



CMS COLLEGE KOTTAYAM

(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University, Kottayam, Kerala

**CURRICULUM FOR UNDER GRADUATE
PROGRAMME**

BACHELOR OF SCIENCE IN BOTANY

**UNDER CHOICE BASED CREDIT SYSTEM 2018
(With effect from 2018)**

Approved by the Board of Studies on 26-03-2018

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Board of Studies

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ACKNOWLEDGEMENT

The designing of the B. Sc. Programme curriculum of the Department of Botany C M S College (Autonomous), Kottayam, was a yearlong process, since it involved the purposeful, deliberate and systematic organization of the curricula of the various core, complementary and extra credit courses of the programme. Care is taken to align the learning goals and outcome of the said courses with the programme specific outcome that in turn is set in line with the vision and mission of the Institution. The ultimate goal of curriculum design is to improve student learning and also aid teachers in planning out the methods that they would adopt for transacting the syllabus and identifying what will be done, when and by whom.

On behalf of the Botany Department, I thank the Management, Principal and IQAC, CMS College for organizing umpteen sessions by experts and advisors from the National Educational arena to train us teachers in the science and art of Curriculum design.

Dr. T. P. Sasikumar, educationalist, writer, science communicator, motivational speaker, life skills trainer and founder of “Shiksha” that promotes learning from all quarters needs a special mention amongst our galaxy of resource persons, since he conveyed to us the need for redefining the learning pattern in today’s generation. We extend our heartfelt thanks to Prof. N. J. Rao, former Professor, Indian Institute of Science and advisor to University Grants Commission for giving us an insight into the current UGC requirements in curriculum design.

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We owe our gratitude to members of the Board of studies of Botany and Chairman of the Curriculum Review Workshop of Botany Dr. Anil Kumar M., Assistant professor, U. C. College, Aluva and Member, Board of studies M. G. University for their constructive and valuable inputs towards the design of the present curriculum. Thanks are due to all my colleagues of the Department of Botany especially Ms. Annie T. John, Ms. Sheeba Thomas and Ms. Christine Sara Abraham for their whole hearted support in the design of the B.Sc. Botany Curriculum.

PREFACE

The Botany curriculum is a guide to both students and teachers to explore each one's talents and abilities during the course of its progress from the beginning of the first academic year to the end of the third year. This programme concerns much more than simply the content of the course as presented here. It concerns the lifelong process of personal growth from the student – teacher interactions that every student acquires from here. It is on this process that I would like to reflect on.

Each student comes to this course from different backgrounds with different personal interests, skills, and styles. Each will therefore, in very subtle ways, get something very different from this course. We will come together during the class hours to discuss and involve ourselves with a variety of ideas and exercises. We hope that the common thread among these diverse learning experiences will be an appreciation of the effective "two-way" communication between the teacher and the taught. This indeed is a skill that must be developed and continually refined by the student. We the teachers of the Botany department hope that during your time in the department, the students will recognize some ways in which to refine their knowledge base in the subject, ethical values, communication skills and ways in which you might continue this process even after your programme here ends. Although, it might be easy to think of a set of behaviours that we want our students to have so that we can get on with the curriculum that we need to cover, it becomes apparent that we teachers, need to provide specific opportunities for students to practice these habits. Habits are formed only through continuous practice. And to practice the habits, the transaction of the curriculum and its assessments must provide generative and rich opportunities for using them. For example, when we are concerned about persistence, we need to provide the kinds of problems and rich tasks that engage students and hold their attention long enough for persistence to be important. When we are concerned with the habit of metacognition, we need to provide opportunities for students to plan for, monitor, thoughtfully reflect upon, and become explicitly aware of how they are thinking. We, as teachers, need to interact with their metacognitive thinking so that we understand better how to reach each student and motivate learning. We need to continuously be asking, what have we done today that creates the opportunity for expressing wonderment and awe? Has there been a problem, an event, an observation that really deserves the exclamation "Awesome!"?

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO)

At the completion of the Undergraduate Programme, the student will be able to accomplish the following outcomes:

GPO No.	Graduate Programme Outcomes
GPO.1	Critical Thinking: Take an informed and analytical approach to learning and demonstrate in-depth knowledge of the subject and give opinion(s) supported by logical reasoning that one have judged to be appropriate and understanding different approaches and using them
GPO.2	Effective Communication: Demonstrate proficiency in communicating competently in groups and organizations, competence in interpersonal communication; possess skills to effectively deliver formal and informal presentations to a variety of audiences in multiple contexts
GPO.3	Social Interaction: Foster social skills and peer interaction enabling them to make all people feel valued and respect their differences by being responsible citizens for creating a socially inclusive society
GPO.4	Ethical Standards: Recognize values such as justice, trust, equity, fairness, kindness and develop a commitment to meeting and upholding standards of ethical behavior in all walks of life and comprehending the moral dimensions of decisions and actions
GPO.5	Environmental Consciousness: Discern the issues of environmental contexts and engages in promoting values and attitudes that claim coexistence and sustainable living with reduced, minimal, or no harm upon ecosystems
GPO.6	Lifelong Learning: Acquire the skill to be an independent lifelong learner embracing real-time changes in the socio-technological context, promoting continuous development and improvement of the knowledge and skills needed for employment and personal fulfillment

PROGRAMME SPECIFIC OUTCOMES (PSO)

SL NO	PSO No.	Intended Programme Specific Outcomes <i>Upon completion of the B.Sc. Botany Degree Programme, the graduates will be able to:</i>	GPO No
1	PSO-1	Identify the different groups of botany and appreciate plant diversity	1,5
2	PSO-2	Understand the current developments in the different areas of Botany	6
3	PSO-3	Analyze and apply the methodologies and techniques learnt during the course of studying botany	6
4	PSO-4	Integrate the knowledge acquired in botany to solve problem, take real time decisions and innovate, while working with plants	1,2
5	PSO-5	Share social and environmental consciousness with their fellow citizens	5,4
6	PSO-6	Use concept, tools and techniques related to Chemistry and Zoology to acquire knowledge and its application in Botany	6
7	PSO-LG	Organize and deliver relevant applications of knowledge through effective written verbal, graphical/ virtual communication and interact productively with people from diverse background.	3

PROGRAMME DESIGN

B. Sc. BOTANY PROGRAMME

The UG programme in Botany includes(a) Common Courses(b) Core Courses(c)Complementary Courses(d) Open Course(e) Choice based Course andProject work.No course shall carry more than 5 credits. The student shall select one Open course in Semester V offered by different departments in the same institution. The number of courses for the programme should contain 12 compulsory core courses,1open course,1elective course from the frontier area of the core courses, 6 core practical courses, 1project work, 8 complementary courses and 2 complementary practical courses. There should be 10 common courses, or otherwise specified, which includes the first and second language of study. A student shall acquire minimum 120 credits for successfully completing this UG Programme.

Sl. No.	Coursetype	No.of courses	Total credits
1	Common course I-English	6	22
2	Common course II– Additional language	4	16
3	Core	12	34
4	Core Practical	12	12
5	Complementary I	4	10
6	Complementary IPractical	4	04
7	Complementary II	4	10
8	Complementary IIPractical	4	04
9	Choice based Open course	1	3
10	Choice based elective	1	3
11	Project work	1	2
Total		53	120

**PROGRAMME STRUCTURE – B.Sc. Botany
(Semester wise)**

SEMESTER I					
Course Code	Title of the Course	Course Category	Hours /week	Total hours	Credits
EN1811501	Fine-tune Your English	Common I - English 1	5	90	4
EN1811502	Pearls from the Deep	Common I - English 2	4	72	3
	Additional Language	Common Course			
HN1811501	Prose and One Act Plays	Common II - Hindi 1			
ML1811501	<i>Kathasahithyam</i>	Common II - Malayalam 1	4	72	4
SC1811501	Poetry/ Grammar & History of Syriac Language & Literature	Common II – Syriac 1			
BY1811101	Methodology of science and an introduction to botany	Core 1	2	36	2
BY1811601	Methodology of science and an introduction to botany	Core Practical 1	2	36	1
ZY1811201	Non chordate diversity	Complementary 1 - Zoology	2	36	2
ZY1811701	Non chordate diversity	Complementary 1– Zoology Practical	2	36	1
CH1811201	Basic Theoretical and Analytical Chemistry	Complementary 1-Chemistry	2	36	2
CH1811701	Volumetric analysis	Complementary 1-Chemistry Practical	2	36	1
		Total	25	450	20
SEMESTER II					
Course Code	Title of the Course	Course Category	Hours /week	Total hours	Credits
EN1812503	Issues that Matter	Common I - English 3	5	90	4
EN1812504	Savouring the Classics	Common I - English 4	4	72	3
	Additional Language	Common Course			
HN1812503	Short stories and Novel	Common II- Hindi 2	4	72	4
ML1812504	<i>Kavitha</i>	Common II- Malayalam 2			

SC1812503	Poetry/ Grammar & History of Syriac Literature	Common II - Syriac 2			
BY1812102	Microbiology, mycology and plant pathology	Core 2	2	36	2
BY1812602	Microbiology, mycology and plant pathology	Core Practical 2	2	36	1
ZY1812202	Chordate Diversity	Complementary Zoology 2	2	36	2
ZY1812702	Chordate Diversity	Complementary Zoology 2- Practical	2	36	1
CH1812202	Basic Organic Chemistry	Complementary Chemistry 2	2	36	2
CH1812702	Volumetric analysis	Complementary Chemistry 2- Practical	2	36	1
		Total	25	450	20

SEMESTER III

Course Code	Title of the Course	Course Category	Hours /week	Total hours	Credits
EN1813505	Literature and/ as Identity	Common I - English 5	5	90	4
	Additional Language	Common Course			
HN1813505	Poetry/Grammar and Translation	Common II-Hindi 3			
ML1813507	<i>Drishyakalashahithyam</i>	Common II- Malayalam 3	5	90	4
SC1813505	Prose, Grammar & Literature	Common II- Syriac 3			
BY1813103	Phycology and Bryology	Core 3	3	54	3
BY1813603	Phycology and Bryology	Core Practical 3	2	36	1
ZY1813203	Physiology and Immunology	Complementary Zoology 3	3	54	3
CH1813203	Physiology and Immunology	Complementary Zoology 3- Practical	2	36	1
CH1813203	Advanced Inorganic and Organic Chemistry	Complementary Chemistry 3	3	54	3
CH1813703	Organic analysis	Complementary Chemistry 3- Practical	2	36	1
		Total	25	450	20

SEMESTER IV

Course Code	Title of the Course	Course Category	Hours /week	Total hours	Credits
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EN1814507	Illuminations	Common I - English 6	5	90	4
	Additional Language	Common Course			
HN1814506	Drama and Long Poem	Common II- Hindi 4			
ML1814508	<i>Malayala Gadyarachanakal</i>	Common II- Malayalam 4	5	90	4
SC1814506	Poetry, Grammar & Syriac Heritage in India	Common II- Syriac 4			
BY1814104	Pteridology, Gymnosperms and Paleobotany	Core 4	3	54	3
BY1814604	Pteridology, Gymnosperms and Paleobotany	Core Practical 4	2	36	1
ZY1814204	Applied Zoology	Complementary Zoology 4	3	54	3
ZY1814704	Applied Zoology	Complementary Zoology 4- Practical	2	36	1
CH1814204	Advanced Bio Organic Chemistry	Complementary Chemistry 4	3	54	3
CH1814704	Organic Analysis	Complementary Chemistry 4- Practical	2	36	1
		Total	25	450	20
SEMESTER V					
Course Code	Title of the Course	Course Category	Hours /week	Total hours	Credits
BY1815105	Anatomy, Reproductive Botany and Microtechnique	Core 5	3	54	3
BY1815605	Anatomy, Reproductive Botany and Microtechnique	Core Practical 5	2	36	1
BY1815106	Research Methodology, Biophysics and Biostatistics	Core 6	3	54	3
BY1815606	Research Methodology, Biophysics and Biostatistics	Core Practical 6	2	45	1
BY1815107	Plant Physiology and Biochemistry	Core 7	3	54	3
BY1815607	Plant Physiology and Biochemistry	Core Practical 7	2	45	1
BY1815108	Environmental Science and Human Rights	Core 8	3	54	3
BY1815608	Environmental Science and Human Rights	Core Practical 8	2	36	1
BY1816401	Agri-based microenterprises	Open Course	4	72	3

		Total	25	450	19
SEMESTER VI					
Course Code	Title of the Course	Course Category	Hours /week	Total hours	Credits
BY1816109	Genetics, Plant breeding and Horticulture	Core 9	3	54	3
BY1816609	Genetics, Plant breeding and Horticulture	Core Practical 9	2	45	1
BY1816110	Cell and Molecular Biology	Core 10	3	54	3
BY1816610	Cell and Molecular Biology	Core Practical 10	2	36	1
BY1816111	Angiosperm Morphology, Taxonomy and Economic Botany	Core 11	3	72	3
BY1816611	Angiosperm Morphology, Taxonomy and Economic Botany	Core Practical 11	2	45	1
BY1816112	Biotechnology and Bioinformatics	Core 12	3	54	3
BY1816612	Biotechnology and Bioinformatics	Core Practical 12	2	36	1
BY1816301	Agribusiness	Choice Based Course (Elective)	3	54	3
BY1816801	Project work		-	-	2
		Total	25	450	21

PROGRAMME STRUCTURE – B.Sc. Botany
(Category wise)
COMMON COURSES

Sl.No	Course Name		Credit	Hrs/ W	Semester
1	Common I -English 1 Fine-tune Your English		4	5	1
2	Common I- English 2 Pearls from the Deep		3	4	1
3	Common I -English 3 Issues that Matter		4	5	2
4	Common I- English 4 Savouring the Classics		3	4	2
5	Common I – English 5 Literature and/ as Identity		4	5	3
6	Common I – English 6 Illuminations		4	5	4
7	Additional language –1		4	4	1
	Prose and One Act Plays	Common II - Hindi 1			
	<i>Kathasahithyam</i>	Common II - Malayalam 1			
	Poetry/ Grammar & History of Syriac Language & Literature	Common II –Syriac 1			
8	Additional language –1		4	4	2
	Short stories and Novel	Common II - Hindi 2			
	<i>Kavitha</i>	Common II- Malayalam 2			
	Poetry/ Grammar & History of Syriac Literature	Common II –Syriac 2			
9	Additional Language - 1		4	4	3
	Poetry Grammar and Translation	Common II -Hindi 3			
	<i>Drishyakalasaahithyam</i>	Common II-Malayalam 3			
	Prose, Grammar & Literature	Common II- Syriac 3			
10	Additional Language – 1		4	4	4
	Drama and Long Poem	Common II- Hindi 4			
	<i>Malayala Gadyarachanakal</i>	Common II-Malayalam 4			
	Poetry, Grammar & Syriac Heritage in India	Common II- Syriac 4			
Total			38	45	

CORE COURSES

Sl.No	Course Name	Credit	Hrs/W	Semester
1	Methodology of Science and an Introduction to Botany	2	2	1
2	Microbiology, Mycology and Plant Pathology	2	2	2
3	Phycology and Bryology	3	2	3
4	Pteridology, Gymnosperms and Paleobotany	3	2	4
5	Anatomy, Reproductive Botany, Microtechnique	3	2	5
6	Research Methodology, Biophysics and Biostatistics	3	2	5
7	Plant Physiology and Biochemistry	3	2	5
8	Environmental sciences and Human Rights	3	2	5
9	Genetics, Plant Breeding and Horticulture	3	2	6
10	Cell and Molecular Biology	3	2	6
11	Angiosperm morphology, Taxonomy and Economic Botany	3	2	6
12	Biotechnology and Bioinformatics	3	2	6
13	Investigatory project work done individually or in groups	2	-	6
Total		36	24	

CORE COURSES-PRACTICAL

Sl.No	Course Name	Credit	Hrs/W	Semester
1	Methodology of Science and an Introduction to Botany	1	2	1
2	Microbiology, Mycology and Plant Pathology	1	2	2
3	Phycology and Bryology	1	2	3
4	Pteridology, Gymnosperms and Paleobotany	1	2	4
5	Anatomy, Reproductive Botany, Microtechnique	1	2	5
6	Research Methodology, Biophysics and Biostatistics	1	2	5
7	Plant Physiology and Biochemistry	1	2	5
8	Environmental sciences and Human Rights	1	2	5
9	Genetics, Plant Breeding and Horticulture	1	2	6
10	Cell and Molecular Biology	1	2	6
11	Angiosperm morphology, Taxonomy and Economic Botany	1	2	6
12	Biotechnology and Bioinformatics	1	2	6
Total		12	24	

COMPLEMENTARY COURSES- THEORY

Sl.No	Course Name	Credit	Hrs/W	Semester
1	Non chordate diversity	2	2	1
2	Basic Theoretical and Analytical Chemistry	2	2	1
3	Chordate Diversity	2	2	2
4	Basic Organic Chemistry	2	2	2
5	Physiology and Immunology	3	3	3
6	Advanced Inorganic and Organic Chemistry	3	3	3
7	Applied Zoology	3	3	4
8	Advanced Bio Organic Chemistry	3	3	4
Total		20	20	

COMPLEMENTARY COURSES- PRACTICAL

Sl.No	Course Name	Credit	Hrs/W	Semester
1	Non chordate diversity	1	2	1
2	Volumetric analysis	1	2	1
3	Chordate Diversity	1	2	2
4	Volumetric analysis	1	2	2
5	Physiology and Immunology	1	2	3
6	Organic analysis Advanced Inorganic and Organic Chemistry	1	2	3
7	Applied Zoology	1	2	4
8	Organic analysis	1	2	4
Total		08	16	

Open Course - Choice Based

Sl.No	Course Name	Credit	Hrs/Wk	Semester
1	Open Course –Agri Based Microenterprises	3	4	5

Choice Choice Based- Elective

Sl.No	Course Name	Credit	Hrs/Wk	Semester
1	Agribusiness	3	3	6

Extra credit courses

Sl.No	Course Name	Credit
1	Processing of fruits and vegetables	2
2	Solid waste management	2

Add-on Courses

Sl.No	Course Name
1	Medicinal and Ornamental Plants

DETAILED SYLLABUS OF THE COURSES

OFFERED BY THE DEPARTMENT

SEMESTER I				
Course Code	Title of the Course	Course Category	Hours/week	Credits
EN1811501	Fine-tune Your English	Common I -English 1	5	4
EN1811502	Pearls from the Deep	Common I - English 2	4	3
	Additional Language	Common Course		
HN1811501	Prose and One Act Plays	Common II - Hindi 1		
ML1811501	<i>Kathasahithyam</i>	Common II - Malayalam 1	4	4
SC1811501	Poetry/ Grammar & History of Syriac Language & Literature	Common II –Syriac 1		
BY1811101	Methodology of science and an introduction to botany	Core 1	2	2
BY1811601	Methodology of science and an introduction to botany	Core Practical 1	2	1
ZY1811201	Non chordate diversity	Complementary 1 - Zoology	2	2
ZY1811701	Non chordate diversity	Complementary 1– Zoology Practical	2	1
CH1811201	Basic Theoretical and Analytical Chemistry	Complementary 1- Chemistry	2	2
CH1811701	Volumetric analysis	Complementary 1- Chemistry Practical	2	1
		Total	25	20

Course	Details				
Code	BY1811101				
Title	METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/I				
Type	CORE 1 THEORY				
Credits	2	Hr/Week	2	Total hrs	36

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understand the universal nature of science	U	1
2	Demonstrate the use of scientific method	Ap	2
3	Impart an insight into the different types of classifications in the living kingdom.	U	1
4	Appreciate the world of organisms and its course of evolution and diversity.	Ap	1
5	Develop basic skills in Botany so that students can innovate using scientific methodology	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	INTRODUCTION TO SCIENCE AND THE METHODOLOGY OF SCIENCE	4	
1.1	Scientific method: steps involved - observation and thoughts, formulation of hypothesis;	1	1
1.2	Experimentation	1	1
1.3	Testing of hypothesis	1	1
1.4	Formulation of theories and laws	1	1
2.0	EXPERIMENTATION IN SCIENCE	2	
2.1	Kosch's experiment as an example of moving from observations to questions, then to hypothesis and finally to experimentation.	1	2
2.2	Ethics in science.	1	2
3.0	ORIGIN AND EVOLUTION OF LIFE	10	
3.1	Origin of life on earth from molecules to life – Oparin's hypothesis, Haldane's hypothesis,	1	4
3.2	Miller-Urey experiment, Panspermia, origin of cells and the first organisms.	1	4
3.3	Evolutionary history of Biological diversity – fossil record	1	4
3.4	Geological time scale – major events in each era	1	4
3.5	Causes of Evolution – Adaptation and Mutation Evidences of evolution	1	4
3.6	Theories of evolution: Lamarck	1	4
3.7	Theories of evolution: Wallace	1	4
3.8	Theories of evolution: Charles Darwin	1	4

3.9	Theories of evolution: Hugo De Vries	1	4
3.10	Neo-Darwinism – major postulates - isolation, mutation, genetic drift, speciation.	1	4
4.0	DIVERSITY OF LIFE AND ITS CLASSIFICATION	2	
4.1	Diversity of plant life		
4.1.1	Study the salient features of algae, fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms (Life cycle not required)	1	2
4.1.2	An introduction to classification, Need for classifying organisms	1	2
4.2	Types of Classification	12	
4.2.1	Two kingdom classification (Carolus Linnaeus, 1735)	1	3
4.2.2	Phylogenetic classification (August W Eichler, 1878);	1	3
4.2.3	Five kingdom classification (R H Whittaker, 1969)	1	3
4.2.4	Three domains, six kingdom classification, (Carl Woese, 1990)	1	3
4.2.5	Criteria for classification, general characters of each kingdom (Brief)	1	3
4.2.6	General characters of domain: Archaea	1	3
4.2.7	General characters of domain: Bacteria	1	3
4.2.8	General characters of domain: Eucarya	1	3
4.2.9	Study the salient features of algae & fungi	1	3
4.2.10	Study the salient features of bryophytes & pteridophytes	1	3
4.2.11	Study the salient features of gymnosperms	1	3
4.2.12	Study the salient features of angiosperms	1	3
5.0	BASIC BOTANICAL SKILLS	6	
5.1	Microscopy: Evolution of Microscopes	1	5
5.2	Simple microscope, Compound microscope, Dissection microscope and Stereo microscope, Parts of a compound microscope, Adjustments in microscope, Handling and care of a microscope	1	5
5.3	Collection and preservation of plant specimens	1	5
5.4	Preparation of specimens for light microscopy - Hand sectioning – TS, LS	1	5
5.5	Staining of plant tissues: Purpose; Stains – safranin and	1	5

	acetocarmine		
5.6	Temporary mount preparation	1	5

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Course	Details				
Code	BY1811601				
Title	METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/I				
Type	CORE-PRACTICAL				
Credits	1	Hrs/ week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Demonstrate the use of scientific method	Ap	2
2	Impart an insight into the different types of classifications in the living kingdom.	U	1
3	Develop basic skills in Botany so that students can innovate using scientific methodology	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1	PRACTICALS	36	
1.1	Design an experiment to verify a given hypothesis.	4	1
1.2	Conduct a survey-based inquiry on a given topic (To test the validity of a given hypothesis. E.g., all angiosperm parasites are Dicot plants).	6	1
1.3	Select an important classical experiment and find out the different elements of the methodology of science (e.g., Mendel's experiment).	6	1
1.4	Conduct field surveys to identify and collect plant specimens to appreciate the diversity of plant kingdom. Submit a field report with necessary diagrams / photographs, five preserved specimens (in bottles and/or herbarium) belonging to diverse groups.	8	2
1.5	Identification of plants with vascular elements, plants which produce flowers, fruits, seeds, cone, sporophyll, embryos and study their salient features.	6	2
1.6	Prepare temporary, stained hand sections (TS and LS) of plant specimens for light microscopic studies.	6	3

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1. Carl R Woese, O Kandler, M L Wheelis, 1990. "Towards a natural system of organisms: proposal for the domains Archaea, Bacteria, and Eucarya". Proceedings of the National Academy of Sciences of the United States of America, 87 (12): 4576–4579.
2. Kenneth A Mason, Jonathan B Losos, Susan R Siger, 2013. Biology (IX Edn). McGraw Hill.
3. James B Reece, Lisa A Urry, Michael L Cain, Steven A Wasserman, Peter V Minorsky, Robert B Jackson, 2011. Biology (IX Edn). Pearson.

SEMESTER II

Course Code	Title of the Course	Course Category	Hours/week	Credits
EN1812503	Issues that Matter	Common I - English 3	5	4
EN1812504	Savouring the Classics	Common I -English 4	4	3
	Additional Language	Common Course		
HN1812503	Short stories and Novel	Common II- Hindi 2		
ML1812504	<i>Kavitha</i>	Common II- Malayalam 2	4	4
SC1812503	Poetry/ Grammar & History of Syriac Literature	Common II -Syriac 2		
BY1812102	Microbiology, mycology and plant pathology	Core 2	2	2
BY1812602	Microbiology, mycology and plant pathology	Core Practical 2	2	1
ZY1812202	Chordate Diversity	Complementary Zoology 2	2	2
ZY1812702	Chordate Diversity	Complementary Zoology 2- Practical	2	1
CH1812202	Basic Organic Chemistry	Complementary Chemistry 2	2	2
CH1812702	Volumetric analysis	Complementary Chemistry 2- Practical	2	1
		Total	25	20

Course		Details			
Code	BY1812102				
Title	MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	1/II				
Type	CORE COURSE 2 THEORY				
Credits	2	Hrs/week	2	Total hours	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Understand the world of microbes, fungi and lichens	U	1
2	Appreciate the adaptive strategies of the microbes, fungi and lichens	E	3
3	Understand the economic and pathological importance of bacteria and fungi	U	2
4	Understand the ecological significance of lichens	U	5
5	Identify common plant diseases and device control measures	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-ApPLY; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	Theory	36	
1.0	Microbiology	9	
1.1	Microbiology: A brief historical prelude with milestones, scope of microbiology	1	1
1.2	Bacteria: general characters and classification based on staining, morphology and flagellation	1	3
1.3	Ultra structure of bacteria, Bacterial identification – Motility, staining, colony characters and biochemical test (IMVic only) – A short description.	1	1
1.4	Reproduction - binary fission. Genetic recombination in bacteria - conjugation, transformation and transduction.	1	1
1.5	Economic importance of bacteria.	1	2

1.6	General characters of viruses, virioids and prions. Structure of TMV and Bacteriophage (λ)	1	1
1.7	Multiplication of λ phage – lytic and lysogenic cycle	1	1
1.8	Isolation and culture of bacteria; media used – general purpose and selective media, applications of bacterial culture (brief study only)	1	2
1.9	Role of microbes: in producing antibiotics, wine, vinegar, curd – role in N ₂ fixation, as biofertilizers – role in food spoilage (Brief study only)	1	2
2.0	Mycology	13	
2.1	General characters of fungi	1	1
	Classification of fungi - Ainsworth (1973)	1	1
2.2	Distinguishing characters of the different classes of fungi with special reference to reproductive structures and life history of the genera mentioned in each group	1	2
2.3	Myxomycotina – <i>Physarum</i>	1	1
2.4	Mastigomycotina – <i>Albugo</i>	1	1
2.5	Zygomycotina - <i>Rhizopus</i>	1	1
2.6	Ascomycotina – Hemiascomycetes - <i>Saccharomyces</i>	1	1
2.7	Plectomycetes - <i>Penicillium</i>	1	1
2.8	Pyrenomycetes – <i>Xylaria</i>	1	1
2.9	Discomycetes- <i>Peziza</i>	1	1
2.10	Basidiomycotina – Teliomycetes – <i>Puccinia</i>	1	1
2.11	Hymenomycetes – <i>Agaricus</i>	1	1
2.12	Deuteromycotina – <i>Fusarium</i>	1	1
3.0	Economic importance of Fungi	3	
3.1	Useful and harmful effects of fungi - medicinal, industrial, agricultural, food	1	3
3.2	Fungi in genetic studies, spoilage, fungal toxins and diseases	1	3
3.3	Mycorrhiza: ecto- and endomycorrhiza, significance.	1	3
4.0	Lichens	2	
4.1	General characters, types, general internal structure. Economic and ecological significance of lichens.	1	4
4.2	Structure, reproduction and life cycle of <i>Parmelia</i> .	1	4
5.0	Plant pathology	9	
5.1	History of plant pathology	1	5
5.2	Classification of plant diseases on the basis of causative organism and symptoms	1	5
5.3	Host parasite interaction - defence mechanisms in host, mechanism of infection, transmission and dissemination of diseases.	1	5
5.4	Common plant diseases with emphasis on symptoms,	1	5

	cause, disease cycle and control–Bunchy top of Banana		
5.5	Bacterial blight of Paddy, Root wilt of Coconut	1	5
5.6	Abnormal leaf fall of Rubber, Root knot disease of Pepper	1	5
5.7	Leaf mosaic disease of Tapioca, Citrus canker	1	5
5.8	Control of diseases - Prophylaxis - quarantine measures, seed certification; Therapeutic - physical therapy, chemotherapy; Biological control and its significance.	1	5
5.9	Fungicides - Bordeaux mixture. Tobacco and Neem decoction	1	5

REFERENCES

1. Ahamadjian Vernon, Hale M E (eds), 1973. *The Lichens*. Academic press, New Delhi.
2. Ainsworth G C, Sparrow K F, Sussman A S (eds), 1973. *The Fungi: an advanced Treatise*, Vol. 4a & 4b, a Taxonomic review with keys. Academic press, New York.
3. Alexopoulos C J, Mims C W C, Blackwell M, 1996. *Introductory Mycology*. John Willy and sons, Inc. New York.
4. Campbell R, 1987. *Plant Microbiology*. ELBS Edward Arnold, London.
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6. Hale M E, 1983. *The Biology of Lichen* (III Edn). Edward Arnold, London.
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12. Nair M C (eds), 1990. *Mushroom Technical Bulletin* 17. Kerala Agricultural University, Mannuthy.
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Course	Details				
Code	BY1812602				
Title	MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	1/II				
Type	CORE COURSE 2-PRACTICAL				
Credits	1	Hrs/week	2	Total hours	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Understand the world of microbes, fungi and lichens	U	1
2	Appreciate the adaptive strategies of the microbes, fungi and lichens	E	3
3	Understand the economic and pathological importance of bacteria and fungi	U	2
4	Identify common plant diseases and device control measures	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Practicals	36hrs	
1.1	Gram staining	3	1
1.2	Isolation of microbes from soil through serial dilution and streak plate method	2	2
1.3	Demonstrate the culture of bacteria (Pour plate method)	2	2
1.4	Microbes and type of fermentation - vine, vinegar, curd.	2	3
1.5	Micropreparation and detailed microscopic study of <i>Rhizopus</i> , <i>Albugo</i> , <i>Saccharomyces</i> , <i>Penicillium</i>	3	2
1.6	Micropreparation and study of <i>Xylaria</i> , <i>Peziza</i> , <i>Puccinia</i> , <i>Fusarium</i> and <i>Parmelia</i>	3	2
1.7	Staining and microscopic observation of endomycorrhizal fungus	2	2
1.8	Investigation of fungal succession on cow dung	1	2

1.9	Identify the diseases mentioned in the syllabus with respect to causative organisms and symptoms	3	4
1.10	Submit herbarium preparations of any three of the diseases mentioned.	2	4
1.11	Learn the technique of preparing Bordeaux mixture, Tobacco and Neem decoction.	4	4

REFERENCES

1. Ahamadjian Vernon, Hale M E (eds), 1973. *The Lichens*. Academic press, New Delhi.
2. Ainsworth G C, Sparrow K F, Sussman A S (eds), 1973. *The Fungi: an advanced Treatise*, Vol. 4a & 4b, a Taxonomic review with keys. Academic press, New York.
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4. Campbell R, 1987. *Plant Microbiology*. ELBS Edward Arnold, London.
5. Gupta V K, Paul T S, 2004. *Fungi & Plant diseases*. Kalyani publishers, New Delhi
6. Hale M E, 1983. *The Biology of Lichen* (III Edn). Edward Arnold, London.

SEMESTER III				
Course Code	Title of the Course	Course Category	Hours/week	Credits
EN1813505	Literature and/ as Identity	Common I - English 5	5	4
	Additional Language	Common Course		
HN1813505	Poetry/Grammar and Translation	Common II-Hindi 3	5	4
ML1813507	<i>Drishyakalasaahithyam</i>	Common II-Malayalam 3		
SC1813505	Prose, Grammar & Literature	Common II-Syriac 3		
BY1813103	Phycology and Bryology	Core 3	3	3
BY1813603	Phycology and Bryology	Core Practical 3	2	1
ZY1813203	Physiology and Immunology	Complementary Zoology 3	3	3
CH1813203	Physiology and Immunology	Complementary Zoology 3- Practical	2	1
CH1813203	Advanced Inorganic and Organic Chemistry	Complementary Chemistry 3	3	3
CH1813703	Organic analysis	Complementary Chemistry 3- Practical	2	1
		Total	25	20

Course	Details				
Code	BY1813103				
Title	PHYCOLOGY AND BRYOLOGY				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	2/III				
Type	CORE COURSE 3 THEORY				
Credits	2	Hrs/week	3	Total Hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understand the unique and general features of Algae and Bryophytes and familiarize it	U	1
2	Identify the external morphology, internal structure and reproduction of different types of algae and bryophytes	An	3
3	Examine the possible applications in phycology and Bryology	Ap	3
4	Predict the economic and ecological significance of bryophytes	C	5

Module	Course Description	Hrs	CO.No.
	Theory	36	
1.0	Phycology	9	
1.1	Introduction: General characters of algae	1	1
1.2	Habitat diversity	1	1
1.3	Range of thallus structure	1	1
1.4	pigments in algae	1	1
1.5	structure of algal flagella	1	1
1.6	Different types of life cycle and alternation of generations in algae.	1	1
1.7	Different types of life cycle and alternation of generations in algae.	1	1
1.8	Classification by Fritsch (1945)	1	1
1.9	Brief introduction to the modern classification by Lee(2009) [up to divisions]	1	1
2.0	Algae - Type study	18	
2.1	Salient features, thallus structure and reproduction of algae	1	2
2.2	Cyanophyceae	1	2
2.3	<i>Nostoc</i>	1	2
2.4	Chlorophyceae	1	2
2.5	<i>Volvox</i>	1	2
2.6	Oedogonium	1	2

2.7	<i>Cladophora</i>	1	2
2.8	<i>Chara</i>	1	2
2.9	Xanthophyceae	1	2
2.10	<i>Vaucheria</i>	1	2
2.11	Bacillariophyceae	1	2
2.12	<i>Pinnularia</i>	1	2
2.13	Phaeophyceae	1	2
2.14	<i>Ectocarpus</i>	1	2
2.15	<i>Sargassum</i>	1	2
2.16	Rhodophyceae	1	2
2.17	<i>Polysiphonia</i>	1	2
2.18	<i>Polysiphonia lifecycle</i>	1	2
3.0	Artificial culture and Economic importance of Algae	9	
3.1	Algal culture: isolation and cultivation	1	3
3.2	Preservation of micro and macro algae.	1	3
3.3	Economic importance of algae:algae as food,SCP,fodder,green manure,	1	3
3.4	Role in N2fixation, medicine and biofuels.	1	3
3.5	Commercial productsfromAlgae-carrageenin,agar-agar,alginates anddiatomaceous earth.	1	3
3.6	Role of algae in pollution studies as indicators of pollution and as bioremediation agents.	1	3
3.7	Eutrophication–algal bloom	1	3
3.8	Harmful and toxic algal blooms– neurotoxins	1	3
3.9	Parasitic algae	1	3
4.0	Bryology	4	
4.1	Introduction	1	1
4.2	general characters of bryophytes	1	1
4.3	classification of bryophytes by Rothmaler (1951)	1	1
4.4	Brief account of systems by Goffinet etal (2008)	1	1
5.0	Bryophytes - Type Study	12	
5.1	Distribution and morphology of bryophytes	1	1
5.2	Anatomy of bryophytes	1	2
5.3	Reproduction	1	2
5.4	Life cycle of bryophytes	1	2
5.5	Hepaticopsida	1	2
5.6	Riccia	1	2
5.7	Marchantia	1	2
5.8	Anthocerotopsida	1	2
5.9	Anthoceros	1	2
5.10	Bryopsida	1	2
5.11	Funaria.	1	2
5.12	Evolution of gametophyte and sporophyte among bryophytes	1	2
6.0	Economic importance of bryophytes	2	
6.1	Biological and ecological importance of bryophytes	1	4
6.2	Medicinal importance and as potting material	1	4

REFERENCES

1. Anand N, 1989. Culturing and cultivation of BGA. Handbook of Blue Green Algae.
2. Fritsch F E, 1935. The structure and reproduction of the algae, Vol.1 and II. Uni. Press. Cambridge.
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16. Vasishta B R. Bryophyta. S Chand and Co. New Delhi.
17. Watson E V, 1971. The structure and life of Bryophytes. Hutchinson University Library, London.

Course	Details				
Code	BY1813603				
Title	PHYCOLOGY AND BRYOLOGY				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	2/III				
Type	CORE COURSE 3- PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the unique and general features of Algae and Bryophytes and familiarize it	U	1
2	Identify the external morphology, internal structure and reproduction of different types of algae and bryophytes	An	3
3	Examine the possible applications in phycology and Bryology	Ap	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Practicals	36hrs	
1.1	Conduct a field visit to any one of the ecosystems rich in Algae to experience algal diversity. Submit a report with photographs.	4	1
1.2	Make micropreparations of vegetative and reproductive structures of <i>Nostoc</i> ; <i>Volvox</i> , <i>Oedogonium</i> , <i>Cladophora</i> , <i>Chara</i> , <i>Vaucheria</i> , <i>Pinnularia</i> , <i>Ectocarpus</i> , <i>Sargassum</i> and <i>Polysiphonia</i> .	18	2
1.3	Algal Culture: isolation and cultivation of micro and macro-algae in suitable growth media (Demonstration only).	4	3
1.4	Familiarizing the technique of algal collection preservation	2	3
1.5	Study the habit, anatomy of thallus and reproductive structures of <i>Riccia</i> , <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> .	8	2

REFERENCES

1. Anand N, 1989. Culturing and cultivation of BGA. Handbook of Blue Green Algae.
2. Fritsch F E, 1935. The structure and reproduction of the algae, Vol.1 and II. Uni. Press. Cambridge.
3. Morris I, 1967. An Introduction to the Algae. Hutchinson and Co. London.
4. Robert Edward Lee, 2008. Phycology. Cambridge University Press,
5. Singh V, Pandey P C, Jain DK. A text book of botany.

SEMESTER IV				
Course Code	Title of the Course	Course Category	Hours/ week	Credits
EN1814507	Illuminations	Common I - English 6	5	4
	Additional Language	Common Course	5	4
HN1814506	Drama and Long Poem	Common II- Hindi 4		
ML1814508	<i>Malayala Gadyarachanakal</i>	Common II- Malayalam 4		
SC1814506	Poetry, Grammar & Syriac Heritage in India	Common II- Syriac 4		
BY1814104	Pteridology, Gymnosperms and Paleobotany	Core 4	3	3
BY1814604	Pteridology, Gymnosperms and Paleobotany	Core Practical 4	2	1
ZY1814204	Applied Zoology	Complementary Zoology 4	3	3
ZY1814704	Applied Zoology	Complementary Zoology 4- Practical	2	1
CH1814204	Advanced Bio Organic Chemistry	Complementary Chemistry 4	3	3
CH1814704	Organic Analysis	Complementary Chemistry 4- Practical	2	1
		Total	25	20

Course	Details				
Code	BY1814104				
Title	PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	2/IV				
Type	CORE THEORY				
Credits	3	Hrs/ week	3	Total hrs	54

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Describe the general characters and classifications in lower forms of plants- Pteridophytes and Gymnosperms.	U	1
2	Examine the distribution, morphology, anatomy, reproduction and life cycle of types mentioned in the syllabus	Ap	1
3	Identify the economic importance of gymnosperms and pteridophytes	An	2
4	Understand the significance of Paleobotany and its applications.	U	3
5	Familiarize basic skills and techniques in micropreparation and formulate methods to identify cryptogams and gymnosperms	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	General introduction and classification of Pteridophytes	5	
1.1	Introduction to pteridophytes	1	1
1.2	General characters of pteridophytes	1	1
1.3	General classification	1	1
1.4	Classification upto classes by Smith (1955)	1	1
1.5	Brief account of the classification by Christenhusz <i>et al.</i> , 2011.	1	1
2.0	Type Study - pteridophytes	18	
2.1	Distribution of Psilophyta - <i>Psilotum</i> ; Lycophyta- <i>Lycopodium</i> , <i>Selaginella</i> ;	1	2
2.2	Distribution of Sphenophyta- <i>Equisetum</i> ; Pterophyta-	1	2

	<i>Pteris, Marsilea.</i>		
2.3	Morphology, anatomy, of Psilotum	1	2
2.4	Reproduction, life cycle of Psilotum	1	2
2.5	Morphology, anatomy, of <i>Lycopodium</i>	1	2
2.6	Reproduction, life cycle of <i>Lycopodium</i>	1	2
2.7	Morphology, anatomy, of <i>Selaginella</i>	1	2
2.8	Reproduction, life cycle of <i>Selaginella</i>	1	2
2.9	Morphology, anatomy, of <i>Equisetum</i>	1	2
2.10	Reproduction, life cycle of <i>Equisetum</i>	1	2
2.11	Morphology, anatomy, of <i>Equisetum</i>	1	2
2.12	Reproduction, life cycle of <i>Equisetum</i>	1	2
2.13	Morphology, anatomy, of <i>Marsilea</i>	1	2
2.14	Reproduction, life cycle of <i>Marsilea</i>	1	2
2.15	Stelar types in Pteridophytes	1	2
2.16	Stelar evolution in Pteridophytes;	1	2
2.17	Heterospory in Pteridophytes	1	2
2.18	Seed habit in Pteridophytes	1	2
3.0	Economic importance of Pteridophytes	4	
3.1	General importance of Pteridophytes	1	3
3.2	Medicinal importance of Pteridophytes	1	3
3.3	Pteridophytes as Ornamental plants	1	3
3.4	Pteridophytes as biofertilizers	1	3
4.0	General introduction and Classification of Gymnosperms	5	
4.1	Introduction to gymnosperms	1	1
4.2	General characters of gymnosperms	1	1
4.3	General classification of Gymnosperms	1	1
4.4	Classification of Gymnosperms by Sporne (1965)	1	1
4.5	Classification of Gymnosperms Christenhusz <i>et al</i> (2011).	1	1
5.0	Type Study- Gymnosperms	11	
5.1	Distribution of Cycadopsida– <i>Cycas</i> ; Coniferopsida– <i>Pinus</i> ; Gnetopsidae – <i>Gnetum</i>	1	2
5.2	Morphology of <i>Cycas</i>	1	2
5.3	Anatomy of stem, root, leaves and reproductive structures of <i>Cycas</i>	1	2
5.4	Reproduction and life cycle of <i>cycas</i> (Developmental details are not required)	1	2
5.5	Morphology of <i>Pinus</i>	1	2
5.6	Anatomy of stem, root, leaves and reproductive structures of <i>Pinus</i>	1	2
5.7	Reproduction and life cycle of <i>Pinus</i> (Developmental details are not required)	1	2

5.8	Morphology of Gnetum	1	2
5.9	Anatomy of stem, root, leaves and reproductive structures of Gnetum	1	2
5.10	Reproduction and life cycle of Gnetum (Developmental details are not required)	1	2
5.11	Affinities of Gymnosperms with Pteridophytes and Angiosperms	1	2
6.0	Economic importance of Gymnosperms	2	
6.1	Uses of Gymnosperms: as food and medicine	1	3
6.2	Uses of Gymnosperms in industry and as ornamental plants	1	3
7.0	Paleobotany - Fossils	6	
7.1	Introduction to Paleobotany and its significance.	1	4
7.2	Fossil formation, types of fossils.	1	4
7.3	Study of fossil Bryophyte- <i>Naiaditalanceolata</i> ;	1	4
7.4	fossil Pteridophytes- <i>Rhynia</i> , <i>Calamites</i> ;	1	4
7.5	fossil Gymnosperm- <i>Williamsonia</i>	1	4
7.6	Applied aspects of Paleobotany- exploration of fossil fuels.	1	4
8.0	Paleobotany in India	3	
8.1	Brief study of the fossil deposits in India.	1	4
8.2	Important Indian Paleobotanical Institutes,	1	4
8.3	Contributions of Indian Paleobotanists-Birbal Sahni.	1	4

REFERENCES

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Course	Details				
Code	BY1814604				
Title	PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	2/IV				
Type	CORE IV PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Examine the classification, distribution, morphology, anatomy, reproduction and life cycle of pteridophyte types mentioned in the syllabus	U	1
2	Examine the classification, distribution, morphology, anatomy, reproduction and life cycle of Gymnosperms types mentioned in the syllabus	Ap	1

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
9.0	Practicals	36	
9.1	Pteridology – Habit, TS of stem, LS of strobilus and sections of special structures of the following types – <i>Psilotum</i> , <i>Lycopodium</i> , <i>Selaginella</i> , <i>Equisetum</i> , <i>Pteris</i> , <i>Marselia</i>	18	1
9.2	Study of the habit, TS of leaf and stem and Morphology of reproductive structures – <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i>	18	2

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1. Chamberlain CJ, 1935. Gymnosperms: Structure and Evolution. Chicago University Press.
2. Coutler J M, CJ Chamberlain, 1958. Morphology of Gymnosperms. Central book depot. Allahabd.
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4. Sreevastava H N, 1980. A Text Book of Gymnosperms. S Chand and Co. Ltd., New Delhi.
5. Vasishta P C, 1980. Gymnosperms. S Chand and Co., Ltd., New Delhi.
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SEMESTER V				
Course Code	Title of the Course	Course Category	Hours /week	Credits
BY1815105	Anatomy, Reproductive Botany and Microtechnique	Core 5	3	3
BY1815605	Anatomy, Reproductive Botany and Microtechnique	Core Practical 5	2	1
BY1815106	Research Methodology, Biophysics and Biostatistics	Core 6	3	3
BY1815606	Research Methodology, Biophysics and Biostatistics	Core Practical 6	2	1
BY1815107	Plant Physiology and Biochemistry	Core 7	3	3
BY1815607	Plant Physiology and Biochemistry	Core Practical 7	2	1
BY1815108	Environmental Science and Human Rights	Core 8	3	3
BY1815608	Environmental Science and Human Rights	Core Practical 8	2	1
BY1816401	Agri-based microenterprises	Open Course	4	3
		Total	25	19

Course	Details				
Code	BY1815105				
Title	ANATOMY, REPRODUCTIVE BOTANY AND MICROTECHNIQUE				
Degree	B. Sc.				
Branch(s)	BOTANY				
Year/Semester	3/V				
Type	CORE COURSE 5 THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understand the Individual Cells and Tissues Simultaneously.	U	1
2	Discuss the Structural Adaptations in Plants Growing in Different Environment.	E	2
3	Understand the Morphology and Development of Reproductive Parts.	U	2
4	Discuss Fruit and Seed Development.	E	2
5	Devise Techniques to Preserve and Study Plant Materials.	C	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
ANATOMY			
1.0	STRUCTURE AND COMPOSITION OF PLANT CELLS	08 hrs	1-4
1.1	Cell wall: Structure of Cell Wall.	01	1
1.2	Cell wall: Sub-microscopic Structure- Cellulose, Micelle, Micro-fibril and Macrofibril.	01	1
1.3	Structure and Function of Plasmodesmata. Simple and Bordered Pits.	01	1
1.4	Different types of Cell Wall Thickening in Treachery Elements; Extra Cell Wall Thickening Materials.	01	1

1.5	Growth of Cell Wall-Apposition and Intussusception.	01	1
1.6	Non-living Inclusions in Plant Cells: Food Products.	01	1
1.7	Non-living inclusions in plant cells: Secretory products, Excretory (waste) Products -Nitrogenous and Non-nitrogenous.	01	1
1.8	Non-Living Inclusions in Plant Cells:Nitrogenous and Non-nitrogenous.	01	1
2.0	ORGANIZATION OF TISSUES	09 hrs	1-4
2.1	Tissues: Meristematic Tissue - Characteristic Features, Functions and Classification.	01	1
2.2	Theories on Organization of Shoot -Apical Cell Theory, Histogen Theory andTunica-CorpusTheory.	01	1
2.3	Structure and Functionsof:- Simple and Complex Tissues.	01	1
2.4	Secretory Tissues - External Secretory Tissue-Glands and Nectaries; Internal Secretory Tissues-Laticifers.	01	2
2.5	Tissue Systems - Epidermal Tissue System: -Epidermis, Cuticle and Trichomes.	01	1
2.6	Stomata – Structure, Types; Bulliform Cells.	01	1
2.7	Ground tissue system - cortex, endodermis, Pericycle, Pith and Pith Rays.	01	1
2.8	Vascular Tissue System - Structure of Xylem andPhloem.	01	1
2.9	Different Types of Vascular Bundles and their Arrangement in Root and Stem.	01	1
3.0	PLANT BODY STRUCTURE	06 hrs	1-4
3.1	Primary Structure of Stem, Root and Leaf (Dicot and Monocot)	01	1
3.2	Normal Secondary Growth in Dicot - Stem and Root.	01	1
3.3	Periderm: Structure and Development. (Phellum, Phellogen, Phelloderm, Barkand Lenticels)	01	1
3.4	Anomalous Secondary Thickening: Bignonia Stem.	01	2
3.5	Anomalous Secondary Thickening: Boerhaavia Stem.	01	2
3.6	Anomalous Secondary Thickening: Dracaena Stem.	01	2
4.0	WOOD ANATOMY	04 hrs	1-4
4.1	Basic Structure of Wood - Heart Wood, Sap Wood; Hard Wood and Soft Wood.	01	1
4.2	Growth Rings and Dendrochronology.	01	1
4.3	Porous and Non-porous Wood; Ring porous and Diffuse porous Wood.	01	1

4.4	Tyloses; Reaction Wood: - Tension Wood and Compression Wood.	01	1
REPRODUCTIVE BOTANY			
5.0	INTRODUCTION	02 hrs	1-4
5.1	Introduction to Embryology.	01	3
5.2	Floral Morphology- Parts of Flower.	01	3
6.0	MICROSPORANGIUM AND MALE GAMETOPHYTE	04 hrs	
6.1	Microsporangium: Structure and Development of Anther.	01	3
6.2	Microsporogenesis and Dehiscence of Anther,	01	3
6.3	Structure of Pollen.	01	3
6.4	Malegametophyte Development.	01	3
7.0	MEGASPORANGIUM AND FEMALE GAMETOPHYTE	06 hrs	1-4
7.1	Megasporangium: Types of Ovules – Anatropous, Orthotropous, Amphitropous and Campylotropous	02	3
7.2	Megasporogenesis– Female Gametophyte. Structure of a Typical Embryosac.	01	3
7.3	Types of Embryo sac- Monosporic (<i>Polygonum</i> type).	01	3
7.4	Types of Embryo sac- Bisporic (<i>Allium</i> type).	01	3
7.5	Types of Embryo sac- Tetrasporic (<i>Peperomia</i> type).	01	3
8.0	FERTILIZATION	02 hrs	
8.1	Mechanism of Pollination, Agents of pollination and Germination of pollen grains.	01	3
8.2	Double Fertilization.	01	3
9.0	ENDOSPERM AND EMBRYO	04 hrs	
9.1	Endosperm: Types– Cellular, Nuclear and Helobial.	01	4
9.2	Embryogeny, Structure of Dicot and Monocot Embryo.	01	4
9.3	Seed Formation.	01	4
9.4	Polyembryony.	01	4
MICROTECHNIQUE			
10	PRESERVATION OF PLANT SPECIMENS, SECTIONING AND MOUNTING	09 hrs	
10.1	Introduction to Microtechnique.	01	5
10.2	Killing and Fixing – Purpose, Agents used – Carnoy’s fluid, Farmer’s fluid, FAA Dehydration - Purpose, Agents Used	01	5
10.3	Sectioning: Hand Sections (TS, LS, TLS, RLS) and Serial Section.	01	5
10.4	Microtome- Rotary and Sledge (application only).	01	5
10.5	Staining Technique - Principle of Staining.	01	5

10.6	Stains - Hematoxylin, Fastgreen and Acetocarmine, Vital stains- Neutral red and Evans blue.	01	5
10.7	Types of Staining - Single Staining and Double Staining, Mordants - Purpose with examples	01	5
10.8	Mounting and Mountants – Purpose, Mounting Media - Glycerine, DPX and Canada balsam.	01	5

REFERENCES

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Course	Details				
Code	BY1815605				
Title	ANATOMY, REPRODUCTIVE BOTANY AND MICROTECHNIQUE				
Degree	B. Sc.				
Branch(s)	BOTANY				
Year/Semester	3/V				
Type	CORE COURSE 5 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understand the Individual Cells and Tissues Simultaneously.	U	1
2	Discuss the Structural Adaptations in Plants Growing in Different Environment.	E	2
3	Understand the Morphology and Development of Reproductive Parts.	U	2
4	Devise Techniques to Preserve and Study Plant Materials.	C	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	PRACTICALS	36	
1	Anatomy	19	
1.1	Study of cell types and tissues	2	1
1.2	Non-living inclusions – starch grains, cystolith, raphides, aleurone grains	2	1
1.3	Primary structure of stem Root and Leaf – Dicots and Monocots	6	1
1.4	Dissect and identify the stomatal types – Anomocytic, Anisocytic, Paracytic and Diacytic	4	2
1.5	Secondary structure of Dicot stem and root	2	2
1.6	Anomalous secondary structure of <i>Begonia</i> stem, <i>Boerhaavia</i> stem, <i>Dracaena</i> stem	3	2
2	Reproductive Botany	7	
2.1	Dissect and display – Parts of different types of flowers	2	3
2.2	Identification of CS of Anther, Embryosac and Embryo	2	3

	(Cordate)		
2.3	Identification of Anther types –Monothecous, Dithecous	1	3
2.4	Identify the different types of ovules	2	3
3	Microtechnique	10	
3.1	Familiarize preparation and use of stains, fixatives and mounting media	2	4
3.2	Preparation of smears and squash	2	4
3.3	Demonstration of Microtome sectioning	2	4
3.4	Maceration and identification of Tracheary elements	2	4
3.4	Preparation of single stained Permanent Hand sections (Demonstration only)	2	4

REFERENCES

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2. Coutler EG, 1969. *Plant Anatomy-Part 1: Cells and Tissues*. Edward Arnold, London.
3. DickinsonW C, 2000.Integrative Plant Anatomy. Harcourt Academic Press, USA.
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Course	Details				
Code	BY1815106				
Title	RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/V				
Type	CORE-THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Discuss different methodologies and techniques used in research work.	U	1
2	Explain basic computer skills necessary for the conduct of research.	An	1
3	Assess the basic function and working of analytical instruments used in research	E	2
4	Propose the required numerical skills necessary to carry out research.	C	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Introduction to Research Methodology	4	
1.1	Objectives of Research	1	1
1.2	Types of research – pure and applied. Identification of research problem.	1	1
1.3	Review of literature: purpose, literature sources – names of reputed National and International journals in life science (2 international & 3 National);	1	1
1.4	Reprint acquisition - INSDOC, INFLIBNET.	1	1
2.0	Process of research	7	
2.1	Conduct of Research: define the problem, identify the objective, design the study	1	1
2.2	Collection of data, analysis and interpretation.	1	1
2.3	Preparation of research report: preparation of dissertation- IMRAD system	1	1
2.4	Preliminary pages, introduction and review of literature	1	1
2.5	Materials and Methods, Results,	1	1
2.6	Discussion, Conclusion	1	1
2.7	Bibliography	1	1
3.0	Use of Computer in Research	7	
3.1	Introduction to MS-WINDOWS and LINUX	1	2
3.2	Application of MS WORD – word Processing, editing tools (cut, copy, paste), formatting tools.	1	2
3.3	MS EXCEL- creating worksheet, data entry, sorting data. Statistical tools (SUM, MEAN, MEDIAN and MODE). Preparation of graphs and diagrams (Bar diagram, pie chart, line chart, histogram).	1	2
3.4	MS POWERPOINT- presentation based on a biological topic; inserting tables, charts, pictures.	1	2
3.5	Open source and free alternatives to MS Office: Libre Office, Open Office	1	2

	(Brief study).		
3.6	Search engines: Google.com; Meta search Engine–dogpile.com ;academic search–Google scholar.	1	2
3.7	Educational sites related to biological science - Scitable, DNAi.	1	2
4.0	Introduction to Biophysics	2	
4.1	Introduction to biophysics	1	3
4.2	Branches of biophysics - Molecular, Cellular, Membrane Scope of Biomedical instrumentation	1	3
5.0	Biophysical Instrumentation	16	
5.1	Principle, Working and Applications of Microscopes - Phase-contrast microscope, Electron Microscope (SEM, TEM, STEM)	2	3
5.2	Principle, Working and Applications of Colorimeter	2	3
5.3	Principle, Working and Applications of Spectrophotometer	2	3
5.4	Principle, Working and Applications of Centrifuge and Ultra centrifuge	2	3
5.5	Principle, Working and Applications of Chromatography – Paper, Thin layer and Column Chromatography	2	3
5.6	Principle, Working and Applications of Electrophoresis - PAGE	2	3
5.7	Principle, Working and Applications of pH meter	2	3
5.8	Principle, Working and Applications of Haemocytometer	2	3
6.0	Biostatistics	18	
6.1	Introduction	1	4
6.2	Statistical terms and symbols(Brief study only).	1	4
6.3	Sampling: concept of sample	1	4
6.4	Sampling methods - Random and Non Random sampling.	1	4
6.5	Collection and representation of data: Diagrammatic and Graphic representation	1	4
6.6	Line Diagram	1	4
6.7	Bar diagram	1	4
6.8	Pie diagram, histogram	1	4
6.9	Frequency curve.	1	4
6.10	Measures of Central Tendency: Mean (Discrete and Continuous series).	1	4
6.11	Measures of Central Tendency: Median (Discrete and Continuous series).	1	4
6.12	Measures of Central Tendency: Mode (Discrete and Continuous series).	1	4
6.13	Measures of Dispersion: Standard Deviation.	1	4
6.14	Distribution patterns: Normal Distribution	1	4
6.15	Distribution patterns: Binomial Distribution	1	4
6.16	Tests of Significance	1	4
6.17	Chi-square Test	1	4
6.18	Chi-square test - Uses, Procedure.	1	4

REFERENCES

1. Anita Goel.Computer Fundamentals.Dorling Kindersley (India) Pvt. Ltd.
2. Agarwal SK, 2008.*Foundation course in Biology*. Ane Books Pvt. Ltd., NewDelhi.
3. Day R A, 1998. *How to Write and Publish a Scientific Paper*.University Press Cambridge.
4. SunderRao PSS, Richard J, 2012. *Introduction to Biostatistics and Research methods*.PHI Learning, NewDelhi.
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19. Ranjit Kumar, 2014. *Research Methodology: A Step-by-Step Guide for Beginners*. SAGE Publications India Pvt Ltd, New Delhi.

Course	Details				
Code	BY1815606				
Title	RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/V				
Type	CORE 6 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Discuss different methodologies and techniques used in research work.	U	1
2	Explain basic computer skills necessary for the conduct of research.	An	1
3	Assess the basic function and working of analytical instruments used in research	E	2
4	Propose the required numerical skills necessary to carry out research.	C	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	PRACTICAL	36	
1.0	Research Methodology	18	
1.1	Prepare outline of a dissertation (IMRAD system).	3	1
1.2	Prepare a list of References (not less than 10) on a topic in biological science.	2	2
1.3	Review the literature on a given topic	2	2
1.4	Collect information on a topic related to biological science using the internet.	2	2
1.5	Make a report based on the collected information from the internet (using MS-WORD).	2	2
1.6	Prepare tables/charts/graphs using EXCEL.	2	2
1.7	Prepare a work sheet using a set of data collected and	2	2

	find out the SUM.		
1.8	Prepare a PowerPoint presentation based on any Experiment.	3	2
2.0	Biophysics	9	
2.1	Measurement of pH and adjusting pH using pH meter.	2	3
2.2	Separation of plant pigments using TLC.	2	3
2.3	Determination of the concentration of a sample solution using colorimeter.	2	3
2.4	Demonstration of column chromatography.	1	3
2.5	Count the number of cells/spores using Haemocytometer	2	3
3.0	Biostatistics	9	
3.1	Collect numerical data, tabulate and represent in Line diagram, Bar diagram, Pie diagram, Histogram, Frequency curve	2	4
3.2	Problems related to Mean	1	4
3.3	Problems related to Median	1	4
3.4	Problems related to Mode	1	4
3.5	Problems related to Standard Deviation	2	4
3.6	Problems related to Chi-square Test.	2	4

REFERENCES

- Anita Goel. Computer Fundamentals. Dorling Kindersley (India) Pvt. Ltd.
- Agarwal SK, 2008. *Foundation course in Biology*. Ane Books Pvt. Ltd., New Delhi.
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Course	Details				
Code	BY1815107				
Title	PLANT PHYSIOLOGY AND BIOCHEMISTRY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3/V				
Type	CORE THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Describe the various physiological aspects in plants	U	2
2	Examine the role, structure and importance of biomolecules associated with plant life	Ap	3
3	Discuss the basic aspects of plant metabolism	U	3
4	Evaluate the role of enzymes in plant life	E	4
5	Devise methods to improve basic skills and techniques related to plant hysiology and biochemistry	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	WATER RELATIONS	6	
1.1	Plant water relations	1	1
1.2	Water potential - Concepts and Components	1	1
1.3	Absorption of water	1	1
1.4	Ascent of sap	1	1
1.5	Transpiration - types, mechanism, significance; antitranspirants. Guttation	1	1
1.6	Theories of stomatal movement (Starch-sugar, Proton-K ⁺ ion exchange)	1	1
2.0	MINERAL NUTRITION	3	
2.1	Roleofmajorandminorelementsinplantnutrition	1	2
2.2	Passive absorption of minerals	1	1
2.3	Active absorption of minerals	1	1

3.0	PLANT GROWTH AND DEVELOPMENT	5	
3.1	Plant hormones- Auxin – physiological effect and practical application	1	3
3.2	Plant hormones- Cytokinin and Gibberlins - physiological effect and practical application	1	3
3.3	Plant hormones- ABA & ethylene - physiological effect and practical application	1	3
3.4	Plant movements: : tropic movements – geotropism and phototropism; nastic movements – seismonastic and nyctinastic movements	1	2
3.5	Physiology of flowering- phytochrome, Photoperiodism and vernalization	1	2
4.0	STRESS PHYSIOLOGY	2	
4.1	Concepts of plant responses to abiotic stresses (water, salt, temperature), biotic stress (pathogens)	1	2
4.2	Allelopathy	1	2
5.0	PHOTOSYNTHESIS	12	
5.1	Photosynthetic pigments, photo excitation - fluorescence, phosphorescence;	1	3
5.2	Red drop and Emerson Enhancement Effect	1	3
5.3	Photosystems – components and Organization	1	3
5.4	Cyclic and Non-cyclic photophosphorylation	1	3
5.5	Carbon assimilation pathways-C3	1	3
5.6	C4 plants – kranz anatomy	1	3
5.7	CAM	1	3
5.8	Photorespiration	1	3
5.9	Factors affecting photosynthesis –Blackmann’s law of limiting factors	1	3
5.10	Translocation of solutes; pathway of phloem transport	1	3
5.11	Mechanism- pressure flow, Massflow Hypothesis	1	3
5.12	Phloem loading and unloading.	1	3
6	RESPIRATION	8	
6.1	Respiration: Anaerobic and Aerobic	1	3
6.2	Glycolysis	1	3
6.3	Kreb’s cycle	1	3
6.4	Mitochondrial electron transport system - components	1	3
6.5	Oxidative phosphorylation, ATPase	1	3
6.6	Chemiosmotic hypothesis	1	3
6.7	RQ- significance	1	3
6.8	Factors affecting respiration.	1	3

7.0	WATER	3	
7.1	Physical and chemical properties of water	1	2
7.2	Acids and Bases; pH-definition, significance; Measurement of pH - Colorimetric, Electrometric (briefstudyonly).	1	2
7.3	Buffers: Buffer action, Uses of buffers.	1	2
8.0	CARBOHYDRATES	3	
8.1	General structure and functions	1	2
8.2	Classification– mono(glucose and fructose), di (maltose and sucrose) and Polysaccharides (starch and cellulose)	2	2
9.0	PROTEINS	4	
9.1	Generalstructure	1	2
9.2	Classification of Aminoacids – Peptidebond;	1	2
9.3	Structural levels of proteins- Primary, Secondary, Tertiary and Quaternary;	1	2
9.4	Functionsof proteins	1	2
10.0	LIPIDS	2	
10.1	General features and roles of lipids, types of lipids	1	2
10.2	Fatty acids – saturated and unsaturated; fattyacid derivatives - fats and oils; compound lipids (brief study only).	1	2
11.0	ENZYMES	6	
11.1	Classification	1	4
11.2	Nomenclature	1	4
11.3	Mechanism of action	1	4
11.4	Enzyme kinetics, Michaelis – Menten constant (brief study only)	1	4
11.5	Regulation of enzyme action	1	4
11.6	Factors affecting enzyme action	1	4

REFERENCES

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Course	Details				
Code	BY1815607				
Title	PLANT PHYSIOLOGY AND BIOCHEMISTRY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3/V				
Type	CORE 7 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	45

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Upon completion of this course, the students will be able to: Describe the various physiological aspects in plants	U	2
2	Devise methods to improve basic skills and techniques related to plant physiology and biochemistry	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1	PRACTICAL	36	
	CORE EXPERIMENTS	10	
1.1	Determination of osmotic pressure of plant cell sap by plasmolytic/weighing method.	2	1
1.2	Compare the stomatal indices of hydrophytes, xerophytes and mesophytes	2	2
1.3	Separation of plant pigments by TLC/Paper chromatography.	2	2
1.4	Measurement of photosynthesis by Wilmott's bubbler/any suitable method.	2	2
1.5	Estimation of plant pigments by colorimeter.	2	2
	DEMONSTRATION EXPERIMENTS	16	
1.6	Papaya petiole osmoscope.	2	2
1.7	Demonstration of tissue tension.	2	2
1.8	Relation between transpiration and absorption.	2	2
1.9	Necessity of chlorophyll, light and CO ₂ in photosynthesis.	2	2

1.10	Simple respiroscope.	2	2
1.11	Respirometer and measurement of RQ.	2	2
1.12	Fermentation.	2	2
1.13	Measurement of transpiration rate using Ganong's potometer/Farmer's potometer.	2	2
2	BIOCHEMISTRY EXPERIMENTS	10	
2.1	General test for carbohydrates – Molisch's test, Benedict's test, Fehling's test.	2	2
2.2	Colour test for starch – Iodine test.	1	2
2.3	Colour tests for proteins in solution: Xanthoproteic test, Biuret test, Million's test, Ninhydrin test.	2	2
2.4	Action of various enzymes in plant tissues: Peroxidase, Dehydrogenase.	1	2
2.5	Quantitative estimation of protein using colorimeter	4	2

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3. Jain JL, Sanjay Jain, Nitin Jain, 2005. Fundamentals of Biochemistry. S Chand, New Delhi.
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Course	Details				
Code	BY1815108				
Title	ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3 / V				
Type	CORE 8 -THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Identify various types of natural resources, human impact on these resources, and common resource management practices	R	2
2	Develop skills and a commitment to act independently and collectively to sustain and enrich the environment.	U	2
3	Understand the multidisciplinary nature, important theories and concepts of environmental science, ecosystems, natural resources and conservation	U	2
4	Describe environmental hazards and risks and the social and economic ramifications	E	2
5	Familiarize with the major environmental problems its causes and potential solutions	U	2
6	Identify issues and problems relating to the human rights.	U	2
7	Analyse country's situation or international situation in terms of human rights.	An	2
8	Create awareness on various environmental acts in India	C	2

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Module I	18	1,3
1.1	Multidisciplinary nature of environmental studies Definition, scope and importance. Need for public awareness	2	3
1.2	Natural Resources and associate problems - Introduction, renewable and non-renewable resources	1	1,3
1.2.1	Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.	1	1
1.2.2	Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.	1	1

1.2.3	Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.	2	1
1.2.4	Food resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.	2	1
1.2.5	Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, case studies.	1	1
1.2.6	Land resources: Land as a resource, land degradation, man induced land slides, soil erosion and desertification	1	1
1.2.7	Role of individual in conservation of natural resources. Equitable use of resources for sustainable life styles	1	2
1.3	Ecosystems - Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem	1	3
1.3.1	Food chains, food webs and ecological pyramids. Ecological succession	1	3
1.3.2	Introduction, types, characteristic features, structure and function of the given ecosystem - Forest ecosystem, grassland, desert	2	3
1.3.3	Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)	2	3
2.0	Module 2	24	
2.1	Biodiversity and its conservation		
2.1.1	Introduction, Definition, Genetic species and Ecosystem diversity	1	1,3
2.1.2	Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values	1	3
2.1.3	Biodiversity at global, National and local levels, India as a mega-diversity nation	1	3
2.1.4	Hot-spots of biodiversity	1	3
2.1.5	Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India.	1	5
2.1.6	Conservation of biodiversity: In situ and Ex situ conservation of biodiversity	1	1
2.2	Environmental Pollution and social issues		
2.2.1	Introduction and types of pollution	1	4,5
2.2.2	Causes, effects and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards and Municipal solid waste	3	4,5
2.2.3	Pollution case studies (Local and National). Role of an individual in prevention of pollution.	2	4,5
2.2.4	Disaster management: floods, earthquake, cyclone and landslides.	2	4,5
2.2.5	Environmental ethics: Consumerism, Sustainable development	1	2

2.2.6	Water conservation, rain water harvesting, watershed management: its problems and concerns. Ramsar sites in Kerala	2	5,2
2.2.7	Climate change, global warming	1	5
2.2.8	Acid rain, ozone layer depletion	1	5
2.2.9	Environment Protection Act (1986) Air (Prevention and Control of Pollution) Act (1981)	2	8
2.2.10	Water (Prevention and control of Pollution) Act (1974), Wildlife Protection Act (1972).	1	8
2.2.11	Forest Conservation Act (1980). Issues involved in enforcement of environmental legislation. Biodiversity Act (2002)	2	8
3.0	Module 3	2	3
3.1	Population Ecology	1	3
	Characteristics of a Population Population size, density, natality, mortality, age, rate of natural increase, growthform and carryingcapacity Population interactions between species -competition, parasitism, predation, commensalism, protocoooperation, mutualism, neutralism.		
3.2	Community Ecology	1	3
	Characteristics of a community Species diversity, species richness, dominance; growth forms and structure, trophic structure, ecotone, edge effect, habitat, ecological niche, micro-climate, ecological indicators, keystone species.		
4.0	Human Rights	6	
4.1	An introduction to human rights, meaning, concept and development.	2	7
4.2	Three Generations of human rights (civil and political rights; economic, social and cultural rights).	2	7
4.3	Human Rights and United Nations Contributions, main human rights related organizations- UNESCO, UNICEF, WHO, ILO	2	7
4.4	Mechanisms for checking violations of Human rights, National human right commission	1	6,7
4.5	Declarations for women and children, Universal Declaration of human rights	1	
4.6	Human rights in India – fundamental rights and Indian constitution, rights for children and women, Euthanasia, scheduled castes, scheduled tribes, other backward castes and minorities	2	6,7

References

Environmental Science

1. Clark. R.S. Marine Pollution, Clanderson Press Oxford.
2. Cunningham, W.P. Cooper, T.H. Gorhani, Hepworth. M.T (2001). Environmental Encyclopedia, Jaico Publ. House. Mumbai. 1196p.
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Human Rights

1. Amartya Sen (2009). The Idea Justice, New Delhi: Penguin Books, 2009.
2. Chatrath, K. J.S (ed.)(1998). Education for Human Rights and Democracy (Shimla: Indian Institute of Advanced Studies.
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6. Sudhir Kapoor (2001). Human Rights in 21st Century, Mangal Deep Publications, Jaipur.
7. United Nations Development Programme (2004). Human Development Report Cultural Liberty in Today's Diverse World, New Delhi: Oxford University Press, 2004.

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1. Odum. E.P (1971). Fundamentals of Ecology. W.B. Saunders Co. USA 574p
2. Shireesh Pal Singh, Human Rights Education in 21st Century, Discovery Publishing House Pvt. Ltd, New Delhi,
3. Chatrath, K. J.S (1998) Education for Human Rights and Democracy (Shimla: Indian Institute of Advanced Studies)
4. Clarke G. L (1954). Elements of Ecology (John Wiley and sons New York.
5. BharuchaErach (2013). Text Book of Environmental Studies for undergraduate Courses. University Press, Second Edition
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Course	Details				
Code	BY1815608				
Title	ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3 / V				
Type	CORE 8 -PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Identify various types of natural resources, human impact on these resources, and common resource management practices	R	2
2	Develop skills and a commitment to act independently and collectively to sustain and enrich the environment.	U	2
3	Understand the multidisciplinary nature, important theories and concepts of environmental science, ecosystems, natural resources and conservation	U	2
4	Describe environmental hazards and risks and the social and economic ramifications	E	2
5	Familiarize with the major environmental problems its causes and potential solutions	U	2

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember;

U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1	PRACTICAL	36	
1.1	Estimation of CO ₂ , Cl, and alkalinity of water samples (Titrimetry)	6	2
1.2	Determination of pH of soil and water.	2	2
1.3	Assessment of diversity, abundance, and frequency of plant species by quadrat method (Grasslands, forests)	6	1,3
1.4	Study of the most probable number (MPN) of	4	2,5

	Coliform bacteria in water samples.		
1.5	EIA studies in degraded areas (Sampling, Line transect ,Quadrat)	6	1,4,5
1.6	Ecological adaptations in xerophytes, hydrophytes, epiphytes, halophytes and mangroves.	8	3
1.7	Visit to local area to document environmental assets – River/Forest/Grassland/Hill/Mountain	2	3
1.8	Visit to a local polluted site – Urban/Rural/Industrial/Agricultural	1	2
1.9	Study of Simple Ecosystems - Pond/River/Hill slopes etc.with reference to common plants, insects and birds	1	3

References

Environmental Science

1. Clark. R.S. Marine Pollution, Clanderson Press Oxford.
2. Cunningham, W.P. Cooper, T.H. Gorhani, Hepworth. M.T (2001). Environmental Encyclopedia, Jaico Publ. House. Mumbai. 1196p.
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5. Heywood. V.H , Watson. R.T (1995). Global Biodiversity Assessment, Cambridge University Press 1140p.
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7. Kumar R (Ed). Environmental pollution and health hazards in India. Ashish Pub. House, New Delhi.
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11. Odum. E.P (1971). Fundamentals of Ecology. W.B. Saunders Co. USA 574p
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Course	Details				
Code	BY1816401				
Title	AGRI – BASED MICROENTERPRISES				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3/V				
Type	CORE THEORY				
Credits	3	Hrs/week	4	Total hrs	72

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Explain sustainable agriculture and organic farming practices.	U	4
2	Examine the opportunities and potentials in the field of food processing technology	Ap	3
3	Devise methods for skill acquisition in tissue culture, mushroom cultivation and spawn production	C	4
4	Devise methods for skill acquisition in agronomy, food technology and horticultural practices	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Organic farming and composting techniques	9	
1.1	Advantages of organic manures and fertilizers.	1	1
1.2	Composition of fertilizers – NPK content of various fertilizers.	1	1
1.3	Common organic manures – bonemeal, cowdung, poultrywaste, oilcakes	1	1
1.4	Organic mixtures and compost.	1	1
1.5	Preparation of compost – aerobic and anaerobic – advantages of both	1	1
1.6	Vermicompost - Preparation,vermiwash.	1	1
1.7	Biofertilizers: definition, types – <i>Trichoderma</i> , <i>Rhizobium</i> , PGPR.	1	1

1.8	Biopesticides–Tobacco and Neem decoction.	1	1
1.9	Biological control.	1	1
2.0	Horticulture and Nursery management	18	
2.1	Soil components	1	1
2.2	Preparation of potting mixture.	1	1
2.3	Common Garden tools and implements.	1	1
2.4	Methods of plant propagation	1	1
2.5	Plant propagation – by seeds – advantage and disadvantages.	1	1
2.6	Vegetative propagation	1	1
2.7	Vegetative propagation - advantages and disadvantages.	1	1
2.8	Natural methods of vegetative propagation.	1	1
2.9	Artificial methods of vegetative propagation.	1	1
2.10	Cutting, grafting	1	1
2.11	Budding and layering.	1	1
2.12	Use of growth regulators for rooting.	1	1
2.13	Gardening – types of garden	1	1
2.14	Ornamental garden	1	1
2.15	Indoor garden	1	1
2.16	Kitchen garden	1	1
2.17	Vegetable garden	1	1
2.18	Marketing of vegetables.	1	1
3.0	Food spoilage and preservation techniques	9	
3.1	Causes of spoilage	1	2
3.2	Food preservation techniques	2	2
3.3	Preservation techniques - asepsis, removal of microorganisms, anaerobic conditions	1	2
3.4	Preservation methods– by drying, by heat treatment, by low temperature storage	1	2
3.5	Preservation methods of food by chemicals (Food Additives)	1	2
3.6	Preparation of wine	1	2
3.7	Preparation of vinegar	1	2
3.8	Preparation of dairy products	1	2
4.0	Mushroom cultivation and Spawn production	9	
4.1	Types of mushrooms – button mushroom, oyster mushroom, milky mushroom, poisonous mushroom	3	3
4.5	Methods of identification of poisonous mushroom	1	3
4.6	Spawn – isolation and preparation.	2	3
4.7	Cultivation milk mushrooms – using paddy straw and sawdust by polybag.	2	3
4.9	Value added products from mushroom – pickles, candies, dried mushrooms.	1	3
5.0	Plant tissue culture and micropropagation (9 hrs)	9	
5.1	Concept of totipotency.	1	3

5.2	Micropropagation:different methods – shoot tip, axillary bud and meristem culture	1	3
5.2	Micropropagation:different methods – shoot tip, axillary bud and meristem culture	1	3
5.3	Organogenesis and somatic embryogenesis	1	3
5.4	Infrastructure of a tissue culture laboratory.	1	3
5.5	Solid and liquid media – composition and preparation.	1	3
5.6	Sterilization techniques.	1	3
5.7	Explant – inoculation and incubation techniques.	1	3
5.8	Stages of micropropagation – hardening and transplantation.	1	3
5.9	Packaging and transportation of tissue culture regenerated plantlets.	1	3
6.0	Hands on Training	18	
6.1	Prepare a chart showing the NPK composition of minimum 6 manures and fertilizers.	2	4
6.2	Identification and familiarization of the following organic manures: cowdung (dry), Coconut cake, Vermicompost, neem cake, organic mixture, bone meal.	2	4
6.3	Preparation of potting mixture.	2	4
6.4	Make a vermicompost pit/pot in the campus/house of the student	3	4
6.5	Familiarization of common garden tools and implements.	1	4
6.6	Estimation of germination percentage of seeds	2	4
6.7	Demonstrate the effect of a rooting hormone on stem cutting.	1	4
6.8	Demonstration of ‘T’ budding and air layering on live plants.	2	4
6.9	Familiarization of garden components from photographs.	1	4
6.10	Familiarization of different mushrooms and preparation of a polybag of <i>Pleurotus</i> using straw/sawdust.	2	4
6.11	Visit to a well-established Tissue culture lab.		4
6.12	Visit to a well-established nursery.		4
6.13	Visit to a well-established mushroom cultivation unit.		4

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20. Sharma R R, 2005. Propagation of Horticultural Crops. Kalyani Publishers.
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SEMESTER VI				
Course Code	Title of the Course	Course Category	Hours /week	Credits
BY1816109	Genetics, Plant breeding and Horticulture	Core 9	3	3
BY1816609	Genetics, Plant breeding and Horticulture	Core Practical 9	2	1
BY1816110	Cell and Molecular Biology	Core 10	3	3
BY1816610	Cell and Molecular Biology	Core Practical 10	2	1
BY1816111	Angiosper.m Morphology, Taxonomy and Economic Botany	Core 11	3	3
BY1816611	Angiosperm Morphology, Taxonomy and Economic Botany	Core Practical 11	2	1
BY1816112	Biotechnology and Bioinformatics	Core 12	3	3
BY1816612	Biotechnology and Bioinformatics	Core Practical 12	2	1
BY1816301	Agribusiness	Choice Based Course (Elective)	3	3
	Project work		-	2
		Total	25	21

Course	Details				
Code	BY1816109				
Title	GENETICS, PLANT BREEDING AND HORTICULTURE				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE 9 THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understand the patterns of inheritance in different organisms	U	3
2	Outline basics of linkage of genes, sex determination and quantitative inheritance	U	2
3	Understand the inheritance pattern of extranuclear genes	U	4
4	Understand the concept of population genetics	U	4
5	Examine the methods of crop improvement	Ap	3
6	Explain tissue culture as a method of plant breeding	An	3
7	Discuss the various methods of plant propagation and its importance in human welfare	E	3
8	Devise methods to improve gardening skills in students	C	3
9	Solve problems related to genetics	Ap	5

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	ORIGIN AND DEVELOPMENT OF GENETICS	3	
1.1	Genetics as science: origin – experiments of Mendel with <i>Pisum sativum</i>	1	1
1.2	General terminology used in genetics	1	1
1.3	Principles of inheritance, Mendelian laws-monohybrid and dihybrid cross, test cross and back cross.	1	1
2.0	EXCEPTIONS TO MENDELISM	10	
2.1	Modification of Mendelian ratios	1	1
2.2	Incomplete dominance - <i>Mirabilis</i>	1	1
2.3	Co-dominance – MN blood group in man	1	1
2.4	Lethal genes – pigmentation in Snapdragon	1	1

2.5	Genetic interaction: Epistasis	1	1
2.6	Dominant Epistasis – fruit colour in summer squashes	1	1
2.7	Recessive epistasis – coat colour in mice;	1	1
2.8	Complementary genes – flower colour in sweet pea.	1	1
2.9	Non-epistasis - comb pattern in Fowls.	1	1
2.10	Multiple alleles – ABO blood groups in man; self-sterility in <i>Nicotiana</i> .	1	1
3.0	LINKAGE OF GENES	3	
3.1	Linkage: chromosome theory of linkage	1	2
3.2	Crossing over – types of crossing over, mechanism of crossing over.	1	2
3.3	Linkage map - 2 point cross, interference and coincidence.	1	2
4.0	DETERMINATION OF SEX	6	
4.1	Sex determination: sex chromosomes and autosomes	1	2
4.2	Chromosomal basis of sex determination; XX-XY, XX-XO mechanism	1	2
4.3	Sex determination in higher plants (<i>Melandrium album</i>)	1	2
4.4	X – linked - Morgan's experiment e.g. eye colour in <i>Drosophila</i> , Haemophilia in man; Y-linked inheritance	1	2
4.5	Sex limited and sex influenced inheritance	1	2
4.6	Pedigree analysis	1	2
5.0	QUANTITATIVE INHERITANCE	2	
5.1	Quantitative characters: polygenic inheritance	1	2
5.2	Continuous variation – kernel color in wheat, ear size in maize.	1	2
6.0	EXTRA-CHROMOSOMAL INHERITANCE	2	
6.1	Extra-chromosomal inheritance: chloroplast mutation – variegation in 4 O'clock plant; mitochondrial mutations in yeast.	1	3
6.2	Maternal effects – shell coiling in snail; infective heredity – kappa particles in <i>Paramecium</i> .	1	3
7.0	POPULATION GENETICS	1	
7.1	Concept of population, gene pool, Hardy – Weinberg principle (brief).	1	4
8.0	INTRODUCTION TO PLANT BREEDING	1	
8.1	Introduction and objectives of plant breeding. Plant breeding centers in Kerala, their achievements – CPCRI, CTCRI, RRII.	1	5
9.0	PLANT INTRODUCTION	2	
9.1	Plant introduction: domestication – centers of origin – agencies of plant introduction in India, major achievements.	1	5
9.2	Procedure of plant introduction - quarantine regulations, acclimatization	1	5

10.0	PLANT SELECTION	2	
10.1	Plant Selection: mass selection	1	5
10.2	Pure-line and clonal selection	1	5
11.0	HYBRIDIZATION	4	
11.1	Hybridization: types, procedure, important achievements	1	5
11.2	Heterosis in plant breeding, inbreeding depression, genetics of heterosis and inbreeding depression.	1	5
11.3	Handling segregating generation – pedigree method, bulk method, backcross method	1	5
11.4	Disease resistance breeding	1	5
12.0	MUTATION BREEDING AND POLYPLOIDY BREEDING	2	
12.1	Mutation breeding: methods, applications and important achievements.	1	5
12.2	Polyploidy breeding: methods and applications.	1	5
13.0	TISSUE CULTURE AS A METHOD IN PLANT BREEDING	2	
13.1	Application of meristem culture, embryo culture and pollen culture in plant breeding.	1	6
13.2	Role of tissue culture in the creation of transgenic plants.	1	6
14.0	INTRODUCTION TO HORTICULTURE	3	
14.1	Introduction to horticulture - Definition, History, Classification of horticultural plants. Disciplines of horticulture -pomiculture, olericulture, floriculture, arboriculture.	1	7
14.2	Garden implements – budding knife, secateurs, hedge shear, hand cultivator, sprayers, lawn mower, garden rake, spade.	1	7
14.3	Irrigation methods: surface, sub, drip and spray irrigations; mist chambers –advantages and disadvantages.	1	7
15.0	PLANT PROPAGATION	5	
15.1	Seed propagation: seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling	1	8
15.2	Advantages and disadvantages of seed propagation	1	8
15.3	Vegetative propagation: natural	1	8

15.4	Artificial methods - cutting, layering, grafting and budding, micro-propagation	1	8
15.5	Advantages and disadvantages of vegetative propagation	1	8
16.0	GARDENING	6	
16.1	Types of garden: brief study on ornamental garden, indoor garden, kitchen garden, aquatic garden, vertical garden, medicinal garden, terrace garden, terrarium.	1	9
16.2	Garden designing: garden components -lawns, shrubs and trees, borders, topiary, hedges, edges, walks, drives	1	9
16.3	Physical control of plant growth: training and pruning	1	9
16.4	Bonsai – selection of plant – bonsai containers and method of bonsai formation.	1	9
16.5	Plant growing structures: green house, orchidarium, conservatory	1	9
16.6	Potting mixture – components	1	9

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Course	Details				
Code	BY1816609				
Title	GENETICS, PLANT BREEDING AND HORTICULTURE				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE 9 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	45

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Discuss the various methods of plant propagation and its importance in human welfare	E	2
2	Devise methods to improve gardening skills in students	C	5
3	Solve problems related to genetics	Ap	5

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	PRACTICALS	45	.
1.0	GENETICS PROBLEMS	18	
1.1	Work out problems from: monohybrid cross	1	3
1.2	Work out problems from: dihybrid cross	1	3
1.3	Work out problems from: back-cross	1	3
1.4	Work out problems from: testcross	1	3
1.5	Work out problems from: Incomplete dominance	2	3
1.6	Work out problems from: Co-dominance	2	3
1.7	Work out problems from: Dominant Epistasis	2	3
1.8	Work out problems from: Recessive epistasis	2	3
1.9	Work out problems from: Complementary genes	2	3

1.10	Work out problems from: Non-epistasis	2	3
1.11	Work out problems from: Multiple alleles	2	3
2	PLANT BREEDING	9	
2.1	Emasculation and bagging.	3	2
2.2	Demonstration of hybridization in plants.	3	2
2.3	Estimation of pollen sterility/viability.	3	1
3	HORTICULTURE	18	
3.1	Approach grafting (demonstration only)	2	2
3.2	Budding (T patch)	4	2
3.3	Air layering	2	2
3.4	Identification of different garden tools and their uses.	2	1
3.5	Visit to established horticultural/ agricultural/ ornamental/ kitchen gardens and observe the components there.	8	2

REFERENCES

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9. Shukla RS, Chandel PS, 2004. *Cytogenetics Evolution and Plantbreeding*. S. Chand &Co. Ltd. New Delhi.
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Course	Details				
Code	BY1816110				
Title	CELL AND MOLECULAR BIOLOGY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE BOTANY THEORY				
Credits	3 (T)	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Explain the idea of origin, continuity and complexity of life activities	U	2
2	Discuss the structure and composition of hereditary unit of life	U	2
3	Analyze the cytological aspects of growth and development	An	2
4	Assess the chromosomal basis of variations	E	3
5	Interpret DNA as the basis of heredity and variation	Ap	2
6	Examine the basis of biological inheritance	An	2
7	Discuss the basic knowledge about transfer of information from gene to proteins	E	3
8	Discuss the control of gene expression	E	3
9	Summarize genetics of cancer	U	5
10	Create basic skills to make cytological preparations and identification of various stages of cell division and to work out elementary problems in molecular biology	C	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	ULTRASTRUCTURE OF CELL COMPONENTS	8	
1.1	Cell biology through ages: a brief history of cell biology.	1	1
1.2	Cytosol – chemical composition	1	2
1.3	Composition, structure and function of plasma membrane-fluid mosaic model	1	2
1.4	The ultra-structure of a plant cell with structure and function of the following organelles: Endoplasmic reticulum, chloroplasts	1	2
1.5	The ultra-structure of a plant cell with structure and function	1	2

	of the following organelles : Mitochondria, Ribosomes, Dictyosomes,		
1.6	The ultra-structure of a plant cell with structure and function of the following organelles : Microbodies-peroxisomes and glyoxisomes, lysosomes and vacuole	1	2
1.7	Cytoskeleton-microtubules and microfilaments.	1	2
1.8	Ultrastructure of nucleus: nuclear envelope – detailed structure of pore complex, nucleoplasm - composition, nucleolus.	1	2
2.0	CHROMOSOMES	6	
2.1	Chromosomes: introduction,	1	3
2.2	Chromosome number, autosomes and allosomes, morphology - metacentric, submetacentric, acrocentric and telocentric.	1	3
2.3	Structure - chromatid, chromonema, chromomere, centromere and kinetochor, telomere, secondary constriction and nucleolar organizer	1	3
2.4	Chromatin fibres: heterochromatin and euchromatin. Karyotype and Ideogram.	1	3
2.5	Chemical composition of chromatin: histones and non-histones, arrangement of proteins and DNA in chromatin-the 10 nm fibre (nucleosome model), 30nm fibre (solenoid model) and central axis with radial loops of 300nm fibre.	1	3
2.6	Special type of chromosomes: giant chromosomes (salivary gland chromosomes, Lampbrush chromosomes), supernumerary chromosomes (B chromosome).	1	3
3.0	CELL DIVISION	6	
3.1	Cell cycle - definition, different stages – interphase (G ₁ , S and G ₂) and division phase.	1	3
3.2	Mitosis: karyokinesis and cytokinesis	1	3
3.3	Significance of mitosis	1	3
3.4	Meiosis: stages – first meiotic division (reduction division) and second meiotic (equational division)	1	3
3.5	Structure and function of synaptonemal complex	1	3
3.6	Significance of meiosis; comparison of mitosis and meiosis.	1	3
4.0	CHROMOSOMAL ABERRATIONS	4	
4.1	Numerical: heteroploidy; euploidy – haploidy; polyploidy – autopolyploidy, allopolyploidy (<i>Raphanobrassica</i>)	1	4
4.2	Aneuploidy - monosomy, trisomy (Fruit morphology in <i>Datura</i>), nullisomy (<i>Triticum</i>).	1	4
4.3	Numerical chromosomal abnormalities in man: Down's syndrome, Klinefelter's syndrome, Turner's syndrome	1	4
4.4	Structural: deletion (Cri-du-chat syndrome), duplication (Barr	1	4

	eye in <i>Drosophila</i>), inversions(paracentric and pericentric) and Translocations (Robertsonian translocation)		
5.0	MUTATION	3	
5.1	Mutation: definition, importance. Types of mutations: somatic and germinal; spontaneous and induced; chromosomal and gene or point mutations.	1	5
5.2	Molecular basis of mutation: frame shift, transition, transversion and substitution. Mechanism of mutation induction: base replacement, base alteration, base damage, errors in DNA replication.	1	5
5.3	Mutagens: physical – non – ionizing and ionizing radiations; chemical – base analogs, alkylating agents, deaminating agents.	1	5
6.0	THE GENETIC MATERIAL	8	
6.1	Molecular biology: a brief historical prelude.	1	5
6.2	Identification of DNA as genetic material: direct evidences – transformation experiment by Avery et al	1	5
6.3	Hershey and Chase Experiment.	1	5
6.4	Evidences for RNA as genetic material in some viruses.	1	5
6.5	Nucleicacids: DNA and RNA	1	5
6.6	Important features of Watson and Crick model of DNA; Chargaff's rule.	1	5
6.7	Alternate forms of DNA – comparison of A, B and Z forms.	1	5
6.8	Structure and function of different types of RNA -tRNA, mRNA, rRNA, snRNA, mi RNA.	1	5
7.0	REPLICATION OF DNA	4	
7.1	Semi conservative replication of DNA	1	6
7.2	Messlson and Stahl's experiment;	1	6
7.3	Process of semiconservative replication	1	6
7.4	Enzymes involved in each step of replication	1	6
8.0	GENE EXPRESSION	8	
8.1	Gene expression: concept of gene, Split genes	1	7
8.2	One gene one enzyme hypothesis	1	7
8.3	One gene one polypeptide hypothesis,	1	7
8.4	The central dogma, reverse transcription.	1	7
8.5	Details of transcription in prokaryotes; m RNA, splicing, release of m RNA.	1	7
8.6	Details of transcription in eukaryotes; hn RNA,	1	7
8.7	Translation-initiation, elongation and termination.	1	7
8.8	Genetic code and itsfeatures,wobblehypothesis	1	7
9.0	REGULATION OF GENE EXPRESSION	5	
9.1	Regulation of gene expression in prokaryotes: operon concept	1	8

9.2	Inducible and repressible systems, negative control and positive control	1	8
9.3	Lac operon, catabolic repression.	1	8
9.4	Tryptophan operon, attenuation.	1	8
9.5	Regulation in eucaryotes (brief account only)	1	8
10.0	GENETICS OF CANCER	2	
10.1	Genetic basis of cancer – brief description of proto-oncogenes and oncogenes, tumour suppressor genes	1	9
10.2	Characteristics of cancer cells.	1	9

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Course	Details				
Code	BY1816610				
Title	CELL AND MOLECULAR BIOLOGY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE 10 BOTANY PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Create basic skills to make cytological preparations and identification of various stages of cell division and to work out elementary problems in molecular biology	C	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	PRACTICALS	36	
	CELL BIOLOGY		
1.1	Make acetocarmine squash preparation of onion root tip to identify mitotic stages.	10	1
1.2	Study the mitotic index of onion root tip cells (Demonstration only).	6	1
1.3	Study of the different stages of meiosis and identification of different sub-stages of prophase I using photographs	5	1
1.4	Identify and study the chromosomal anomalies, patterns and karyotype in man :Down's syndrome	5	1
1.5	Identify and study the chromosomal anomalies, patterns and karyotype in man: Turner's syndrome	5	1
1.6	Identify and study the chromosomal anomalies, patterns and karyotype in man: Klinefelter's syndrome (with the help of photographs)	5	1
2	MOLECULAR BIOLOGY PROBLEMS	9	
2.1	Work out elementary problems based on DNA structure	2	1
2.2	Work out elementary problems based on replication	2	1
2.3	Work out elementary problems based on transcription	2	1
2.4	Work out elementary problems based on translation	2	1
2.5	Work out elementary problems based on genetic code	1	1

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Course	Details				
Code	BY1816111				
Title	ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE COURSE 11 THEORY				
Credits	4	Hrs/week	4	Total hrs	72

CO No.	<i>Expected Course Outcomes</i> <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Understand the plant morphology terminologies as a foundation for plant recognition and identification.	U	1
2	Analyze the methods and principles of classification and nomenclature.	An	3
3	Plan desk, lab and field based studies of angiosperm diversity, identifying morphological specialties and writing short species descriptions and illustrations.	C	3
4	Identify members of the major angiosperm families by observing their diagnostic features and economic importance.	An	4
5	Evaluate the contributions of ethnobotany, BSI and interdisciplinary approaches to the advancement of plant taxonomy.	E	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Angiosperm Morphology (Leaf, Inflorescence and Fruit morphology)	13 hrs	
1.1	Leaf Morphology: types, venation, phyllotaxy.	1	1
1.2	Morphology of flower: flower as modified a shoot	1	1
1.3	Detailed structure of flowers – floral parts	1	1
1.4	Floral parts: their arrangement, relative position -symmetry	1	1
1.5	Aestivation	1	1
1.6	Placentation types – cohesion and adhesion	1	1
1.7	Floral diagram and floral formula	1	1
1.8	Inflorescence: racemose types – simple raceme, corymb, umbel,	1	1

	spike, spadix, head and catkin		
1.9	Cymose types-simple cyme; monochasial – scorpid and helicoid, dichasial and polychasial	1	1
1.10	Special type - cyathium, hypanthodium, verticillaster, thyrus and panicle	1	1
1.11	Fruits: simple - fleshy	1	1
1.12	Dry-dehiscent, schizocarpic, indehiscent	1	1
1.13	Aggregate, multiple (sorus and syconus).	1	1
2.0	Taxonomy:Principles of Plant Systematics	12 hrs	
2.1	Aim and Scope and significance of Taxonomy	1	2
2.2	Components of Taxonomy	1	2
2.3	Types of classification – artificial (brief account)	1	2
2.4	Natural : Bentham and Hooker (Detailed account)	1	2
2.5	Phylogenetic : (Brief account)	1	2
2.6	Angiosperm phylogeny group system (introduction only)	1	2
2.7	Plant nomenclature -binomial	1	2
2.8	ICBN/ICN	1	2
2.9	Cytotaxonomy	1	5
2.10	Chemotaxonomy	1	5
2.11	Herbarium technique–importance of herbarium; preparation of herbarium and their preservation. Important herbaria in India	1	3
2.12	BSI	1	5
3.0	Detailed study of Families: Study the following families of Bentham and Hooker’s system with special reference to their vegetative and floral characters; special attention should be given to common and economically important plants within the families	30 hrs	
3.1	Annonaceae	1	4
3.2	Nymphaeaceae	1	4
3.3	Malvaceae	1	4
3.4	Rutaceae	1	4
3.5	Anacardiaceae	1	4
3.6	Leguminosae-Mimosaceae	1	4
3.7	Leguminosae-Caesalpinaceae	1	4
3.8	Leguminosae-Fabaceae	1	4
3.9	Combretaceae	1	4
3.10	Myrtaceae	1	4
3.11	Cucurbitaceae	1	4
3.12	Umbelliferae-APIaceae	1	4
3.13	Rubiaceae	1	4
3.14	Compositae-Asteraceae	1	4
3.15	Sapotaceae	1	4
3.16	Apocynaceae	1	4
3.17	Asclepiadaceae	1	4

3.18	Solanaceae	1	4
3.19	Convolvulaceae	1	4
3.20	Scrophulariaceae	1	4
3.21	Acanthaceae	1	4
3.22	Verbenaceae	1	4
3.23	Labiatae-Lamiaceae	1	4
3.24	Amaranthaceae	1	4
3.25	Euphorbiaceae	1	4
3.26	Orchidaceae	1	4
3.27	Palmae-Arecaceae	1	4
3.28	Graminae-Poaceae	1	4
3.29	Principles-rule of priority and author citation	1	2
3.30	Interdisciplinary approach in taxonomy	1	2
4.0	Economic Botany: Study the following groups of plants with special reference to the botanical name, family and morphology of the useful part and uses	12 hrs	
4.1	Cereals-Rice ,Wheat;Millets-Ragi	1	4
4.2	Pulses –Green gram, Bengal gram, Black gram	1	4
4.3	Sugar yielding plants – Sugarcane; Fruits-Apple, Pineapple	1	4
4.4	Fruits: Orange, Mango and Banana	1	4
4.5	Vegetables- Bittergourd, Ladiesfinger, Carrot and Cabbage; Tuber crops -Tapioca	1	4
4.6	Beverages - Tea, Coffee	1	4
4.7	Oil yielding plants - Groundnut, Coconut, Gingelly	1	4
4.8	Spices –Cardamom, Pepper, Cloves, Ginger	1	4
4.9	Timber yielding plants – Teakwood and Rosewood	1	4
4.10	Fibre yielding plants -Coir, Jute, Cotton	1	4
4.11	Rubber yielding plants - Pararubber; Gums and Resins –White damer, Gum Arabic, Asafoetida	1	4
4.12	Insecticide yielding Plants – Tobacco and Neem	1	4
5.0	Ethnobotany	5 hrs	
5.1	Introduction	1	5
5.2	Scope and significance of ethnobotany	1	5
5.3	Study of the following plants used in daily life by tribals and village folks for: Food – Artocarpus heterophylla, Corypha	1	5
5.4	Shelter - Bambusa, Ochlandra and Calamus	1	5
5.5	Medicine –Curcuma longa, Trichopus zeylanicus and Alpinia galanga.	1	5

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2. Cornquist A, 1968.The evolution and Classification of Flowering Plants.
3. Davis PH and Heywood VH, 1967. Principles of Angiosperm Taxonomy. Oliver and Boyd, Edinburgh.
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Course	Details				
Code	BY1816611				
Title	ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE COURSE 11 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	45

CO No.	Expected Course Outcomes <i>Upon completion of this course, the students will be able to:</i>	Cognitive Level	PSO No.
1	Plan desk, lab and field based studies of angiosperm diversity, identifying morphological specialties and writing short species descriptions and illustrations.	C	3
2	Identify members of the major angiosperm families by observing their diagnostic features and economic importance.	An	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Appl; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1	Practicals	45 hrs	
1.1	Identify the following inflorescence and fruits with reference to their morphological specialities: (a) Inflorescence - simple raceme, spike, corymb, head, simple cyme, cyathium and hypanthodium.(b)	1	1
1.2	Fruits – simple - (fleshy) – berry drupe, pepo, hesperidium. Dry indehiscent - nut. Drydehiscent -legume, capsule (loculicidal). Aggregate.	2	1
1.3	Preparation of floral formula and floral diagram from floral description (of families studied)	10	1
1.4	Identify the families mentioned in the syllabus by noting their vegetative and floral characters.	10	1
1.5	Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of atleast one flower from each family.	10	1
1.6	Prepare herbarium of 25 plants with field notes.	5	1
1.7	Conduct field work for a period of not less than 5days under	2	1

	the guidance of a teacher and submit field report.		
1.8	Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphology of the useful part, botanical name and family.	3	2
1.9	Identify and describe the ethnobotanical uses of the items mentioned in the syllabus.	2	2

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Course	Details				
Code	BY1816112				
Title	BIOTECHNOLOGY AND BIOINFORMATICS				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE COURSE 12 THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Understand the history and current developments in the field of Biotechnology and Bioinformatics	U	2
2	Explain the methods involved in Tissue Culture and Molecular techniques	An	3
3	Understand the repositories of Biological Data Knowledge	U	2
4	Analyze the data available in databases	An	3
5	Predict Social and ethical issues and concerns related to biotechnological processes and advancements	C	5

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Plant Tissue culture	6 hrs	
1.1	Biotechnology– an overview (History)	1	1
1.2	Biotechnology– an overview (Current Developments)	1	1
1.3	Plant tissue culture– basic concepts, totipotency, differentiation, de-differentiation and redifferentiation.	1	2
1.4	Tissue culture media: components, role of plant growth regulators in tissue culture.	1	2
1.5	Preparation of MS medium	1	2
1.6	Sterilization of equipments, glassware and culture medium, surface sterilization of explants.	1	2

2.0	Applications of plant tissue culture	10 hrs	
2.1	Micropropagation methods, Axillary bud proliferation, adventitious regeneration	1	2
2.2	Shoot organogenesis and Somatic Embryogenesis - direct and indirect	1	2
2.3	Meristem culture and Stages of micropropagation, hardening and transplantation.	1	2
2.4	Advantages and Disadvantages of Micropropagation	1	2
2.5	Somaclonal Variations	1	2
2.6	Embryo culture, Callus and Cell suspension culture	1	2
2.7	<i>In vitro</i> production of haploids – anther and pollen culture, uses of haploids	1	2
2.8	Protoplast culture: isolation of protoplast, culture methods, applications, Protoplast fusion, Cybrids	1	2
2.9	Artificial seeds, advantages and disadvantages	1	2
2.10	Cell immobilization, bioreactors (brief study only).	1	2
3.0	Recombinant DNA technology and its applications	10 hrs	
3.1	Steps in rDNA technology	1	1
3.2	Cloning vectors and their desirable properties ; plasmids, cosmids, phage vectors	1	1
3.3	Cloning vectors and their desirable properties: Phasmids, YAC and BAC	1	1
3.4	Structure and applications of pBR 322, M13 and Ti plasmid	1	1
3.5	Cutting and joining of DNA molecules – Restriction endonucleases and ligases	1	1
3.6	Ligation techniques.	1	1
3.7	Transformation and selection of transformants – using antibiotic resistance markers and complementation.	1	1
3.8	Achievements of recombinant DNA technology: in medicine (Human insulin and gene therapy)	1	1
3.9	Achievements of recombinant DNA technology: in agriculture – Bt cotton;	1	1
3.10	Achievements of recombinant DNA technology: in environmental cleaning -super bugs.	1	1
4.0	Techniques in rDNA technology	10 hrs	
4.1	DNA isolation	1	1
4.2	Agarose gel electrophoresis	1	1
4.3	Southern hybridization	1	1
4.4	Autoradiography.	1	1
4.5	DNA fingerprinting	1	1
4.6	Applications of DNA Fingerprinting	1	1

4.7	PCRTechnology	1	1
4.8	Applications of PCR Technology.	1	1
4.9	DNA sequencing by Sanger's dideoxy method	1	1
4.10	Uses of refrigerated centrifuges, UV trans-illuminator, gel documentation system and Laminar Air Flow chamber (brief account only).	1	1
5.0	Genomics	4 hrs	
5.1	A brief account of genomics and proteomics	1	3
5.2	Major findings of the <i>E.coli</i> , genome project	1	3
5.3	Major findings of the Human genome project	1	3
5.4	Major findings of the <i>Arabidopsis thaliana</i> genome project	1	3
6.0	Basic Bioinformatics	7 hrs	
6.1	An introduction to bioinformatics	1	3
6.2	Objectives and applications of bioinformatics.	1	3
6.3	Biological databases: types - primary, secondary and composite databases	1	3
6.4	Nucleotide sequence databases –NCBI (GenBank), ENA (EMBL), DDBJ	1	3
6.5	Protein Sequence databases - SWISS-PROT, PIR	1	3
6.6	Protein structure database – PDB	1	3
6.7	Bibliographic database – PubMed	1	3
7.0	Sequence analysis and Molecular phylogeny	7 hrs.	
7.1	Sequenceanalysisistools– BLASTand FASTA	1	4
7.2	Molecular visualization tool – RASMOL(basiccommands)	1	4
7.3	Sequence alignment –Scoring matrices, global and local alignment, Pair wise and multiple sequence alignment	1	4
7.4	Common software used in alignment – CLUSTAL w and CLUSTAL x	1	4
7.5	Molecularphylogeny-homologs,orthologsandparalogs	1	4
7.6	Phylogenetic tree– rootedandunrootedtree,advantages of phylogenetic tree	1	4
7.7	Use ofPHYLIPsoftware.	1	4

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4. David W Mount. Bioinformatics: sequence and genome analysis. CBS Publishers.
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Course	Details				
Code	BY1816612				
Title	BIOTECHNOLOGY AND BIOINFORMATICS				
Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	CORE COURSE 12 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Understand the history and current developments in the field of Biotechnology and Bioinformatics	U	2
2	Explain the methods involved in Tissue Culture and Molecular techniques	An	3
3	Understand the repositories of Biological Data Knowledge	U	2
4	Analyze the data available in databases	An	3

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	Practicals	36 hrs	
1.1	Preparation of nutrient medium - Murashige and Skoog medium (Demonstration only).	3	2
1.2	Sterilization and inoculation of plant tissue in culture media.	4	2
1.3	Establishing shoot tip, axillary bud cultures (Demonstration only)	2	2
1.4	Immobilization of whole cells or tissues in sodium alginate	2	2
1.5	Isolation of DNA from plant tissue.	2	2
1.6	Agarose gel electrophoresis of the isolated DNA (Demonstration only).	2	1
1.7	Familiarise the instruments included in the syllabus such as Autoclave, laminar air flow chamber, UV-trans-illuminator, PCR machine, Electrophoresis apparatus, centrifuge etc. and prepare short notes with diagrammatic sketch or photographs.	5	1

1.8	Familiarizing GENBANK, DDBJ, ENA, SWISS-PROT and PDB databases (Demonstration only).	4	3
1.9	Analysis of structural features of proteins using RASMOL	4	4
1.10	Local alignment of sequences using BLAST (Demonstration only).	4	4
1.11	Retrieving a few research papers related to genetic engineering from PubMed(Demonstration only).	4	4

REFERENCES

- 1.R Keshavachandran and KV Peter. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient Blackswan.
2. G Smita Rastogi and Neelam Pathak. Genetic Engineering. Oxford Higher Education.
3. Jean-Michel Claverie, Cedric Notredame. Bioinformatics: A beginner's Guide. Wiley India.
4. David W Mount. Bioinformatics: sequence and genome analysis. CBS Publishers.
5. Cynthia Gibas and Per Jambeck. Developing Bioinformatics and Computer Skills. O'Reilly.
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Course	Details
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Code	BY1816301				
Title	AGRIBUSINESS				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	3/VI				
Type	ELECTIVE COURSE				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Identify the business opportunities in the field of plant sciences.	U	2
2	Harness the opportunities and potentials in the field of Nursery management, processing technology and food sciences.	Ap	3
3	Give an idea about the need of sustainable development and organic farming.	Ap	3
4	Develop skills in mushroom cultivation techniques	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Entrepreneurship	2	
1.1	Basic qualities of an Entrepreneur and Financial assistance from Banks.	1	1
1.2	Role of Institutions like MSME Training Institute, Khadi and village industries board, self-help groups, Co-operative sector, Kudumbasree projects and microenterprises.	1	1
2.0	Value added food products	8	
2.1	Preparation and preservation techniques	1	2
2.2	Major causes of spoilage of food.	1	2
2.3	Principles of preservation - asepsis, removal of microorganisms, anaerobic situation	1	2
2.4	Special methods of food preservation - drying, thermal processing-pasteurization, sterilization and canning-low temperature, use of chemical preservatives and food additives.	1	2
2.5	Preparation of wine, vinegar	1	2
2.6	Preparation of pickles, jam, jelly.	1	2
2.7	Preparation of syrups, sauce, dry fruits	1	2
2.8	Preparation of dairy products - cheese, butter, yoghurt, paneer.	1	2

3.0	Processing Techniques(8 hrs)	8	
3.1	Processing of latex: centrifuged latex products and galvanized rubber products.	1	2
3.2	Processing, storage and marketing of Cocoa	1	2
3.3	Processing, storage and marketing of Coconut (Copra, Coir and Tender coconut)	1	2
3.4	Processing, storage and marketing of Rice (parboiled, raw rice and rice flour)	1	2
3.5	Processing, storage and marketing of Pepper, Cardamom, Ginger,	1	2
3.6	Processing, storage and marketing of Arrowroot, Tapioca, Cashew	1	2
3.7	Processing, storage and marketing of Mango, Jackfruit, Guava, Grapes	1	2
3.8	Processing, storage and marketing of Lemon, Papaya, Musa, Garcinia.	1	2
4.0	Nursery Management.	6	
4.1	Preparation of potting mixtures, polybags.	1	2
4.2	Plant growing structures – green houses, shaded houses, poly shed, mist chamber	1	2
4.3	Irrigation methods- sprinkling system, drip irrigation.	1	2
4.4	Modern strategies in propagation by root initiation of cutting, layering technique, budding and grafting technique.	1	2
4.5	Micropropagation, Planting, transplanting and hardening of seedlings.	1	2
4.6	After care of seedlings, Packing and transport of seedlings.	1	2
5.0	Organic farming and composting techniques	6	
5.1	Organic manures and fertilizers, composition of fertilizers , NPK content of various fertilizers and preparation of fertilizer mixtures.	1	3
5.2	Common organic manures - bonemeal, cowdung , poultry waste, oilcakes, organic mixtures and compost.	1	3
5.3	Preparationofcompost– aerobic and anaerobic – advantages and limitations.	1	3
5.4	Vermicompost-preparation; Vermiwash-preparation.	1	3
5.5	Biofertilizers-definition and preparation of different types - Trichoderma, Rhizobium, PGPR, PSB, mycorrhiza.	1	3
5.6	Application of biofertilizers. Biopesticides, Tobacco and Neem decoction. Biological control of disease and pests.	1	3
6.0	Cultivation of vegetables, fruits and medicinal plants	6	
6.1	Types - home gardening, market gardening and truck gardening.	1	3
6.2	Packing and transporting of vegetables.	1	3
6.3	Organic farming of fruit crops.	1	3

6.4	Packing and transporting of fruits	1	3
6.5	Induction of flowering and weed control.	1	3
6.6	Cultivation of medicinal and aromatic plants of common use and great demand.	1	3
7.0	Floriculture and Apiculture	6	
7.1	Floriculture: problems and prospects of floriculture in Kerala.	1	2
7.2	Scope of growing Anthurium, Orchids and Jasmine in Kerala.	1	2
7.3	Common cut flowers-Rose, Gerbera, Gladiolus, Aster, Chrysanthemum, Anthurium and Orchids.	1	2
7.4	Common leaves used in flower arrangement - Cyprus, Podocarpus, Asparagus, Palms, Cycads and Ferns.	1	2
7.5	Apiculture: Scope and significance. Structure, installation and maintenance of an Apiarium.	1	2
7.6	Extraction, processing, preservation and marketing of honey.	1	2
8.0	Flower arrangement	4	
8.1	Flower arrangement types-Western, Eastern (Japanese/Ikebana) and modern.	1	1
8.2	Flower vases, flower holders and floral foam. Vase life of flowers and leaves.	1	1
8.3	Aftercare of flower arrangements – Bouquets.	1	1
8.4	Packing and maintenance of flower and leaves.	1	1
9.0	Ornamental garden designing	4	
9.1	Garden component.	1	1
9.2	Lawn preparation by seeds, seedling and turfing.	1	1
9.3	Maintenance of ornamental garden by Irrigation, Pruning, Repotting.	1	1
9.4	Disease and Pest control of ornamental garden plants.	1	1
10	Mushroom Cultivation and farming	4	
10.1	Mushrooms: significance, nutritive value.	1	4
10.2	Types of Mushrooms – Button – <i>Pleurotus</i> , <i>Volvorella</i> . Spawn production, storage and marketing.	1	4
10.3	Growth of Mushrooms on paddy straw and saw dust by polybag. Mushroom growing structures and maintenance of humidity.	1	4
10.4	Pests and defects of mushrooms. Storage, transporting and marketing of mushrooms.	1	4

REFERENCES

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COMPLEMENTARY COURSES FOR MODEL I B.Sc. ZOOLOGY

Course	Details				
Code	BY1811201				
Title	CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/I				
Type	COMPLEMENTARY 1 THEORY				
Credits	2	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes. Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Demonstrate an attitude of curiosity, appreciation and enquiry of various life forms of plants.	U	ZY 7
2	Identify the different types included in the syllabus.	An	ZY 7
3	Evaluate the diversity of plants with respect to Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms	E	ZY 7
4	Explain the economic importance of algae, fungi and lichens	U	ZY 7
5	Identify the common plant diseases	An	ZY 7
6	Formulate basic skills and techniques in micropreparation so that students can identify cryptogams and gymnosperms by themselves	C	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	ALGAE	13	
1.1	General characters of algae and their classification up to classes (F E Fritsch)	2	1
1.2	Range of thallus variation in Algae	1	3
1.3	Reproduction and life history of the following groups with reference to the types mentioned: Cyanophyceae – <i>Nostoc</i>	1	2
1.4	Reproduction and life history of the following groups with reference to the types mentioned: Chlorophyceae – <i>Oedogonium</i> ,	1	2
1.5	Reproduction and life history of the following groups with reference to the types mentioned: Chlorophyceae – <i>Volvox</i> (vegetative features only)	1	2
1.6	Reproduction and life history of the following groups with reference to the types mentioned: Chlorophyceae – <i>Spirogyra</i> (vegetative features only)	1	2
1.7	Reproduction and life history of the following groups with reference to the types mentioned: Chlorophyceae – <i>Cladophora</i> (vegetative features only)	1	2
1.8	Reproduction and life history of the following groups with reference to the types mentioned: Phaeophyceae – <i>Sargassum</i> ;	1	2
1.9	Reproduction and life history of the following groups with reference to the types mentioned: Rhodophyceae – <i>Polysiphonia</i> ;	1	2
1.10	Economic importance of Algae: food, industry	1	4
1.11	Economic importance of Algae: medicine, biofertilizers	1	4
1.12	Algal bloom	1	4
2.0	FUNGI AND LICHENS	9	
2.1	General characters and outline on the classification of fungi by Ainsworth.	1	1
2.2	General characters, thallus structure, reproduction and life history of the following groups with reference to the types mentioned: Zygomycotina – <i>Rhizopus</i>	1	2
2.3	General characters, thallus structure, reproduction and life history of the following groups with reference to the types mentioned: Ascomycetes – <i>Xylaria</i>	1	2
2.4	General characters, thallus structure, reproduction and life history of the following groups with reference to the types mentioned: Basidiomycetes – <i>Puccinia</i> .	1	2
2.5	Economic importance of Fungi: as food, industry, decomposition of organic matter	1	4
2.6	Fungal toxins and human health.	1	4
2.7	Lichens: Classification based on thallus morphology.	1	2
2.8	Usnea - morphology and anatomy of vegetative and reproductive structure.	1	2
2.9	Economic importance of lichen: food, industry, medicine.	1	4
3.0	BRYOPHYTES	2	
3.1	General characters of Bryophytes.	1	2
3.2	Morphology, anatomy, reproduction and life cycle of <i>Riccia</i> .	1	2
4.0	PTERIDOPHYTES	3	
4.1	General characters of Pteridophytes.	1	2
4.2	Morphology, anatomy (stem) of <i>Selaginella</i> .	1	2
4.3	Reproduction and life cycle of <i>Selaginella</i> .	1	2
5.0	GYMNOSPERMS	4	
5.1	General characters of Gymnosperms	1	2
5.2	Morphology, anatomy (leaf let) of <i>Cycas</i> .	1	2

5.3	Reproduction of Cycas.	1	2
5.4	Life cycle of Cycas.	1	2
6.0	PLANT DISEASES	5	
6.1	Classification of plant diseases on the basis of causative organism	1	5
6.2	Classification of plant diseases on the basis of symptoms.	1	5
6.3	Study the following diseases with special emphasis on causative organism, symptoms and control measures: Nut fall of Arecanut	1	5
6.4	Study the disease with special emphasis on causative organism, symptoms and control measures: Bacterial blight of Paddy	1	5
6.5	Study the disease with special emphasis on causative organism, symptoms and control measures: Leaf mosaic of Tapioca	1	5

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2. Alexopoulou C J, Mims C W, 1983. Introductory Mycology. Wiley Eastern, New York.
3. Bhatia K N, 1975. A treatise on Algae. S Chand and Co.
4. Bilgrami K S, Dube H C, 1976. Text Book of Modern Plant pathology. Vikas Publishing House Pvt. Ltd. New Delhi.
5. Chaube H S, Ramji S, 2001. Introductory Plant Pathology. International Book Distributing Co. Lucknow.
6. Chopra R N, Kumra P K, 1988. Biology of Bryophytes. Wiley Eastern Ltd. New Delhi.
7. Fritsch F E, 1945. Structure and Reproduction of Algae Vol. I & II. Cambridge University Press.
8. Gangulee H C, Kar A K, 1993. College Botany Vol. II. New Central Book Agency, Calcutta.
9. Kanika Sharma, 2009. Manual of Microbiology. Ane Books Pvt. Ltd.
10. Mamatha Rao, 2009. Microbes and Non-flowering plants: Impact and applications. Ane Books Pvt. Ltd.
11. Pandey S N, Trivedi P S, 1994. A Text book of College Botany Vol. I.
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13. Pandey B P, 2007. College Botany Vol. I. S.Chand and Company.
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15. Sharma P D, 2003. Microbiology, Plant Pathology and Biotechnology. Rasthogy Publications.
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Course		Details			
Code	BY1811701				
Title	CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/I				
Type	COMPLEMENTARY 1 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes. Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Formulate basic skills and techniques in micropreparation so that students can identify cryptogams and gymnosperms by themselves	C	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	PRACTICALS	36	
	Micropreparation and identification of		
1.1	Algae: vegetative structure of Nostoc	2	1
1.2	Algae: vegetative structure of Volvox,	2	1
1.3	Algae: vegetative structure of Spirogyra	2	1
1.4	Algae: vegetative structure of Oedogonium	2	1
1.5	Algae: vegetative structure of Cladophora	2	1
1.6	Algae: vegetative structure of Polysiphonia.	2	1
1.7	Algae: vegetative structure and reproductive structure of Sargassum	2	1
1.8	Fungi: vegetative and reproductive structure of <i>Rhizopus</i>	2	1
1.9	Fungi: vegetative and reproductive structure of <i>Xylaria</i>	2	1
1.10	Fungi: vegetative and reproductive structure of <i>Puccinia</i>	4	1
1.11	Lichen: morphology of Usnea thallus and Apothecium.	2	1
1.12	Bryophytes: <i>Riccia</i> thallus anatomy.	2	1
1.13	Pteridophytes: <i>Selaginella</i> - anatomy of stem and morphology of strobilus	4	1
1.14	Gymnosperms: <i>Cycas</i> - Anatomy of leaflet, morphological features of megasporophyll, microsporophyll and ovule.	4	1
1.15	Identify plant diseases mentioned in the syllabus	2	1

REFERENCES

1. Ahamdijan, Vernon, Mason H E, 1973. The Lichens. Academic press, New York.
2. Alexopoulou C J, Mims C W, 1983. Introductory Mycology. Wiley Eastern, New York.
3. Bhatia K N, 1975. A treatise on Algae. S Chand and Co.
4. Bilgrami K S, Dube H C, 1976. Text Book of Modern Plant pathology. Vikas Publishing House Pvt. Ltd. New Delhi.
5. Chaube H S, Ramji S, 2001. Introductory Plant Pathology. International Book Distributing Co. Lucknow.
6. Chopra R N, Kumra P K, 1988. Biology of Bryophytes. Wiley Eastern Ltd. New Delhi.
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10. Mamatha Rao, 2009. Microbes and Non-flowering plants: Impact and applications. Ane Books

Course	Details				
Code	BY1812202				
Title	PLANT PHYSIOLOGY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/II				
Type	COMPLEMENTARY THEORY				
Credits	2	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Upon completion of this course, the students will be able to: Impart an insight into the various plant water relations	U	ZY 7
2	Take students to higher levels of learning about the mineral nutrition in plants	Ap	ZY 7
3	Understand the mechanism of various metabolic processes in plants	An	ZY 7
4	Acquire basic knowledge about growth and development in plants	Ap	ZY 7
5	Equip students with skills and techniques related to plant physiology so that they can design their own experiments	C	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Modul	Course Description	Hrs	CO.No.
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e			
1.0	WATER RELATIONS	11	
1.1	Physical aspects of water absorption - Diffusion, DP, DPD	1	1
1.2	Imbibition	1	1
1.3	Osmosis - OP, Exosmosis, Endosmosis, Plasmolysis	1	1
1.4	Water potential and its components	1	1
1.5	Mechanism of water absorption by root - active and passive absorption	1	1
1.6	Movement of water towards xylem by apoplast and symplast pathway	1	1
1.7	Ascent of sap – theories - transpiration pull theory	1	1
1.8	Root pressure theory; guttation	1	1
1.9	Transpiration: types	1	1
1.10	Mechanism of transpiration and stomatal movement (K ⁺ - ABA theory)	1	1
1.11	Significance and factors affecting transpiration, antitranspirants	1	1
2.0	MINERAL NUTRITION	4	
2.1	A brief account on Micro and macro nutrients	1	2
2.2	Function and deficiency symptoms of the following mineral nutrients: N, P	1	2
2.3	Absorbable form, function and deficiency symptoms of the following mineral nutrients: K, Mg	1	2
2.4	Absorbable form, function and deficiency symptoms of the following mineral nutrients: B, Fe, Zn.	1	2
3.0	PHOTOSYNTHESIS AND TRANSLOCATION OF PHOTOSYNTHATES	15	
3.1	Basic requirements of Photosynthesis	1	3
3.2	Light – PAR	1	3
3.3	Site of photosynthesis; chloroplast	1	3
3.4	Photosynthetic pigments	1	3
3.5	Photosynthetic unit	1	3
3.6	Red drop and Emersons enhancement effect	1	3
3.7	Two pigment systems	1	3
3.8	Light dependent reaction - cyclic and non cyclic photo phosphorylation	1	3
3.9	Light independent reaction (dark reactions) C3 cycle	1	3
3.10	Brief account on C4 CYCLE	1	3
3.11	Brief account on CAM Cycle	1	3
3.12	Factors affecting photosynthesis.	1	3
3.13	Photorespiration (brief study only)	1	3
3.14	Translocation of photosynthate and organic solutes: path of translocation	1	3
3.15	Mechanism of translocation (Pressure Flow Hypothesis).	1	3
4.0	GROWTH AND DEVELOPMENT	6	

4.1	Seed dormancy - causes of seed dormancy - methods of breaking dormancy.	1	4
4.2	Germination of seeds - physiological changes. Growth: Phases of growth.	1	4
4.3	Plant growth regulators - auxins, and their physiological role (brief study only)	1	4
4.4	Plant growth regulators – gibberellins and cytokinins, and their physiological role (brief study only)	1	4
4.5	Plant growth regulators - abscissic acid and ethylene and their physiological role (brief study only)	1	4
4.6	Photoperiodism - definition, short day plants, long day plants, day neutral plants. Vernalization	1	4

REFERENCES

1. Hopkins W G, Norman P A, Huner, 2008. Introduction to Plant Physiology. JohnWiley & Sons, NewYork.
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3. Kochhar P L, Krishnamoorthy H N. Plant Physiology. Atmaram and sons, Delhi.
4. Kumar and Purohit. Plant Physiology: Fundamentals and Applications.Agrobotanical Publishers.
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Course	Details
Code	BY1812702

Title	PLANT PHYSIOLOGY				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/II				
Type	COMPLEMENTARY PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Upon completion of this course, the students will be able to: Impart an insight into the various plant water relations	U	ZY 7
2	Equip students with skills and techniques related to plant physiology so that they can design their own experiments	C	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1	PRACTICAL		
1.1	CORE EXPERIMENTS	15	
1.2	Demonstration of osmosis using potato tuber osmoscope/Papaya petiole osmoscope.	5	1
1.3	Separation of leaf pigments by paper chromatography.	5	2
1.4	Compare the stomatal indices of hydrophytes and xerophytes.	5	2
2	DEMONSTRATION EXPERIMENTS	21	
2.1	Measure the rate of transpiration by Ganong's potometer.	3	2
2.2	Relationship between transpiration and absorption.	3	2
2.3	Measurement of growth using Arc Auxanometer.	3	2
2.4	Demonstration of geographic curvature using Clinostat.	3	2
2.5	Evolution of oxygen during photosynthesis.	3	2
2.6	Mohl's half leaf experiment.	3	2
2.7	Light screen experiment	3	2

REFERENCES

14. Hopkins W G, Norman P A, Huner, 2008. Introduction to Plant Physiology. JohnWiley & Sons, NewYork.
15. JainVK, 2008. Fundamentals of Plant Physiology.S Chand andCo.
16. Kochhar P L, Krishnamoorthy H N. Plant Physiology. Atmaram and sons, Delhi.
17. Kumar and Purohit. Plant Physiology: Fundamentals and Applications.Agrobotanical Publishers.
18. Malik CP, 2002. Plant Physiology. Kalyani publishers.
19. Mukherjii S, Ghosh AK, 2005. Plant Physiology. New Central Book Agency, Culcutta.
20. Noggle GR, Fritz GJ, Introductory Plant Physiology.Prentice Hall of India.
21. Pandey SN, Sinha BK, 2006. Plant physiology.Vikas Publishing House, NewDelhi.
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Course	Details
Code	BY1813203
Title	ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY

Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	2/III				
Type	COMPLEMENTARY COURSE THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understanding of plant morphology terminologies and identifying morphological peculiarities.	U	ZY 7
2	Understand the systems of classification of angiosperms, nomenclature and interdisciplinary approaches.	U	ZY 7
3	Provide lab based training in writing short species descriptions and illustration.	C	ZY 7
4	Recognize members of the major angiosperm families by identifying their diagnostic features and economic importance.	R	ZY 7
5	Evaluate the medicinal importance of selected angiosperms.	E	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Morphology	10	
1.1	Leaf - simple, compound; venation and phyllotaxy	1	1
1.2	Flower as a modified shoot, structure of flower	1	1
1.3	Floral parts, their arrangement, relative position; cohesion and adhesion of floral parts	1	1
1.4	Symmetry of flowers; types of aestivation and placentation	1	1
1.5	Floral diagram and floral formula	1	1
1.6	Inflorescence: racemose - simple, spike, spadix, catkin, corymb, umbel and head	1	1
1.7	Cymose - simple, monochasial - helicoid and scorpioid; special types - cyathium, verticillaster	1	1
1.8	Fruits: outline of the classification; Simple: Fleshy - drupe, berry, hesperidium	1	1
1.9	Fruits: Dry - Dehiscent - legume, capsule; Indehiscent - Caryopsis, Cypsella, Schizocarpic - lomentum, carcerulus, regma, cremocarp with examples.	1	1
1.10	Fruits: Aggregate. Multiple: sorosis, syconus. (Examples should be from families prescribed in the syllabus).	1	1
2.0	Plant Classification and Herbarium Techniques	8	

2.1	Importance of plant classification	1	2
2.2	Types of classification -artificial, natural and phylogenetic (brief account only)	1	2
2.3	Binomial nomenclature; ICBN (Brief account only)	1	2
2.4	Bentham and Hooker's system of classification (upto series)	1	2
2.5	Bentham and Hooker's system of classification :merits and demerits	1	2
2.6	Cytotaxonomy-brief study only	1	2
2.7	Chemotaxonomy-brief study only	1	2
2.8	Herbarium techniques,importance of herbarium, Two important national herbaria	1	2
3.0	Angiosperm Families	18	
3.1	Annonaceae	1	4
3.2	Malvaceae	1	4
3.3	Rutaceae	1	4
3.4	Leguminosae-Mimosaceae	1	4
3.5	Leguminosae-Caesalpiaceae	1	4
3.6	Leguminosae-Fabaceae	1	4
3.7	Comparative account of Leguminosae		4
3.8	Apiaceae-Umbelliferae	1	4
3.9	Rubiaceae	1	4
3.10	Asteraceae-Compositae-general features	1	4
3.11	Asteraceae-advanced features	1	4
3.12	Apocynaceae	1	4
3.13	Lamiaceae-Labiatae	1	4
3.14	Euphorbiaceae	1	4
3.15	Arecaceae-Palmae	1	4
3.16	Poaceae-Gramineae-general features	1	4
3.17	Poaceae-advanced features	1	4
3.18	Identifying characters of the mentioned families	1	4
4.0	Economic Botany:Classes of economically important plants	10	
4.1	Cereals-Paddy ,Wheat	1	4
4.2	Pulses –Green gram, Bengal gram	1	4
4.3	Tuber crops-Tapioca	1	4
4.4	Spices –Pepper,Cardamom	1	4
4.5	Beverages – Tea, Coffee	1	4
4.6	Oil yielding plants – Coconut,Ground nut	1	4
4.7	Fibre yielding plants –Cotton,Coir	1	4
4.8	Timber yielding plants – Teak,Rosewood; Latex yielding plants-Para rubber	1	4
4.9	Biopesticides-Neem,Tobacco	1	4
4.10	Ornamental plants-Rose,Orchids,Anthurium	1	4
5.0	Medicinal Plants: Study of the following medicinal	8	

	plants with special reference to their binomial, family, morphology of useful parts and uses:		
5.1	Adhatoda	1	5
5.2	Aloe	1	5
5.3	Bacopa	1	5
5.4	Catharanthus	1	5
5.5	Eclipta	1	5
5.6	Neem, Ocimum	1	5
5.7	Phyllanthus amarus	1	5
5.8	Rauvolfia, Sida	1	5

REFERENCES

1. Eames AJ, 1969. *Morphology of Angiosperms*. Mc , New York.
2. Hill A F, 1952. *Economic Botany: A Textbook of Useful Plants and Plant Products*. Tata Mc Graw-Hill Publishing Company Limited, New Delhi.
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4. Kochhar S L, 1981. *Economic Botany in the Tropics*. Mac millan India Limited, Delhi.
5. Lawrence GHM, 1951. *Taxonomy of Vascular Plants*. Oxford & IBH, New Delhi.
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7. Pandey S N, S P Misra, 2008. *Taxonomy of Angiosperms*. Ane Books India, New Delhi.
8. Sharma O P, 1993. *Plant Taxonomy*. Tata Mc Graw Hill Publishing Co Ltd., New Delhi.
9. Simpson BS, M Conner – Ogorzaly, 1986. *Economic Botany: Plants in Our World*. Mc Graw Hill Book Company, New York.
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Course	Details
Code	BY1813703
Title	ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY

Degree	B.Sc.				
Branch(s)	BOTANY				
Year/Semester	2/III				
Type	COMPLEMENTARY COURSE PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
	Upon completion of this course, the students will be able to:		
1	Understanding of plant morphology terminologies and identifying morphological peculiarities.	U	ZY 7
2	Provide lab based training in writing short species descriptions and illustration.	C	ZY 7
3	Recognize members of the major angiosperm families by identifying their diagnostic features and economic importance.	R	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1	Practicals	36	
1.1	Students should be trained to identify the different types of inflorescence and fruits of typical plants belonging to the families prescribed in the syllabus.	3	1
1.2	Students should be trained to identify typical local plants belonging to the families prescribed in the syllabus.	4	3
1.3	Students should be trained to describe the floral parts in technical terms and draw the L.S. of flower, construct the floral diagrams and write the floral formula of at least one flower from each family.	15	2
1.4	Study of the groups of plants mentioned in the economic botany syllabus with special reference to their botanical name, family, morphology of useful part, economic products and uses.	10	3
1.5	Students should study the botanical name, family, morphology of the useful part and the uses of the medicinal plants listed in the syllabus.	4	3

REFERENCES

1. Eames AJ, 1969. *Morphology of Angiosperms*. Mc , New York.
2. Hill A F, 1952. *Economic Botany: A Textbook of Useful Plants and Plant Products*. Tata Mc Graw-Hill Publishing Company Limited, New Delhi.
3. Jain SK, 1987. *A Manual of Ethnobotany*. Scientific Publishers, Jodhpur.
4. Kochhar S L, 1981. *Economic Botany in the Tropics*. Mac millan India Limited, Delhi.
5. Lawrence GHM, 1951. *Taxonomy of Vascular Plants*. Oxford & IBH, NewDELHI

Course		Details			
Code	BY1814204				
Title	ANATOMY AND APPLIED BOTANY				
Degree	B. Sc				
Branch(s)	BOTANY				
Year/Semester	2/ IV				
Type	COMPLEMENTARY COURSE 4 THEORY				
Credits	3	Hrs/week	3	Total hrs	54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understand the different types of Plant tissues.	U	ZY 7
2	Understand the Process of Normal and Anomalous Secondary thickening in Plants.	E	ZY 7
3	Differentiate the Morphological and Anatomical adaptations of Plants growing in various Habitats.	An	ZY 7
4	Propose how the Botanical Knowledge acquired can be applied for Crop Improvement.	C	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	CELLS AND TISSUES	9	
1.1	Gross Structure of Primary Cell Walls.	01	1
1.2	Gross Structure Secondary Cell Walls.	01	1
1.3	Structure and Function of Plasmodesmata.	01	1
1.4	Non-living Inclusions – Cystolith and Raphides.	01	1
1.5	Tissues- Meristematic Tissues.	01	1
1.6	Permanent types of Meristems.	01	1 & 2
1.7	Simple and Complex Tissues.	01	1 & 2
1.8	Secretory Tissues - Nectaries and Hydathodes.	01	3
1.9	Secretory Tissues - Mucilage Ducts and Lactiferous Tissue.	01	3
2.0	ANATOMY OF PLANT ORGANS	12	
2.1	Primary Structure of Stem in Dicots.	01	1
2.2	Primary Structure of Root in Dicots.	01	1
2.3	Primary Structure of Stem in Monocots.	01	1

2.4	Primary Structure of Root in Monocots.	01	1
2.5	Anatomy of Monocot Leaf.	01	1
2.6	Anatomy of Dicot Leaf.	01	1
2.7	Secondary Thickening in Dicot Stem.	02	2
2.8	Secondary Thickening in Dicot Root.	01	2
2.9	Heart Wood and Sap Wood; Tyloses; Hard Wood and Soft Wood; Growth Rings and Dendrochronology.	01	1
2.10	Anomalous Secondary Thickening in <i>Bignonia</i> .	02	2
3.0	ECOLOGICAL ANATOMY	6	
3.1	Study of the Morphological and Anatomical Adaptations of the following Group: Hydrophytes- Nymphaea.	01	3
3.2	Study of the Morphological and Anatomical Adaptations of the following Group: Hydrophytes –Hydrilla.	01	3
3.3	Study of the Morphological and Anatomical Adaptations of the following Group: Xerophytes – Nerium.	02	3
3.4	Study of the Morphological and Anatomical Adaptations of the following Group: Epiphytes- Vanda.	02	3
4.0	PLANT BREEDING	12	
4.1	Objectives of Plant Breeding.	1	4
4.2	Methods of Plant Improvement.	1	4
4.3	Plant Introduction.	1	4
4.4	Acclimatization.	1	4
4.5	Plant Quarantine.	1	4
4.6	Selection.	1	4
4.7	Mass Selection.	1	4
4.8	Pure Line Selection.	1	4
4.9	Clonal Selection.	1	4
4.10	Hybridization.	1	4
4.11	Intervarietal, Interspecific and Intergeneric- Hybridization.	1	4
4.12	Procedure of Hybridization – Selection of parents, Emasculation, Pollination	1	4
5.0	ARTIFICIAL AND VEGETATIVE PROPAGATION METHODS	5	
5.1	Propagation of Plants through Cutting and Layering.	1	4
5.2	Air layering.	1	4
5.3	T- Budding and Patch-Budding.	1	4
5.4	Tongue-Grafting and Splice-Grafting.	1	4
5.5	Role of Cambium in Budding and Grafting.	1	4
6.0	PLANT TISSUE CULTURE	10	

6.1	Principles of Tissue Culture.	1	4
6.2	Micro-propagation – Different Steps.	1	4
6.3	Selection of Explants.	1	4
6.4	Culture Media – General Composition and Preparation (MS Medium)	1	4
6.5	Sterilization of Media and surface sterilization of <i>explants</i>	1	4
6.6	Inoculation, Incubation	1	4
6.7	Callusing and regeneration of Plants, Organogenesis, Somatic Embryogenesis.	2	4
6.8	Artificial Seeds.	1	4
6.9	Applications of Plant Tissue Culture.	1	4

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1. Christopher E P, 1958. *Introductory Horticulture*. Mc Graw – Hill, New York.
2. Esau K, 1965. *Plant Anatomy*. Wiley, New York.
3. Fahn A, 1985. *Plant Anatomy*. Pergamon Press, Oxford.
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6. Pandey BP, 1984. *Plant Anatomy*. S Chand and Company, New Delhi.
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Course	Details				
Code	BY1814704				
Title	ANATOMY AND APPLIED BOTANY				
Degree	B. Sc.				
Branch(s)	BOTANY				
Year/Semester	2/ IV				
Type	COMPLEMENTARY COURSE 4 PRACTICAL				
Credits	1	Hrs/week	2	Total hrs	36

CO No.	Expected Course Outcomes	Cognitive	PSO No.
	Upon completion of this course, the students will be able to:		

		Level	
1	Understand the different types of Plant tissues.	U	ZY 7
2	Understand the Process of Normal and Anomalous Secondary thickening in Plants.	E	ZY 7
3	Differentiate the Morphological and Anatomical adaptations of Plants growing in various Habitats.	An	ZY 7
4	Propose how the Botanical Knowledge acquired can be applied for Crop Improvement.	C	ZY 7

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1	Anatomy	36	
1.1	Primary structure of stem and root of dicots and monocots; Dicot stem - Centella; Monocot stem – Bamboo, grass, asparagus; Dicot root - Tinospora; Monocot root - Colocasia, Musa.	18	1
1.2	Structure of dicot stem and dicot root after secondary thickening; Stem - Vernonia, Eupatorium; Root - Tinospora, Papaya.	4	2
1.3	Anomalous secondary thickening in <i>Bignonia</i> .	2	2
1.4	Anatomical adaptations of Hydrophytes - <i>Nymphaea</i> petiole, <i>Hydrilla</i> stem; Xerophytes - <i>Nerium</i> Leaf; Epiphytes - Velamen root of <i>Vanda</i> .	4	3
1.5	Emasculation of pea or <i>Caesalpinia</i> flower.	2	4
1.6	Demonstrate T and patch budding.	2	4
1.7	Demonstration of tissue culture techniques: culture media, surface sterilization and inoculation of explants.	2	4
1.8	Identification of non living inclusions - cystolith, raphides.	2	3

REFERENCES

1. Christopher E P, 1958. *Introductory Horticulture*. Mc Graw – Hill, New York.
2. Esau K, 1965. *Plant Anatomy*. Wiley, New York.
3. Fahn A, 1985. *Plant Anatomy*. Pergamon Press, Oxford.
4. Hartman HT, DE Kester, 1991. *Plant Propagation: Principles and Practices*. Prentice Hall of India, New Delhi.

Course		Details			
Code	BYX1801				
Title	PROCESSING OF FRUITS AND VEGETABLES				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/II				
Type	EXTRA CREDIT COURSE-1				
Credits	2	Hrs/Week	2	Total Hrs	36

CO No.	Expected Course Outcomes	Cognitive Level	PSO No.
1	Upon completion of this course, the students will be able to: Understand different types of fruits and vegetables.	U	4
2	Examine the opportunities and potentials in the field of food processing technology	Ap	3
3	Devise methods for preservation of fruits and vegetables	C	4
4	Devise methods for skill acquisition in food processing technology	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Processing of fruits and vegetables	18	1-4
1.1	Identifications of Fruits and vegetables.	2	1
1.2	Identification of spices and food additives used in fruits and vegetable processing.	2	1
1.3	Spoilage of fruits and vegetables	2	1
1.4	Study of common food processing equipments such as pulper, sealers, juice extracting machines, autoclaves, corking machines etc.	2	1
1.5	Refrigeration and other methods for storing perishables.	2	1
1.6	Preparation of Fruit Juice. Preservation of fruits juices with addition of preservative	2	1
1.7	Preparation of common fruit beverages. Determination of Acids in fruits and vegetable products	2	1 & 2
1.8	Preparation of tomato juices, sauces, ketchups, soup, paste, chutney	2	1 & 2
1.9	Various methods of drying: sun drying, cabinet drying and solar drying.	2	3

	Hands own training and Industrial visit	18	
2.1	Preparation of wine	2	3
2.2	Preparation of synthetic vinegars.	2	3
2.3	Preparation of candies, Jam, jelly and fruit bars.	2	3
2.4	Demonstration of Canning process in fruits and vegetables canning industry.	2	3,4
2.5	Freezing demonstration on market sample of frozen fruits and vegetables.	2	3,4
2.6	Preparations of different types of pickles from fruits and vegetables.	2	3
2.7	Examination of processed products.	2	4
2.8	Cleaning and maintenance of the equipments.	2	4
2.9	Industrial Training: Fruits and vegetables processing industry.	2	2

REFERENCES

1. Adams MR, M O Moss, 1995. FoodMicrobiology. PanimaPublishing.
2. Casida L E(Jr.),2005.IndustrialMicrobiology.NewAgeInternational.
3. Frazier, Westhoff, 1988. Food Microbiology. Tata Mc GrawHill.
4. GeorgeJBanwant, 2004. Basic FoodMicrobiology.CBS Publishers and Distributors.
5. James M. Jay, 2005. Modern Food Microbiology .CBS Publishers and Distributors.
6. Neshamani S, 2000. Pazhangal, Pazhavibhavangal (Malayalam).Kerala Bhasha Institute.

Course	Details				
Code	BYX1802				
Title	Solid waste management				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	2/IV				
Type	EXTRA CREDIT COURSE-2				
Credits	2	Hrs/Week	2	Total Hrs	36

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Understand different types of solid waste.	U	4
2	Examine the current status of solid waste management	Ap	3
3	Devise methods for Municipal waste management	C	4
4	Devise methods for collection and recycling of solid waste	C	4

PSO-Program Specific outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	Solid Waste-Introduction	18	1-4
1.1	Municipal Solid Waste Management.	2	1
1.2	Generation and Characteristics of Waste.	2	1
1.3	Health and Environmental Effects.	2	1
1.4	Waste Collection, Storage and Transport.	2	1
1.5	Record Keeping, Control, Inventory and Monitoring.	2	1
1.6	Implementing Collection and Transfer System.	2	1
1.7	Case Study-Waste Storage, Collection and Transport.	2	1 & 2
1.8	Waste Disposal - Key issues and features.	2	1 & 2
1.9	Sanitary Landfill.	2	3
2.0	Solid waste- Collection and processing	18	

2.1	Waste Processing Techniques.	2	3
2.2	Volume, size and Chemical reduction techniques.	2	3
2.3	Source Reduction, Product Recovery and Recycling.	2	3
2.4	Planning of a Recycling Programme.	2	3,4
2.5	Recycling Programme Elements.	2	3,4
2.6	Recovery of Biological Conversion Products: Composts and Biogas.	2	3
2.7	Composting and Bio-gasification: Technology.	2	4
2.8	Cleaning and maintenance of the equipments.	2	4
2.9	Visit to solid waste management unit.	2	2

REFERENCES

1. D.Bhide and B.B.Sundaresan, "Solid Waste Management –Collection, Processing and disposal" Mudrashilpa Offset Printers, Nagpur, 2001.
2. J. Glynn Henry and Gary. W. Heinke "Environmental Science and Engineering", Pretice Hall of India, 2004.
3. George Techobanoglous et al,"Integrated Solid Waste Management" McGraw -Hill, 1993.
4. R.E.Landrefh and P.A.Rebers," Municipal Solid Wastes -Problems & Solutions",Lewis, 1997.

**UNIVERSITY GRANTS COMMISSION
NEW DELHI**

Career Oriented Programme

**Syllabus for
Certificate/ Diploma/ Advanced Diploma Course in**

DEPARTMENT OF BOTANY
CMS COLLEGE
KOTTAYAM
KERALA- 686001

.....
MAHATMA GANGHI UNIVERSITY
PRIYADARSHINI HILLS, KOTTAYAM
KERALA-686560

**Certificate/ Diploma/ Advanced Diploma Course in
Medicinal and Ornamental Plants.**

(The career oriented programme is framed for 20 Credits for each course. Classes will be conducted on Saturdays)
Fees: Rs- 1000/Year

Objectives of the Career oriented programme

This programme was designed with the following objectives:

1. To promote cultivation and conservation of medicinal and ornamental plants.
2. To provide basic training in medicinal and ornamental plants in tune with the flourishing Ayurvedic and floriculture industries in Kerala.
3. To meet the increasing demands of trained personals in Ayurvedic and Floriculture industries.
4. To improve the quality of ayurvedic products and to generate Ayurveda based self employment opportunities
5. To generate a new generation of medicinal plant specialists who can translate Traditional knowledge in the light of advancement in modern medicine.

Pre-requisites:

Candidate should have passed higher secondary or its equal in science stream and should have an aptitude for medicinal and floriculture.

CERTIFICATE COURSE- FIRST YEAR		
Distribution of papers	Hours	Credits
Theory: Paper 1- Medicinal and Aromatic Plants- 1	90 Hrs	06
Theory: Paper 2-Floriculture -1	90 Hrs	06
Paper 3. Practical and Field Work	120 Hrs	08
Total	300 Hrs	20
DIPLOMA COURSE- SECOND YEAR		
Distribution of papers	Hours	Credits
Theory: Paper 1- Medicinal and Aromatic Plants- 2	90 Hrs	06
Theory: Paper 2-Floriculture- 2	90 Hrs	06
Paper 3. Practical and Field Work	120 Hrs	08
Total	300 Hrs	20
ADVANCED DIPLOMA COURSE- THIRD YEAR		

Distribution of papers	Hours	Credits
Theory: Paper 1- Phytochemical application of crude drugs with special reference to Ayurveda.	90 Hrs	06
Theory: Paper 2- Floriculture- 3.	90 Hrs	06
Paper 3. Practical and Field Work.	120 Hrs	08
Total	300 Hrs	20

CERTIFICATE COURSE- FIRST YEAR (300 Hrs, 20 Credits)

Paper 1- Medicinal and Aromatic Plants- 1 (90 Hrs, 06 Credits)

Module 1. Introduction to major medicinal plants.

AYUSH- Ayurveda (3hrs), Yoga (3hrs), Uanani (3hrs), Siddha (3hrs), Homeopathy (3hrs) **(15 hrs)**

Module 2. Major Medicinal group of plants:-

1. Dasamoola (6hrs)
2. Dasapushpam (6hrs)
3. Nalpamara (3hrs)
4. Panchamoola (3hrs)
5. Panchapallava m (3hrs)
6. Trikadu (3hrs)
7. Triphala (3hrs) **(27 hrs)**

Module 3. Factors leading to deterioration of quality of drugs. **(03 hrs)**

Module 4. Common Ayurvedic preparations:-

1. Choorna (3hrs)
2. Ghrita (3hrs)
3. Kashaya (3hrs)
4. Lehya (3hrs)
5. Taila (3hrs) **(15 hrs)**

Module 5. Cultivation and medicinal uses of:-

1. Adhatoda (3hrs)
2. Andrographis (3hrs)
3. Asoca (3hrs)

4. Bael (3hrs)
5. Brahmi (3hrs)
6. Castor (3hrs)
7. Cinnomon (3hrs)
8. Ginger (3hrs)
9. Tinospora (3hrs)
10. Turmeric (3hrs) **(30 hrs)**

Paper 2- Floriculture- 1 (90 Hrs, 06 Credits)

Module 1. Introduction (3 hrs), Importance and scope of floriculture (6 hrs), Present status of floriculture in India (3 hrs). **(12hrs)**

Module 2. Classification of Ornamental plants (3 hrs).
Importance, Scope, Origin, Botanical and common name of cultivars (25 minimum). **(28hrs)**

Module 3. Cut flowers and its importance (6 hrs), selection of cultivars for cut flower (8 hrs). **(14 hrs)**

Module 4. Principles of flower arrangements:-

1. Bouquet making (3 hrs)
2. Bridal makes (3 hrs)
3. Car decorations (3 hrs)
4. Wreath making (3 hrs) **(12hrs)**

Module 5. Cultivation of Ornamental plants:-

1. Cold frame (6 hrs)
2. Green house (6 hrs)
3. Hot beds (6 hrs)
4. Poly house (6 hrs) **(24 hrs)**

Paper- 3 Practical and field work (120 Hrs, 08 credits)

1. Working knowledge and identification of garden tools and implements.
2. Different propagation techniques:-
 - a. Cutting and other vegetative parts
 - b. Seeds
 - c. Layering
 - d. Budding
 - e. Grafting
3. Different types of flower arrangements according to Japanese and Western Style.
4. Preparation of herbarium of common medicinal plants and dried specimens.

5. Visit a well maintained medicinal plant garden in Ayurvedic industry and submit an industrial visit report.

DIPLOMA COURSE- SECOND YEAR (300Hrs, 20 Credits)

Paper 1- Medicinal and aromatic plants- 2 (90 hrs, 06 Credits)

Module 1. Cultivation of Medicinal plants:-

1. *Adhatoda zeylanica* (3hrs)
2. *Aloe vera* (3hrs)
3. *Alpinia galanga* (3hrs)
4. *Andrographis paniculata* (3hrs)
5. *Asparagus racemosus* (3hrs)
6. *Bacopa monnieri* (3hrs)
7. *Centella asiatica* (3hrs)
8. *Cissus quadrangularis* (3hrs)
9. *Piper longum* (3hrs)
10. *Piper nigrum* (3hrs)
11. *Plumbago zeylanica* (3hrs)
12. *Pogostemon pacholi* (3hrs)

(36hrs)

Module 2. Cultivation of Ornamental Plants:-

1. Heliconia (3hrs)
2. Jasmine (3hrs)
3. Orchid (3hrs)
4. Rose (3hrs)

(12 hrs)

Module 3. Cultivation of Medicinal Hedge:-

1. *Acalypha fruticosa* (3hrs)
2. *Adhatoda zeylanica* (3hrs)

(6 hrs)

Module 4. Cultivation of Medicinal Lawn:-

1. *Centella asiatica* (3hrs)
2. *Cyanadon dactylon* (3hrs)

(6hrs)

Module 5. Construction of herbal hut (Parnakudeeram):-

1. *Alangium salvifolium* (3hrs)
2. *Asparagus racemosus* (3hrs)

(6 hrs)

Module 6. Cultivation of flowering medicinal trees as avenue plants:-

1. *Cassia fistula* (3hrs)
2. *Lawsonia inermis* (3hrs)
3. *Saraca asoka* (3hrs)

(9hrs)

Module 7. Prospect of herbal technology:-

- I. Plants as nutraceuticals (1hrs).
- II. Under-utilized fruits: - 1. *Avarroha bilimbi*, 2. *Phyllanthus acidus* (3hrs).
- III. Processing and preservation of seasonal fruits in Kerala:-
1. Mango, 2. Pineapple, 3. Jack fruit. (3hrs)
- IV. Indigenous herbs used as vegetables:-
1. *Boerhavia diffusa*, 2. *Moringa oleifera*, 3. *Amaranthus viridis*,
4. *Amaranthus spinosa* (8hrs) (15hrs)

Paper 2. Floriculture -2 (90Hrs, 06 Credit)

- Module 1.** Soil and climate requirement (3hrs), water management and propagation techniques (8hrs) . (11hrs)
- Module 2.** Propagation technique by different methods:-
1. Seeds, 2. Stem 3. Root cuttings and 4. Underground stem.(10hrs)
Advantages and disadvantages (2hrs) (12hrs)
- Module 3.** Gardening and Harvesting (2hrs), marketing of commercially important flower crops (4hrs)
1. Rose, 2. Orchid, 3. Canna (6hrs) (12hrs)
- Module 4.** History and scope of Bonsai making (3hrs). Bonsai and art (3hrs),
Classification of plants suitable for Bonsai (6hrs). (12hrs)
- Module 5.** Bonsai containers, Bonsai Making and important points for bonsai making (10hrs). Changing of pots / Containers (2hrs). (12hrs)
- Module 6.** Pruning of roots and stems in Bonsai technique (6hrs).
Trimming of plants:- Irrigation, Mannuring, protection from adverse Conditions (6hrs) (12hrs)
- Module 7.** Principles and types of flower arrangement (4hrs).
1. Western (3hrs) and 2. Japanese(3hrs) (10 hrs)
- Module 8.** Growth regulators (3hrs). Role and classification of growth regulators for ornamental crops (3hrs). Different methods for the use of growth regulators (3hrs) (9hrs)

Paper 3: Practical and field work (120Hrs, 08 Credits)

1. Botany, binomial, common name and morphology of useful parts of common medicinal plants used in Ayurvedic industries.
2. Preparation of a raw drug museum of major medicinal plants in Kerala.
3. Preparation of garden designs: - small and medium.
4. Identification and study of indoor plants.
5. Identification and description of shrubs.
6. Preparation of pot- mixtures for potting of medicinal/ ornamental plants.
7. Visiting famous botanic gardens in Kerala/ neighbouring state (any one).
8. Submit a field visit report.

ADVANCED DIPLOMA COURSE – THIRD YEAR
(300Hrs, 20 Credits)

Paper 1 Phytochemical application of crude drugs with special reference to Ayurveda
(90hrs, 06 credits)

Module 1. Morphological evaluation of Raw Drugs from adulterants (detailed approach). (10hrs)

Module 2. Isolation techniques in plant secondary metabolites: -TLC/GC/HPLC. (15hrs)

Module 3. Utility of plant drugs as:-

1. Anti-oxidants (5hrs),
2. Anti-diabetic agents (5hrs),
3. Anti-cancer agents (5hrs). (15hrs)

Module 4. Prospects of medicinal plants in:-

1. Nanotechnology (10hrs),
2. Drug delivery (10hrs),
3. Chemotherapy (10hrs),
4. Phytoremediation (10hrs). (40hrs)

Module 5. Conservation and resource management of medicinal plants with special reference to RET- plants. (10hrs)

Paper -2 Floriculture -3 (90Hrs, 06 Credits)

Module 1. Gardening: -

1. History of gardening in India (5hrs).
2. Importance and scope of gardening (5hrs).
3. Various garden components and common plants used to make each components (10hrs).
4. Types of gardens (3hrs).
5. Preparation of garden designs (5hrs).
6. Famous garden in India (2hrs). (30hrs)

Module 2. Dry flower technology: -

1. Introduction (2hrs).
2. Advantages and uses of dried flowers (3hrs).
3. Techniques for the production of dry flowers (7hrs).
4. Selection of plant materials for dry flower arrangement (3hrs).
5. Drying plant materials (3hrs).
6. Methods of drying plant materials: Air drying, Press drying and Embedded drying (7hrs).
7. Preparation of plant materials for arrangement: Dyeing/colouring (3hrs).
8. Care of dried flowers (2hrs). (30hrs)

Module 3. Artificial flower arrangement: -

1. Types of materials used for making artificial flowers (3hrs).
2. Artificial flower making: Rose/Carnation/Marigold (6hrs).
3. Advantages of artificial flowers (4hrs).
4. Care of artificial flowers (2hrs). (15hrs)

Module 4. Value addition from dry/artificial materials: -

1. Dry/artificial flower arrangements (5hrs).
2. Potpourri making (3hrs).
3. Floral handicraft using pressed flowers and leaves: Cards/Collages (7hrs). (15hrs)

Paper 3. Practical (120Hrs, 08 Credits)

1. List out common raw drugs used for pharma products.
2. List out common plants used for making various garden components.
3. Dry flower arrangement using the collected dried plant materials.
4. Artificial flower arrangement using the handmade flowers.
5. Artificial flower arrangement using the handmade leaves.
6. Visit a well maintained Nanotechnology lab in Kerala/ neighbouring state (any one).
7. Submit a Lab visit report.

References:

1. **Arora J.S.** 2006. *Introductory Ornamental horticulture*. Kalyani Publications.
2. **Bhattacharjee S.K.** 2006. *Advances in Ornamental Horticulture*. Vols. I-VI.
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5. **Lauria A.** and Ries V.H. 2001. *Floriculture – Fundamentals and Practices*. Agrobios. Pointer Publ.
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8. **Sheela V.L.** 2007. *Flowers in Trade*. New India Publ. Agency.
9. **Valsalakumari.** 2008. *Flowering Trees*. New India Publ. Agency. Woodrow M.G.1999. *Gardening in India*. Biotech Books.
10. **Valsalakumari P.K.**, Rajeevan P.K., Sudhadevi P.K. and Geetha C.K. 2008. *Flowering Trees* New India Publ. Agency. Vol 1.The Back Ground. Springer, Netherlands.