SCHEME & SYLLABUS

Programme: M. Sc. Botany

Post-Graduate (PG) Programme as per NEP

Programme Code: PG029

(Academic Session 2023-24 onwards)

Department of Life Sciences, Allied Health Sciences and Agricultural Sciences

University Institute of Sciences

Sant Baba Bhag Singh University

2023

SANT BABA BHAG SINGH UNIVERSITY, KHIALA -1430030, JALANDHAR

Institute Name:	University Institute of Sciences
Department Name:	Life Sciences, Allied Health Sciences and Agricultural Sciences
Programme Name:	M.Sc. Botany
Programme Code:	PG029
Number of Semesters	4

Vision:

Our vision is to acquaint the students about classical and modern aspects of plant sciences which lead them to scientific excellence in botanical research with specific emphasis on the role of plants in the structure and functioning of communities and ecosystems. They can work on their own research work or in the leading research organization or may be an entrepreneur and can become self-sustainable and useful for the society.

Mission:

1. To provide the holistic knowledge of plant's structure, functions and importance in the life of man.
2. Provide knowledge about environmental factors and natural resources and their importance in the sustainable development.
3. Acquire the ability to engage in independent and life-long learning in the broadest context socio- technological changes.
4. To develop the effective communication skills and impart through project preparations and seminars by reading latest research communications, books, media and technologies.
5. Elicit views of others, mediate disagreements and help reach conclusions in group settings.
6. Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

I. Salient Features of the National Education Policy (for UG and PG programmes)

a) The Undergraduate (UG) degree programmes of either 3 or 4-year duration, shall be structured in a semester mode with multiple exit options with the followings with multiple entry and exit points and re-entry options, with appropriate certifications such as:

(i) Certification (UG Certificate) at the completion of first year (1 year = 2 semesters)
(ii) Diploma (UG Diploma) at the completion of second year (2 years = 4 semesters)
(iii) Bachelor's Degree at the completion of third year (3 years = 6 semesters)

b) The candidate who completes the four yearsUndergraduate Program, either in one stretch or through multiple exits and re-entries (within the stipulated maximum period of seven years) would get a Bachelor's degree with Honours or Research. For example:

(i) Bachelor's Degree (Honours) at the completion of fourth year (4 years = 8 semesters)
(ii) Bachelor's Degree (Honours with Research) at the completion of fourth year (4 years = 8 semesters)

c) The four years undergraduate Honours degree holders with a research component anda suitable grade are eligible to enter the

- Ph.D. (Doctoral) Programme in a relevant discipline or
- Two Semester Master's Degree programme with project/research work

d) Candidates who wish to enter the master's/doctoral programme in a discipline other than the major discipline studied at the undergraduate programmes, have to take additional courses in the new discipline to meet the requirement or to make up thegap between the requirement and the courses already studied.

e) There may be parallel five years integrated master's degree programmes with exit options at the completion of third and fourth years, with the undergraduate degree andundergraduate degree with honours in a discipline, respectively.

f) There may also be an integrated doctoral programme with an exit option at the end of the first year with the Master's degree.

g) The students who exit with Certification, Diploma and Basic Bachelor Degree shallbe eligible to re-enter the programme at the exit level to complete the programme or to complete the next level.

h) The Multidisciplinary Undergraduate Programme, like B. Sc. (Hons./Hons. with Research) Life Sciences may help in the improvement of all the educational outcomes, with a flexible and imaginative curricular approach. A range of courses are offered with rigorous exposure to multiple disciplines and areas while specializing in one or two areas.

i) The curriculum combines conceptual knowledge with practical engagement and understanding that has relevant real world application through practical laboratory work, field work, internships, workshops and research projects.

j) The areas of specialization which the students are required to choose are either two disciplines/ subjects or a discipline called **'major course'**. Students gain deep disciplinary knowledge through theory and practical experiences in their area of specialization (major). Students should secure the prescribed number of credits (about 50% of total credits) through core courses in the major discipline.

k) The areas of additional discipline which the students are required to choose are called **'minor course'**. Students gain a reasonable understanding of the area of additional study (minor) that they choose.

l) Students can choose subject combinations across streams. Oneof the disciplines can also be a vocational subject or Teacher Education.

m) The students may study two disciplines at the same level or breadth up to the sixth semester and choose one of them for study in the fourth year to obtain **the Honours degree in that discipline**. A student who wishes to get **dual honours degrees** may repeat the fourth year of the program in the second discipline.

n) Students shall be given options to choose courses from a basket of courses being offering. There shall be no rigidity of combination of subjects.

II. CURRICULUM STRUCTURE AS PER NEP

M. Sc. (Hons.) Botany programme will have a curriculum with Syllabi consisting of following Course Types:

I. **MajorCourses/Core Courses (CR):** A course, which should compulsorily by studiedby a candidate as a core requirement is termed as a Core course. These courses are employability enhancement courses relevant to the chosen program of study. Program core comprises of Theory, Practical, Project, Seminar etc. Project work is considered as a special course involving application of knowledge in solving/ analyzing/exploring a real-life situation/ difficult problem.

II. **Elective Courses:** Elective course is generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or with provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill. Accordingly, elective course may be categorizes as:

A. Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.
B. Project (I): An elective course designed to acquire special/advanced knowledge, such as supplement study/support study toa project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

III. **Ability Enhancement Courses (AEC):** The Ability Enhancement Courses (AEC) may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). AECC courses are the courses based upon the content that leads to Knowledge enhancement; these are mandatory for all disciplines.

SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

A. Ability Enhancement Compulsory Courses (AECC): Environmental Science, English Communication/MIL Communication.

B. Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge.

III. NOMENCLATURE USED:

A. Core Courses

i. Core Courses. Major Courses (MC)
ii. Theory subject (T)
iii. Practical (P)

B. Ability Enhancement Courses/Minor Courses (AEC):

i. Ability Enhancement Compulsory Courses (AECC)
ii. Skill Enhancement Courses (SEC).

C. Elective Courses (EL-Major)

i. Discipline Specific Elective (DSE)

Details of Programme Educational Objectives, Program Outcomes, Program Specific Outcomes

S.No.	Programme Educational Objective (PEO) (The Graduate/Undergraduate will ….)	
1	PEO1.	To develop a strong and competent knowledge in basic plant sciences.

	PEO2.	To learn interdisciplinary knowledge of other subjects with connecting links to botany and apply it for the betterment of the society.
	PEO3	To develop an ability to understand the evolution of earth and plants with their role in the development of human civilization which gives them values to protect earth and plant species for the improvement of environment.
	PEO4	To develop an ability to identify, prepare and solve the plant related problems and contribute the services to community in professional, personal and private level.

Programme Outcomes (PO) (At the end of Programme/Degree mentioned above, the graduates will be able to ……)

2	PO1.	Detailed knowledge about the classification, importance and structure of fungi Algae, Bryophyta, pteridophyta, Fungi, lower plants and their life cycle, plant diseases, growth, diversity of plants, biology of seed plants, metabolism and structure between different groups of plant.
	PO2.	Knowledge about chemical properties and evolutionary relationship among taxonomic groups.
	PO3	Knowledge of anatomical and physiological characters related to study of plant and their relationship in physiology.
	PO4	Knowledge of other subjects which will help the students to understand the behaviour and functions of plants related to environment.
	PO5	Knowledge of latest technologies such as biotechnology, molecular biology, remote sensing, computers and their use in the field of botany.
	PO6	Knowledge of various instruments used and their functions in the fields of plant sciences.
	PO7	Knowledge of evolution of plants with respect to changing environment from the beginning of life in the earth.
	PO8	Developing skills on creating and designing research projects, data analysing skills and presentation of the data.

Programme Specific Outcomes (PSO)

3	PSO1.	Gaining the fundamental and core knowledge & understanding of plant sciences such as (taxonomy, anatomy, genetics, physiology, embryology, pathology and ecology.
	PSO2.	Gaining the fundamental knowledge of subjects which works as connecting links to other disciplines such as plant biochemistry, plant breeding, biostatistics, computer, biotechnology and molecular biology, cellular biology and tissue culture.
	PSO3	Gaining the working skills in the area of classical botany and latest technologies through labs from above mentioned subjects.
	PSO4	Gaining the knowledge about evolution of plants which gives leap in the future with changing climate and harness its potential for the betterment of the society.
	PSO5	Gaining skills to design and create projects, data analysis, and presentation of data using computer skills, research working ethics, research, team work and critical thinking.

COURSE SCHEME OF M. SC. BOTANY (SEMESTER-I-IV)

INDEX

COURSE SCHEME OF M. SC. BOTANY (SEMESTER-I-IV)

SEMESTER I

I. Theory Courses

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major	BOT551	Biology and Diversity of Fungi and Plant Pathology	4:0:0	4:0:0	4	4
2	Major	BOT553	Biology and Diversity of Algae, Bryophytes and Lichens	4:0:0	4:0:0	4	4
3	Major	BOT555	Plant Biochemistry and Metabolism	4:0:0	4:0:0	4	4
4	Major (Discipline Specific Elective) **(Choose any one)**	BOT557/ BOT559/ BOT561 **(Choose any one)**	Landscaping and Nursery Techniques/ Mushroom Cultivation/ Evolution **(Choose any one)**	4:0:0	4:0:0	4	4
5	Minor	BOT563	Water relationship, Growth and Development	4:0:0	4:0:0	4	4
6	Value Added	BOT565	Intellectual Property Rights	3:0:0	3:0:0	3	3

II. Practical Subjects

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major	BOT567	Practical Course on Fungi, Pathology, Algae, Lichens and Bryophytes	0:0:4	0:0:2	4	2
2	Major	BOT569	Practical Course on Plant Metabolism, Biochemistry, Water Relation Growth, Development & Biochemistry and Elective	0:0:4	0:0:2	4	2
Total						34	28

Total Contact Hours: 34
Total Credits: 28

COURSE SCHEME OF M. SC. BOTANY (SEMESTER-I-IV)

SEMESTER II

I. Theory Courses

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major	BOT552	Biology and Diversity of Pteridophytes and Gymnosperms	4:0:0	4:0:0	4	4
2	Major	BOT554	Reproductive and Developmental Biology of Angiosperms	4:0:0	4:0:0	4	4
3	Major	BOT556	Genetics and Plant Breeding	4:0:0	4:0:0	4	4
4	Major (Discipline Specific Elective) **(Choose any one)**	BOT558/ BOT560/ BOT562 **(Choose any one)**	Remote Sensing and Ecological Modelling/ Forestry/ Advanced Industrial Botany **(Choose any one)**	4:0:0	4:0:0	4	4
5	Minor	BOT564	Metabolic Integration	3:0:0	3:0:0	3	3
6	Multidisciplinary (MDC)	MAT540	Biostatistical Methods	3:0:0	3:0:0	3	3

II. Practical Subjects

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major	BOT566	Practical Course on Pteridophytes, Gymnosperms, Developmental and Reproductive Biology	0:0:4	0:0:2	4	2
2	Major	BOT568	Practical Course on Genetics & Plant Breeding, Metabolic Integration and Elective	0:0:4	0:0:2	4	2
3	**Major** **(Skill Enhancement Course: SEC)**	**BOT570**	**Summer Internship***	**0:0:4**	**0:0:2**	**4**	**2**
Total						31	28

Total Contact Hours: 31
Total Credit Hours: 27

P.S.: *Summer Internship (2 credit, only practicum course) shall be carried out during summer vacations after second semester. Evaluation of 2nd semester internship to be done after submission of internship report and viva-voce of the students.

COURSE SCHEME OF M. SC. BOTANY (SEMESTER-I-IV)

SEMESTER III

I. Theory Courses

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major **(Research)**	RM651	Basics of Research Methodology in Biological and Chemical Sciences	4:1:0	4:1:0	5	5
2	Major (Discipline Specific Elective) **(Choose any one)**	BOT651/ BOT653/ BOT655 **(Choose any one)**	Taxonomy and Biodiversity/ Ecology and Environment/ Plant Anatomy and Cytogenetics	4:0:0	4:0:0	4	4
3	Major (Discipline Specific Elective) **(Choose any one)**	BOT657/ BOT659/ BOT661 **(Choose any one)**	Plant Tissue Culture and Genetic Engineering/ Advanced Cell Biology/ Molecular Genetics and Cell communication	4:0:0	4:0:0	4	4
4	Minor	BOT663	Analytical Techniques in Plant Sciences	2:0:0	2:0:0	2	2
5	Minor **(Research)**	RM655	Publication and Research Ethics	2:0:0	2:0:0	2	2

II. Practical Subjects

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major	BOT665	Practical Course on Discipline Specific Electives	0:0:4	0:0:2	4	2
2	Major **(Research)**	BOT667	Dissertation-I	0:0:8	0:0:4	8	4
3	Major **(Skill Enhancement Course: SEC)**	BOT669	Seminar and Training	0:0:4	0:0:4	4	2
Total						33	25

P.S.: Evaluation of Dissertation-I will be based on submission of synopsis and approved objectives by the student.

Total Contact Hours: 33
Total Credit Hours: 25

COURSE SCHEME OF M. SC. BOTANY (SEMESTER-I-IV)

SEMESTER IV

I. Theory Courses

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major **(Research)**	RM652	Advances in Research Methodology in Biological and Chemical Sciences	4:1:0	4:1:0	5	5
2	Major (Discipline Specific Elective) **(Choose any one)**	BOT652/ BOT654/ BOT656 **(Choose any one)**	Economic Botany and Plant Genetic Resource/ Ethnobotany and pharmacognosy/ Plant Natural Resources, Conservation and Sustainable Development	4:0:0	4:0:0	4	4
3	Major (Discipline Specific Elective) **(Choose any one)**	BOT658/ BOT660/ BOT662 **(Choose any one)**	Bioinformatics/ Advanced Physiology and Molecular Biology/ Instrument Principles and Analytical Techniques	4:0:0	4:0:0	4	4

II. Practical Subjects

S. No.	Course Type	Course Code	Course Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits
1	Major	BOT664	Practical Course on Discipline Specific Electives	0:0:4	0:0:2	4	2
2	Major **(Research)**	BOT668	Dissertation-II	0:0:16	0:0:8	16	8
3	Minor **(Skill Enhancement Course: SEC)**	RM656	Scientific and Technical Writing	0:0:4	0:0:2	4	2
Total						37	25

P.S.: Evaluation of Dissertation-II will be based on submission of complete dissertation by the student and subsequent evaluation of submitted dissertation through institutional RDC.

Total Contact Hours: 37
Total Credit Hours: 25

COURSE SCHEME SUMMARY OF M. SC. BOTANY
(Post-graduate Programme as per NEP)

(SEMESTER-I-IV)

Course Scheme Summary

Semester	L	T	P	Contact hrs/Wk	Credits
I	23	0	8	31	27
II	22	0	12	34	28
III	16	1	16	33	25
IV	12	1	24	37	25
Total	**73**	**2**	**60**	**135**	**105**

Total contact hours for I-IV semester = 135

Total credits for I-IV semester = 105

SEMESTER - I

SEMESTER I

BOT551 - BIOLOGY AND DIVERSITY OF FUNGI AND PLANT PATHOLOGY

Course Code	**BOT551**	
Course Title	**BIOLOGY AND DIVERSITY OF FUNGI AND PLANT PATHOLOGY**	
Course Type	**Major Course**	
Course Category	Lecture	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	The main objective of Biology and Diversity and Plant pathology is to study the concepts of fungal diversity and comparative study of the different fungal genera. In plant pathology focus is to study the commonly occurring disease, their etiology and control mechanisms.	
Course Outcome	CO1	Students will learn basic understanding of fungi, classification and diversity of fungi, external and internal structure of various fungi and different methods of reproduction in fungi.
	CO2	Students will learn different symptoms and causal agents of plant disease, different disease cycles of fungi in plants and their control measures.
	CO3	Students will learn about the different economic uses of fungi.

SYLLABUS
(THEORY)

UNIT: I

Recent trends on the classification of fungi with reference to morphological and paramorphological criteria, Comparative study of the following sub division:
Mastigomycotina: *Albugo. Peronospora, Plasmopora.*

UNIT: II

Comparative study of the following sub-division: Zygomycotina: *Mucor, Rhizopus, Syncephalastrum,* Ascomycotina:*Tapharina, Emericella, Penicillium, Chaetamium, Morchella.*

UNIT: III

Comparative study of the following sub-divisions: *Basidiomycotina: Puccinia, Melampspora, Ustilago, Polyporus, Cyathus, Deuteromycotina: Fusarium, Cercospora, Colletotrichum*
Mushroom cultivation: Mycorrhizal application in agriculture and forestry, Fungal cytology and genetics: Heterothallism, Heterokaryosis, parasexual cycle, mutation.

UNIT: IV

Symptomatology in fungal, bacterial and viral infection of plants. Etiology and control of the following crop diseases. Paddy: Paddy blast, paddy blight, Wheat: Black stem rust, Bunt of Wheat, Bajara: green ear and Ergot, Sugar cane: Red rot disease of sugar cane, Ground nut: Tikka disease, Maize smut.
Role of enzymes and toxins in pathogenesis, Disease control by physical, chemical and biological methods, resistant varieties, Crop rotation, plant quarantines, seed certification.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Introductory Mycology	Alexopoulos, C.J., Mims, C.W. and Blackwell, M.	John Wiley and sons, INC, New York.
2	Plant Pathology	Mehrotra, R.S.	Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3	Botany for degree students-Fungi.	Vashista, B.R. and Sinha, A.K.	S. Chand and Company Ltd, New Delhi-pp 1-752.
4	An Introduction to Mycology.	Mehrotra, R.S. and Aneja, K.R.	New Age International
5	Stereochemistry of carbon compounds	Ernest Eliel	McGraw Hill, New York (1962).

SEMESTER I

BOT553 - BIOLOGY AND DIVERSITY OF ALGAE, BRYOPHYTES AND LICHENS

Course Code	**BOT553**	
Course Title	**BIOLOGY AND DIVERSITY OF ALGAE, BRYOPHYTEs AND LICHENS**	
Course Type	Major Course	
Course Category	Lecture	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of Biology and diversity of algae, Bryophytes and lichens. In this focus is the comparative study of different genera of algae and bryophytes.	
Course Outcome	CO1	Students will learn about the structure, pigmentation, food reserves and methods of reproduction of algae.
	CO2	Students will learn about the structure, pigmentation, food reserves and methods of reproduction of lichens and bryophytes.
	CO3	Students will learn about the economic importance of algae, bryophytes and lichen, algal bloom and control of physical and chemical means of algal bloom.

SYLLABUS
(THEORY)

UNIT: I

Algae: diverse habitats (terrestrial, freshwater, marine); thallus organization; evolutionary relationships; cell ultrastructure; reproduction (vegetative, asexual, sexual); criteria for classification of algae (pigments, reserve food, flagella). Classification and salient features: Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

UNIT: II

Algal blooms: causal factors and dynamics of freshwater algal blooms; physical and chemical means and bio-manipulation (top- down and bottom-up) for controlling nuisance blooms; role of phycoviruses in algal bloom control; algal bio-fouling of ships and its control.

UNIT: III

Origin of Bryophytes- evolution of gametophyte and sporophyte; economic, ecological and microbial importance of bryophytes, symbiotic associations of bryophytes Liverwort and Hornworts: classification, morphology, anatomy and reproduction of Marchantiales, Metageniales, Jungermanniales and Anthocerotales.

UNIT: IV

Mosses: classification, morphology, anatomy and reproduction of Funariales, Sphagnales and Polytrichales, Bryophytes in bioindication: direct and indirect biomonitoring.
Spore germination, Protonemal differentiation, bud germination
Parthenogenesis, apogamy, apospory and regeneration
Lichens: General account, structure, structure and reproduction

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	An Introduction to Pteridophytes.	Rashid, A. (1991).	Vikas Publishing House Pvt. Ltd. New Delhi.
2	The Biology and Morphology of Pteridophytes,	Parihar, N.S. (1987).	Central Book Distributors, Allahabad.
3	Cryptogamic Botany. Vol. II,	Smith, G.M. (1955).	Tata McGraw Hill Publishing Co. Ltd. New Delhi.
4	Botany for Degree Students-Bryophytes	B.R. Vashishta (2001)	S. Chand Limited
6	Morphology, Growth and Differentiation	Prem, P. (1981)	Atma Ram & Sons,
7	A text Book of Algae	Bilgrami, K. S., & L. C. Saha	CBS Publishers & Distributors (P) Ltd., New Delhi - 260 pp.
8	Botany for degree students-Algae.	Vashista, B. R.	S. Chand & Co., (P) Ltd., New Delhi – 567pp.

SEMESTER I

BOT555 - PLANT BIOCHEMISTRY AND METABOLISM

Course Code	**BOT555**	
Course Title	**PLANT BIOCHEMISTRY AND METABOLISM**	
Course Type	Major Course	
Course Category	Lecture	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To study the classification, occurrence and structure of biomolecules and their metabolism. To study the general concept of nitrogen fixation and its role in plant growth and development.	
Course Outcome	CO1	Students will able to understand structure, function and biosynthetic pathways of essential biochemical molecules including their key chemical and physical properties.
	CO2	Students will use subject knowledge about amino acid structures and relate their chemical properties to the synthesis and function of proteins.
	CO3	The concept of free enengy and entropy, high energy compounds, Gibb's free energy will help him to undersatnd the basics of biochemistry and metabolism.

SYLLABUS
(THEORY)

UNIT: I

Carbohydrates: Classification, occurrence and structure of monosaccharides, oligosaccharides and polysaccharides (Starch, cellulose and pectin); Proteins: Amino acids, structure and characteristics, peptides and protein structure, functions of proteins, Conjugate proteins, Accounts of lectins and their function

UNIT: II

Lipids: Classification, occurrence, structure and importance of acryl lipids and phosphates, Concept of free energy and entropy, high energy compounds, Gibb's free energy concept in biochemical reaction, Synthesis of ATP through oxidative electron transport chain, Chemiosmotic regeneration of ATP

UNIT: III

Gluconeogenesis *vs* glycolysis, Biosynthesis of fatty acids, Degradation of fatty acids, Lipid as high energy molecule, Role of Kreb's cycle

UNIT: IV

Nitrogen fixation by free living and symbiotic organisms, mechanism of nitrogen fixation, Soil nitrogen sources, nitrogen uptake by plants and assimilation, Nitrate reductase system, substrate controlled induction, interrelation between photosynthesis and nitrogen metabolism.

Brief account of amino acid synthesis by reductive amination, GS-GOGAT system, transamination, Basic structure of important phenolics and alkaloids: a general view of their synthesis

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Biochemistry and Molecular Biology of Plants.	Buchanan, B. B., Gruissem, W., and Jones, R. L. (2000).	American Society of Plant Physiologists, Maryland.
2	Lehninger Principles of Biochemistry: 6th Edition	Nelson, D. L., and Cox, M. M. (2012).	Macmillan Learning
3	Plant Physiology,	Salisbury, F. B., and Ross, C.W. (1992).	Wadsworth Publishing Co., California.
4	Plant Physiology	Mukherji, S. and Ghosh, A.K. (2009).	New Central Book Agency (P) Limited,
5	Plant Physiology.	Taiz, L., and Zeiger, E. (1998).	Sinauer Associates, Inc., Publishers, Massachusetts.

SEMESTER I

DISCIPLINE SPECIFIC ELECTIVE

BOT557 - LANDSCAPING AND NURSERY TECHNIQUES

Course Code	**BOT557**	
Course Title	**LANDSCAPING AND NURSERY TECHNIQUES**	
Course Type	Theory Course	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basics of landscaping and nursery techniques	
Course Outcome	CO1	Students will learn about the preparation of different types of landscapes for gardening.
	CO2	Student will learn about establishing nurseries of seasonal and permanent plants (herbs, shrubs and trees) for gardening purposes.
	CO3	Student will learn about medicinal, ornamental and aromatic plants.

SYLLABUS

(THEORY)

UNIT: I

Importance and scope of landscaping. Principles of landscaping, garden styles and types,terrace gardening, vertical gardening, indoor gardening garden components, adornments, lawn making, rockery,water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes.

UNIT: II

Definition of nurseries, scope and its management, raising nurseries from seeds, cuttings and other propagation methods, Bed preparation, nursery layout, Training and pruning of Ornamental plants seed, treatment, nutrient, water and weed management and management.

UNIT: III

Trees, Climber and creepers, selection, propagation, planting,annuals selection, propagation, planting scheme,Other garden plants: palms, ferns, grasses and cacti succulents. Pot plants: selection, arrangement,management, Landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places.

UNIT: IV

Importance and scope of ornamental crops, medicinal and aromatic plants. Production technology of important cut flowers like rose, gerbera, carnation, lilium and orchids under protected condition sand gladiolus, tuberose, chrysanthemum under open conditions.

Text and Reference books:

S. No	Name	Author(s)	Publisher
1	Introductory Ornamental Horticulture	Arora, J.S	Kalyani Publishers, Ludhiana
2	Flowers and Trees	Randhawa, M.S.,	National book trust-New Delhi
3	Home gardening	Trivedy . P.P. 1987.	ECA Publication
4	Gardening in India	Bose T K and Mukerjee D	Oxford Book House

DISCIPLINE SPECIFIC ELECTIVE

BOT559 - MUSHROOM CULTIVATION

Course Code	**BOT559**	
Course Title	**MUSHROOM CULTIVATION**	
Course Type	Theory Course	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic techniques of mushroom culture.	
Course Outcome	CO1	Student will learn about the different types of mushroom species.
	CO2	Students will learn the techniques of growing mushrooms.
	CO3	They will learn about the management of produce and its marketing strategy.

SYLLABUS
(THEORY)

UNIT: I

Mushrooms- edible and poisonous types, nutritive values, Mushrooms types in nature and its production in wild. Nutritive values of mushrooms, Economic importance of mushroom.

UNIT: II

Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, Sterilization, Preparation of spawn, Multiplication. Mushroom culture- Spawn production, Culture and production techniques, harvesting, packing and storage.

UNIT: III

Cultivation practices of *Agaricus bisporus*, *Pleurotus* sp. and *Volvoriella volvacea*. Composting technology in mushroom production, Low cost technology, Mushroom bed preparation – paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation.

UNIT: IV

Short-term storage (Refrigeration – upto 24 hours), Long termStorage (canning, pickels, papads), drying, storage in salt solutions. Types of foods prepared from mushroom. Research Centres – National level and Regional level. Cost benefit ratio – Marketing in India and abroad, Export Value, Diseases and Pests of Mushrooms.

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Mushrooms: A Manual for Cultivation.	Biswas, S., Datta, M. and Ngachan, S.V. 2012.	PHI Learning Private Limited,
2	Mushroom Cultivation	Kapoor, J.N.	ICAR, New Delhi.
3	Hand book of Mushrooms.	Nita Bahl (2000)	Oxford & IBH Publishing Co. Pvt. Ltd

SEMESTER I
DISCIPLINE SPECIFIC ELECTIVE

BOT561 - EVOLUTION

Course Code	**BOT561**	
Course Title	**EVOLUTION**	
Course Type	Theory Course	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn about the evolutionary processes taken place and development of the plant species in relation to the today's biodiversity.	
Course Outcome	CO1	They will learn the different evolutionary processes among the different species.
	CO2	They will learn the similarity and dissimilarity among the nearest species and their evolution.
	CO3	It will help them to build the scientific understanding about the existence of species.

SYLLABUS
(THEORY)

UNIT: I
Historical prospective of evolutionary biology, fundamental concepts of cosmology and geology
Origin and Evolution of Cells: First cell, evolution of metabolism, Present day Prokaryotes, Eukaryotic Cells, Development of multicellular organisms. Pre-Darwinian and Darwinian theories of organic evolution, Concept of Oparin and Haldane; Experiment of Miller (1953), phylogenetic tress, taxonomic and biological concept of species, dating methods

UNIT: II
Ancient environment and earliest form of plant life, Evolution of photosynthesis, evolutionary trend: algae to land plants, evolutionary trend in land plants: vascular to nonvascular, influence of land dwelling plants on the earth system. Evolution of C4 and CAM photosynthetic pathways.
Origins of multicellularity in the plant kingdom, development and genetics in the evolution of land plant body plans, the evolution of plant development: past, present and future, innovations in the origin of vascular plants

UNIT: III
Altruism, Kin selection, Biological clocks; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes. Allopatric speciation, genetic models, peripetric speciation, disjunct distributions, the theory of island biogeography, Sympatric speciation, the role of genetic drift and gene flow in evolution, models of genetic drift, evolutionary development of plant speciation, macroevolution and the biological diversity of plants, Concepts of neutral evolution, molecular divergence and molecular clocks

UNIT: IV
Paleontology, geological time scale, eras, periods and epochs, major evolutionary events in the geological time scale, fossil evidence for plant terrestrialization, examples of earliest land plants in the fossil record. Mass extinction events in plants: evidence in the geological record, evidence for persistence in the plant fossil record, Pleistocene glaciations. Molecular tools in phylogeny, classification and identification; origin of new genes and proteins; Gene duplication and divergence

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Evolutionary Biology	Douglas, J. Futuyma.	Sinauer Publications
2	Evolutionary Genetics.	Smith, J.M.	Oxford University Press.
3	Evolutionary Biology	Minkoff, J.C. 1983.	Addison Wesley Publishing Company
4	The Evolution of Plants	Kathy Willis, Jennifer McElwain 2016.	Oxford University Press.2016.
5	The origin and early evolution of plants on land.	Kenrick, Paul, and Peter R. Crane.	Nature 389.6646 (1997): 33-39

SEMESTER I

BOT563 - WATER RELATIONSHIP, GROWTH AND DEVELOPMENT

Course Code	**BOT563**	
Course Title	**WATER RELATIONSHIP, GROWTH AND DEVELOPMENT**	
Course Type	Minor Course	
Course Category	Lecture	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	The main objective of this branch is to study concept of water relations in plants, photosynthesis and growth and development in plants	
Course Outcome	CO1	Students will learn about different physiological processes occur in the plants.
	CO2	Students will learn the how the physical processes like transpiration help the plants to translocate the water from roots to aerial parts of the plant even in tall trees.
	CO3	Students will learn the different aspects of light and dark reaction in photosynthesis and different modification of plants.

SYLLABUS
(THEORY)

UNIT: I
Water relationships in plants: Unique physio-chemical properties of water, Chemical potential, water potential, Apparent free space, bulk movement of water, soil plant atmosphere continuum (SPAC), Stomatal regulation of transpiration, hormonal and energy dependent hypothesis.
Inorganic nutrition, physicochemical aspects of solute transport, diffusion and facilitated diffusion, passive and active transport. Nernst equation and Donnan's potential. Role of ATPase as a carrier, Co-transport (Symport) and counter transport (antiport), Ion channels, role of calmodulin, Importance of foliar nutrition and use of chelates.

UNIT: II
Photosynthesis: Energy pathway in photosynthesis, chloroplast as an energy transducing organelle. Composition and characterization of photo systems I and II, electron flow through cyclic, non cyclic and pseudo cyclic photophosphorylation. Pathways of CO2 fixation, Difference between C3 and C4 fixation and different kinds of C4 pathways

UNIT: III
CAM pathway: Occurrence, biological events and adaptive advantage. Photorespiration: Mechanism and regulation of photorespiration. Enzymes: Classification, mode of action, km value, Industrial application, immobilized enzymes, their preparation and application, Enzyme regulation: Competitive and non-competitive, allosteric enzymes

UNIT: IV
Chemical control of growth and morphogenesis. Hormonal effect on growth and development. Bioassay of plant growth regulators and mode of action with reference to auxins, Gibberellins, cytokinins, abscisic acid and ethylene. Phytochrome: Chemistry and photo morphogenetic effects and role in flowering. Dormancy: Seed and bud dormancy; hormonal regulation

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Biochemistry and Molecular Biology of Plants.	Buchanan, B.B., Gruissem, W., and Jones, R.L. (2000).	American Society of Plant Physiologists, Maryland.
2	Plant Physiology.	Taiz, L., and Zeiger, E. (1998).	Sinauer Associates, Inc., Publishers, Massachusetts.
3	Plant Physiology,	Salisbury, F.B., and Ross, C.W. (1992).	Wadsworth Publishing Co., California.
4	Plant Physiology	Mukherji, S & Ghosh, A.K.	New Central Book Agency (P) Limited, 2009-

SEMESTER I

BOT565 -INTELLECTUAL PROPERTY RIGHTS

Course Code	**BOT565**	
Course Title	**INTELLECTUAL PROPERTY RIGHTS**	
Course Type	Minor Course	
Course Category	Lecture	
L T P	3 0 0	
Credits	3	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To acquaint the students about the different types of property rights that a person possesses.	
Course Outcome	CO1	Students will learn about different types of patent, copyright, trade secret, geographical indication.
	CO2	They will learn how to file a patent.
	CO3	They will learn about the infringements in IPR.

SYLLABUS
(THEORY)

UNIT I

Introduction and historical prospective to intellectual property right (IPR), IPR in India and World, Basic concept and types of IPR. Economic importance of IPR. Information about some important organization such as WTO, TRIPS, WIPO).

Patents its objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, infringement.

UNIT II

Introduction to copyrights, protection under copyright law, rights, transfer of copyright, infringement, Trademarks its objectives, types, rights, protection of goodwill, infringement, passing off, Defenses, Domain name.

Geographical Indications its justification, International Position, national level and Indian position.

UNIT III

Concept of Traditional Knowledge, traditional knowledge in international arena, at WTO, at Nationallevel, Traditional Knowledge Digital Library (TKDL). Bio-Prospecting and Bio-Piracy, Industrial Designs its objectives, rights, infringements, Defenses of Design, Infringement

UNIT IV

Plant Varieties Protection, its objectives, internationalposition, Plant varieties protection in India. Rights of farmers, Breeders andResearchers. Protection of Plant Varieties and Farmers'Rights Act, 2001, National gene bank, Benefit sharing.

Information Technology Related Intellectual Property Rights, Database and Data Protection, Biotechnology and Intellectual Property Rights, Moral Issues in Patenting Biotechnological inventions.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Plant Breeding	B. D. Singh	Kalyani Publisher
2	Introduction to Plant Biotechnology	H S Chawla	CRC Press
3	An Introduction to Intellectual Property Rights	Venkataraman M	Affliated East-West Press
4	Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets	Bouchoux	Cenage Learning

SEMESTER I

BOT567 - PRACTICAL COURSE ON FUNGI, PATHOLOGY, ALGAE, LICHENS AND BRYOPHYTES

Course Code	**BOT567**	
Course Title	**PRACTICAL COURSE ON FUNGI, PATHOLOGY, ALGAE, LICHENS AND BRYOPHYTES**	
Course Type	Major Course	
Course Category	Practicum	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To understand the different commonly occurring diseases and study the specimens.	
Course Outcome	CO1	Students will able to earn about the morphological characters and reproductive structures of the different algal genera.
	CO2	Students will able to earn about the morphological characters and reproductive structures of the different Bryophyta and Lichens.
	CO3	Students will able to earn about the morphological characters and reproductive structures of the different fungi and their disease cycle in plants.

SYLLABUS (PRACTICAL)

LIST OF EXPERIMENTS

1. Study of morphological characters and reproductive structures of the genera mentioned in the theory.
2. Study of diseased specimens of plants with reference to symptomatology.
3. Isolation, purification and single spore culture of pathogens.
4. Demonstration of biological control of pathogenic fungi *in vitro*.
5. Collection and study of algae mentioned in theory, identification up to generic level using algal monographs.
6. Staining techniques of cytological studies.
7. Morphological and structural study of representative member of the following group using cleared whole amount preparation, dissection and section: *Pelia, Porella, Marchantia, Mumortiera, Weisnerella, Sphagnum*.
8. Experiments to study spore germination, formation of protonema and bud development.
9. Lichens.
10. Field Visits and Educational Tour.

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Practical Plant Pathology	Vijay Yadav	New India Publishing Company
2	Fungi & Plant Pathology	Annie Ragland , V. Kumaresan , N. Arumugam	Saras Publication
3	Practical Manual of Algae	Rajan S. Sundara	Anmol Publisher
4	Practical Manual for Bryophytes and Pteridophytes	Mohammed Gufran Khan	Lambert Academic Publishing

SEMESTER I

BOT569 - PRACTICAL COURSE ON PLANT METABOLISM, BIOCHEMISTRY, WATER RELATION GROWTH, DEVELOPMENT AND BIOCHEMISTRY

Course Code	**BOT569**	
Course Title	**PRACTICAL COURSE ON PLANT METABOLISM, BIOCHEMISTRY, WATER RELATION GROWTH, DEVELOPMENT AND BIOCHEMISTRY**	
Course Type		
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic instrumentation used in plant physiology and biochemistry and different quantitative as well quantitative methods for determination of biomolecules and activity of enzymes.	
Course Outcome	CO1	Students will use subject knowledge about amino acid structures and relate their chemical properties to the synthesis and function of proteins.
	CO2	Students will able to quantifying biomolecules like protein, amino acids and chl.
	CO3	Students will use subject knowledge to perform SDS PAGE.

SYLLABUS

LIST OF EXPERIMENTS

1. Determination of water potential in different tissues
2. Estimation of the Hill reaction activity
3. Estimation of total nitrogen by Kjaldahl method
4. Principle of colorimetry, spectrophotometry and fluorimetry
5. Determination of chlorophyll a and chlorophyll b, total chlorophyll (Arnon;s method)
6. Estimation of protein by Biuret and Lowry's method
7. Estimation of seed germination as affected by red and infrared radiation
8. Extraction and Estimation of starch
9. Determination of reducing sugars in fruits
10. Estimation of amino acids by ninhydrin
11. Separation and identification of sugars by paper chromatography
12. Separation of soluble protein by gel electrophoresis

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Practical in Plant Physiology and Biochemistry	Sunita Gupta, N.K. Gupta & M.K. Sangha Manju Bala	Scientific Publishers.
2	A Practical Manual for Plant Physiology and Biochemistry	ShriramMirajkar, Prashant Kale, Prashant Shingote	Lambert Academic Publishing

SEMESTER I

SYLLABUS FOR MAJOR (DISCIPLINE SPECIFIC ELECTIVE) COURSE UNDER COURSE CODE BOT569

PRACTICAL OF LANDSCAPING AND NURSERY TECHNIQUES

LIST OF PRACTICALS

1. Raising nursery beds, sowing seeds, raising nurseries.
2. Propagations of plants through cuttings.
3. Weed management in the nurseries and nutrient addition.
4. Visit to a hi-tech nursery.

Text and Reference books

S. No.	Name	Author(S)	Publisher
1	Hi Tech Horticulture	S Parsad, Dharam Singh and B L Bhardwaj	Agro Bios
2	Greenhouse Management for Horticulture Crops	S Prasad and U Kumar	Agro Bios

PRACTICAL OF MUSHROOM CULTIVATION

LIST OF PRACTICALS

1. To study the different types of mushroom.
2. To prepare the compost for the mushroom.
3. Fumigation of the room for mushroom culture.
4. Inoculation of the mushroom and providing the favorable condition for mushroom growth.

Text and Reference books

S.No.	Name/Title	Author	Publisher
1	Practical Text Book of Plant Physiology	DanielTremblyMacdougal	Logmans, Green and Co.
2	Practical Manual of Plant Ecology and Plant Physiology	Sundara S. Rajan	Anmol Publisher

SEMESTER II

SEMESTER II

BOT552: BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS

Course Code	**BOT552**	
Course Title	**BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of biology and diversity of pteridophytes and gymnosperms and study their comparative morphology, anatomy and ontological studies of different genera.	
Course Outcome	CO1	Students will learn about the evolution of present living plants from ancestor alga, the development of vascular bundles and seed formation from previous plants to present plants, the different fossil plants of pteridophytes.
	CO2	Students will learn about the concept of tall trees and their girth formation due to secondary growth in gymnosperm to angiosperm, formation of different specialized organs from primitive plants like tracheid, vessels, phloem, flower, strobili, cones, seeds, stem, leaves, roots and pollens.
	CO3	Students will learn about economic importance of pteridophytes and gymnosperm in present times.

SYLLABUS
(THEORY)

UNIT: I

Pteridophytes: origin and evolution, telome theory; stelar evolution; classification; economic importance Fossil pteridophytes: structural features and evolutionary significance of PsilophytalesLepidodendrales, Calamitales.

UNIT: II

Diversity, morphology, anatomy and reproduction in: Psilopsida (Psilotales), Lycopsida (Lycopodiales, Selaginellales, Isoetales), Sphenopsida (Equisetales), Ophioglossales, Eusporangiate ferns (Marattiales), Leptosporangiate ferns (Filicales, Marsileales, Salviniales).

UNIT: III

Gymnosperms: origin and evolution, classification (Sporne, Christenhuez); economic importance; diversity and distribution in India. Fossil gymnosperms: structural features and evolutionary significance of Pteridospermales, Cycadeoidales, Cordiatales.

UNIT: IV

Diversity, morphology, anatomy and reproduction in: Cycadales, Ginkogoales, Coniferales, Taxales, Ephedrales, Gnetales, Welwitschiales

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Botany for degree students Pteridophytes	Vashista, B. R	S. Chand and Company limited.
2	Botany for degree students Gymnosperms	Vashista, P. C., Sinha, A.K., Kumar A.	S. Chand and Company limited
3	An Introduction to Pteridophytes.	Rashid, A. (1991).	Vikas Publishing House Pvt. Ltd. New Delhi..
4	Gymnosperms	Bhatnagar, S. P., Moitra. A.	New Age International Publisher
5	Gymnosperms	O. P. Sharma	Pragati Prakash-Meerut

SEMESTER II

BOT554: REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY OF ANGIOSPERMS

Course Code	**BOT 554**	
Course Title	**REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY OF ANGIOSPERMS**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of reproductive and developmental biology of angiosperms.	
Course Outcome	CO1	Students will learn about the pattern of senescence and programmed cell death (PCD), polyembryony and apomixes, dynamics of fruit growth.
	CO2	They will learn mechanisms of cell division and cell to cell communication & tissue differentiation with reference to xylem and phloem. Plant development patterns.
	CO3	It will familiarize students with concept of reproductive and developmental biology of angiosperms.

SYLLABUS
(THEORY)

UNIT: I

Flower development: floral evocation, floral organ formation, flowering in perennials, seasonal flowering, polycarpy and biennial bearing. Male and female gametophyte: structure of anther, role of tapetum, micro-sporogenesis and development of pollen, regulation of asymmetric first pollen mitosis, control of second pollen mitosis and sperm cell differentiation, female gametophyte development: initiation, patterning, cell fate specification and maintenance of cell identities of female gametophyte. Co-evolution of flower *vis a vis*Pollinators

UNIT: II

Pollination, pollen-pistil interactions and fertilization: pollination mechanisms, pollination syndromes, structure of pistil, pollen germination and compatible pollenstigma interactions, sporophytic and gametophytic self-incompatibility, pollen tube growth and guidance, double fertilization Seed development, fruit growth and dormancy: endosperm development, embryogenesis- landmarks of embryo pattern formation, polyembryony and apomixes, dynamics of fruit growth, importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy.

UNIT: III

Root development: organization of root apical meristem (RAM); vascular tissue differentiation; lateral roots, root hairs. Root microbe interaction. Leaf growth and differentiation: determination; phyllotaxy; control of leaf form; differentiation of epidermis with special reference to stomata, trichomes, and mesophyll Senescence and programmed cell death (PCD): concept, types of cell death, mechanism of PCD. PCD in the life cycle of plants, metabolic changes associated with senescence significance of Pteridospermales, Cycadeoidales, Cordiatales.

UNIT: IV

Patterns in plant development: growth, differentiation and development, genetic control and hormonal regulation of development, physiology of hormones in plant development.

Shoot development: organization of the shoot apical meristem (SAM); cytological and molecular analysis of SAM; mechanisms of cell division and cell to cell communication; tissue differentiation with reference to xylem and phloem; secretary structures and laticifers Wood development in relation to environmental factors, Genetics of Flower Development in *Antirrhinum* and *Arabidopsis*.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	The Embryology of Angiosperms.	Bhojwani, S.S. and Bhatnagar, S.P. 1975.	Vikas Publishing House, Delhi.
2	Seeds: Physiology of Development and Germination,	Bewley,J.D. and Black, M. 1994.	Plenum Press, New York.
3	Morphology of the Angilosperms.	Eames, A.J. 1961.	Tata McGraw Hill Publishing Co., Bombay.
4	An Introduction to the Embryology of Angiosperms.	Maheshwari, P. 1950.	Tata McGraw Hill Publishing Co. Bombay – New Delhi.

SEMESTER – II
BOT556: GENETICS AND PLANT BREEDING

Course Code	**BOT556**	
Course Title	**GENETICS AND PLANT BREEDING**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of Genetics, Plant Breeding in plants	
Course Outcome	CO1	Students will learn the basics of genetics and hereditary
	CO2	Students will learn about the techniques of plant breeding which help to produce high yielding plant varieties
	CO3	Students will get the knowledge of evolution and help them to understand how plants evolve in all these years.

SYLLABUS
(THEORY)

UNIT: I

A brief history, scope and significance of genetics, Mendel's law of inheritance, Lethality and interaction of genes. An introduction to Quantitative and Qualitative Characters: Dominance, Segregation, Pleiotropy, Penetrance and Expressivity, Modified Genes, Gene interaction and Linkage. Multiple Factor Hypothesis, Polygenic Inheritance and Continuous variation, Normal distribution, Components of Genetic variance. Selection theory; Hardy-Weinberg law, Genetic advance under selection

UNIT: II

Crossing over: theories of crossing over, Mapping of genes on chromosomes. Cytoplasmic inheritance. Heritability, Genotype × Environment interaction: Models; implications in testing programme stabilityof genotype performance. Criteria for selecting parents; Type of crosses and strategies; Sources of parent germplasm.

UNIT: III

Methods of plant breeding (Mass selection, Pureline selection, Pedigree method; Bulk method; Single-seed descent method;Backcross method; Production of doubled haploids), plant introduction, mass line and clonal selection. Euploidy: origin, meiosis and breeding behaviour of haploidy, autopolyploids and allopolyploids. Chromosome and chromatid segregation in autopolyploids Role of polyploidy in crop improvement and evolution of crop plants. Aneuploidy: types of aneuploids, origin, meiosis and breeding behaviour of aneuploids, aneuploid aberrations in humans. Biochemical genetics of *Neurospora*.

UNIT: IV

Mass selection-Genetic gain theory; Gardner's Grid system; Half-sib family selection, Ear-to-row selection; Modified ear-to-row selection; Half-sib recurrent selection (or test cross), Testers; S1 progeny recurrent selection; S2 family selection; Full-sib family recurrent selection. Reciprocal recurrent selection, Half sib and full sib.

Inbreeding; Methods of inbreeding; Inbreeding depression; Types ofhybrid; Prediction of double and 3-way hybrid yields from single cross data; Top cross testers for inbred line development; Type of testers; Stage of testing.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Genomes	Brown, T.A. (1999).	BIOS Scientific Publishers limited, UK.
2	Principles of Genetics.	Gardener, E.J., Simsons, M.J., and Sinustad, D.P. (1991).	John Wiley Sons Inc., New York.
3	Gene VII.	Lewin, B. (2000).	Oxford University Press, New York.
4	Genetics.	Strickberger, M.W. (2001).	Prentice-Hall, Inc., Englewood Cliffs, N. Jersey.
5	Evolutionary Biology (Third Edition)	Douglas J. Futuyma.	Sinauer Publications.
6	Cytogenetics of Aneuploids.	Khush G.S. (1973).	Academic Press, New York
7	Genetics	Veer BalaRastogi	KedarNath Ram Nath

SEMESTER II

DISCIPLINE SPECIFIC ELECTIVE

BOT558 - REMOTE SENSING AND ECOLOGICAL MODELLING

Course Code	**BOT558**	
Course Title	**REMOTE SENSING AND ECOLOGICAL MODELLING**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn about the basic of remote sensing GIS and ecological modelling.	
Course Outcome	CO1	They will learn about the role of satellite and monitoring importance.
	CO2	They will learn about the formation of maps.
	CO3	They will learn about the different software used in the remote sensing.

SYLLABUS
(THEORY)

UNIT: I

Remote sensing: Definition and data acquisition techniques. Application of remote sensing in vegetation classification, understanding the key environmental issues and ecosystem management. Geoinformatics and geographic information sciences, components of geoinformatics, applications of geoinformatics, approach to the study of geoinformatics, legal implications, geoinformatics and environmental modelling, GIS data collection, concept and techniques of geoinformatics. Surveying Technology: Introduction, surveyors, datum and reference systems, survey operations classification of surveys, principles of surveying, methods of surveying, stages in surveying, modern trends in surveying and mapping.

UNIT: II

Introduction, GPS elements, GPS satellite constellation and signals, GPS measurements, GPS instrumentation, earth resources satellites, meteorological satellites, satellite carrying microwave sensors, OCEANSAT- 1(IRS-P4) and Ikonos satellite series. Introduction, roots of GIS, overview of information system, the four Ms, GIS architecture, theoretical models of GIS, theoretical frame work for GIS, GIS softwares, GIS applications and GIS operations. Role of remote sensing in Forest resource management, watershed Management, natural disaster management, and urban planning management.

UNIT: III

Exponential Population Growth: Finite rate of increase, population doubling time, life tables, life expectancy, net reproduction rate, generation time, intrinsic rate of natural increase, stable age distribution. Leslies matrix model for population growth in unlimited environment, finite rate of increase with stable age distribution.

UNIT: IV

Logistic Population Growth: Differential and matrix models for population growth in limited environment. Dispersal: Empirical models, random walk model. Interaction Between Two Species: Competition – Differential equations, Leslie-Gower Model, Lotka-Volterra model for predator – prey interaction, Leslie model, deterministic models for simple and general epidemics.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Principles of Remote Sensing	Curran, P.J. (1988)	Longman Scientific and Technical, Harlow.
2	Remote Sensing for Natural Resource Management and Environmental Monitoring	Ustin, S.L. (Ed.) (2004).	John Wiley & Sons, U.S.A.
3	Environmental Hazards	Smith, K.	Routledge Publishers, London
4	Ecology.	Begon, M., Harper, J.L. and Townsend, C.R. (1996)	Blackwell Science, Cambridge
5	Ecology: Principles and Applications	Chapman, J.L. and Reiss, M.J. (1988)	Cambridge University Press, Cambridge.
6	Ecological Diversity and its Measurement.	Magurran, A.E. (1988).	Chapman & Hall, London.
7	Aims and Methods of Vegetation Ecology.	Muller-Dombois, D. and Ellenberq, H. (1974).	Wiley, New York.

SEMESTER II
DISCIPLINE SPECIFIC ELECTIVE

BOT560 – FORESTRY

Course Code	**BOT560**	
Course Title	**FORESTRY**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn about the various types of forest in India, their contribution and various protection policies and rules.	
Course Outcome	CO1	They will learn about the practices of silviculture.
	CO2	They will learn about various forest policies and different types of forest in India.
	CO3	They will learn about the joint forest management and agroforestry.

SYLLABUS
(THEORY)

UNIT: I

Introduction – definitions of basic terms related to forestry, objectives of silviculture, forest classification. Forest regeneration, tending, thinning, pruning and harvesting. Various interactions within forest communities, disturbances and succession, Gap dynamics

UNIT: II

Salient features of Indian Forest Policies, Salient features of the Indian Forest Act1972 (preliminary, reserved forests, protected forests), different methods employed for conservation of forests.

Ecosystem Services: Definition, General account; Different types; Significance.

UNIT: III

Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations. Climate of India, different climatic regions of India; Central characters and distribution of the different forest types of India. Forest Effects: General effects of forests on climate, control of runoff, effects on snow, soil erosion, wild life, pollution control, nutrient cycling, social values and ecotourism, economic values, floods, green belts and control of temperature.

UNIT: IV

Social Forestry: Social forestry- social land allocation programmes (Taungya system). Economic benefits of social forestry.

Agroforestry:Role in- soil conservation, soil restoration, conservation of biodiversity.

Watershed management, Climate change and Forestry: Definition of climate change, impact of climate change on forests, adaptation of trees to climate change.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	A Manual of Indian Forest Botany	Bore, N.L	International Book Dist. New Delhi
2	A Text Book of Silviculture	Diwivedi, A.P	International Book Distributor
3	Forestry Principles and Applications	Antony Joseph Raj and S B Lal	Scientific Publisher
4	Introduction to Forestry and Natural Resources	Donald L. Grebner, Peter Bettinger and Jacek P. Siry	Elsevier

SEMESTER II
DISCIPLINE SPECIFIC ELECTIVE

BOT562 – ADVANCED INDUSTRIAL BOTANY

Course Code	**BOT562**	
Course Title	**ADVANCED INDUSTRIAL BOTANY**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn about the various industrial application of the plant product and their extraction	
Course Outcome	CO1	They will learn about the different types of plants and their parts used for industrial application
	CO2	They will learn about the different processes take place to produce the product from the raw material
	CO3	They will learn about different types of industries and products based on plant and their parts

SYLLABUS
(THEORY)

UNIT: I

Physical characteristics of Indian woods: Methods of seasoning and chemical treatment of specialized use, fire proofing of the wood. Industrial manufacturing of packing material and plywood and the classifications of plywoods according to their use. Some important commercial woods: *Dalbergia* spp., *Shorea robusta*, *Tectona grandis, Cedrus deodara*, Bamboo-the 'green gold' of India. Manufacturing of paper and board from raw plant material: Manufacturing of crude and high quality paper, recycled paper.

UNIT: II

Extraction of sugar from sugar cane. Flow diagram of the process with a critical study of the steps involved, problems faced by the sugar industry in India. Bye-products of sugar industry, distillation of alcohol and other products with special reference to distilleries in Punjab.
Agro industries in India with particular reference to Punjab. The manufacturing and packing of milk and milk products, pickles, jams, jellies, juices, pastes, sauces etc. Problems of storage and marketing.

UNIT: III

Sources of natural dyes in India and their extraction methods, merits and limitations of plant based dyes**.** Sources and methods of extractions of vegetable oils and fats and their utilization

UNIT: IV

An introduction to pharmaceutical industry in India, extraction of antibiotics from microorganisms. Medicines extracted from higher plants, Industrial manufacturing of quinine, the concept of nutraceuticals, their availability, uses & problems. Essential oil yielding plants of India, their use in perfumery and extraction, Sources of gums and resins and their classifications according to their chemical nature. Extraction of the raw resin and down the line processing for turpentine and other products.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Economic Botany in the Tropics.	Kochhar S. L. (1998).	MacMillan India limited, Delhi.
2	Economic Botany (3rd Ed.)	Pandey B. P. (1984).	S. Chand & Company Ltd. New Delhi
3	The Common Commercial Timbers of India And TheirUses.	Trotter H. (1982).	The Controller of Publications, Delhi.
4	The Useful Plants of India. (3rd Ed.)	Ambasta S. P. (1994).	Publications & Information Directorate, New Delhi.

SEMESTER II

BOT564: METABOLIC INTEGRATION

Course Code	**BOT564**	
Course Title	**METABOLIC INTEGRATION**	
Course Type	Theory	
L T P	3 0 0	
Credits	3	
Course prerequisite	B. Sc. Medical/Life sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of metabolism of biomolecules, signal transduction and Senescence in plants	
Course Outcome	CO1	They will learn the different pathways of biomolecules synthesis and regulation in plants.
	CO2	It will help them to understand the pathways of signal transduction which can later be use to carry out research and innovation by the students.
	CO3	To learn the concepts of metabolism of biomolecules, signal transduction and Senescence in plants

SYLLABUS
(THEORY)

UNIT: I

Long distance transport:Introduction, Overview of diffusive and active transport in plants, Importance of channel dimensions in defining the transport properties of the apoplast and symplasm. Comparison of xylem and phloem transport. Transpirational water movement in the xylem, Symplasmtic transport via plasmodesmata, Phloem transport, Intercellular transport of endogenous macromolecules, Secondary Metabolites: types, biosynthesisand their role in plants.

UNIT: II

Nitrogen and sulphur : Introduction, Overview of nitrogen in the biosphere and in plants, Overview of nitrogen fixation, Enzymology of nitrogen fixation, Symbiotic nitrogen fixation, Ammonia uptake and transport, Overview of nitrate uptake and reduction, Nitrate reduction, Nitrate reduction, Interaction between nitrate assimilation and carbon metabolism, Overview of sulfate assimilation, Sulfur chemistry and function, Sulfur uptake and transport, The reductive sulfate assimilation pathway, Synthesis and function of glutathione and its derivatives.

UNIT: III

Signal perception and transduction: Introduction, Overview of signal transduction, receptors, specific examples of plant receptors, G-proteins and phospholipid signaling, Cyclic nucleotides, Calcium, Protein kinases : primary elements in signal transduction, Particulars pathways of signal transduction associated with plant growth regulators, The future of plant cell signal transduction research.

UNIT: IV

Senescence and Programmed Cell Death: Types of cell deaths observed in animals and plants, PCD in the life cycle of plants, Overview of senescence, Pigment metabolism during senescence, Protein metabolism in senescence, Impact of senescence of photosynthesis, Impact of senescence on oxidative metabolism, Degradation of nucleic acids during senescence, Regulation of metabolic activity in senescing cells, Endogenous plant growth regulators and senescence, Environmental influences on senescence, Examples of developmental PCD in plants, Examples of PCD as a plant response to stress, Further questions and future directions for PCD research.

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Biochemistry and Molecular Biology of Plants.	Buchanan, B.B., Gruissem, W., and Jones, R.L. (2000).	American Society of Plant Physiologists, Maryland.
2	Lehninger Principles of Biochemistry: 6th Edition	Nelson, D. L., Cox, M.M	Macmillan Learning, 2012
3	Galston, A.W. (1989).	Life Processes in Plants.	Scientific American Library, Springer-Verlag, New York.
5	Plant Physiology.	Taiz, L., and Zeiger, E. (1998).	Sinauer Associates, Inc., Publishers, Massachusetts.
6	Salisbury, F.B., and Ross, C.W. (1992).	Plant Physiology,	Wadsworth Publishing Co., California.

SEMESTER II

MAT540 - BIOSTATISTICAL METHODS

Course Code	**MAT540**	
Course Title	**BIOSTATISTICAL METHODS**	
Course Type	Theory	
L T P	3 0 0	
Credits	3	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To aware students about the use and significance of statistical techniques in biological science.	
Course Outcome	CO1	Students will learn about the basics of statistic and its use in botany.
	CO2	They will learn how to represent the graphical data of their analysis. They will learn about the various central tendencies and dispersion.
	CO3	They will learn about the different methods of sampling and their analysis during data collection in botany.

SYLLABUS

UNIT: I

Data collection, tabulation, Frequency distribution and its graphical representation
Measures of Central tendency: mean, mode, median
Measures of Dispersion: range, variance, Standard deviation and Standard error

UNIT: II

Mathematical definition of a probability event
Conditional probability
Additive and Multiple law of Probability
Theoretical Distributions: Binomial, Poisson and Normal

UNIT: III

Null Hypothesis and Level of Significance
Confidence limit and confidence interval
Skewness and Kurtosis moments.
Student's t- test (Paired and Unpaired)

UNIT: IV

Chi Square test
Correlation: Covariance, Karl Pearson's correlation coefficient and Spearman's rank correlation coefficient
Regression: Least square technique for regression lines, regression coefficient
Relation between Correlation and Regression

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Introduction to Mathematics for Life Scientists	Batschelet, E	Springer-Verlag, Berlin
2	Mathematical Biology	Murray, J.D.	Springer-Verlag, Berlin
3	Statistical Methods	Snedecor& Cochran	Affliated East-West Press
4	Biostatistics	P. Ramakrishnan	Saras Publications
5	Biostatistics: Basic Concepts and Methodology for the Health Sciences	Wayne W. Daniel	Wiley Publication

SEMESTER II

BOT566 - PRACTICAL COURSE ON PTERIDOPHYTES, GYMNOSPERMS, DEVELOPMENTAL AND REPRODUCTIVE BIOLOGY

Course Code	**BOT566**	
Course Title	**PRACTICAL COURSE ON PTERIDOPHYTES, GYMNOSPERMS, DEVELOPMENTAL AND REPRODUCTIVE BIOLOGY**	
Course Type	Practicum	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	Study of comparative morphology and anatomy of vegetative and reproductive study of different genera of pteridophytes and gymnosperms. To understand different developmental stages of plant embryology.	
Course Outcome	CO1	Students will observe the observed specimens and study about their vegetative and morphological characters in labs. Preparation of the TS and LS sections of stem, roots, leaves, rhizomes of the plants and study the anatomy of the plants.
	CO2	Students will observe the gymnosperms and pteridophytes in their natural habitats and will prepare the assignments of pteridophytes and gymnosperm and submit the specimen of their collections to the herbarium with their reports.
	CO3	Students will learn about the different types of stomata in the plants. Students will prepare their own slides of stomata and count the stomata in the various plants.

SYLLABUS

LIST OF EXPERIMENTS

1. Study of morphology and anatomy of vegetative and reproductive tissues and organs using cleared whole mounts, dissections, sections, macerations and permanent preparation of living and fossil forms covered under theor.y
2. Study of Pteridophytes in their natural habitat.
3. Experiments on spore germination of prothallus, induction of sporophytes
4. Comparative study of the anatomy of vegetative and reproductive parts of *Gingkgo, Cedrus, Abies, Taxodium, Podocarpus, Taxus, Ephedra and Gentum*
5. Study of the important reproductive stages through specimens and permanent slides
6. Study of living shoot apex of Hydrilla
7. Study of cytological zonation in the shoot apical meristem in double stained permanent slides of any suitable plant.
8. Study of different leaf arrangements
9. Study of epidermal peels of leaves of appropriate to study various stomatal types
10. Study of anatomy of dicot and monoct roots and stems using appropriate materials
11. Study of microsporogenesis and gametogenesis in appropriate materials
12. Study of different types of ovules, embryo sacs through examination of permanent slides

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Practical Manual for Bryophytes and Pteridophytes	Mohammed Gufran Khan	Lambert Academic Publishing
2	Practical Botany (Cryptogams & Gymnosperms)	PrabhaChoudhary, Tarkeshwar Prasad S SChoudhary	CBS Publishers & Distributors
3	An Introduction to the Embryology of Angiosperms.	Maheshwari, P. 1950.	Tata McGraw Hill Publishing Co. Bombay – New Delhi.

SEMESTER II

BOT568 - PRACTICAL COURSE ON GENETICS & PLANT BREEDING, METABOLIC INTEGRATION, AND ELECTIVE

Course Code	**BOT568**	
Course Title	**PRACTICAL COURSE ON GENETICS & PLANT BREEDING, METABOLIC INTEGRATION, AND ELECTIVE**	
Course Type	Practicum	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic principles of metabolism and determination of probability of genetics and of elective subject	
Course Outcome	CO1	Students will learn about basic techniques such as staining, and observe the cell structure and organelles.
	CO2	Students will observe the chromosomes and learn about mitosis and mitotic division.
	CO3	Students will learn about various plant metabolism during experimentation.

SYLLABUS

LIST OF EXPERIMENTS

1. Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis.
2. Determination of probability for the throw of dice
3. Preparation and study of karyotype
4. X^2 test as applied to the result of above three experiments
5. Permutation and combination
6. Correlation analysis
7. Determination of genotype from the data provided
8. Determination of linkage values from the data provided and preparation of chromosome map.
9. Linear differentiation of chromosomes through banding techniques, such as G-banding, C-banding and Q-banding (Photographs/Slides).
10. Determination of various Mendelian ratio by checker board as well as by binomial equation
11. To grow plants under salt and drought stress and demonstration of different stress enzymes like catalase, superoxide dismutase, peroxidise

Text and Reference books:

S. No.	Name/Title	Author	Publisher
1	Practical and Numerical problems in Plant Breeding	Singh, P.	Kalyani Publishers (2013)
2	Practical Handbook of Genetics	Pali, V.	Kalyani Publishers

SEMESTER II

BOT570 – SUMMER INTERNSHIP

Course Code	**BOT570**	
Course Title	**SUMMER INTERNSHIP**	
Course Type	Practicum	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To gain exposure to industry projects; interactions with professionals and other summer interns; and improving their presentation, writing, and communication skills, and it provides as an opportunity for the better placements of the students.	
Course Outcome	CO1	Transfer their analytical, integrative, team skills honed in the classroom to the workplace, and understand the complexities of the industry/company/corporates/organizations first hand
	CO2	Identify opportunities for networking with people in industry/company/ corporates/organizations;
	CO3	Aim for pre-placement offers where feasible/appropriate

GUIDELINES

1. It is mandatory for a student to successfully complete the Summer Internship.
2. Summer Internship is for a period of 6 weeks starting from mid of May. (In case, more time is required the internship should begin early, so that it does not extend beyond 31st July).
3. Summer Internship will carry a weightage of two credits (four contact hours).
4. Each student will be allotted a Faculty Guide from the University and a company/industry/ industry/ corporates/organizations mentor.
5. The Summer Internship will be assessed not only by the company/industry/ industry/ corporates/organizations mentor but also by faculty mentor.
6. Any adverse remarks from the industry/ corporates/organizations may lead to rejection of the report.
7. The final summer internship report has to be submitted to the Faculty Guide/mentor within 15 days from the date of joining III trimester (latest by 15th August).
8. The student is required to prepare 5 hard copies of the report (1 for student, 1 for faculty mentor, 1 for company/industry/ industry/ corporates/organizations, 1 for department and 1 for library record). The soft copy should be submitted with both the faculty and company mentors.
9. The student will be required to make presentation of summer project/internship before internal panel of faculty members on a given date.
10. Summer Internship (2 credit, only practicum course) shall be carried out during summer vacations after second semester. Evaluation of 2nd semester internship to be done after submission of internship report and viva-voce of the students. The Summer Project/internship will carry two credits (100 marks). For this purpose, the basis for assessment will be:
    a. Evaluation by panel of faculty members,
    b. Evaluation by Company Mentor (Feed Back Form),
    c. Observations of faculty guide and
    d. Activity cum progress report.
11. Summer Project Evaluation is done by awarding the grades directly.

SEMESTER III

SEMESTER III

RM651: BASICS OF RESEARCH METHODOLOGY IN BIOLOGICAL AND CHEMICAL SCIENCES

Course Code	**RM651**	
Course Title	**BASICS OF RESEARCH METHODOLOGY IN BIOLOGICAL AND CHEMICAL SCIENCES**	
Course Type	Theory	
L T P	4 1 0	
Credits	5	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic concepts of research methodology.	
Course Outcome	CO1	Students will learn basic aspects of research like experimental design, collection and analysis of data.
	CO2	Students will learn basic tools for writing and preparing a research report. familiarity with the basics of research for proper planning and execution of their research work but also in the compilation of work.
	CO3	They will develop basic skills in computers and research.

SYLLABUS
(THEORY)

UNIT: I

Outline of basic statistics and research methodology, Importance of statistics in Biological Sciences and Analytical chemistry, Statistical measures such as mean, variance and standard deviation with emaphasis on practical problems associated with biological and chemical sciences; Difference between sample and the population, sampling techniques; Calculation of errors and definition of residuals; The normal distribution of random set of data and its implication on data analysis; Experimental Design.

UNIT: II

Definition of confidence level; Degree of freedom; Linear regression and the calibration curve; correlation coefficient; The regression equation; Limits of detection; Q test; Data evaluation and Comparison; t-test for comparing the means of different data sets; F-Test for testing differences between standard deviations of data sets for comparing precision**;** Analysis of variance (one way and two way ANOVA).

UNIT: III

Computer-based tools for research purpose: MS-Windows basics; MS-Word – Meaning of Word–Processing, Creating, Saving, Printing documents, Formatting, Spell-Check, Adding page numbers, Header and Footer, Macros, Creating tables, Converting table to text and vice–versa, Mail Merge; MS-Excel – Spreadsheets, Using different types of formulae, Creating graphs and charts, Exporting charts to MS-Word; MS-PowerPoint – Creating presentations, Formatting, Adding effects and timings.

UNIT: IV

An Insight into Research: What is Research?, Objectives of Research, Significance of Research, Research Techniques, Finding Research Materials, Scientific Writings, History of Scientific Writing, Writing a Review Paper and Thesis.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	John W. Creswell and J. David Creswell	Sage Pubns; 5th edition (2 January 2018)
2	The Craft of Research	Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams	University of Chicago Press; 4th edition (28 October 2016)
3	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	Sage Publications
4	Research Methodology: methods and techniques	CR Kothari & Gaurav Garg	New Age International Publishers; Fourth edition (1 September 2019)
5.	Research ethics.	Dooly, M., Moore, E., & Vallejo, C.	*Research-publishing. net*. (2017).

SEMESTER III

BOT651: TAXONOMY AND BIODIVERSITY

Course Code	**BOT651**	
Course Title	**TAXONOMY AND BIODIVERSITY**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of taxonomy and biodiversity	
Course Outcome	CO1	Students will learn how to use different kinds of identification keys for the identification of plants.
	CO2	Students will learn about the historical prospects of ICBN and nomenclature types, Botanical Survey of India, IUCN, Red data book and its role and function.
	CO3	They will learn different biodiversity issues and its impact on ecosystem and environment.

SYLLABUS
(THEORY)

UNIT: I

Introduction to the concept and elements of biodiversity, magnitude of extant species, Congruence. Biodiversity profile of India with different zones and its comparison with that of the world. Techniques for assessment of plant diversity, Spatial and temporal assessment, Assessment of threats to biodiversity (qualitative and quantitative).

UNIT: II

In-situ management of biodiversity, protected area system in India and its role in biodiversity management. Trans-boundary issues in biodiversity management. Ex-situ management of biodiversity. Role of zoos, biodiversity parks, gene banks, tissue culture etc. in biodiversity management. Introduction to international policies and legal instruments for biodiversity conservation; nature of treaties, formation of treaties, participation in treaties, interpretation of treaties and reservations. Major international conventions for biodiversity protection, conservation and management. National biodiversity strategy and action Plan. Biodiversity Bill

UNIT: III

Botanical nomenclature, ICBN, Principles, recommendation and amendments of code, Practice of nomenclature: type method (concept and kinds); author citation; effective and valid publication; basionyms and synonyms; homonyms; autonyms and tautonyms.

Plant identification: methods of identification; dichotomous keys (kinds and construction); polyclaves (a brief account). Familiarity with botanical literature, monographs, icons and floras, important periodicals with emphasis on Indian floristics, methods of literature consultation, cybertaxonomy (concept and scope), e-floras and e-herbaria

UNIT: IV

Botanical exploration-historical perspective, Botanical survey of India, its organization and role Threat assessment, different categories of threat, IUCN, CBD, Red Data Book, Important threatened plants of India. Indian Biodiversity Act 2002 and Rules. Human Impact on Biodiversity Resources. Spatio-temporal dependence of different communities on biodiversity resources. Biodiversity Hotspots**:** concept; Biodiversity hotspots of India

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Taxonomy of Angiosperms	Naik, V. N.	Tata McGraw-Hill Education 1984
2	Taxonomy of Vascular Plants	Lawrence H M George.	Scientific Publishers (India) (2012)
3	Biodiversity	E.O. Wilson, Editor, Frances M. Peter,	National Academic Press, Washington, D.C.
4	Biodiversity and Conservation	Peter J. Bryant	School of Biological Sciences, University of California
5	Forest Policy and Law	S.S. Negi	Dehradun
6	Biogeography of India,1st Edn.	Mani, M.S.	Springer

SEMESTER III

BOT653: ECOLOGY AND ENVIRONMENT

Course Code	**BOT653**	
Course Title	**ECOLOGY AND ENVIRONMENT**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of ecological principles and their interaction with environment	
Course Outcome	CO1	Student will apply the knowledge in ecological modeling, understand mechanism of ecological succession and Ecosystem function.
	CO2	Students will understand the composition of biotic and abiotic factors.
	CO3	It will give him knowledge of ecosystem balance and also imparts a sense of responsibility about environment and wild life.

SYLLABUS

UNIT: I

Population ecology: population characteristics; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Habitat and niche: concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Species interactions: types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

UNIT: II

Community ecology: nature of communities; community structure and attributes; species diversity and its measurement, richness and evenness; edges and ecotones; guilds Community development: temporal changes (cyclic and non-cyclic); mechanism of ecological succession (relay floristics and initial floristic composition; facilitation, tolerance and inhibition models, resource ratio hypothesis); changes in ecosystem properties, concept of climax and its characterization. Community stability: diversity- disturbance, and diversity stability relationships; ecology of plant invasion- process of invasion.

UNIT: III

Ecosystem organization: biotic component-food chains, food web, trophic cascades; abiotic component-soil formation, soil profile development, soil horizons and soil classification. Ecosystem function: primary production (gross and net primary production, controlling factors and methods of measurement), energy flow pathways, ecological efficiencies; litter accumulation and decomposition (mechanisms, substrate quality and climatic factors).

UNIT: IV

Diversity Patterns: species abundance distribution, diversity patterns (latitudinal gradient-contributory factors and explanatory theories). Sampling theory and various sampling strategies (random, stratified and systematic), Species area curve and determination of sample size for biodiversity assessment. Concept of species, species richness, evenness and diversity. Various measures of species richness, evenness and diversity. Biogeography: MacArthur and Wilson's island biogeography equilibrium theory: limitations and modifications; colonization vs. extinction; species area relationship Biomes: types (terrestrial and aquatic), distribution and unique features

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Ecology and Environment	P.D. Sharma	Rastogi Publications, 'Gangotri' Shivaji Road, Meerut
2	Ecology: Principles and Applications.	Chapman, J.L. and Reiss, M.J. (1988).	Cambridge University Press, Cambridge.
3	Fundamentals of Ecology.	Odum, E.P. (1971).	Saunders, Philadelphia..
4	Basic Ecology.	Odum, E.P. (1983)	Saunders, Philadelphia
5	Methods in Plant Ecology.	Moore, P .W and Chapman, S.B. (1986).	Blackwell Scientific Publications, Cambridge.

SEMESTER III

BOT655: PLANT ANATOMY AND CYTOGENETICS

Course Code	**BOT655**	
Course Title	**PLANT ANATOMY AND CYTOGENETICS**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of plant cell and tissue and anatomy of plants organs, cytogenetics and molecular mechanism of DNA replication, transcription and translation.	
Course Outcome	CO1	Students will learn the concepts of cell and its organelles
	CO2	They will learn the anatomy of plants and its different parts
	CO3	They will learn about cell division, replication and transcription

SYLLABUS
(THEORY)

UNIT: I

The Plant cell: Structure, Organization. Plant cell wall structure and its synthesis, cystoliths, phytoliths, their distribution in plant groups and plant body, role in taxonomy, the cell and tissue systems, Primary structure of stem, root and leaves, types of steles, vascular cambium and its origin, secondary growth in angiosperms

UNIT: II

Types of nodes in dicot and monocot, leaf trace, node internode transition leaf gaps, types of fruits and seeds, ultrastructure of fruits and seeds, secretary ducts and laticifers. Anatomy of stem and root in relation to habit and growth form, aerial and buttress roots, haustoria and other special structures of epiphytes, parasites, mycorrhizas and nitrogen fixers. Leaf anatomy in relation to photosynthesis and transpiration, anatomical modification of xerophytes and hydrophytes.

UNIT: III

Nucleus: Structure, nucleolus organization, Generalized structure of plant cell organelles**.** Chromosome: Structure, molecular basis of chromosome structure. DNA: packaging of DNA, Nucleosome, nuclear membranes, C-value paradox, Cot curves, Chemical structure, genetic code, Prokaryotic genome organization, Variation in chromosome and its significance**.** Chromosomal aberrations: Heteroploidy, structural changes in chromosomes

UNIT: IV

Meiosis: Origin and molecular events during meiosis. Mitosis: Origin and molecular events during mitosis. DNA replication in prokaryotes and eukaryotes. Transcription, RNA splicing. Translation, Prokaryotic and eukaryotic gene regulation

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Plant Anatomy	Pandey B P	S Chand
2	Plant Physiology	Taiz and Zeinger	Sinauer Associates
3	Cell Biology, Genetics and Molecular Biology	Verma P.S. & V.K. Agarwal, (2000)	S. Chand. Pvt. Ltd
4	Cell and Molecular biology	De Robertis, E.D.P. and Robertis, E.M.F (1991)	Lea and Febiger, Washington
5	Molecular Cell biology	Darnell, J., Lodish, KL and Baltimore, D., (2008)	W. H. Freeman Publishers.

SEMESTER III

BOT657: PLANT TISSUE CULTURE AND GENETIC ENGINEERING

Course Code	**BOT657**	
Course Title	**PLANT TISSUE CULTURE AND GENETIC ENGINEERING**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of Plant Tissue Culture and Genetic Engineering. To understand the different principles and methods of genetic engineering.	
Course Outcome	CO1	Student will able to apply the subject knowledge about to design experiments in recombinant DNA technology, polymerase chain reaction (PCR), technique of somatic hybridization.
	CO2	Students will learn about the importance of tissue culture in the plant breeding and conservation programme.
	CO3	They will understand the techniques of organogenesis, somatic embryogenesis and germplasm conservation.

SYLLABUS

Unit: I

Introduction: historical perspective and scope Cellular totipotency: concept, cytodifferentiation and its mechanism Cell culture and cell cloning: isolation of single cells from plant organs and cultured tissues; cell suspension culture, culture of single cells; organogenesis-processes and controlling factors, shoot- bud differentiation and somatic embryogenesis

Unit: II

Haploids: androgenic and gynogenic; ontogeny of androgenic haploids, applications of haploids in plant breeding. Somatic hybridization: isolation, culture and fusion of protoplasts; selection, regeneration and utility of hybrids and cybrids. Industrial applications: production of secondary metabolites and their applications, hairy root cultures and bioreactors Germplasm conservation: cryopreservation of plant cells and organs, short term and long term storage.

Unit: III

Recombinant DNA technology: gene cloning principles, restriction enzymes characteristics and utility, cloning vehicles and their properties (plasmids, phages, phagemids and cosmids), artificial chromosomes (YAC), construction of recombinant DNA. Isolation of gene of interest - gel electrophoresis, southern blotting, genomic and cDNA libraries, bacterial transformation and selection of recombinants,1 polymerase chain reaction (PCR) – principle, technique and applications.

Unit: IV

DNA sequencing: Maxam-Gilbert's chemical degradation and Sanger's chain termination method, molecular markers (RAPD, AFLP, SSR & SNP) – concept and utility. Genetic engineering of plants: Agrobacterium the natural genetic engineer, Ti plasmids, mechanism of gene transfer, applications of transgenic plants. Direct methods of gene transfer (electroporation and biolistics), biosafety - possible ecological risks and ethical concerns of GM crops. Genomics and proteomics: concept and applications, microarray technology and its applications. Brief account of gene silencing; antisense RNA technology and RNA interference (RNAi).

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	An Introduction to Biotechnology	Gupta P.K., (1990),	Rastogi Publications, Meerut.
2	Plant Tissue Culture. Theory Practice	Bhojwani, S.S. and M.K. Razdan (1983),	Elsevier science publications Amsterdam
3	Hand Book of Plant Cell Culture, Vols. 1 – 5.	Ammirato, P.V., D.A. Evans, N.D. Sharp and Y.P.S. Bajaj (1990).	McGraw Hill Publishing Company, New York.
4	Principles of Gene Manipulation: An Introduction to Genetic Engineering,	Old, R.W. and Primrose S.B. (1991).	Blackwell Scientific Publications, Oxford.
5	Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture,	Reinert, J. and Bajaj, Y.P.S. (1977).	Springer Verlang, Berlin.
	Plant Molecular Biology	Grierson, D., and Covey, S.N. (1984).	Black Publishers, New York

SEMESTER III

BOT659: ADVANCED CELL BIOLOGY

Course Code	**BOT659**	
Course Title	**ADVANCED CELL BIOLOGY**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of advanced cell biology to understand the molecular mechanisms of development of multicellular organisms, transport across membranes, phototrophic energy metabolism and cell cycle regulation.	
Course Outcome	CO1	Students will learn about the evolution of cells, transport of molecules among cells, signaling and their regulation.
	CO2	They will understand the molecular mechanisms of development of multicellular organisms
	CO3	They will also learn about the cancer cell and their regulation.

SYLLABUS

UNIT: I

Cells as experimental models: *Escherichia coli, Yeasts, Dictyostelium discoideum, Caenorhabditis elegans, Drosophila melanogaster, Arabidopsis thaliana.*

Fractionation and marker enzymes and functional integrity, FACS, separation techniques for membrane proteins. Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility)

UNIT: II

Structure of model membrane, lipid bilayer andmembrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electricalproperties of membranes.

Targeting proteins to endoplasmic reticulum, signal recognitionparticle, signal recognition particle receptor, protein folding and processing in ER protein export from ER; Protein sorting and export from Golgi Apparatus; SNARE hypothesis; Protein import into Mitochondria, mitochondrial genome; Import and sorting of chloroplast protein. Cellular energy transactions: Role of mitochondria and chloroplasts. Oxidative metabolism in Mitochondira: Electron transport chain, Chemiosmotic coupling, role of mitochondria in the formation of ATP.

UNIT III

Phototrophic Energy Metabolism: Light Harvesting, NADPH Synthesis, ATP Synthesis.

Signal Transduction: An Overview, Cell signalling: Modes of cell-cell signaling, hormones and their receptors, functions of cell surface receptors, pathways of intracellular signal transduction.

UNIT: IV

Cell cycle mechanism and its molecular basis, cytokinesis, Regulators of cell cycle progression: MPF, families of cyclins and cyclin dependent kinases, Growth factors, cell cycle inhibitors.

Cancer: Properties of cancer cells, types of cancer, virus-induced cancer, oncogenes tumor suppressor genes, Apoptosis. Cilia, flagella of eukaryotes and prokaryotes, their molecular mechanism.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	The World of the Cell.	Becker, W.M., Kleinsmith, L.J. and Hardin, J. (2000).	The Benjamin/Cummings Publishing Company.
2	The Cell – A Molecular Approach.	Cooper, G.M. (2000).	ASM Press, Washington, D.C.
3	Cell and Molecular Biology: Concepts and Experiments.	Karp, G. (1999).	John Wiley & Sons Inc., New York.
4	Cell Biology: Molecular and Cell Biochemistry.	Smith, C.A. and Wood, E.J. (1993).	Chapman & Hall, London
5	Cell Biology: Organelle Structure and Function.	Sadava, D.E. (1993).	Jones and Barlett Publishers, Boston, London.

SEMESTER III

BOT661: MOLECULAR GENETICS AND CELL COMMUNICATION

Course Code	**BOT661**	
Course Title	**MOLECULAR GENETICS AND CELL COMMUNICATION**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of molecular genetic transformations. To understand molecular genetic mechanism of DNA recombination.	
Course Outcome	CO1	Students will able to apply the subject knowledge to design experiments in genetic engineering
	CO2	They will able to understand the basics of Recombinant DNA technology
	CO3	They will understand the basic behind the Genetically Modified Organism

SYLLABUS (THEORY)

UNIT: I

Recombination in bacteria, genetic transformation, conjugation and transduction and their role in mapping of bacterial genes Plasmids – general properties and regulation of replication (control of copy number).

UNIT: II

Genetics of phages – molecular basis of lytic and lysogenic life cycle; genetic recombination in phage; deletion mapping Concept of gene and allele, Cis-Trans/complementation test, genetic fine structure (r-II locus).

UNIT III

Mutations: types of mutations; molecular basis of gene mutation; site directed mutagenesis Transposable elements and its molecular basis, Transposable elements in prokaryotes and eukaryotes, transposon induced mutations. Concept of proto-oncogenes and oncogenes.

UNIT: IV

DNA recombination mechanisms, molecular mechanism of recombination; Multigene families and their evolution Chromosome mapping in eukaryotes: genetic and physical mapping of genes/chromosomes, restriction mapping- concept and applicability.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Genomes.	Brown, T.A. (1999).	BIOS Scientific Publishers limited, UK.
2	Principles of Genetics.	Gardener, E.J., Simsons, M.J., and Sinustad, D.P. (1991).	John Wiley Sons Inc., New York

3	Gene VII	Lewin, B. (2000).	Oxford University Press, New York.
4	Genetics.	Strickberger, M.W. (2001).	Prentice-Hall, Inc., Englewood Cliffs, N. Jersey.
5	Evolutionary Genetics.	Smith, J. M. (1998).	Oxford University Press, New York.
6	Principles of Genetics,	Snustab, D. P., Simmons, M. J. and Jenkins, J. B. (1997).	John Wiley and Sons, Inc., New York.

SEMESTER III

BOT663: ANALYTICAL TECHNIQUES IN PLANT SCIENCES

Course Code	**BOT663**	
Course Title	**ANALYTICAL TECHNIQUES IN PLANT SCIENCES**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	The objective of this course is to expose the students to different analytical techniques which can be used to study different biological processes.	
Course Outcome	CO1	Students will able to get introduced to the fields of various instruments used in Botany/Plant Sciences including the basic principle - application and working.
	CO2	They will able to understand the basic bioinstrumentation, molecular tools and techniques essential for the understanding of life sciences and Botany.
	CO3	They will understand the basic behind the microscopy, spectrophotometry, chromatography and tracer techniques in biology.

SYLLABUS (THEORY)

UNIT: I

IMAGING AND RELATED TECHNIQUES Principles and application of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Transmission and Scanning electron microscopy – sample preparation and staining techniques.

UNIT: II

CELL FRACTIONATION AND RADIOISOTOPES Introduction, Basic Principle of Sedimentation, components and different types of centrifuges - Differential and density gradient centrifugation, analytical centrifugation, ultracentrifugation. Basic concept of radio isotope, Radioactive Isotopes and Half Life of isotopes; GM and scintillation counter, autoradiography, Principles and applications of Tracer Techniques in Biology.

UNIT: III

CHROMATOGRAPHY Basic principle and biological applications. Paper chromatography; Column chromatography, TLC, GLC, HPTLC, Ion-exchange chromatography; Size exclusion chromatography; Affinity chromatography.

UNIT: IV

SPECTROPHOTOMETRY Properties of Electromagnetic radiations; Beer Lambert's Law, Extinction Coefficient, Principle and Applications of UV-Visible light Spectroscopy. Atomic absorption and Flame emission spectroscopic techniques.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Principles and techniques of Biochemistry and molecular Biology.	Wilson, Keith and Walker, John 2009	Cambridge Univ. Press, India
2	An introduction to practical Biochemistry	Plummer, David T. 1996	Tata McGraw Hill
3	Experimental Biochemistry	Rao, B. S. and Deshpande, V. 2000	I. K. International Pvt. Ltd., New York
4	An Introduction to Practical Biochemistry.	Plummer, D.T. (1996).	Tata McGraw- Hill Publishing Co. Ltd. New Delhi. 3rd edition.
5	Short Protocols in Molecular Biology.	Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995).	John Wiley & Sons. 3rd edition
6	Plant Microtechnique and Microscopy.	Ruzin, S.E. (1999).	Oxford University Press, New York. U.S.A.

SEMESTER III

RM655: PUBLICATIONS AND RESEARCH ETHICS

Course Code	**RM655**	
Course Title	**PUBLICATIONS AND RESEARCH ETHICS**	
Course Type	Theory	
L T P	2 0 0	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic concepts of research publications and ethics.	
Course Outcome	CO1	Students will learn research philosophy and ethics.
	CO2	Students will familiarize with scientific conduct.
	CO3	They will develop publication ethics and best practices in research.

SYLLABUS
(THEORY)

UNIT: I

1. Introduction to philosophy: definition, nature and scope, concept, branches.
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions.
3. Ethics with respect to science and research
4. Intellectual honesty and research integrity

UNIT: II

1. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
2. Software tools: Use of plagiarism software like Turnitin, Urkund and other open source software tools
3. Redundant publications: duplicate and overlapping publications, salami slicing
4. Selective reporting and misrepresentation of data.

UNIT: III

1. Publication ethics: definition, introduction and importance
2. Group Discussions: Subject specific ethical issues, FFP, authorship.
3. Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad
4. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.

UNIT: IV

1. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
2. Violation of publication ethics, authorship and contributorship
3. Identification of publication misconduct, complaints and appeals
4. Predatory publishers and journals

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Research ethics.	Dooly, M., Moore, E., & Vallejo, C.	*Research-publishing. net*. (2017).
2	*Research ethics: Cases and materials*.	Penslar, R. L. (Ed.).	Indiana University Press. (1995).
3	Research ethics in the real world.	Kara, H.	Bristol: Policy Press. (2018).

SEMESTER III

BOT655: Practical Course on Discipline Specific Electives

Course Code	**BOT655**	
Course Title	**Practical Course on Discipline Specific Electives**	
Course Type	Practicum	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic concepts of tools and techniques relevant to theory.	
Course Outcome	CO1	Students will learn the biological techniques.
	CO2	Students will familiarize with the different branches of research in plant sciences.
	CO3	They will have hand-on-training experience.

GUIDELINES:

The candidate has to choose any two majors (discipline specific electives) in Semester III. According to the choice of the candidate for theory courses, a combined practical course of 2 credits will be taught. The relevant practical can be opted from the following list by the course teacher:

TENTATIVE LIST OF EXPERIMENTS

1. Staining
2. Study of microscope
3. Study of the size and shape of the cell
4. Vital staining
5. Staining of mitochondria
6. Study of chloroplast
7. Cytoplasmic streaming
8. Study of meiosis by squash and smear method
9. Study of internal structure of plant cell wall, stem, roots and leaves.
10. Study of special structure of monocot stem such as Dracena and Nyctanthes secondary growth, Kranz anatomy, Xerphytic leaves, Hydrophytic, stem leaves and root
11. Study of meiosis
12. Study of salivary and meiotic chromosome
13. Camera-Lucida diagrams of chromosome
14. Study of ultra structure of various cell organelles from electrom micrographs
15. Washing and sterilization of glassware.
16. Techniques for establishment of callus cultures and study of different types of calli viz. Compact, friable and nodular types.
17. In vitro differentiation of roots and shoots in suitable explants.
18. Demonstration of rhizogenesis in *Glycine max*.
19. DNA extraction protocol and its quantification by UV- spectrophotometric method
20. Demonstration of DNA sequencing by Sanger's dideoxy method.
21. Demonstration of RAPD, SSR and AFLP analysis.

22. Demonstration of PCR, centrifuge, deep freezer, and gel electrophoresis apparatus
23. Gel electrophoresis techniques and analysis
24. Preparation of cleared whole mounts of floral parts of polypetalae, Sympetalae and monocots for vasculature
25. Description of specimen
26. Preparation of models (plasticine/thermocol) of vascular skelton of flower and placentation
27. Location of key characters, use of keys at generic levels, after description a collective exercise
28. Location of key characters, use of keys at family levels
29. Identification of diagnostic characters and use of key (Provided) at level of various families after description has been made
30. Determination of minimum size of quadrat by species area curve method
31. Determination of minimum number of quadrat by species area curve method
32. Determination of frequency of various species by quadrat method and preparation of frequency diagram.
33. Determination of density of quadrat method
34. Determination of abundance of species by quadrat method
35. Determination of relative density by quadrat method
36. Preparation of biological spectrum of a locality

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Practical Manual of Plant Morphology	Rajan S. Sundara	Anmol Publications, Publishers & Distributors
2	Practical Manual of Plant Ecology and Plant Physiology	Sundara S. Rajan	Anmol Publisher
3	Practical Book of Biotechnology & Plant Tissue Culture	Nagar Santosh,AdhavMadhavi	S Chand & Company
4	Principles of Gene Manipulation: An Introduction to Genetic Engineering,	Old, R.W. and Primrose S.B. (1991).	Blackwell Scientific Publications, Oxford.

SEMESTER III

BOT667: DISSERTATION-I

COURSE CODE	**BOT667**	
COURSE TITLE	**DISSERTATION-I**	
Course Type	Research (Practicum)	
L T P	0 0 8	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	The main objective of project work is to introduce the candidate to the practical aspects of research work	
Course Outcome	CO1	Students will learn how to design, plan and execute the project.
	CO2	Students will become more aware of the issues to consider when making decisions about the assessment of their overall research.
	CO3	Students will build on their research competencies from their methods courses. .

GUIDELINES

1. Each student will submit synopsis and approved objectives of his/her research topic related to Botany/Life Sciences/ Plant Sciences or allied field, after consultation with the assigned supervisor.

2. Research work will be guided by supervisor of the university.

3. Student will ensure the following under the guidance of supervisor:
   (i) Design and commence an original research project
   (ii) Plan and design a discipline specific research methodology to execute the research project
   (iii) Apply scientific writing skills
   (iv) Learn to apply reference style (APA) while writing references in the synopsis.
   (v) Study and analyze research and other topics with academics in field of Botany/Plant Sciences/Life Sciences and/or Allied Health Sciences.

4. Evaluation of Dissertation-I will be done by the departmental research committee headed by the supervisor, based on submission of synopsis and approved objectives by the student.

SEMESTER III

SEMINAR AND TRAINING

Course Code	**BOT669**	
Course Title	**SEMINAR AND TRAINING**	
Course Type	Skill and personality enhancement course	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn how to research the subject topics, prepare the topic in PowerPoint presentation, deliver the presentation among students and faculty members.	
Course Outcome	CO1	Students will learn how to present a seminar among the people.
	CO2	Students will learn how to understand the topic and collect the data for presentation.
	CO3	It will impart a sense of self responsibility among the students to research, prepare and present the data.

Guidelines

1. In this course, each students will be given a topics of general understanding about the research problems and recent advances in science.
2. Student will collect the literature from books, research publications and internet sites. After collecting the literature, each students shall give a presentation, which will be evaluated by the departmental faculty.
3. It will help the students to know about new topics other than syllabus and student will develop a habit to study, prepare and deliver the presentation among the people.
4. The candidate has to present a paper pertaining to his/her topic of interest in the relevant subject and also to submit a hardcopy of the same not exceeding 1000 words.
5. Student may undergo training/on job training/departmental training and may prepare seminar on the same. Or at the department level, students shall be trained to effectively present their topics.

SEMESTER IV

SEMESTER IV

RM652: ADVANCES IN RESEARCH METHODOLOGY IN BIOLOGICAL AND CHEMICAL SCIENCES

Course Code	**RM652**	
Course Title	**ADVANCES IN RESEARCH METHODOLOGY IN BIOLOGICAL AND CHEMICAL SCIENCES**	
Course Type	Theory	
L T P	4 1 0	
Credits	5	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the advanced concepts of research methodology.	
Course Outcome	CO1	Students will learn good lab and safety practices.
	CO2	Students will learn and adopt newer and recent trends in research activities including data management.
	CO3	They will develop technical skills in computers and research.

SYLLABUS
(THEORY)

UNIT: I

General safety and accident prevention guidelines, Good personnel safety practices, Laboratory safety practices (Do's and Don'ts), Fire safety principles and fire handling, Care in handling chemicals, Understanding materials safety data sheet (MSDS), Storing and indexing of materials & chemicals, Disposal of materials, chemicals and biological wastes, First aid, Reporting accidents and requisitioning help, Combating accidents. Awareness about members of the Institutional Safety Committee and emergency contact numbers. Lab bench co-operation with colleagues and co-workers, cultivating practice of collectivism, shared responsibilities and team-spirit among fellow researchers, Advancing culture of scientific sharing and discussion in campus and lab.

UNIT: II

Maintenance of laboratory records & e-Note books, Management of data and self-navigation of research project and academic program progress (objectives, milestone as well as timeline compliance), Data integrity & archiving of observational data for re-tracing, Basic mathematical and statistical treatments of data for appropriate/rational interpretation, Reporting data in inference perspectives, Common computational tools like Process flow diagram, Chemical structure drawing, statistical analyses, Data tabulation and figure presentation (graph, bar diagram, Venn Diagram, heat maps etc.)

UNIT: III

Computer applications a) Applications of computer in Taxonomy and biodiversity study b) Use of computer in biostatistics c) Collection, preservation and maintence of animals for biodiversity study d) Proteomics- proteomic analysis by mass spectrometry and genomicsgenome wide analysis of gene structure and expression.

UNIT: IV

Analytical Tools and Techniques in Research: A General Cross-disciplinary Exposure: Flexibility of the contents but it must be within the frameworks of different faculties of AcSIR (Biological Sciences, Chemical Sciences, Physical Sciences, Engineering Sciences, and Mathematical & Information Sciences).

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	CSIR Guidelines for Ethics in Research and in Governance - CSIR (2019)	CSIR	CSIR (2019)
2	Ethics in Science Education, Research and Governance	Amit Ghosh, Ashok Kumar Singhvi -	INSA (2019)
3	Research Design: Qualitative, Quantitative, and Mixed Methods Approaches	John W. Creswell and J. David Creswell	Sage Pubns; 5th edition (2 January 2018)
4	The Craft of Research	Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams	University of Chicago Press; 4th edition (28 October 2016)
5	Research Methodology: A Step-by-Step Guide for Beginners	Ranjit Kumar	Sage Publications
6	Research Methodology : methods and techniques	CR Kothari & Gaurav Garg	New Age International Publishers; Fourth edition (1 September 2019)

SEMESTER-IV

ECONOMIC BOTANY AND PLANT GENETIC RESOURCE

Course Code	**BOT652**	
Course Title	**ECONOMIC BOTANY AND PLANT GENETIC RESOURCE**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the concepts of domestication, economic importance, origin, distribution and processes of various types of crops	
Course Outcome	CO1	Course will impart the skills in using the economically important plants and their employability in related industries and pharmaceuticals.
	CO2	Course will recognize the plants of economic importance and Utilization of plants to enable the student about utility in life.
	CO3	Economic Botany will provide knowledge the basic information necessary for communication of information concerning basic plant structure and function, the role of plants in society, and plants of the region.

SYLLABUS

UNIT: I

Origin, history, domestication, distribution, cultivation and production of cereals; wheat, rice, maize, sorghum, pearl millet, and minor millets
pulses; Pigeon pea, chick pea, black gram, green gram, cowpea, soyabean, pea, lentil, horse gram, lab lab bean, rice bean, winged bean, French bean, lima bean, sword bean.
Oil seeds; groundnut, sesame, castor, rapeseed, mustard, sunflower, safflower, niger, oil palm, coconut, and linseed

UNIT: II

Origin, history, domestication, distribution, cultivation and production of fibers; cotton, silkcotton, jute, sunnhemp, Agave, flax and mesta
Sugars; sugarcane, sugarbeet, sugarpalm, and sweet sorghum.
Fodders and green manures. Plantation crops; coconut, cocoa, tea.
Roots and tubers; potato, sweet potato, tapioca, aroids etc.
Vegetables; tomato, Brinjal, okra, cucumber, cole crops, gourds etc.

UNIT: III

Origin, history, domestication, distribution, cultivation and production offruits; mango, banana, citrus, guava, grapes, apple, plum, pear, peach, cashewnut and walnut.
Fumigatories and masticatories; tobacco, betelvine, arecanut. Medicinal and aromatic plants; sarpgandha, belladonna, cinchona, nux-vomica, vinca, mentha, glycirrhiza, plantago etc.
Narcotics; cannabis, datura, gloriossa, pyrethrum and opium. Dye-tannins-gum and resins yielding plants. Agroforestry – Multipurpose plants; subabool, *Acacia nilotica*, poplar, sesbania, neem.

Economic and non traditional plants; jojoba, guayule, jatropha, carcus etc.

UNIT: IV

History and importance of germplasm collection, gene banks, seed storage behaviour (orthodox and recalcitrant), gene bank management based by ISTA, AOSA, IPGRI guidelines, transgenic and biosafety issues.

Principle, objective, and relevance of plant quarantine, regulation and plant quarantine setup in India, detection and post quarantine operation, domestic quarantine. Principle and strategies of Plant Genetic Resource (PGR) evaluation, germplasm characterization and diversity analysis, concept of core collection, descriptor and descriptor state for data scoring, maintenance of active collection and self-cross pollinated and vegetative propagated crops, perennials and wild relatives. Post-harvest handling of germplasm and PGR database management.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Economic Botany	Kocchar SL	Mac Millan India
2	Hill's Economic Botany	Sharma, O.P.,	Tata McGraw Hill
3	Plants and Society	Swaminathan, M.S. and Kocchar, S.L.	MacMillan Publications.
4	Economic Botany- Plants in Our World	Simpson, B.B. and Conner-Ogorzaly. E.M.	McGraw-Hill Book Company

SEMESTER IV

BOT654: ETHNOBOTANY AND PHARMACOGNOSY

Course Code	**BOT654**	
Course Title	**ETHNOBOTANY AND PHARMACOGNOSY**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn about the traditional ethnobotanical wisdom from the tribal people and its role in development of modern medicine	
Course Outcome	CO1	They will learn about the use of different plants and its parts in traditional by many ethnic people
	CO2	They will learn about the medicinal use of plants
	CO3	They will learn about the different types of methodologies used by local people to cure many diseases and their pharamacognosy

SYLLABUS
(THEORY)

UNIT: I

Ethnobotany: 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.

Traditional Systems of Medicine: Brief history of use of medicinal herbs; Introduction to indigenous systems of medicines- Ayurveda, Unani and Siddha system of medicine.

UNIT: II

Plants Used by the Tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous usesd Sacred plants.

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*.

Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Taxus wallichiana, Trichopus zeylanicus, Artemisia, Withania*

UNIT: III

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

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.

UNIT: IV

Pharmacognosy and pharmacopial standards of *Adhatoada vasica, Arctium lapa, Terminalia belerica, Bidens tripartite, Sida rhombifolia, Symplocos racemose, Syzygium aromaticum, Tectona grandis.*

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Traditional Systems of Medicine	Abdin, M.Z. and Y.P. Abrol, Y.P. 2006.	Narosa Publishing House, New Delhi.
2	Plants, People and Culture: The Science of Ethnobotany.	Balick, M.J. and Cox, P.A. 1996.	The Science of Ethnobotany. Scientific American Library
3	Ethnobotany: Principles and Applications	Colton C.M. 1997.	John Wiley and Sons.
4	Wealth of India (Vol 1-13)		CSIR New Delhi

SEMESTER IV

BOT656: PLANT NATURAL RESOURCES, CONSERVATION AND SUSTAINABLE DEVELOPMENT

Course Code	**BOT656**	
Course Title	**PLANT NATURAL RESOURCES, CONSERVATION AND SUSTAINABLE DEVELOPMENT**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn about the different plant natural resources their conservation and sustainable development	
Course Outcome	CO1	They will learn about the different types of natural resources available
	CO2	They will learn to about the sustainable use of these energy processes
	CO3	They will learn about the economic, social and environmental impact of utilization of natural resources

SYLLABUS

UNIT: I

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Interrelationships among different types of natural resources. Concern on Productivity issues. Ecological, social and economic dimension of resource management.

UNIT: II

Different types of resources, their production, management and sustainability; Forest resources, Land resources, Water resources, Energy resources, Food resources, Fish and other marine resources, Mineral resources, Resource Management Paradigms.

Management of Common International Resources: Ocean, climate, International fisheries and management commissions; Antarctica: the evolution of an international resource management regime

UNIT: III

Global and local governance, challenges of good governance. Ostrom design principles and basic frameworks, organizational structure and stakeholders in NRM and livelihood. Natural Resource Governance in rapidly changing world. Local utilization and institutions: Joint Forest Management Committees (JFMCs), watershed committees, irrigation committees, Forest Rights Act (FRA) committees, Biodiversity Management Committees (BMCs), etc.

International and National efforts: CITES and other international treatiesand conventions, roles of international organizations and NGOS with special reference to UN and specialized agencies, institutional regulatory bodies and authorities: direct intervention by the state, green business and green ethics, stakeholder analysis, understanding and managing governance issue, governance tactics and tools, CSR (Corporate Social Responsibility) as a tool for sustainable NRM based business.

UNIT: IV

Concept of Economic value, relevance of environmental economics, ecosystems services, direct and indirect economic benefit from – forest ecosystems, mountain ecosystems, mineral and water resources, ecotourism.

Conservation and management, cost / benefit analysis, methods of costing, cost criteria, evaluating alternative projects, operational vs. total costs, determining benefiting vs. comprehensive stakeholders Application of resource accounting Methods of pricing resources- example forest and mineral resources.

Role of national and international organizations in the promotion of sustainable natural resource use and management.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Ecology of Natural Resources	Francois Ramade 1984.	John Wiley & Sons Ltd
2	Nature and the Marketplace: Capturing The Value Of Ecosystem Services	Heal, Geoffrey. 2000.	Island Press
3	A New Century for Natural Resources Management.	Knight, Richard L., editor, et al. 1995	Island Press
4	Introduction to Forestry and Natural Resources	Donald L. Grebner, Peter Bettinger and Jacek P. Siry	Elsevier
5	Environmental and Natural Resource Economics: A Contemporary Approach, 2nd edition.	Harris, J.M. 2006	Houghton Mifflin
6	Economics: Natural Resources Scarcity and Development	Barber, E. 1989.	Earthscan

SEMESTER IV

BOT658: BIOINFORMATICS

Course Code	**BOT658**	
Course Title	**BIOINFORMATICS**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To understand application of bioinformatics in molecular biology and its implication	
Course Outcome	CO1	They will learn about the different bioinformatics tools
	CO2	They will learn to analyze the massive molecular data with the use of bioinformatics software
	CO3	They will learn to understand the molecular and computation integration.

SYLLABUS

UNIT: I

Network: Introduction, objectives, applications, types of network, components of network, elementary idea of OSI model, network topologies; star, ring, bus, hybrid, tree. Internet: development, management, services available, various applications of Internet Overview of Bioinformatics: Introduction, bioinformatics and the internet, useful bioinformatics sites on the WWW.

UNIT: II

Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Meta symbols, Pattern modifiers, Subroutines. Applications of PERL in Bioinformatics: Storing DNA sequence, DNA to RNA transcription, Finding motifs, Counting nucleotides, Generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA.

UNIT: III

Biological Databases: Introduction, classification of databases on the basis of type of molecule, nucleic acid, protein sequence and structure databases, classification of databases on the basis of source and type of information. Data Mining Methods for Sequence Analysis: Data retrieval with Entrez and DBGET/ Link DB and SRS (Sequence retrieval system). Analysis of Data: sequence similarity search, amino acid substitution matrices, web-based tools for sequence searches (FASTA and BLAST), motif analysis.

UNIT: IV

Sequence Alignment: Multiple sequence alignment and family relationships, phylogenetics. Structural Bioinformatics: Obtaining, viewing and analyzing structural data, structural alignment, classification of known three dimensional structure : CATH and SCOP, structure prediction by comparative modeling. Applications of Bioinformatics.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Bioinformatics: A practical guide to the analysis of genes and proteins.	Baxevains, A.D. and Ouellete, B.F.F. (2001)	John Wiley and Sons, NewYork.
2	Learning Perl, 4th Edition.	Foy, B.D. Phoenix, T and Schwartz, R. L. (2005)	O' Rilley
3	Bioinformatics: Methods and Protocols.	Misenere, S. and Krawetz, S.A. (2001).	Humana Press, Totowa, New Jersey
4	Essentials of Genomics and Bioinformatics	Sensen, C.W. (Ed.) (2002)	Wiley-VCH, Verlag GmbH Winheim

SEMESTER IV

BOT660: ADVANCED PHYSIOLOGY AND MOLECULAR BIOLOGY

Course Code	**BOT660**	
Course Title	**ADVANCED PHYSIOLOGY AND MOLECULAR BIOLOGY**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To understand the advanced physiological processes on the bases of molecular relation in the plants	
Course Outcome	CO1	They will learn about the core molecular basics of different processes taken place in the cell
	CO2	They will understand the molecular bases of photosynthesis and respiration
	CO3	They will learn about the different types of molecular techniques.

SYLLABUS

UNIT: I

Regulatory action of uncoupling agents of photophosphorylation; energy loss during vectorial electron transfer in light reaction; genetics of RUBISCO subunit assembly and organization in plants; Regulation of C_3, C_4, CAM and C_2 cycle in photosynthesis. Physiological and ecological aspects of photosynthesis

UNIT: II

Regulation of key respiratory enzymes with particular emphasis on phosphofructo kinase, glyceraldehydes-3-phosphate dehydrogenase and pyruvate dehydrogenase; mechanism of action of inhibitors of oxidative phosphorylation; arrangement and organization of protein complexes in mitochondrial electron transport chain.

UNIT: III

Process of biological nitrogen fixation; nodule formation-role of NOD genes and nodulins; NIF genes; molecular biology of nitrogenase complex; regulation of nitrogen fixation; nitrogen assimilation in higher plants.

Regulation of Auxin, Cytokinins, Gibberellin, Abscisic acid, Polyamines Jasmonic acid Salicylic acid, Strigolactones. Stomatal movement; morphogenesis; circadian rythms; regulation of plant movements.

UNIT: IV

Methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques.

Southern/Northern/ Western blotting.Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Generation of genomic and cDNA libraries. Protein sequencing methods, detection of post-translation modification of proteins.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Principles and techniques of Biochemistry and molecular Biology.	Wilson, Keith and Walker, John 2009	Cambridge Univ. Press, India
2	An introduction to practical Biochemistry	Plummer, David T. 1996	Tata McGraw Hill
3	Experimental Biochemistry	Rao, B. S. and Deshpande, V. 2000	I. K. International Pvt. Ltd., New York
4	Plant Physiology	Taiz and Zeinger	Sinauer Associates

SEMESTER IV
BOT662: INSTRUMENT PRINCIPLE AND APPLICATIONS

Course Code	**BOT662**	
Course Title	**INSTRUMENT PRINCIPLES AND ANALYTICAL TECHNIQUES**	
Course Type	Theory	
L T P	4 0 0	
Credits	4	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the principles of various instruments used in life sciences	
Course Outcome	CO1	This course will give basic knowledge on instrumental methods of biological, chemical and physical analysis.
	CO2	It will train students to perform practical work on real samples to get acquainted with instrumentation and equipment which is needed in monitoring of various samples.
	CO3	Students will learn the working culture and practice of science which further ready him future projects.

SYLLABUS

UNIT: I

Basic Principles of research techniques and safety measures: Aims of Lab investigation, Experimental designs, SI units, safety against Chemical, Physical and Biological hazards. Waste disposals.

Functioning and application of microtomy, stains and staining techniques; Maceration; Principle of fixation, types of fixatives and their applications.

UNIT: II

Basics of Buffers and Solutions.

pH meter – Principles and applications.

ELECTROPHORESIS Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE. Immunoelectrophoresis, Isoelectrofocussing, Capillary Electrophoresis, Electrophoresis and Isoelectric focusing: Principle, working and applications of Electrophoresis. Colorimetery and Spectrophotometery: Lambert Beer Law, Basic components, applications.

UNIT: III

CENTRIFUGATION: Principle, functioning and applications of low speed, high speed and ultracentrifugation.

Polymerase Chain Reaction, DNA sequencing. Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing.

UNIT: IV

SPECTROSCOPY: Principle, functioning and applications of spectrofluorometry. Mass spectrometry: X-ray diffraction; X-ray crystallography; Principle & biological applications of IR & NMR.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Principles and techniques of Biochemistry and molecular Biology.	Wilson, Keith and Walker, John 2009	Cambridge Univ. Press, India
2	An introduction to practical Biochemistry	Plummer, David T. 1996	Tata McGraw Hill
3	Experimental Biochemistry	Rao, B. S. and Deshpande, V. 2000	I. K. International Pvt. Ltd., New York

SEMESTER IV

BOT664: Practical Course on Discipline Specific Electives

Course Code	**BOT664**	
Course Title	**Practical Course on Discipline Specific Electives**	
Course Type	Practicum	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic concepts of tools and techniques relevant to theory.	
Course Outcome	CO1	Students will learn the biological techniques.
	CO2	Students will familiarize with the different branches of research in plant sciences.
	CO3	They will have hand-on-training experience.

GUIDELINES:

The candidate has to choose any two majors (discipline specific electives) in Semester IV. According to the choice of the candidate for theory courses, a combined practical course of 2 credits will be taught. The relevant practical can be opted from the following list by the course teacher:

TENTATIVE LIST OF EXPERIMENTS

1. Study of DNA replication mechanism
2. Demonstration of cell cycle, mitosis and meiosis.
3. Identification of different stages of mitosis and meiosis from temporary and permanent slides.
4. Study of morphology of metaphase chromosomes from onion root meristems.
5. Study of various cell organelles using prepared slides and models
6. Demonstration of microscopes (Simple compound microscope, phase contrast, fluorescence, SEM)
7. Isolation of plant DNA and its quantification by spectrophotometric method.
8. Plant DNA extraction using standard protocols.
9. Aseptic culture techniques for establishment and maintenance of cultures
10. Isolation of plant DNA and its quantification by spectrophotometric method
11. DNA check run by Agarose Electrophoresis
12. Preparation of different growth media for bacteria
13. Estimation of growth rate in different bacteria and preparation of growth curve.
14. Isolation of different bacterial colonies by streaking method.
15. Preparation of bacterial colonies by plating method.
16. Preparation of cleared whole mounts of floral parts of polypetalae, Sympetalae and monocots for vasculature
17. Description of specimen
18. Preparation of models (plasticine/thermocol) of vascular skelton of flower and placentation
19. Location of key characters, use of keys at generic levels, after description a collective exercise
20. Location of key characters, use of keys at family levels
21. Identification of diagnostic characters and use of key (Provided) at level of various families after description has been made

22. Determination of minimum size of quadrat by species area curve method
23. Determination of minimum number of quadrat by species area curve method
24. Determination of frequency of various species by quadrat method and preparation of frequency diagram.
25. Determination of density of quadrat method
26. Determination of abundance of species by quadrat method
27. Determination of relative density by quadrat method
28. Preparation of biological spectrum of a locality
29. To study the seeds of various cereal crops, oil and fibre crops and collect the seed specimen of each crop
30. To study and collect the various types of woods of trees and its economic importance from campus and surrounding areas
31. Morphology, anatomy, microchemical tests for stored food materials: Wheat, jute, rice, maize, chickpea (Bengal gram), potato, sugarcane Changes in catalase in response to biotic/abiotic stress
32. Learn the processing of various plant products (cotton, jute, rubber, essential oils, sugarcane etc.)
33. Visit to a nearest industry to see the processing of the economic important crop in the region.
34. Practicals pertaining to Chromatographic techniques: Column Chromatography (Exclusion and Affinity Chromatography), Paper Chromatography and Thin Layer Chromatography Changes in protein levels in response to cold stress by SDS-PAGE
35. Practicals pertaining to centrifugation.
36. Practical pertaining to Electrophoresis
37. Extraction and separation of chloroplast pigments in the plant material by partitioning into different solvent systems.
38. Separation of chloroplast pigments by thin layer chromatography.
39. To study principles of colorimetry and spectrophotometry.
40. Extraction of chloroplast pigments from leaves and preparation of absorption spectrum of photosynthetic pigments and anthocyanins.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	Practical Manual of Plant Morphology	Rajan S. Sundara	Anmol Publications, Publishers & Distributors
2	Practical Manual of Plant Ecology and Plant Physiology	Sundara S. Rajan	Anmol Publisher
3	Practical Applications of Plant Molecular Biology	Robert J. Henry	Nelson Thornes
4	Plant Molecular Biology — A Laboratory Manual	Melody S. Clark	Springer-Verlag Berlin Heidelberg
5	Principles and techniques of Biochemistry and molecular Biology.	Wilson, Keith and Walker, John 2009	Cambridge Univ. Press, India
6	An introduction to practical Biochemistry	Plummer, David T. 1996	Tata McGraw Hill
7	Experimental Biochemistry	Rao, B. S. and Deshpande, V. 2000	I. K. International Pvt. Ltd., New York

SEMESTER III

BOT668: DISSERTATION-II

COURSE CODE	**BOT668**	
COURSE TITLE	**DISSERTATION-II**	
Course Type	Research (Practicum)	
L T P	0 0 16	
Credits	8	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	The main objective of project work is to introduce the candidate to the practical aspects of research work	
Course Outcome	CO1	Students will learn how to design, plan and execute the project.
	CO2	Students will become more aware of the issues to consider when making decisions about the assessment of their overall research.
	CO3	Students will build on their research competencies from their methods courses. .

GUIDELINES

1. Each student will complete his/her research work and must submit the complete dissertation as per the University format

2. Research work will be guided by supervisor of the university.

3. Evaluation of Dissertation-II will be done by the institutional RDC (Research Degree Committee).

SEMESTER IV

RM656: SCIENTIFIC AND TECHNICAL WRITING

Course Code	**RM656**	
Course Title	**SCIENTIFIC AND TECHNICAL WRITING**	
Course Type	Practicum	
L T P	0 0 4	
Credits	2	
Course prerequisite	B. Sc. Medical/Life-sciences/Allied field with Botany as one main subject.	
Course Objective	To learn the basic concepts of research publications and ethics.	
Course Outcome	CO1	Students will learn research philosophy and ethics.
	CO2	Students will familiarize with scientific conduct.
	CO3	They will develop publication ethics and best practices in resaerch.

SYLLABUS
(PRACTICUM)

1. Introduction to Databases and research metrics
2. Indexing databases
3. Citation databases: Web of Science, Scopus, etc.
4. Research Metrics
5. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
6. Metrics: h-index, g index, i10 index, altmetrics
7. Basics of Writing & Communication of Research Results and Inferences
8. Scientific writing (including Language proficiency)
9. State-of-the-art scientific literature comprehension
10. Art and ethics of writing research report/paper
11. Writing of an abstract for scientific community and general public
12. Skills of making Powerpoint presentation
13. Art of web-meeting interactions & presentations using latest video-meeting modes
14. Letter writing and official correspondence
15. Introduction to Open Access Publishing tools
16. Open access publications and initiatives: SHERPA/RoMEO online resource to check publisher copyright & self archiving policies
17. Software tool to identify predatory publications developed by SPPU
18. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Text and Reference books:

S.No.	Name/Title	Author	Publisher
1	*Scientific writing: easy when you know how*.	Peat, J., Elliott, E., Baur, L., & Keena, V.	John Wiley & Sons. (2013)
2	*Scientific writing= thinking in words*.	Lindsay, D.	Csiro Publishing. (2020).
3	Research ethics.	Dooly, M., Moore, E., & Vallejo, C.	*Research-publishing. net*. (2017).