dependence on imports); Ecologically friendly alternatives and Possible Measures	12
Unit-3: Environmental Contamination	Ambient Air pollution, Indoor air pollution and Health Impacts, Surface water pollution, Ground water pollution and Health Impacts Solid Waste Pollution and Sustainable Solid Waste Management; Hazardous waste pollution, Radioactive waste, Electronic waste and Biomedical waste	12
Unit-4: Ecological Footprints and Carrying Capacity	Ecological footprints: Concepts, perspectives, carbon footprint, water footprint, Overshoot of ecological footprint and biocapacity of planet Earth, Resources Depletion.	12
Total		48

Referred Text Books

1. Cunningham WP and Cunningham MA (2002). Principles of Environmental Science: Inquiry and Applications. McGrawHill Publications, New Delhi, 418 pp.
2. Johri R (2009). E-Waste: Implications, regulations, and management in India and current global best practices. TERI Press, New Delhi. 330 pp.
3. McKillop A and Newman S (2005). The Final Energy Crisis. Pluto Press, London. 325 pp.
4. Miller GT Jr. (1996). Living in The Environment: Principles, Connections, and Solutions. 9th Edition. Wadsworth Publishing Company, New York. 727 pp.
5. Park C (2001). The Environment: Principles and Applications. 2nd Edition, Routledge Publishers, London and New York, 598 pp.

Semester: III, Course No: MARB CT-300**Course Name: Environmental Impact Assessment and Management Plans****Credits: 4****Core/Elective: Interdisciplinary**

Units	Contents	Hours
Unit-1	Introduction to Environmental Impact Assessment. Environmental impact Statement and Environmental Management Plan. EIA notifications of Government of India from time to time. Guidelines for Environmental audit.	20

Unit-2	Environmental Impact Assessment (EIA) Methodologies. Generalized approach to impact Assessment. EIA processes, Scoping EIA methodologies, Procedure for reviewing Environmental impact analysis and statement. Environmental Management Plan and its monitoring, Evaluation of proposed actions.	20
Unit-3	Nexus between development and environment, Socio-economic impacts, Aid to decision making, Formulation of development actions, Sustainable development, categorization of projects under EIA, project planning and implementation, Impact prediction, Mitigation measures.	20
Unit-4	Introduction to. Selection of appropriate procedures, Restoration and rehabilitation technologies. Landuse policy for India. Urban planning for India. Rural planning and landuse pattern. Environmental priorities in India and sustainable development. CRZ notifications and Environmental Impact Assessment in coastal zone. Coastal zone management plans of India.	20
Total		80

Referred Text Books / References

1. W.P. Cunningham, 2010: Principles of Environmental Science.
2. Satsangi and A.Sharma 2015: Environmental Impact Assessment and Disaster Management.
3. R.R.Barthwal 2002: Environmental Impact Assessment.
4. R.Paliwal and L.Srivastava, 2014: Policy Intervention Analysis- Environmental Impact Assessment.
5. C.H.Eccleston, 2004: Environmental Impact Assessment.
6. J. Hou, 2015: New Urbanism: The future City is Here.
7. James R. Craig, 2010: Earth Resources and the Environment.
8. J. Glasson, 2011: Introduction to Environmental Impact Assessment.
9. Glasson J., Therivel R., Chadwick A, (2005): Introduction to environmental impact assessment Taylor & Francis Group, London and NewYork.
10. Morris P., Therivel R., (2009): Methods of Environmental Impact Assessment 2009, 3rdedition, Routledge, Taylor & Francis Group, London and NewYork.
11. Morris P., Therivel R., (2001): Methods of Environmental Impact Assessment 2001, 2ndedition, Spon Press, Taylor & Francis Group, London and NewYork.
12. Eccleston C. H., (2011): Environmental Impact Assessment 2011, CRC Press, Taylor &Francis Group.

Semester: III, Course No: ZOOL CT-300**Course Name: Human Health & Nutrition****Credits: 4****Core/Elective: Interdisciplinary**

Units	Contents	Hours
Unit-1 Nutrition & nutritional requirement	1. Fundamentals of human nutrition and essential nutrients for human; 2. Carbohydrates, fats, proteins 3. Minerals and water 4. Vitamins	16
Unit-2 Metabolism, supplementation and deficiency	1. Basal metabolism 2. Nutritional requirement variation with physiological changes and age, 3. Supplementary and balanced diet, 4. Diseases associated with nutritional deficiency.	16
Unit-3	1. Air borne diseases: Tuberculosis, Chicken pox; 2. Water borne diseases: Cholera, Typhoid;	16

Communicable Diseases	3. Sexually transmitted diseases: HIV, Syphilis; 4. Vector borne diseases: Malaria and Dengue	
Unit-4 Food safety hazards	1. Biological and Biotechnology related hazards, 2. Chemical hazards, 3. Food additives and fast food, 4. Food associated allergy	16
Total		64

Referred Books and References:

1. SA Lanham-New, TR Hill, AM Gallagher, HH Vorster, Introduction to human nutrition, 3rd Ed, Willey Blackwell.
2. MJ Gibney, HH Vorster, FJ Kok, Introduction to human nutrition, Willey Blackwell Publishing.
3. SR Mudambi, MV Rajagopal, Fundamental Food Nutrition and Diet Therapy, New Age International Publishers.
4. AA Agrawal, SA Udipi, Textbook of human nutrition, Jeypee Publishers.
5. T Rekhi, H Yadav, Fundamentals of food and nutrition, Elite publishing House.
6. C. Gopalan, BVR Sastri, SC Balasubhranian, Nutritive values of Indian Food, ICMR, NIN.