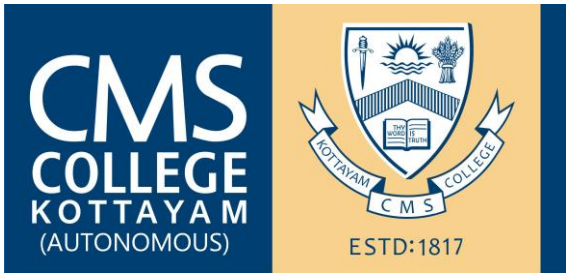

CMS COLLEGE, KOTTAYAM

(AUTONOMOUS)

Affiliated to Mahatma Gandhi University, Kottayam, Kerala

CURRICULUM FOR UNDER GRADUATE PROGRAMME

BACHELOR OF SCIENCE IN BOTANY & BIOTECHNOLOGY (DOUBLE MAIN)

UNDER CHOICE BASED CREDIT SYSTEM
(with effect from 2018)

Approved by the Board of Studies on 27-03-2018

CONTENTS

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ACKNOWLEDGEMENT

The Board of Studies in Biotechnology, CMS College, Kottayam, had the pleasant but hard task of redesigning the curriculum of the Botany-Biotechnology (Double main) Under Graduate Course, after the College became autonomous in 2016. Several experts in the field of Biotechnology, teachers and Professors at various levels in higher education as well as the entire faculty of the Department were deeply involved in this noble task.

On behalf of the Department of Biotechnology, I wish to place on record our thanks to the Principal, Prof. Dr.Roy Sam Daniel and the Vice Principal Prof. Dr. Varghese C. Joshua for their support and encouragement all through.

Dr.K.Jayachandran, Subject Expert in the Board of Studies, Associate Professor, School of Biosciences, Mahatma Gandhi University, was a constant source of inspiration and support. We wish to thank him for the meticulous care with which he approached the entire curriculum redesigning work with us, always taking care to see that the redesigned curriculum is as perfect as humanly possible. We wish to thank him for his earnest efforts and good will.

Dr. Bindu Roy, Scientist, Germplasm Division, Rubber Research Institute of India attended most of the meetings of the BoS and helped in the redesigning of the curriculum in a meaningful manner. We place on record, our gratefulness to her.

I wish to express my sincere gratitude to the other board members - Dr. Jinu John, Mr. Renji Varghese, Dr. Latha Sadanandan, Dr. Sunitha T.K and Dr. Anuja Kurian for their valauble contributions towards the designing of the curriculum.

We wish to thank Dr. Mini Chacko, Professor and Head of the Department of Botany, and the entire Faculty of the Department for redesigning the curriculum of Botany.

It is our hope that the present redesigned curriculum for the Graduate programme in Botany-Biotechnology will enable the students to discover the immense possibilities for higher studies, research or employment in various areas in modern Biotechnology.

Let me thank all who were involved in this curriculum designing effort with us.

Chairman,
Board of Studies

PREFACE

The B.Sc. Botany - Biotechnology (Double Main) Graduate programme of CMS College Kottayam (Autonomous) is designed as an inter-disciplinary programme drawing inputs and resources from several related disciplines in biological, physical and chemical sciences. The course is designed as a technology oriented one equipping the students get employed or pursue research objectives in any of the related fast developing areas \of modern science and technology.

The present redesigned curriculum of the Graduate Programme in Botany-Biotechnology exposes the students to all relevant areas and cutting edge technologies of modern biological sciences. Biotechnology involves the study of molecules, cells and organisms with the aim of understanding how biological processes work. This enables the student to think in terms of developing more refined methods for the production of biomolecules such as vaccines, enzymes and so on. The present curriculum aims at equipping the students for research careers in several areas in Biosciences.

The present scenario in Higher Education, Research and Development sector or in Biotech industries is one of innovation, fast changes, intense competition, prevalence of start up technologies and ventures, and so on. There fore, we have strived hard to make the curriculum orientation to keep pace with the developments in the educational, research and industrial sectors in national and global levels.

The curriculum has been designed with the view of training students in the relevant fundamental and modern disciplines of Biotechnology and Botany, imparting them practical exposure to these emerging fields and widening their mental horizons, promoting the spirit of enquiry in the students, and making learning a joyful experience, as one move forward.

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO)

At the completion of the under graduate program, the student will be able to accomplish the following programme 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* *Upon completion of* ***B.Sc. Botany and Biotechnology*** *Programme, the graduates will be able to:*	GPO No.
1	BT PSO-1	Recall the fundamentals of Biotechnology which would enable them to comprehend the emerging and advanced engineering concepts in life sciences.	1
2	BT PSO-2	Apply the acquired conceptual knowledge by connecting disciplinary and interdisciplinary aspects of biotechnology.	6
3	BT PSO-3	Propose the technological knowhow in domains of biotechnology for their applications in industry and research.	2
4	BT PSO-4	Identify the importance of bioethics, IPR, entrepreneurship, ecotourism so as to usher in the next generation of Indian Industrialists and Naturalists.	1, 4
5	BT PSO-5	Evaluate the need and impact of scientific solutions on the environment and the society, keeping in view of their sustainable development.	5
6	BT PSO-6	Analyze the knowledge gained in Biotechnology for lifelong learning.	1, 6
7	BY PSO-1	Identify the different groups of botany and appreciate plant diversity.	1, 5
8	BY PSO-2	Understand the current developments in the different areas of botany.	6
9	BY PSO-3	Analyze and apply the methodologies and techniques learnt during the course of studying botany.	6
10	BY PSO-4	Integrate the knowledge acquired in botany to solve problem, take real time decisions and innovate, while working with plants.	1, 2
11	BY PSO-5	Share social and environmental consciousness with their fellow citizens.	4, 5
12	PSO-LG	Organize and deliver relevant applications of knowledge through effective written, verbal, graphical/virtual communications and interact productively with people from diverse backgrounds	3

BY – Botany, BT – Biotechnology, PSO – Program Specific Outcome, LG - Language

PROGRAMME DESIGN

B.Sc. BOTANY AND BIOTECHNOLOGY PROGRAMME – MODEL III (DUAL CORE)

The UG programme in Botany and Biotechnology (Model – III, Dual core) includes the following courses,

(a) One Common Course - English

(b) Two Core Courses – Biotechnology & Botany

(c) Two Complementary Courses – Biochemistry & Zoology

(d) Open Course

(e) Choice Based Course

(f) Project Work

(g) On the Job Training.

Sl. No.	Course Type	No. of Courses	Total Credits
1	Common course I - English	2	8
2	Core 1 + Practical - Biotechnology	10+10	27+10
3	Core 2 + Practical - Botany	10+10	27+10
4	Complementary I + Practical - Biochemistry	4+4	10+4
5	Complementary II + Practical - Zoology	4+4	10+4
6	Choice Based Open course	1	3
7	Choice Based Elective course	1	3
8	Project work	1	3
9	OJT (On the Job Training)	1	1
	Total	62	120

PROGRAMME STRUCTURE – SEMESTER WISE

SEMESTER I					
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Total hours**	**Credits**
EN1811501	Fine-tune Your English	Common course I – English 1	5	90	4
BY1811101	Methodology of Science & Introduction to Botany	Core Botany -1	2	36	2
BY1811601	Methodology of Science & Introduction to Botany	Core Botany -1 Practical	2	36	1
BY1811102	Biostatistics	Core Botany -2	3	54	2
BY1811602	Biostatistics	Core Botany -2 Practical	1	18	1
BT1811101	Cell Biology and Developmental Biology	Core Biotechnology- 1	3	54	2
BT1811601	Cell Biology and Developmental Biology	Core Biotechnology - 1 Practical	1	18	1
BT1811201	Elementary Biochemistry	Complementary 1 Biochemistry 1	2	36	2
BT1811701	Elementary Biochemistry	Complementary 1 Biochemistry 1 Practical	2	36	1
ZY1811201	Non Chordate Diversity	Complementary 2 Zoology 1	2	36	2
ZY1811701	Non Chordate Diversity	Complementary 2 Zoology 1 - Practical	2	36	1
		Total	**25**	**450**	**19**
SEMESTER II					
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Total hours**	**Credits**
EN1812503	Issues That matter	Common course I – English 2	5	90	4
BY1812102	Microbiology, Mycology & Plant Pathology	Core Botany -3	2	36	2
BY1812602	Microbiology, Mycology & Plant Pathology	Core Botany -3 Practical	2	36	1
BT1812102	Biophysics & Instrumentation	Core Biotechnology -2	3	54	2
BT1812602	Biophysics & Instrumentation	Core Biotechnology -2 Practical	1	18	1
BT1812103	Molecular Biology	Core Biotechnology -3	3	54	2

BT1812603	Molecular Biology	Core Biotechnology -3 Practical	1	18	1
BT1812202	Biomolecules	Complementary 1 Biochemistry 2	2	36	2
BT1812702	Biomolecules	Complementary 1 Biochemistry 2 Practical	2	36	1
ZY1812202	Chordate Diversity	Complementary 2 Zoology 2	2	36	2
ZY1812702	Chordate Diversity	Complementary 2 Zoology 2- Practical	2	36	1
		Total	**25**	**450**	**19**
SEMSTER III					
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Total hours**	**Credits**
BY1813103	Phycology & Bryology	Core Botany -4	3	54	3
BY1813603	Phycology & Bryology	Core Botany -4 Practical	2	36	1
BT1813104	Microbiology & Microbial Biotechnology	Core Biotechnology -4	3	54	3
BT1813604	Microbiology & Microbial Biotechnology	Core Biotechnology -4 Practical	2	36	1
BT1813105	Immunology	Core Biotechnology -5	3	54	3
BT1813605	Immunology	Core Biotechnology -5 Practical	2	36	1
BT1813203	Enzymology and Metabolism	Complementary 1 Biochemistry 3	3	54	3
BT1813703	Enzymology and Metabolism	Complementary 1 Biochemistry 3 Practical	2	36	1
ZY1813203	Physiology and Immunology	Complementary 2 Zoology 3	3	54	3
ZY1813703	Physiology and Immunology	Complementary 2 Zoology 3- Practical	2	36	1
		Total	**25**	**450**	**20**
SEMESTER IV					
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Total hours**	**Credits**
BY1814104	Pteridology, Gymnosperms & Paleobotany	Core Botany -5	3	54	3
BY1814604	Pteridology, Gymnosperms & Paleobotany	Core Botany -5 Practical	2	36	1
BT1814106	Animal Biotechnology & Nanobiotechnology	Core Biotechnology -6	3	54	3

BT1814606	Animal Biotechnology & Nanobiotechnology	Core Biotechnology -6 Practical	2	36	1
BT1814107	Plant Biotechnology	Core Biotechnology -7	3	54	3
BT1814607	Plant Biotechnology	Core Biotechnology -7 Practical	2	36	1
BT1814204	Nutritional and Clinical Biochemistry	Complementary 1: Biochemistry 4	3	54	3
BT1814704	Nutritional and Clinical Biochemistry	Complementary 1: Biochemistry 4 - Practical	2	36	1
ZY1814204	Applied Zoology	Complementary 2 : Zoology 4	3	54	3
ZY1814704	Applied Zoology	Complementary 2 : Zoology 4 Practical	2	36	1
Total			**25**	**450**	**20**

SEMSTER V					
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Total hours**	**Credits**
BY1815105	Anatomy, Reproductive botany, Microtechniques	Core Botany -6	3	54	3
BY1815605	Anatomy, Reproductive botany, Microtechniques	Core Botany -6 Practical	2	36	1
BY1815107	Plant Physiology & Biochemistry	Core Botany -7	3	54	3
BY1815607	Plant Physiology & Biochemistry	Core Botany -7 Practical	2.5	45	1
BY1815108	Environmental sciences and Human Rights	Core Botany -8	3	54	3
BY1815608	Environmental sciences and Human Rights	Core Botany -8 Practical	2	36	1
BT1815108	Applied Molecular Biology	Core Biotechnology -8	3	54	3
BT1815608	Applied Molecular Biology	Core Biotechnology -8 Practical	2.5	45	1
BT1815401	Ecotourism	Open	4	72	3
BT1815801	OJT (on the job training)	Core BT			1
	Total		**25**	**450**	**20**

SEMESTER VI					
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Total hours**	**Credits**
BY1816109	Genetics, Plant Breeding and Horticulture	Core Botany -9	3	54	3
BY1816609	Genetics, Plant Breeding and Horticulture	Core Botany -9 Practical	2.5	45	1
BY1816111	Angiosperm Morphology, Taxonomy & Economic Botany	Core Botany -10	4	72	3
BY1816611	Angiosperm Morphology, Taxonomy & Economic	Core Botany -10 Practical	2.5	45	1

	Botany				
BT1816109	Recombinant DNA Technology	Core Biotechnology -9	3	54	3
BT1816609	Recombinant DNA Technology	Core Biotechnology -9 Practical	2	36	1
BT1816110	Bioinformatics	Core Biotechnology -10	3	54	3
BT1816610	Bioinformatics	Core Biotechnology -10 Practical	2	36	1
BT1816301	Phytochemistry & Pharmacognosy	Elective	3	54	3
BT1816802	Investigatory project work done individually or in groups	Project Core Biotechnology -11			3
		Total	**25**	**450**	**22**

PROGRAMME STRUCTURE – B.Sc. BOTANY AND BIOTECHNOLOGY

(CATEGORY WISE)

Common Courses

Sl. No.	Course Name	Credit	Hrs/Week	Semester
1	Fine-tune Your English	4	5	1
2	Issues that Matter	4	5	2
Total		**8**		

CORE COURSES

Sl. No.	Course Name	Credit	Hrs/Week	Semester
1	Methodology of Science & Introduction to Botany BT1811101	2	2	1
2	Methodology of Science & Introduction to Botany – Practical BT1811601	1	2	1
3	Biostatistics	2	3	1
4	Biostatistics - Practical	1	1	1
5	Cell Biology and Developmental Biology	2	3	1
6	Cell Biology and Developmental Biology - Practical	1	1	1
7	Microbiology, Mycology & Plant Pathology	2	2	2
8	Microbiology, Mycology & Plant Pathology - Practical	1	2	2
9	Biophysics & Instrumentation	2	3	2
10	Biophysics & Instrumentation - Practical	1	1	2
11	Molecular Biology	2	3	2
12	Molecular Biology - Practical	1	1	2
13	Phycology & Bryology	3	3	3
14	Phycology & Bryology - Practical	1	2	3
15	Microbiology & Microbial Biotechnology	3	3	3
16	Microbiology & Microbial Biotechnology - Practical	1	2	3
17	Immunology	3	3	3
18	Immunology - Practical	1	2	3
19	Pteridology, Gymnosperms & Paleobotany	3	3	4
20	Pteridology, Gymnosperms & Paleobotany - Practical	1	2	4
21	Animal Biotechnology & Nanobiotechnology	3	3	4
22	Animal Biotechnology & Nanobiotechnology - Practical	1	2	4
23	Plant Biotechnology	3	3	4
24	Plant Biotechnology - Practical	1	2	4
25	Anatomy, Reproductive botany, Microtechniques	3	3	5
26	Anatomy, Reproductive botany, Microtechniques - Practical	1	2	5
27	Plant Physiology & Biochemistry	3	3	5

28	Plant Physiology & Biochemistry - Practical	1	2.5	5
29	Environmental sciences and Human Rights	3	3	5
30	Environmental sciences and Human Rights - Practical	1	2	5
31	Applied Molecular Biology	3	3	5
32	Applied Molecular Biology - Practical	1	2.5	5
33	OJT (on the job training)	1	-	5
34	Genetics, Plant Breeding and Horticulture	3	3	6
35	Genetics, Plant Breeding and Horticulture - Practical	1	2.5	6
36	Angiosperm Morphology, Taxonomy & Economic Botany	3	4	6
37	Angiosperm Morphology, Taxonomy & Economic Botany - Practical	1	2.5	6
38	Recombinant DNA Technology	3	3	6
39	Recombinant DNA Technology - Practical	1	2	6
40	Bioinformatics	3	3	6
41	Bioinformatics - Practical	1	2	6
42	Project	3	-	6
Total		**78**		

COMPLEMENTARY COURSES

Sl. No.	Course Name	Credit	Hrs/Week	Semester
1	Elementary Biochemistry	2	2	1
2	Elementary Biochemistry - Practical	1	2	1
3	Non Chordate Diversity	2	2	1
4	Non Chordate Diversity - Practical	1	2	1
5	Biomolecules	2	2	2
6	Biomolecules - Practical	1	2	2
7	Chordate Diversity	2	2	2
8	Chordate Diversity - Practical	1	2	2
9	Enzymology and Metabolism	3	3	3
10	Enzymology and Metabolism - Practical	1	2	3
11	Physiology and Immunology	3	3	3
12	Physiology and Immunology - Practical	1	2	3
13	Nutritional and Clinical Biochemistry	3	3	4
14	Nutritional and Clinical Biochemistry - Practical	1	2	4
15	Applied Zoology	3	3	4
16	Applied Zoology - Practical	1	2	4
Total		**28**		

CHOICE BASED OPEN COURSE

Sl. No.	Course Name	Credit	Hrs/Week	Semester
1	Agri-based Microenterprises	3	4	5
2	Horticulture and Nursery Management			
3	Ecotourism			
Total		**3**		

CHOICE BASED ELECTIVE COURSE

Sl. No.	Course Name	Credit	Hrs/Week	Semester
1	Agribusiness	3	4	6
2	Plant Genetic Resources Management			
3	Phytochemistry and Pharmacognosy			
Total		**3**		

DETAILED SYLLABUS OF THECOURSES

OFFERED BY THE DEPARTMENT

SEMESTER I				
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Credits**
EN1811501	Fine-tune Your English	Common course I – English 1	5	4
BY1811101	Methodology of Science & Introduction to Botany	Core Botany-1	2	2
BY1811601	Methodology of Science & Introduction to Botany	Core Botany-1 Practical	2	1
BY1811102	Biostatistics	Core Botany-2	3	2
BY1811602	Biostatistics	Core Botany -2 Practical	1	1
BT1811101	Cell Biology and Developmental Biology	Core Biotechnology - 1	3	2
BT1811601	Cell Biology and Developmental Biology	Core Biotechnology - 1 Practical	1	1
BT1811201	Elementary Biochemistry	Complementary 1 Biochemistry 1	2	2
BT1811701	Elementary Biochemistry	Complementary 1 Biochemistry 1 Practical	2	1
ZY1811201	Non Chordate Diversity	Complementary 2 Zoology 1	2	2
ZY1811701	Non Chordate Diversity	Complementary 2 Zoology 1- Practical	2	1
Total			**25**	**19**

Course	Details				
Code	BY1811101				
Title	**METHODOLOGY OF SCIENCE AND INTRODUCTION TO BOTANY**				
Degree	BSc				
Branch(s)	BOTANY				
Year/Semester	1/I				
Type	CORE 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	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; 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 Evolotion – Adaptation and MutationEvidences 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 ofdomain: 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 –	1	5

	safranine and acetocarmine		
5.6	Temporary mount preparation	1	5

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Course	Details				
Code	BY1811601				
Title	**METHODOLOGY OF SCIENCE AND 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 Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
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; 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

REFERENCES

- 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.
- Kenneth A Mason, Jonathan B Losos, Susan R Siger, 2013. Biology (IX Edn). McGraw Hill.
- James B Reece, Lisa A Urry, Michael L Cain, Steven A Wasserman, Peter V Minorsky, Robert B Jackson, 2011. Biology (IX Edn). Pearson.

Course	Details			
Code	BY1811102			
Title	**BIOSTATISTICS**			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	1/I			
Type	Core Course			
Credits	2	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Describe various application area of biostatistics	U	1
2	Distinguish different types of data and sampling techniques.	U	1
3	Summarize, organize and display quantitative data	U	2
4	Calculate and interpret measures of central tendency and variability in statistical data.	Ap	6
5	Compute and interpret the result of correlation and regression analysis	An	3
6	Compare different population sample using ANOVA	C	3
7	Recall the characteristics of probability distribution	U	1
8	Identify appropriate tests to perform hypothesis testing and experimental design for biological experiment and interpret the output adequately.	An	3
9	Explain the characteristics and use of statistical software and packages of biostatistics	U	6

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Introduction**	**10**	
1.1	Introduction to statistics and application of statistics in biosciences with examples.	1	1
1.2	Various types of data: Primary data, secondary data, quantitative and qualitative data	1	2
1.3	Collection of data	1	3
1.4	Classification of data	1	3
1.5	Frequency distribution	1	3
1.6	Diagrammatic representation of data – significance and utility	1	3
1.7	Types of diagrams-bar diagrams, pie diagram, histograms, frequency polygon, frequency curve	1	3
1.8	Population and sampling techniques-significance and utility.	1	2
1.9	Random sampling and stratified sampling	1	2
1.10	Systematic sampling and multistage sampling	1	2

2.0	**Descriptive statistics**	**25**	
2.1	Measures of central tendency- introduction, definition, Advantages and limitations.	2	4
2.2	Mean, median and mode - computation in grouped and ungrouped data	3	4
2.3	Comparison of mean, median, mode	1	4
2.4	Measures of dispersion- introduction.	1	4
2.5	Range, Mean deviation - computation in grouped and ungrouped data.	3	4
2.6	Standard deviation, standard error - computation in grouped and ungrouped data.	2	4
2.7	Correlation and Regression - introduction, definition and utility	1	5
2.8	Types of correlation, positive and negative correlation, scatter diagram and correlation graph	1	5
2.9	Calculation of Coefficient of correlation	1	5
2.10	Regression Analysis	2	5
2.11	Skewness and Kurtosis- definition, types, graphical representation with examples	1	5
2.12	Analysis of variants: ANOVA - introduction, Assumptions	1	6
2.13	Technique of analyzing variance, one way ANOVA	2	6
2.14	Two-way ANOVA	2	6
2.15	Multivariate analysis of variants and its application in biological sciences.	2	6
3.0	**Probability**	**9**	
3.1	Probability - introduction, classical definition and application	1	7
3.2	Theorems of probability - addition theorem and multiplication theorem, conditional probability	1	7
3.3	Standard probability distributions - introduction and applications.	1	7
3.4	Binomial distribution - definition, assumption with respect to a biological example.	2	7
3.5	Poisson distribution - definition, forms of Poisson distribution, assumption with respect to a biological example.	2	7
3.6	Normal distribution - definition, properties, standard normal curve, assumption with respect to a biological example	2	7
4.0	**Inferential statistics**	**10**	
4.1	Testing of hypothesis - Hypothesis - definition, hypothesis testing	1	8
4.2	Procedure of hypothesis testing, errors in hypothesis testing – type I and type II errors, two tailed and one tailed test of hypothesis.	1	8
4.3	Chi square test and estimation of linkages	1	8
4.4	student t-test and F test	1	8
4.5	Experimental designs – introduction, principles, replication and randomisation.	1	8
4.6	CRD, RBD, Latin square design, factorial design	1	8
4.7	Interpolation and extrapolation - introduction, definitions, significance and utility, assumptions,	1	8

	graphic methods.		
4.8	Computer analysis of data – application of computer in statistical data processing	1	9
4.9	Statistical programmes, preparation of charts and graphs, formula application with respect to M Stat.	2	9

Text Books for Reference

- Bernard Rosner, 2005. Fundamentals of Biostatistics. Duxbury Press.
- Marcello Pagano, Kimberlee Gauvreau. 2000. Principles of Biostatistics. Duxbury Press
- Panse, V.G. and Sukathme, P.V. 1995. Statistical methods for agricultural workers. ICAR, New Delhi.
- Pranab Kumar Banerjee, 2004. Introduction to Biostatistics. S. Chand and company Limited.
- Roland Ennos, 2006. Statistical and Data Handling Skills in Biology, 2nd Edition. Pearson Education

Text Books for Enrichment

1. Richard Issac, The Pleasures of Probabilty, Springer Verlag.
2. W. J. Ewens& Gregory Grant, Statistical Methods in Bioinformatics, Springer
3. Elizabeth S. Allman & John A. Rhodes, Mathematical Models in Biology, Cambridge.

Course	Details			
Code	BT1811602			
Title	**BIOSTATISTICS (Practical)**			
Degree	B.Sc.			
Branch(s)	BOTANY & BIOTECHNOLOGY (Double core)			
Year/Semester	1/I			
Type	Core Course			
Credits	1	Hrs/week	1	Total hours: 18

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Use various graphical and pictorial representation for presenting data	Ap	6
2	Analyzing biological data using methods for central tendency	Az	2
3	Calculate measures of dispersion in various data	Ap	6
4	Predict the significance of experiment using statistical methods	C	3
5	Interpret the correlation coefficient to determine the strength and direction of the linear relationship between variables.	Ap	3
6	Apply statistical software for manipulating biological data.	Ap	3

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1	**Classification and presentation of data**	**2**	
1.1	Frequency Distribution	1	1
1.2	Graphical and pictorial representation	1	1
2	**Analyse a data using central tendency methods**	**3**	
2.1	Mean	1	2
2.2	Median	1	2
2.3	Mode	1	2
3	**Measures of deviation**	**3**	
3.1	Mean deviation	1	3
3.2	Standard deviation	1	3
3.3	Standard error	1	3
4	**Test of significance of the given data**	**3**	

4.1	chi-square test	1	4
4.2	t test	1	4
4.3	f test.	1	4
5	**Analyse a set of data for correlation and regression**	**3**	
5.1	Correlation Analysis	2	5
5.2	Regression Analysis	1	5
6	**Preparation of data with statistical tools**	**4**	
6.1	Introduction to statistical packages	2	6
6.2	Problem with M-Stat	2	6

REFERENCES

- Pranab Kumar Banerjee, 2004. Introduction to Biostatistics. S. Chand and company Limited.
- Roland Ennos, 2006. Statistical and Data Handling Skills in Biology, 2nd Edition. Pearson Education.

Course	Details			
Code	BT1811101			
Title	**CELL BIOLOGY AND DEVELOPMENTAL BIOLOGY**			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	1/I			
Type	Core course			
Credits	2	Hrs/week	4	Total hours: 54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Recall the history of cytology and draw the structure of cell organelles and locate its parts along with functions	R	1
2	Design the model of a cell.	C	6
3	Distinguish the structure of prokaryotic and eukaryotic cell.	U	2
4	Explain the organization of Genes and chromosomes, chromosome morphology and its aberrations	U	3
5	Distinguish the types and mechanism of mutations.	An	2
6	Compare and contrast the events of cell cycle and its regulation	An	3
7	Summarize the definition, sources and applications of stem cells.	U	3
8	Explain the communications of cells with other cells and to the environment.	U	6
9	Explain the process of development in general	U	1
10	Distinguish the various process involved in plant and animal development.	U	2

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**HISTORY OF CYTOLOGY AND INTRODUCTION TO CELL ORGANELLES**	**12**	
1.1	Historical account of cell biology; cell theory and protoplasm theory	1	1
1.2	Prokaryotic and Eukaryotic cell	1	2
1.3	Cell: physio-chemical nature of plasma membrane and cytoplasm	1	1
1.4	Structural organization and function of intracellular organelles- cell wall	1	1
1.5	Nucleus	1	1
1.6	Mitochondria	1	1
1.7	Ribosomes, Dictyosomes	1	1
1.8	Microbodies, peroxisome	1	1
1.9	Golgibodies, lysosomes	1	1
1.10	Plastids, chloroplast	1	1
1.11	Endoplasmic reticulum, vacuoles	1	1
1.12	Structure and function of cytoskeleton and its role in motility	1	1
2.0	**CHROMOSOMES**	**10**	
2.1.1	Chromosome morphology	1	4
2.1.2	Fine structure, Dupraw model, Nucleosome model	1	4
2.1.3	Chemical organization of nucleosome-nucleoproteins	1	4
2..1.4	Types of chromosomes based on centromere, karyotype and idiogram	1	4
2.1.5	Special types of chromosomes- salivary gland, lampbrush and B chromosome.	1	4
2.2	**Organization of genes and chromosomes**		
2.2.1	Operon, interrupted genes, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons	1	4
2..2.2	Numerical aberrations of chromosomes-Aneuploidy and euploidy	1	4
2..2.3	Structural aberrations of chromosomes: deletion, duplication, inversion and translocation and their Meiotic behaviour	1	4
2.3	**Mutations**		
2.3.1	Spontaneous and induced. Mutagens – physical and chemical mutagens	1	5
2.3.2	Chromosomal and point mutation, Molecular mechanism of mutation: transition, transversion and substitution	1	5
3	**CELL DIVISION AND CELL CYCLE**	**10**	
3.1	Cell division and cell cycle: mitosis	1	6
3.2	Meiosis	1	6
3.3	Cell cycle regulation, steps and control of cell cycle	2	6
3.4	Stem cells- sources and applications	1	7
3.5	Cell-cell interactions, interactions of cells with their environment	2	8
3.6	Cell signaling	3	8
4.0	**DEVELOPMENTAL BIOLOGY**	**22**	
4.1	**Introduction to developmental biology**		
4..1.1	Basic concepts of development, potency,	4	9

	commitment, specification, induction, competence, determination and differentiation, genomic equivalence and cytoplasmic determinants: imprinting mutants and transgenics analysis of development.		
4.2	**Fertilization**		
4.2.1	Gametogenesis, fertilization and early development	2	9
4.2.2	Animal development: oogenesis, fertilization, embryonic cleavage divisions: blastulation, gastrulation and morphogenesis	3	10
4.2.3	Development of model organisms- Drosophila, Caenorabitidis	2	10
4.2.4	Maternal and zygotic gene activity in development	1	10
4.3	**Plant development**		
4.3.1	Microsporogenesis	1	10
4.3.2	Megasporogenesis	1	10
4.3.3	Embryogenesis (brief only)	1	10
4.3.4	Establishment of symmetry in plants	1	10
4.3.5	Seed formation and development of seedling	2	10
4.3.6	Shoot and root meristem, leaf development	2	10
4.3.7	Development of model organism- neurospora, Arabidopsis	2	10

Text Books for Reference

1. Lodish et al.2004. Molecular Cell Biology " (Scientific American Book)
2. Alberts et al. .2002. The Biology of the Cell
3. Cooper & Hausman .2004. The Cell – A Molecular Approach
4. Maheaswari, P. 1950. An introduction to embryology of Angiosperms. Mc Graw Hill.
5. Dodd, H.I., and Dodd, J.M. , 1978. The biology of metamorphosis , In Physiology of amphibia, Vol. 3, Academic press, N.Y
6. Gilbert, S.F., 1997. Developmental Biology, 5th Edn, Sinauer, Associates, Massachusettes.
7. Tamarin, R., 1991, Principles of Genetics, 3rd edition.
8. Vasudeva Rao, 1994. Developmental Biology: A modern synthesis, Oxford & IBH, New Delhi
9. De Robertis, E.D.P. and Robertis, E.M.F. 1991. Cell and molecular biology. Lea and Febiger

Text Books for Enrichment

1. Balinsky, B.I., 1965. An Introduction to embryology, W.B. Saunders company
2. Bodemer, L.W., 1968. Modern Embryology, Winston Inc. USA
3. George, M. Malacinski (ed) 1988, Developmental genetics of higher organisms, Macmillan Publishing Co.

Course	Details			
Code	BT1811601			
Title	**CELL BIOLOGY AND DEVELOPMENTAL BIOLOGY (Practical)**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**1/I**			
Type	**Core Course- Practical**			
Credits	**1**	Hrs/week	1	Total hours: 18

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Identify prokaryotic and Eukaryotic cell	An	2
2	Identify the blood group	An	6
3	Interpret the cell number	U	2
4	Visualize the cell size	U	2
5	Examine cell division	An	3
6	Predict chromosome length	C	2
7	Visualize mitochondria	U	2

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	Examination of different kinds of cells- prokaryotic and Eukaryotic	**2**	1
2.0	Blood grouping	**2**	2
3.0	**Cell counting methods**	**2**	
3.1	Haemocytometer: WBC, RBC	1	3
3.2	Differential counting using Leishman's stain	1	3
4.0	Micrometry: calibration using ocular micrometer, finding out average cell size	**2**	4
5.0	Squash preparation, study of mitotic stages	**6**	5
6.0	Measurement of chromosome length	**2**	6
7.0	Staining of mitochondria	**2**	7

REFERENCE

- Cell and Molecular Biology: A Lab Manual (2013). Chaitanya K.V. Prentice Hall India Learning Private Limited.
- Eduard Gasque–"Manual of Laboratory Expts in Cell Biol. W.C. Wilson Pub.
- Basic Methods in Cellular and Molecular Biology (2017). Usinga Hemacytometer to
- Count Cells. JoVE Science Education Database, Cambridge, MA.
- Cell Biology: A Laboratory Manual, G. Shanmugam, Macmillan (1988).

Course	Details			
Code	BT1811201			
Title	**ELEMENTARY BIOCHEMISTRY**			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	1/I			
Type	**Complementary Course**			
Credits	2	Hrs/week	2	Total hours: 36

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Draw the structure of water.	R	1
2	Recognize the different types of bonds involved in interactions in aqueous systems.	R	1
3	Predict the ionization of water, strong and weak acids and bases and their dissociation.	C	3
4	Apply the concepts of p^H and buffers.	Ap	2
5	Describe the structure of biological membrane.	R	1
6	Identify the membrane proteins.	R	1
7	Categorize the transport mechanisms across cell membranes.	An	6
8	Recognize Donnan equilibrium.	R	1
9	Describe the structure of chloroplast.	R	1
10	Investigate photosynthesis.	An	6
11	Describe biological nitrogen fixation.	R	1
12	Analyze the basic techniques in biochemistry.	An	6

Module	Course Description	Hrs	CO.No.
1.0	**PHYSICAL ASPECTS OF BIOCHEMISTRY**	**10**	
1.1	Structure of water.	1	1
1.2	Interactions in aqueous systems- covalent bond, hydrophobic interactions, ionic interactions.	1	2
1.3	Interactions in aqueous systems- hydrogen bond and van der Waals interactions.	1	2
1.4	Ionization of water, strong and weak acids and their dissociation.	1	3
1.5	Ionization of strong and weak bases and their dissociation.	1	3
1.6	Henderson-Hasselbalch equation with derivation.	1	4
1.7	Concepts of pH.	1	4
1.8	Concepts of Buffers.	1	4
1.9	Buffers in biological systems – Phosphate buffer, Bicarbonate Buffer, Hemoglobin buffer.	1	4
1.10	Buffers in biological systems – Bicarbonate Buffer, Hemoglobin buffer.	1	4

2.0	**MEMBRANE BIOCHEMISTRY**	**8**	
2.1	Fluid mosaic model of membrane.	1	5
2.2	Types of membrane proteins (peripheral, integral and amphitropic).	1	6
2.3	Solute transport across membranes (passive transport - simple diffusion and facilitated diffusion).	1	7
2.4	Solute transport across membranes (active transport - primary transport).	1	7
2.5	Solute transport across membranes (active transport - secondary transport - uniport, symport, antiport).	1	7
2.6	Osmosis.	1	7
2.7	Fundamental study of Donnan equilibrium.	1	8
2.8	Donnan equilibrium-application in biological system.	1	8
3.0	**PLANT BIOCHEMISTRY**	**8**	
3.1	Basic ideas of photosynthesis - Structure of chloroplast.	1	9
3.2	Photosynthetic pigments. Absorption and utilisation of light energy by photosynthetic pigments.	1	10
3.3	Red drop and Emerson's enhancement effect.	1	10
3.4	Photosystems. Light reaction - cyclic photophosphorylation and noncyclic photophosphorylation.	1	10
3.5	Dark reaction, fixation of CO_2 and formation of carbohydrate.	1	10
3.6	C3 and C4 plants.	1	10
3.7	Crassulacean Acid Metabolism.	1	10
3.8	Biological nitrogen fixation.	1	11
4.0	**TECHNIQUES IN BIOCHEMISTRY**	**10**	
4.1	Spectrophotometry.	1	12
4.2	Colorimetry.	1	12
4.3	Chromatography - Paper, TLC, HPTLC.	1	12
4.4	Chromatography - Gel Filtration, Affinity chromatography.	1	12
4.5	Electrophoresis - PAGE, AGE.	1	12
4.6	Electrophoresis - PAGE, AGE.	1	12
4.7	Blotting Techniques - Western Blotting.	1	12
4.8	Blotting Techniques - Southern Blotting and Northern Blotting.	1	12
4.9	Introduction to proteomics.	1	12
4.10	Introduction to proteomics - MALDI - TOF MS.	1	12

Text Books for Reference

- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain, (2008) Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7 p: 230, 244, 269.
- Lehninger Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008) 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and, Company, New York
- Plant Biochemistry: P.M. Dey and J.B. Harborne. (Editors.) Harcourt Asia PTE Ltd. Academic Press. (Indian Edition, 2000).

Text Books for Enrichment

- Biochemistry fifth edition by campbellfarrell (2006) Thomson Brooks cole Ltd p:34-54.
- Biochemistry by J. M. Berg, J. L.Tymoczko, L. Stryer6th edition(2007)W. H. Freemanand Company, New Yorkp: 510-555.
- Plant Metabolism: H.D. Kumar and H.N. Singh. Affiliated East-West Press Pvt. Ltd., New Delhi, Madras, Hyderabad and Bangalore. (1993; 2nd edition).

Course	Details			
Code	BT1811701			
Title	ELEMENTARY BIOCHEMISTRY (Practical)			
Degree	B.Sc.			
Branch(s)	BOTANY & BIOTECHNOLOGY (Double core)			
Year/Semester	1/I			
Type	Complementary Course			
Credits	1	Hrs/week	2	Total hours: 36

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Apply methods of preparation of solutions	Ap	2
2	Investigate the results of the basic techniques in biochemistry	An	6
3	Plan colorimetry and spectrophotometry experiments	C	3

Module	Course Description	Hrs	CO. No.
1.0	**Preparation of solutions, buffers and determination of pH**	**8**	
1.1	Molar solutions and Normal solutions	2	1
1.2	Dilution of Stock solutions	2	1
1.3	Preparation of buffers using the Henderson Hasselbalch equation	2	1
1.4	Determination of pH using pH meter (Demonstration)	2	2
2.0	**Biochemical separation Techniques**	**20**	
2.1	Chromatographic techniques (Any one to be performed) – Part 1 Separation of amino acids and simple sugars by Paper chromatography (Descending or ascending) Separation of amino acids and lipids by Thin Layer chromatography Separation of Plant pigments by Column/ Thin layer chromatography	5	2
2.2	Chromatographic techniques (Any one to be performed) – Part 2 Separation of amino acids and simple sugars by Paper chromatography (Descending or ascending) Separation of amino acids and lipids by Thin Layer chromatography Separation of Plant pigments by Column/ Thin layer chromatography	5	2

2.3	Chromatographic techniques (Any one to be performed) – Part 3 Separation of amino acids and simple sugars by Paper chromatography (Descending or ascending) Separation of amino acids and lipids by Thin Layer chromatography Separation of Plant pigments by Column/ Thin layer chromatography	5	2
2.4	Electrophoretic techniques (Demonstration) Analysis of proteins and nucleic acids (PAGE, AGE)	5	2
3.0	**Colorimetry and Spectrophotometry techniques**	**8**	
3.1	Verification of Beer Lambert's law – Part - 1	4	3
3.2	Verification of Beer Lambert's law – Part - 2	4	3

REFERENCE

- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p 12 – 18
- Practical Biochemistry Principles and Techniques by Keith Wilson and John Walker 5th edition (2005), Cambridge University Press, p: 580-681
- Biophysical Chemistry Principles and Techniques by Upadhyay Nath Upadhyay, Himalaya publishing house (2002), p: 175-270, 344-421, 422-478.

SEMESTER II				
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Credits**
EN1812503	Issues That matter	Common course I – English 2	5	4
BY1812102	Microbiology, Mycology & Plant Pathology	Core Botany -3	2	2
BY1812602	Microbiology, Mycology & Plant Pathology	Core Botany -3 Practical	2	1
BT1812102	Biophysics & Instrumentation	Core Biotechnology -2	3	2
BT1812602	Biophysics & Instrumentation	Core Biotechnology -2 Practical	1	1
BT1812103	Molecular Biology	Core BT-3	3	2
BT1812603	Molecular Biology	Core BT-3 Practical	1	1
BT1812202	Biomolecules	Complementary 1 Biochemistry 2	2	2
BT1812702	Biomolecules	Complementary 1 Biochemistry 22 Practical	2	1
ZY1812202	Chordate Diversity	Complementary 2 Zoology 2	2	2
ZY1812702	Chordate Diversity	Complementary 2 Zoology 2 Practical	2	1
	Total		**25**	**19**

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 Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
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; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
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, viriods 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, vine, vinegar, curd – role in N2 fixation, as biofertilizers – role in food spoilage	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 – *Physarum*	1	1
2.4	Mastigomycotina – *Albugo*	1	1
2.5	Zygomycotina - *Rhizopus*	1	1
2.6	Ascomycotina – Hemiascomycetes - *Saccharomyces*	1	1
2.7	Plectomycetes - *Penicillium*	1	1
2.8	Pyrenomycetes – *Xylaria*	1	1
2.9	Discomycetes- *Peziza*	1	1
2.10	Basidiomycotina – Teliomycetes – *Puccinia*	1	1
2.11	Hymenomycetes – *Agaricus*	1	1
2.12	Deuteromycotina – *Fusarium*	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 Parmelia.	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, cause, disease cycle and control–Bunchy top of Banana	1	5
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

- Ahamadjian Vernon, Hale M E (eds), 1973. *The Lichens.* Academic press, New Delhi.
- 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.
- Alexopaulos C J, Mims C W C, Blackwell M, 1996. *Introductory Mycology*. John Willy and sons, Inc. New York.
- Campbell R, 1987. *Plant Microbiology.* ELBS Edward Arnold, London.
- Gupta V K, Paul T S, 2004. *Fungi & Plant diseases*. Kalyani publishers, New Delhi
- Hale M E, 1983. *The Biology of Lichen* (III Edn). Edward Arnold, London.
- Jim Deacon, 2007. *Fungal Biology* (IV Edn). Blackwell Publishing, Ane Books Pvt. Ltd.

- Krishnamurthy K V, 2004. *An Advanced Text Book on Biodiversity Principles and practice*. Oxford and IBH Publishing Co. Pvt. Ltd.
- Kirk P M, Cannon P F, Minter D W, Stalpers J A, 2008. Dictionary of the Fungi (X Edn). Wallingford, UK: CAB International.
- Mamatha Rao, 2009. Microbes and Non flowering plants - impact and application. Ane Books Pvt. Ltd.
- Misra A, Agrawal P R, 1978. *Lichens.* Oxford and IBH, NewDelhi.
- Nair M C (eds), 1990. *Mushroom Technical Bulletin* 17. Kerala Agricultural University, Mannuthy.
- Nita Bahl, 2002. *Hand book on Mushrooms.* Oxford & IBH Publishing C. Pvt.

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 Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
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; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Practicals**	**36 hrs**	
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 Rhizopus, *Albugo, Saccharomyces, Penicillium*	3	2
1.6	Micropreparation and study of *Xylaria, Peziza, Puccinia, Fusarium and Parmelia*	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

- Ahamadjian Vernon, Hale M E (eds), 1973. *The Lichens.* Academic press, New Delhi.
- 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.
- Alexopaulos C J, Mims C W C, Blackwell M, 1996. *Introductory Mycology*. John Willy and sons, Inc. New York.
- Campbell R, 1987. *Plant Microbiology*. ELBS Edward Arnold, London.
- Gupta V K, Paul T S, 2004. *Fungi & Plant diseases*. Kalyani publishers, New Delhi
- Hale M E, 1983. *The Biology of Lichen* (III Edn). Edward Arnold, London.

Course	Details			
Code	BT1812102			
Title	**BIOPHYSICS AND INSTRUMENTATION**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**1/II**			
Type	**Core Course**			
Credits	**2**	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Recall the basic concepts of atomic structure and explain the fundamental principles and origin of spectral lines	**U**	**1**
2	Recall and differentiate absorption and emission spectra. Identify the application of each region of EM spectrum for spectroscopy.	**AP**	**2**
3	Recall and explain the techniques and underlying theory of UV- Visible, IR, NMR and Raman, AAS, XRD and mass spectroscopy	**AP**	**2**
4	Recall and relate the concepts of radioactivity and its applications	**U**	**1**
5	Identify and relate the concepts in routine observations, functions of chloroplast and mitochondria, body temperature and its regulation	**AP**	**1**
6	Recall and describe the structure of cell membrane, membrane transport systems and membrane potential. Relate and differentiate various biopotential measuring instruments	**AP**	**1**
7	Identify and differentiate working principle, instrumentation and applications of various bio-analytical instruments	**AP**	**3**
8	Reproduce and design an experiment with step-by-step instructions to address a research problem or bio-analytical practical/project	**C**	**6**

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Atomic structure**	**5**	
1.1	Introduction to atom and atomic structure: Brief history of discovery of subatomic particles and atomic structure	1	1
1.2	Rutherford Atomic Model, Bohr atom model, concepts of atomic radius and energy value.	1	1
1.3	Rydburg's constant, Bohr-sommerfeld model	1	1
1.4	Vector atom model, Quantization of energy levels, quantum numbers.	1	1
1.5	Pauli's exclusion principle, Selection rules.	1	1
2.0	**Spectroscopy**	**20**	
2.1	Electromagnetic spectrum: Definition, application of each region of EM spectrum for spectroscopy.	1	2
2.2	Introduction to molecular energy levels: absorption, excitation and emission	2	2
2.3	Electronic spectroscopy: UV-Visible spectroscopy: Principle, construction and working of spectrophotometer	2	3
2.4	colorimeter; Applications of UV-Visible spectroscopy	1	3
2.5	Fluorometer: Principle, instrumentation and working	2	3
2.6	Applications Fluorometery to biomolecules (proteins, DNA, Hb, chlorophyll)	1	3
2.7	Rotational and vibrational spectroscopy: Energy levels of diatomic vibrating molecules	1	3
2.8	IR spectroscopy, principle, constructing and working of IR spectrometer	1	3
2.9	Application of IR spectroscopy to biomolecules	1	3
2.10	Raman Spectroscopy	2	3
2.11	Nuclear magnetic resonance spectrometer (NMR)	2	3
2.12	Atomic absorption spectroscopy (AAS)	1	3
2.13	XRD	1	3
2.14	Mass spectroscopy	2	3
3.0	**Radioactivity**	**10**	
3.1	Nucleus - properties. Nuclear forces. Nuclear models (liquid drop and shell model)	1	4
3.2	Radioactive nucleus. Nuclear radiation and their properties - alpha, beta and gamma.	2	4
3.3	Half-life - physical and biological	1	4
3.4	Handling and standardization of alpha, and beta emitting isotopes.	2	4
3.5	Radioimmunoassay	1	4
3.6	Radiopharmaceuticals and its uptake - dosimetry and detection Principle-construction and working of pen and batch dosimeter	1	4
3.7	GM counter	1	4
3.8	Scintillation counter (solid and liquid)	1	4

4.0	**Biophysics and Bioinstrumentation**	19	
4.1	*Thermodynamics:* Enthalpy, entropy, free energy	1	5
4.2	Gibb‟s free energy (G) and Helmholtz free energy (A)	1	5
4.3	Chemical potential, half cell potential. Redox potential	1	5
4.4	Structure and bioenergetics of mitochondria and chloroplast	1	5
4.5	Body temperature and its regulation.	1	5
4.6	*Cell membrane*: Organization of plasma membrane	1	6
4.7	Mass transport, diffusion, basics, passive and active transport	1	6
4.8	Membrane potential. Nernst equation. Passive electrical properties of cell (capacitance and resistance). Active electrical properties.	1	6
4.9	Electrical model (equivalent) of cell membrane. Depolarization, hyperpolarization of membrane (neuronal). Generation of active potential.	2	6
4.10	Types of biopotentials. Biopotential measuring instruments	1	6
4.11	*Bio-instrumentation:* Types of thermometers (clinical, thermocouple, bimetallic, platinum resistance, thermistor-thermometers)	2	7
4.12	Principle construction, working and applications of instruments for analysis of biomolecules: pH meter	1	7
4.13	Electrophoresis	1	7
4.14	Centrifuge (RCF, sedimentation concept), different types of centrifuges	2	7
4.15	Construction, working and sample preparation of SEM	1	7
4.16	Construction, working and sample preparation of TEM and STEM	1	7

Text Books for Reference

- Principles of Physical Chemistry: Puri, Sharma and Pathania (Vishal Publishing Co., Jalandhar)
- Nuclear Physics: an introduction: SB Patel (New Age International)
- Introduction to Atomic Spectra: HE White (Mc Graw Hill)
- Text Book of optics and atomic physics: P P Khandelwal (Himalaya publications)
- Biophysics: Cotrell (Eastern Economy Edition).
- Clinical Biophysics: Principles and Techniques: P Narayanan (Bhalani Publ., Mumbai). Biophysics: Pattabhi and Gautham.

Course	Details			
Code	BT1812602			
Title	**BIOPHYSICS AND INSTRUMENTATION (Practical)**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**1/II**			
Type	**Core Course- Practical**			
Credits	**1**	Hrs/week	2	Total hours: 18

Module	Course Description	Hrs	CO. No.
1.0	Spectral properties	**6**	
1.1	UV/Visible Spectral analysis of colouring pigments: Beta cyanin/ Anthocyanin/ Xanthine/ Lycopene and Curcumin	4	8
1.2	Colorimetric assays	2	8
2.0	Separation Techniques	**6**	
2.1	Chromatography (PC, TLC and Column)	4	8
2.2	GC & HPLC, HPTLC (Demonstration only)	2	8
3.0	Electrophoretic separation of protein	**6**	
3.1	Polyacrylamide gel electrophoresis	6	8

REFERENCE

- Jay Nadeau (2015). Introduction to Experimental Biophysics (Set): Textbook and Lab Manual by CRC Press
- Principles and Techniques of Biochemistry and Molecular Biology (2010). 7th edition Edited by Keith Wilson, University of Hertfordshire, John Walker, University of Hertfordshire Cambridge University Press
- Alexander P, Lundgren HP: A Laboratory Manual of Analytical Methods of Protein Chemistry. Vols. 1–5, Pergamon Press, Oxford. 1966–69.
- Plummer DT (1987). An Introduction to Practical Biochemistry. 3rd ed., McGraw-Hill, London.

Course	Details			
Code	BT1812103			
Title	**MOLECULAR BIOLOGY**			
Degree	B.Sc			
Branch(s)	B.Sc BOTANY & Biotechnology (Double main)			
Year/Semester	1/II			
Type	CORE COURSE			
Credits	2	Hrs/week	2	Total hours: 54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Discuss characteristics of DNA and its primary, secondary and tertiary structure	U	1
2	Explain major contributions towards the development of branch of molecular biology	U	1
3	Describe semi-conservative mode of replication in prokaryotes and eukaryotes	U	1
4	Illustrate recombination process	Ap	1
5	Predict causes of mutation and identify different types of mutation	C	3
6	Summarize the different in-vivo DNA repair mechanisms	U	1
7	Identify RNA types and their functions	An	1
8	Describe process of transcription in prokaryotes & eukaryotes	U	1
9	Examine post transcriptional modifications	An	3
10	Interpret genetic code and its characteristics	An	1
11	Outline translational process	U	1
12	Describe Operon concept, bacterial gene regulation &eukaryotic gene regulation	U	1
13	Analyze nature & causes of cancer and the genes involved in cancer	An	2
14	Evaluate the synthetic theory of evolution and determine driving forces of evolution.	E	2
15	Explain molecular evolution and genome evolution	U	2

Module	Course Description	Hrs	CO. No.
1.0	**Genetic material: Structural and Functional aspects**	**22**	
1.1	Introduction to heredity and the genetic material, characteristics of genetic material, the molecular basis of heredity	1	1
1.2	Early studies of DNA works of F.Miescher, Albert Kossel, Phoebus Levene, Erwin Chargaf] DNA as the source of genetic information.	1	2
1.3	The discovery of transforming principle [Grifith's experiment], Identification of the transforming principle [Avery, MacLeod and McCarty's experiment]	1	1, 2
1.4	Experiment to prove DNA as the genetic material (Hershey and Chase experiment] ,Discovery of RNA as the genetic material in some viruses [Heinz Fraenkal-Conrat's experiment]	1	1, 2
1.5	Watson and Crick‟s discovery of the structure of DNA double helix	1	1
1.6	Primary structure of DNA- structure of nucleosides and nucleotides, phosphodiester bond and structure of a polynucleotide. Secondary Structure of DNA : DNA double helix, different secondary structures [A, B and Z], Tertiary structure, supercoiling and circular DNA	3	1
1.7	Suspected forms of DNA replication: conservative, dispersive and semiconservative. Meselson and Stahl‘s experiment to prove semiconservative mode of replication	1	3
1.8	Requirements for Replication; origin, replication fork, replisome and direction of replication, general mechanism of replication	2	3
1.9	Prokaryotic replication with E.coli as model system	1	3
1.10	Eukaryotic DNA replication	1	3
1.11	Prokaryotic and eukaryotic DNA polymerases	1	3
1.12	Telomere replication-DNA synthesis at the ends of chromosomes, telomerases.	1	3
1.13	Modes of replication: theta replication, rolling circle replication, linear eukaryotic replication.	1	3
1.14	Recombination: Holiday model, enzymes required for recombination	1	4
1.15	Mutations: causes of mutations and types of mutations	1	5
1.16	Changes in chromosome number and structure, genomic	2	5

	instability		
1.17	DNA repair and repair genes: mismatch repair, direct repair, base-excision repair, nucleotide excision repair, photoreactivation, SOS response.	2	6
2.0	**Gene expression and Regulation**	**21**	
2.1	Structure and types of RNA	1	7
2.2	Requirements for transcription, Transcription unit, Transcription factors, promoters, terminators	1	8
2.3	Julius Marmur's experiment to prove that only one strand of DNA acts as template during transcription	1	8
2.4	Bacterial and Eukaryotic RNA polymerases	1	8
2.5	Bacterial Transcription	1	8
2.6	Transcription in eukaryotes	1	8
2.7	Messenger RNA, Discovery of mRNA- Brenner, Jacob and Meselson's experiment	1	8
2.8	Split gene concept- exons and introns	1	9
2.9	Post transcriptional modifications (or Pre-mRNA Processing)-3' and 5' modifications (addition of 5'cap and 3 'polyA tail), RNA splicing, spliceosome, mRNA editing, guide mRNA mediated editing	2	9
2.10	Structure of tRNA, modified bases in tRNA, clover leaf model of tRNA, tRNA genes structure and processing	1	9
2.11	rRNA gene structure and processing	1	9
2.12	Genetic code, characteristics of genetic code	1	10
2.13	Nirenberg and Mathaei experiment, Nirenberg and Leder experiment & contributions of H.G. Khorana in connection with the breaking of the genetic code	1	10
2.14	The process of translation, polyribosomes, RNA-RNA interaction in translation,	1	11
2.15	mRNA surveillance; staled ribosome, translation inhibitors	1	11
2.16	Gene regulation in bacterial cells; operon concept, negative and positive control.	1	12
2.17	Inducible and repressible operons, lac operon and trp operon of E.coli, Catabolite repression, transcriptional attenuation	2	12
2.18	Gene regulations in eukaryotes: chromatin structure, DNase I hypersensitivity sites , histone acetylation, DNA methylation, Alternative splicing of mRNA & RNA silencing.	2	12
3.0	**Cancer genetics**	**2**	

3.1	Nature and causes of cancer, cancer as a genetic disease, genetic changes that contribute to cancer	1	13
3.2	Oncogenes and tumor suppressor genes, Genes that promote vascularisation and the spread of tumors.	1	13
4.0	**Introduction to molecular evolution**	**9**	
4.1	Neo-Darwinism or Synthetic theory of evolution: Integrating Darwinism with Mendelian genetics	1	14
4.2	Factors driving evolution: Gene mutations, Non-random mating, Gene flow, Genetic Drift, Natural selection	1	14
4.3	Reproductive isolation and speciation	1	14
4.4	Variationand evolution, hybridization and evolution, polyploidy and evolution	1	14
4.5	Molecular evolution: concepts of neutral evolution	1	15
4.6	Molecular divergence and molecular clocks	1	15
4.7	Molecular phylogeny : classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.	1	15
4.8	Genome complexity,gene duplications and transposons	1	15
4.9	Genome evolution, stages in primate evolution	1	15

Text Books for Reference

- Watson, J.D. (2007).Molecular Biology of the gene. Pearson, 7th edn. ISBN:978-0321762436
- Karp, G. (2013). Cell and Molecular Biology. Wiley,7th edn. ISBN: 978-1118301791
- Futuyma, D.J.(2013). Evolution. Oxford, 3rd edn. ISBN:978-1605356051

Text Books for Enrichment

- Weaver, R.F. (2011), Molecular Biology, McGrawHill, 5th edn. ISBN**:** 978-0073525327
- Brown, T. (2017), Genomes, Garland Science, 4th edn. ISBN:978-0815345084

Course	Details			
Code	BT1812603			
Title	**MOLECULAR BIOLOGY (Practical)**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**1/II**			
Type	**Core course practical**			
Credits	**1**	Hrs/week	1	Total hours: 18

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Conduct plant genomic DNA isolation	C	1
2	Design an agarose gel electrophoresis procudure for qualitative analysis of DNA	C	1
3	Apply UV-Spectrophotometry principles to quantify DNA	Ap	1
4	Construct phylogentic tree and interpret organismal relationships using MEGA software	C	4

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Plant genomic DNA Isolation**	**6**	1
1.1	Autoclaving microtips, microcentrifuge tubes and water for DNA extraction	1	
1.2	Preparation of solutions for DNA isolation	1	
1.3	Performing protocol based isolation(Inculding various centrifugation and incubation steps)	4	
2.0	**Evaluating the extraction efficiency using Agarose gel electrophoresis (AGE)**	**4**	2
2.1	Preparation of TBE buffer, staining dye, and Ethidium bromide stock solutions and working solutions	1	
2.2	Preparation of agarose gel, casting the gel and loading of extracted plant DNA samples	1	
2.3	Running AGE, photodocumentation of DNA bands using UV transilluminator and estimating DNA size by comparing with molecular size standards.	2	

3.0	**Quantitative analysis of extracted DNA using UV-Spectrophotometry**	**2**	3
3.1	Measure OD for the pure DNA preparations at specific wavelengths		
4.0	**Molecular phylogenetic analysis**	6	4
4.1	Access online databases for related sequences from known organisms	2	
4.2	Learning MEGA software	2	
4.2	Construct Neighbour joining tree using MEGA software	1	
4.3	Interpret phylogenies and identify organisms according to their evolutionary relationships	1	

REFERENCE

- Molecular Cloning: a Laboratory Manual. Sambrook J, Russel D W & Maniatis T. 2001, Cold Spring Harbour Laboratory Press.
- Molecular Biology Techniques, 3rd Edition, 2011. A Classroom Laboratory Manual, Academic Press
- Tamura K, Dudley J, Nei M & Kumar S (2007) MEGA4: Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0. Molecular Biology and Evolution 24:1596-1599.

Course	Details			
Code	BT1812202			
Title	**BIOMOLECULES**			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	1/II			
Type	Complementary Course			
Credits	2	Hrs/week	2	Total hours: 36

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain the structure and properties of carbohydrates.	An	6
2	Describe the reducing action of sugars.	R	1
3	Classify lipids with examples.	Ap	2
4	Combine the structure and functions of lipids.	C	3
5	Define saponification number, acid number and iodine number of fats.	R	1
6	Identify the structure of aminoacids.	R	1
7	Classify proteins with functions.	Ap	2
8	Illustrate the structure of proteins.	Ap	2
9	Describe the denaturation of proteins.	R	1
10	Discuss the structure of DNA.	E	5
11	Describe the structure and functions of RNA.	R	1
12	Judge the denaturation of nucleic acids.	E	5

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**CARBOHYDRATES**	**10**	
1.1	Isomerism of carbohydrates - D and L forms of glyceraldehyde.	1	1
1.2	Isomerism of carbohydrates - epimers, anomers.	1	1
1.3	Isomerism of carbohydrates - mutarotation and its explanation by ring structures.	1	1
1.4	Linear and cyclic structures of glucose, galactose, mannose and fructose.	1	1
1.5	Haworth perspective formula of disaccharides - maltose, sucrose, lactose.	1	1
1.6	Structure and important properties of Homo polysaccharides – Starch, Glycogen.	1	1
1.7	Structure and important properties of Homo	1	1

	polysaccharides –Cellulose and Chitin.		
1.8	Structure and important properties of Hetero polysaccharides –Hyaluronic acid.	1	1
1.9	Structure and important properties of Hetero polysaccharides – Heparin.	1	1
1.10	Reducing action of sugars.	1	2
2.0	**LIPIDS**	**6**	
2.1	Basic ideas about classification and physiological functions of lipids.	1	3
2.2	Classification of Fatty acids.	1	3
2.3	Structure of stearic acid, oleic acid, linoleic acid and triacyglycerol	1	4
2.4	Structure of phosphatidic acid, lecithin, cephalin and phosphatidyl serine.	1	4
2.5	Functions of Sphingolipids. Chemical structure and functions of cholesterol and ergosterol.	1	4
2.6	Definition of saponification number, acid number and iodine number of fats.	1	5
3.0	**AMINOACIDS AND PROTEIN**	**10**	
3.1	Name (with one letter and three letter code) and structures of the 20 standard aminoacids occurring in proteins.	3	6
3.2	Representation of amino acid in the zwitter ionic form.	1	6
3.3	Classification and function of Proteins.	1	7
3.4	Elementary study of primary structure of proteins.	1	8
3.5	Elementary study of secondary structure of proteins.	1	8
3.6	Elementary study of tertiary and quaternary structure of proteins.	1	8
3.7	Specialised proteins - structure and functions of collagen.	1	8
3.8	Denaturation of proteins.	1	9
4.0	**NUCLEIC ACIDS**	**10**	
4.1	Chemical nature of nucleic acids- Structure of purines.	1	10
4.2	Chemical nature of nucleic acids- Structure of pyrimidines.	1	10
4.3	Chemical nature of nucleic acids- Structure of deoxyribose, ribose, nucleosides, nucleotides.	1	10
4.4	Chemical nature of nucleic acids - Formation of phosphodiester linkages	1	10
4.5	Watson-Crick model of DNA, Chargaff rule.	1	10
4.6	Different forms of DNA - A, B and Z DNA.	1	10
4.7	Structure and function of mRNA and rRNA.	1	11
4.8	Structure and function of tRNA.	1	11
4.9	Denaturation of nucleic acids – hyperchromic effect.	1	12
4.10	Denaturation of nucleic acids – Tm values and their significance.	1	12

Text Books for Reference

- A Text Book of Biochemistry by E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, Oxford and IBH Publishing Co., New Delhi, 1974.
- Biochemistry by Donald Voet, Judith G. Voet Publisher: John Wiley &Sons Inc(2004) ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
- Principles Of Biochemistry by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: Mcgraw-hill Book Company – Koga(1995) ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757.
- Principles Of Biochemistry, 4/e by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson(2006) ISBN: 0131977369, ISBN13:9780131977365, 978-0131977365.

Text Books for Enrichment

- Biochemistry (6thEdition) by Jeremy M. Berg, John L. Tymoczko Lubert Stryer Publisher:B.I publications Pvt.Ltd (2007) ISBN:071676766X ISBN13: 9780716767664,978716767664.
- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain, (2008) Publishers: S. Chand &Co Ltd ISBN: 81-219-2453-7 p:73.
- Lehninger Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008) 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and, Company, New York p: 239-255.

Course	Details			
Code	BT1812702			
Title	BIOMOLECULES (Practical)			
Degree	B.Sc.			
Branch(s)	BOTANY & BIOTECHNOLOGY (Double core)			
Year/Semester	1/II			
Type	Complementary Course			
Credits	1	Hrs/week	2	Total hours: 36

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Produce reactions of Carbohydrates and Aminoacids	Ap	2
2	Show reactions of Proteins, Lipids and NPN Substances	Ap	2
3	Analyze Carbohydrates and Aminoacids.	AN	6
4	Analyze Proteins, Lipids and NPN Substances	An	6

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Reactions of Carbohydrates, Aminoacids, Proteins, Lipids and NPN Substances**	**20**	
1.1	Reactions of Carbohydrates	4	1
1.2	Reactions of Aminoacids	4	1
1.3	Reactions of Proteins	4	2
1.4	Reactions of Lipids	4	2
1.5	Reactions of NPN Substances	4	2
2.0	**Qualitative analysis of a given unknown sample**	**16**	
2.1	Identification of Carbohydrates	4	3
2.2	Identification of Aminoacids	2	3
2.3	Identification of Proteins	2	4
2.4	Identification of Lipids	4	4
2.5	Identification of NPN substances	4	4

REFERENCE

- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi, ISBN 81-88237-41
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9
- Practical Biochemistry, R.C. Gupta & S. Bhargava (eds) CBS Publishers and Distributors, New Delhi

SEMESTER III				
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Credits**
BY1813103	Phycology & Bryology	Core Botany -4	3	3
BY1813603	Phycology & Bryology	Core Botany -4 Practical	2	1
BT1813104	Microbiology & Microbial Biotechnology	Core Biotechnology -4	3	3
BT1813604	Microbiology & Microbial Biotechnology	Core Biotechnology -4 Practical	2	1
BT1813105	Immunology	Core Biotechnology -5	3	3
BT1813605	Immunology	Core Biotechnology -5 Practical	2	1
BT1813203	Enzymology and Metabolism	Complementary 1 Biochemistry 3	3	3
BT1813703	Enzymology and Metabolism	Complementary 1 Biochemistry 3 Practical	2	1
ZY1813203	Physiology and Immunology	Complementary 2 Zoology 3	3	3
ZY1813703	Physiology and Immunology	Complementary 2 Zoology 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 3THEORY				
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

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

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		
1.6	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	*Nostoc*	1	2
2.4	Chlorophyceae	1	2
2.5	*Volvox*	1	2
2.6	Oedogonium	1	2
2.7	*Cladophora*	1	2
2.8	*Chara*	1	2
2.9	Xanthophyceae	1	2
2.10	*Vaucheria*	1	2

2.11	Bacillariophyceae	1	2
2.12	*Pinnularia*	1	2
2.13	Phaeophyceae	1	2
2.14	*Ectocarpus*	1	2
2.15	*Sargassum*	1	2
2.16	Rhodophyceae	1	2
2.17	*Polysiphonia*	1	2
2.18	*Polysiphonia*	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

- Anand N, 1989.Culturingand cultivationofBGA.Handbook of BlueGreenAlgae.
- FritschF E, 1935. Thestructureand reproductionof thealgae, Vol.1 and II.Uni.Press.Cambridge.
- MorrisI, 1967. AnIntroductionto theAlgae.Hutchinsonand Co.London.
- RobertEdwardLee,2008.Phycology.CambridgeUniversityPress,
- Singh V, PandeyP C, Jain DK. A text bookofbotany.

- Vashishta B R.TextBookof Algae.NewDelhi.
- GanguleeDas and Dutta. CollegeBotanyVol.I.CentralBookDepot.Calcutta.
- Ganguly, KarAK. College BotanyVol. II.NewCentraBookAgency, Calcutta.
- Khan M, 1983. FundamentalsofPhycology.BishenSinghMahendraPalSingh, Dehradun.
- CampbellH D, 1940.The Evolution of land plants (Embryophyta).Univ.Press, Stanford.
- Chopra R N, P KKumar, 1988. Biologyof Bryophytes.WileyEasternLtd.New Delhi.
- Parihar NS, 1965.AnIntroductionto Bryophyta.CentralBookDepot, Allhabad.
- ShawJA, GoffinetB, 2000.BryophyteBiology.CambridgeUniversityPress.

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 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

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Practicals**	**36**	
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 *Nostoc; Volvox, Oedogonium, Cladophora, Chara, Vaucheria, Pinnularia, Ectocarpus, Sargassum* and *Polysiphonia.*	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 *Riccia, Marchantia, Anthoceros* and *Funaria.*	8	2

REFERENCES

1. Anand N, 1989.CulturingandcultivationofBGA.Handbook of BlueGreenAlgae.
2. FritschF E, 1935. Thestructureand reproductionof thealgae, Vol.1 and II.Uni.Press.Cambridge.
3. MorrisI, 1967. AnIntroductionto theAlgae.Hutchinsonand Co.London.
4. RobertEdwardLee,2008.Phycology.CambridgeUniversityPress,
5. Singh V, PandeyP C, Jain DK. A text bookofbotany.

Course	**Details**			
Code	BT1813104			
Title	**MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY**			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	2/III			
Type	Core course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Identify different types of microscopes with special reference to their working principle and usage along with the needs of different types of staining techniques.	An	3
2	Interpret the structure of bacterial cell with a diagram	U	2
3	Illustrate the various requirements and techniques used for cultivation of microbes and its preservation and control of microbial growth	Ap	3
4	Discuss the bacterial phylogeny	U	6
5	Predict the bacterial growth patterns	U	1
6	Examine the efficiency of a drug.	An	3
7	Interpret the morphology and multiplication of virus.	U	2
8	Design the applications of microbes in industry	C	3
9	Construct the different types of fermenter with special reference to their working principle and its application	Ap	3
10	Explain the application of microbial enzymes in industry.	An	3

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**GENERAL BACTERIOLOGY**	**10**	
1.1	Microscopy		
1.1.1	Microscopy: compound microscope, bright field and dark field microscope	1	1
1.1.2	Phase contrast microscope	1	1
1.1.3	Fluroscent microscope, confocal microscope	1	1
1.1.4	Scanning electron microscope, transmission electron microscope	1	1
1.1.5	Scanning acoustic microscope	1	1
1.1.6	Preparing smears for microscopy	1	1
1.1.7	Staining, differential staining, Gram staining	1	1
1.1.8	Acid fast staining	1	1
1.1.9	Special staining, negative staining for capsules	1	1
1.1.10	Endospore staining, flagella staining	1	1
1.2	**Bacterial systematic and Nutritional requirement**	**13**	
1.2.1	Morphology of bacteria: size range of bacterial cells, Shape and arrangement of bacterial cells	1	2
1.2.2	Methods to classify bacteria: biochemical methods, serological testing, phage typing, fatty acid profiling using FAME, ribotyping and rRNA sequencing	1	4
1.2.3	Bergey's manuel, examples and characteristics (brief account) of gram negative bacteria, gram positive bacteria, bacteria with unusual properties, gram positive filamentous bacteria with complex morphology	1	4
1.2.4	Ultrastructure of bacteria	1	2
1.2.5	Culturing Bacteria: Nutritional requirements, nutritional types of bacteria: phototrophs, chemotrophs, autotrophs, heterotrophs, obligate parasites	1	3
1.2.6	Bacteriological Media: selective media, differential media, media for characterization of bacteria, Solid and semi solid media, broth	1	3
1.2.7	Physical conditions required for growth: temperature, pH, oxygen, cultivation of aerobic and anaerobic bacteria, candle jar, anaerobic jar, CO_2 generating packet, CO_2 incubator	1	3
1.2.8	Batch culture, continuous culture, enrichment culture, pure culture, methods to obtain pure culture: streak plate method, serial dilution method, use of special media	1	3
1.2.9	Preserving bacterial culture: Glycerol stock, deep freezing, lyophilisation	1	3
1.2.10	Growth of bacterial cultures: binary fission, budding (eg. *Pseudomonas acidophila)*, fragmentation (eg. Nocardia)	1	5
1.2.11	Bacterial growth kinetics, Growth curve,	1	5

	different phases		
1.2.12	Measurement of bacterial growth: direct microscopic count, serial dilution, pour plate, spread plate and plate count, membrane filter count, turbidometric method, dry weight method, most probable number method	1	5
1.2.13	Quorum sensing	1	3
2.0	**MICROBIAL GROWTH CONTROL**	**10**	
2.1	Control of microbial growth: Sterilization, methods of sterilization Heat treatment: thermal death point, thermal death time, moist heat and dry heat, autoclave, design, operation, pasteurization, flaming, hot air oven, low temperature treatment	3	3
2.2	Filtration: membrane filters. Chemical methods: phenols, bisphenols, biguanides, halogens, alcohols, compounds of heavy metals, soaps and detergents, acid anionic sanitizers, quaternary ammonium compounds, chemical preservatives; SO2, sodium benzoate, sorbic acid, calcium propionate, sodium nitrate	2	3
2.3	Antimicrobial drugs: drugs inhibiting cell wall synthesis, drugs inhibiting protein synthesis, drugs causing injury to plasma membrane, drugs inhibiting nucleic acid synthesis, drugs inhibiting the synthesis of essential metabolites, penicillins, penicillinase resistant penicillin, penicillin and β-lactamase inhibitors, cephalosporins, bacitracin, vancomycin, tetracyclines, sulfonamides	1	3
2.4	Antifungal Drugs: agents affecting fungal sterols, agents affecting fungal cell walls, agents inhibiting nucleic acid synthesis	1	3
2.5	Antiviral Drugs: nucleoside and nucleotide analogues, enzyme inhibitors, reverse transcriptase inhibitor, protease inhibitors, interferons	1	3
2.6	Determination of the efficiency of a drug: disk diffusion assay,	1	6
2.7	Broth dilution test and determination of minimal inhibitory concentration	1	6
3.0	**VIRUSES**	**6**	
3.1	Viruses: Characteristics of viruses, size range, host range, Classification of viruses	1	7
3.2	Structure of viruses: general morphology, nucleic acids, capsid and envelope	1	7
3.3	Culturing bacteriophages in the laboratory, culturing animal viruses: in living animals, in embryonated eggs, in cell cultures	1	7
3.4	Viral multiplication: Multiplication of bacteriophages; lytic cycle, lysogenic cycle	1	7
3.5	multiplication of animal viruses, differences in the multiplication strategies of DNA and RNA viruses	1	7

3.6	Viruses and cancer, DNA and RNA oncogenic viruses	1	7
4.0	**MICROBIAL BIOTECHNOLOGY**	**15**	
4.1	**General introduction to fermentation technology**		
4.1.1	Introduction, scope and historical developments, importance of microbes in industry; microbial biomass, microbial enzymes, microbial metabolites and microbial recombinant products	1	8
4.1.2	Isolation, screening and genetic improvement of industrially important organisms	1	8
4.1.3	Fermentation, Definition, chronological development of fermentation industry, Submerged fermentation and solid state fermentation	1	9
4.1.4	Media for industrial fermentation, major components, water, carbon sources, nitrogen sources, minerals, chelators, oxygen requirement, rheology, foaming and antifoaming agents	1	9
4.1.5	Medium optimization	1	9
4.1.6	Fermenter, functions of a fermenter, Design of a biofermenter, body constructon	1	9
4.1.7	Types of fermenters: Waldhof type, tower type, air lift type, packed tower type , sterilization of the fermenter, aeration, porous sparger, orifice spurger, nozzle sparger, probes	1	9
4.1.8	Recovery of fermentation products, foam separation, precipitation, filtration, centrifugation	1	9
4.2	**Industrial microbiology**		
4.2.1	Primary metabolism products, production of industrial ethanol as a case study	1	10
4.2.2	Secondary metabolites, bacterial antibiotics production	1	10
4.2.3	Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; metabolic pathway engineering of microbes for production of novel product for industry.	1	10
4.2.4	Microbial enzymes, role in various industrial processes, Bio-transformations, Bioaugmentation with production of vitamin C as a case study, Microencapsulation technologies for immobilization of microbial enzymes.	1	10
4.2.5	Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein	1	10
4.2.6	Bioremediation of soil	1	10
4.2.7	Production of eco-friendly agricultural chemicals, biopesticides, bio-herbicides, bio-	1	10

	fertilizers, bio-fuels, etc.		

Text Books for Reference

- Kun LY. 2006. *Microbial Biotechnology*. World Scientific.
- Tortora et al. 2008. Microbiology an introduction, Pearson Education
- Michael J Pelczar et al. 2000. TATA McGraw Hill
- PF Stanbury et al. 2008. Elsevier

Course	Details			
Code	BT1813604			
Title	**MICROBIOLOGY AND MICROBIAL BIOTECHNOLOGY (Practical)**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**2/III**			
Type	**Core Course- Practical**			
Credits	**1**	Hrs/week	2	Total hours: 36

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Predict bacteria	C	2
2	Examine bacterial motility	An	2
3	Identify bacteria	An	3
4	Construct the growth curve of bacteria	C	3
5	Compare the antimicrobial activity of medicinal plant extracts/antibiotics	An	3

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1	**Isolation of bacteria**	**10**	
1.1	Through serial dilution and plating techniques	5	1
1.2	Streak culture- preparation of pure culture.	5	1
2	**Identification of bacteria**	**10**	5
2.1	Motility	1	2
2.2	Gram staining technique	1	3
2.3	Acid fast staining technique	1	3
2.4	Endospore staining	1	3
2.5	Identification of bacteria using biochemical tests.	6	3
3	Preparation of the growth curve of a bacterium using turbidometric method	**8**	4
4	**Sensitivity testing** Determination of antimicrobial activity of medicinal plant extracts/antibiotics	**8**	5

REFERENCE

- Laboratory Manual in Microbiology (1995). P Gunasekaran. New Age International Private Limited
- Laboratory Manual of Microbiology and Biotechnology (2014).K R Aneja Med tech Publication

Course	Details			
Code	BT1813105			
Title	**Immunology**			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	2/III			
Type	Core Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Compare and contrast innate and adaptive immunity.	U	1
2	Design a model of Immunoglobulins	C	2
3	Describe which cell types and organs present in the immune response.	U	1
4	Illustrate various mechanisms that regulate immune responses and maintain tolerance	Ap	1
5	Exemplify the adverse effect of immune system including Allergy, hypersensitivity and autoimmunity	U	1
6	Apply basic techniques for identifying antigen-antibody interactions.	Ap	3
7	Explain the stages of transplantation responses	U	1
8	Recall the success of various transplant procedures	U	1
9	Describe the immunological response against tumor and blood transfusion	U	6
10	Elucidate the reasons for immunization and aware of different vaccination	U	6

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Introduction to immunology**	**12**	
1.1	Types of immunity: nonspecific-physiological and cellular barriers	2	1
1.2	Acquired immunity- characteristics	2	1
1.3	Antigen, Haptens and Adjuvants, Antibody	1	1
1.4	Structure and types of immunoglobulins	2	2
1.5	Types of immunoglobulins	1	2
1.6	Distribution of immunoglobulins	2	2
1.7	Function of immunoglobulins	2	2
2.0	**Cells and Organs of Immune system**	**15**	
2.1	Organs of immune system - primary and secondary	2	3
2.2	Cells of immunsystem	2	3
2.3	Humoral Immuneresponse	2	4
2.4	Cell mediated immuneresponse	2	4
2.5	MHC structure and function	2	4
2.6	Autoimmunity	2	5
2.7	Hypersensitivity	3	5
3.0	**Immuno-techniques**	**9**	
3.1	Introduction to Antigen-antibody interactions	1	6
3.2	Affinity, avidity, cross reactivity, Precipitation reaction	1	6
3.3	Radial immune diffusion, Ouchterlony double diffusion	1	6
3.4	Aagglutination reaction, agglutination titer, incomplete agglutinin	1	6
3.5	Complement fixation	1	6
3.6	ELISA	2	6
3.7	Immunocytochemistry	2	6
4.0	**Clinical Immunology**	**18**	
4.1	Transplant immunity	3	7
4.2	Immunology of malignancy.	3	8
4.3	Immunohaematology.	2	8
4.4	Blood groups and blood grouping. A, B, Rh antigens and antibodies, Rh typing. Bombay group	2	8
4.5	Immunization: Passive and active	1	9
4.6	Vaccines-Introduction	1	9
4.7	Types and applications	2	9
4.8	DNA vaccines	2	9
4.9	Polyclonal antibodies and monoclonal antibodies	2	9

Text Books for Reference

- Ivan M. Roitt and Peter J delves, Essential Immunology, Blackwell Publishing.
- Helen Chappel and ManselHaeney, Essential Clinical Immunology, ELBS/Blackwell Scientific Publications.
- John W, Kimball Maxwell, Introduction to Immunology, Mac Millan International Edition.

Text Books for Enrichment

- Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, and Janis Kuby,Immunology, W H Freeman and Co.
- Charles A. Janeway Jr., Paul Travers, Mark Walport and Mark J. Shlomchik, Immunobiology, Garland Publishing.

Course	Details			
Code	BT1813605			
Title	**Immunology (Practical)**			
Degree	B.Sc.			
Branch(s)	BOTANY & BIOTECHNOLOGY (Double core)			
Year/Semester	1/III			
Type	Core Course			
Credits	1	Hrs/week	2	Total hours: 36

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Apply immunological laboratory techniques to understand principles of antigen-antibody reaction.	Ap	3
2	Use different immunological test to study the immune effector function and immune development.	Ap	2
3	Demonstrate gel-Immunodiffusion and Immunoelectrophoresis	U	1
4	Evaluate laboratory test outcomes and determine the validity of the test results obtained.	E	6
5	Design a immunological method to improve our understanding of immunology and its relevance to human health and to our society.	C	6

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Agglutination test**	**18**	
1.1	Slide agglutination test- Blood grouping	6	1
1.2	Bacterial agglutination test	6	5
1.3	Haemagglutination test	6	1
2.0	**Precipitation Test**	**16**	
2.1	Slide test	7	5
2.2	Tube test-Capillary test	7	2
2.3	Demonstrate Precipitation in gel-Immunodiffution	2	3
3.0	**Demonstrate Immunoelectrophoresis**	**2**	3

REFERENCE

- A Procedure manual for Routine Diagnostic Tests – Kanai L Mukherjee – Volumes I, II & III
- Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker

Course	Details			
Code	BT1813203			
Title	ENZYMOLOGY AND METABOLISM			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	2/III			
Type	Complementary Course			
Credits	3	Hrs/week	3	Total hours: 54

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Classify enzymes with examples.	Ap	2
2	Justify enzyme kinetics.	E	5
3	Compare coenzymes and cofactors.	An	6
4	Write the specificity of enzymes.	R	1
5	Deduce various pathways of carbohydrate metabolism.	An	6
6	Describe Decarboxylation, Deamination and Transamination of Aminoacids.	R	1
7	Illustrate Urea cycle.	Ap	2
8	Describe Glucogenic and Ketogenic aminoacids with examples.	R	1
9	Reproduce fatty acid biosynthesis.	R	1
10	Assess oxidation of Fatty acids.	E	5
11	Name Ketone bodies.	R	1
12	Imagine Cholesterol biosynthesis.	C	3

Module	Course Description	Hrs	CO. No.
1.0	**ENZYMOLOGY**	**16**	
1.1	Classification of enzymes - six major classes of enzymes with one example each.	2	1
1.2	Elementary study of the factors affecting velocity of enzyme catalyzed reactions- effect of substrate concentration.	1	2
1.3	Elementary study of the factors affecting velocity of enzyme catalyzed reactions- effect	1	2

	of enzyme concentration.		
1.4	Elementary study of the factors affecting velocity of enzyme catalyzed reactions- effect of temperature.	1	2
1.5	Elementary study of the factors affecting velocity of enzyme catalyzed reactions- effect of pH.	1	2
1.6	Michaelis-Menten equation. Km and its significance.	2	2
1.7	The Lineweaver-Burk plot.	2	2
1.8	Cofactors and coenzymes	2	3
1.9	Group specificity of enzyme with example.	1	4
1.10	Optical specificity of enzyme with example.	1	4
1.11	Geometrical specificity of enzyme with example.	1	4
1.12	Cofactor specificity of enzyme with example.	1	4
2.0	**CARBOHYDRATE METABOLISM**	**16**	
2.1	Glycolysis (with structure).	3	5
2.2	Fates of pyruvate - lactic acid fermentation.	1	5
2.3	Fates of pyruvate - alcohol fermentation.	1	5
2.4	Pyruvate dehydrogenase reaction.	1	5
2.5	Citric acid cycle (with structure).	3	5
2.6	Substrate level phosphorylation.	1	5
2.7	Electron transport chain.	2	5
2.8	Oxidative phosphorylation.	2	5
2.9	Glycogen metabolism - glycogenesis.	1	5
2.10	Glycogen metabolism-glycogenolysis.	1	5
3.0	**PROTEIN METABOLISM**	**12**	
3.1	Decarboxylation of aminoacids.	2	6
3.2	Deamination of aminoacids.	1	6
3.3	Transamination of aminoacids.	2	6
3.4	Urea Cycle	3	7
3.5	Glucogenic amino acids with examples.	2	8
3.6	Ketogenic amino acids with examples.	2	8
4.0	**LIPID METABOLISM**	**10**	
4.1	Fatty acid biosynthesis (with structure).	3	9
4.2	Oxidation of fatty acids - Fatty acid activation.	1	10
4.3	Oxidation of fatty acids - Carnitine shuttle.	1	10
4.4	β-Oxidation of fatty acids (with structure) - explain using palmitic acid and ATP yield.	2	10
4.5	Ketone bodies.	1	11
4.6	Cholesterol biosynthesis (without structure).	2	12

Text Books for Reference

- A Text Book of Biochemistry by E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, Oxford and IBH Publishing Co., New Delhi, 1974.
- Harper's Biochemistry by Robert K. Murray , Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell, Publisher: Appleton & Lange; 25th Revised edition (1 July 1999), ISBN-10: 0838536840, ISBN-13: 978-0838536841.
- Biochemistry Seventh Edition by Jeremy M. Berg, John L. Tymoczko and Lubert Stryer,

Publisher: W. H. Freeman; Seventh Edition edition (December 24, 2010).

Text Books for Enrichment

- Biochemistry by Donald Voet, Judith G. Voet, Publisher: John Wiley & Sons (2011), Fourth Edition, ISBN-10: 0071737073, ISBN-13: 978-0071737074.
- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain, Nithin Jain (2008), Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.
- Lehninger, Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M.(2008), 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and Company, New York, p: 677-878.

Course	Details			
Code	BT1813703			
Title	ENZYMOLOGY AND METABOLISM (Practical)			
Degree	B.Sc.			
Branch(s)	BOTANY & BIOTECHNOLOGY (Double core)			
Year/Semester	2/III			
Type	Complementary Course			
Credits	1	Hrs/week	2	Total hours: 36

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Examine the methods of extraction of enzymes	Ap	2
2	Analyze the activity of enzymes	An	6

Module	Course Description	Hrs	CO. No.
1.0	**Extraction of enzymes**	**12**	
1.1	Extraction of Acid phosphatase from Fresh Potato (*Solanum tuberosum*)	6	1
1.2	Extraction of β- amylase from Sweet potato (*Ipomoea batatas*) or Extraction of Urease from Jack bean (*Canavalia ensiformis*)	6	1
2.0	**Enzyme Assay**	**24**	
2.1	Assay of Acid phosphatase – Part 1	6	2
2.2	Assay of Acid phosphatase – Part 2	6	2
2.3	Assay of β- amylase or Urease – Part 1	6	2
2.4	Assay of β- amylase or Urease – Part 2	6	2

REFERENCE

- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8, p: 173-187
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p: 110 – 155
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p: 49- 181, 184 – 255

SEMESTER IV				
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Credits**
BY1814104	Pteridology, Gymnosperms & Paleobotany	Core Botany -5	3	3
BY1814604	Pteridology, Gymnosperms & Paleobotany	Core Botany -5 Practical	2	1
BT1814106	Animal Biotechnology & Nanobiotechnology	Core Biotechnology -6	3	3
BT1814606	Animal Biotechnology & Nanobiotechnology	Core Biotechnology -6 Practical	2	1
BT1814107	Plant Biotechnology	Core Biotechnology -7	3	3
BT1814607	Plant Biotechnology	Core Biotechnology -7 Practical	2	1
BT1814204	Nutritional and Clinical Biochemistry	Complementary 1 Biochemistry 4	3	3
BT1814704	Nutritional and Clinical Biochemistry	Complementary 1 Biochemistry 4 Practical	2	1
ZY1814204	Applied Zoology	Complementary 2 Zoology 4	3	3
ZY1814704	Applied Zoology	Complementary 2 Zoology 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 Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
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; 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 uptoclassesby Smith (1955)	1	1
1.5	Brief account of the classification by Christen husz*et*al., 2011.	1	1
2.0	**Type Study - pteridophytes**	**18**	
2.1	Distribution of Psilophyta -*Psilotum*; Lycophyta-*Lycopodium, Selaginella;*	1	2
2.2	Distribution ofSphenophyta- *Equisetum;* Pterophyta- *Pteris, Marsilea.*	1	2
2.3	Morphology, anatomy, of Psilotum	1	2
2.4	Reproduction, life cycle of Psilotum	1	2
2.5	Morphology, anatomy, of *Lycopodium*	1	2
2.6	Reproduction, life cycle of *Lycopodium*	1	2
2.7	Morphology, anatomy, of *Selaginella*	1	2
2.8	Reproduction, life cycle of *Selaginella*	1	2

2.9	Morphology, anatomy, of *Equisetum*	1	2
2.10	Reproduction, life cycle of *Equisetum*	1	2
2.11	Morphology, anatomy, of *Equisetum*	1	2
2.12	Reproduction, life cycle of *Equisetum*	1	2
2.13	Morphology, anatomy, of *Marsilea*	1	2
2.14	Reproduction, life cycle of *Marsilea*	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 importanceof 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	ClassificationofGymnosperms Christenhusz*etal*(2011).	1	1
5.0	**Type Study- Gymnosperms**	**11**	
5.1	Distribution of Cycadopsida–*Cycas*; Coniferopsida–*Pinus*; Gnetopsidae – *Gnetum*	1	2
5.2	Morphology of Cycas	1	2
5.3	Anatomy of stem, root, leaves and reproductive structures of Cycas	1	2
5.4	Reproduction and life cycle of cycas(Developmental details are not required)	1	2
5.5	Morphology of Pinus	1	2
5.6	Anatomy of stem, root, leaves and reproductive structures of Pinus	1	2
5.7	Reproduction and life cycle of Pinus (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 Paleobotanyand its significance.	1	4
7.2	Fossil formation, types of fossils.	1	4
7.3	Study of fossil Bryophyte-*Naiaditalanceolata;*	1	4
7.4	fossil Pteridophytes–*Rhynia, Calamites;*	1	4
7.5	fossil Gymnosperm–*Williamsonia*	1	4

7.6	Applied aspects of Paleobotany- exploration of fossil fuels.	1	4
8.0	**Paleobotanyin 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- BirbalSahni.	1	4

REFERENCES

- Chamberlain CJ, 1935. Gymnosperms: Structure and Evolution.Chicago University Press.
- CoutlerJ M, CJ Chamberlain, 1958.Morphology of Gymnosperms.Central book depot. Allahabd.
- Sporne K R, 1967.The Morphology of Gymnosperms.Hutchinson and Co. Ltd. London.
- Sreevastava H N, 1980. A Text Book of Gymnosperms. S Chand and Co. Ltd., New Delhi.
- Vasishta P C, 1980. Gymnosperms. S Chand and Co., Ltd., New Delhi.
- Maarten JM, Christenhusz, James L Reveal, Aljos Farjon, Martin F Gardner, Robert R Mill, Mark W Chase, 2011.A new classification and linear sequence of extinct gymnosperms.*Phytotaxa,*19: 55 - 70.
- Campbell H D, 1940. The Evolution of land plants (Embryophyta).Univ. Press, Stanford.
- Bower F O, 1935. Primitive Land Plants.Cambridge, London.
- Chandra S, Srivastava M, 2003. Pteridology in New Millennium. Kluwer Academic Publishers.
- Eames AJ, 1979. Morphology of vascular plants, lower group.Wiley International edition, New Delhi.
- Parihar NS, 1977. Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
- Rashid A, 1976. An Introduction to Pteridopyta.Vikas publ. Co., New Delhi.
- Ranker T A, Haufler C H (eds.), 2008. *Biology and Evolution of Ferns and Lycophytes*. Cambridege University Press.
- Mehltreter K, Walker LR, Sharpe J M (eds), 2010. *Fern Ecology*.Cambridge University Press.
- Smith AR, Pryer KM, Schuttpelz E, Korall P, Schnelder H, Wolf PG, 2006. A Classification for extinct Ferns. *Taxon* 53:705731.
- Smith AR, Pryer KM, Schuettpelz E, 2008. Fern classification. In: T. A. Rankerand C.H. Haufler (eds.). *Biology and Evolution of Ferns and Lycophytes*. Cambridge University press, UK.

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 Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
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; 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 structuresof the following types – *Psilotum, Lycopodium, Selaginella, Equisetum, Pteris, Marselia*	18	1
9.2	Study of the habit, TS of leaf and stem and Morphology of reproductive structures – *Cycas, Pinus and Gnetum*	18	2

REFERENCES

- Chamberlain CJ, 1935. Gymnosperms: Structure and Evolution.Chicago University Press.
- CoutlerJ M, CJ Chamberlain, 1958.Morphology of Gymnosperms.Central book depot. Allahabd.
- Sporne K R, 1967.The Morphology of Gymnosperms.Hutchinson and Co. Ltd. London.
- Sreevastava H N, 1980. A Text Book of Gymnosperms. S Chand and Co. Ltd., New Delhi.
- Vasishta P C, 1980. Gymnosperms. S Chand and Co., Ltd., New Delhi.
- Maarten JM, Christenhusz, James L Reveal, Aljos Farjon, Martin F Gardner, Robert R Mill, Mark W Chase, 2011.A new classification and linear sequence of extinct gymnosperms.*Phytotaxa*,19: 55 - 70.
- Campbell H D, 1940. The Evolution of land plants (Embryophyta).Univ. Press, Stanford.
- Bower F O, 1935. Primitive Land Plants.Cambridge, London.
- Chandra S, Srivastava M, 2003. Pteridology in New Millennium. Kluwer Academic Publishers.
- Eames AJ, 1979. Morphology of vascular plants, lower group.Wiley International edition, New Delhi.

Course	Details			
Code	BT1814106			
Title	***ANIMAL BIOTECHNOLOGY AND NANO-BIOTECHNOLOGY***			
Degree	B. Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	2/IV			
Type	Core Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Outline the history and structure of animal cell	U	1
2	Illustrate the techniques, procedure and growth patterns of animal cell culture.	Ap	3
3	Describe the *in vitro* applications of animal cell culture	U	3
4	Distinguish the structure of gametes and its application in animal cell culture.	U	3
5	Use the assisted reproductive technology practised in livestock and its applications	Ap	3
6	Construct the techniques in production of cloned animal and its applications.	Ap	3
7	Predict the ethical, social and moral issues related to cloning	C	4
8	Construct techniques involved in transgenic animal technology and its applications	Ap	3
9	Apply the applications of Gene therapy for the treatment of various diseases.	Ap	3
10	Identify and recall the basic concepts of structural and functional aspects of macromolecules	R	1
11	Recall and differentiate Biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides) and its structure-property relationships	R	3
12	Recall and explain the techniques and applications of nanoparticles in Drug and gene delivery system, Microfabrication, Biosensors, Chip technologies, Nano-imaging and in related fields	U	2

Module	Course Description	Hrs	CO.No.
1.0	**BASICS OF ANIMAL CELL CULTURE**	**11**	
1.1	Structure of animal cell	1	1
1.2	History of animal cell culture	1	1
1.3	Different types of cell culture media, growth supplements, serum free media, balanced salt solution	1	2
1.4	Culture of different tissues and its application	1	2
1.5	Infra structure requirements	1	2
1.6	Conditions required for culturing animal cells, Behavior of cells in culture conditions, division, their growth pattern, Estimation of cell number	1	2
1.7	Culture of mammalian cells, tissues and organs, primary culture, secondary culture, Continuous cell lines, suspension cultures	1	2
1.8	Stem cells	1	2
1.9	Cryopreservation	1	2
1.10	Common cell culture contaminants	1	2
1.11	Commercial scale production of animal cells.		2
2.0	***IN VITRO* APPLICATION OF ANIMAL CELL CULTURE**	**6**	
2.1	Application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of Environmental pollutants in cell culture	2	3
2.2	Application of cell culture technology in production Of human and animal viral vaccines and pharmaceutical protein	2	3
2.3	Conventional methods of animal vaccine production, recombinant approaches to vaccine production	2	3
2.4	Commercial scale production of diagnostic antigens and antisera	2	3
3.0	**ADVANCED APPLICATION OF CELL CULTURES**	**17**	
3.1	Structure of sperms and ovum	1	4
3.2	Cryopreservation of sperms and ova of livestock	1	4
3.3	Artificial insemination, Super ovulation, *in vitro* fertilization	1	5
3.4	Culture of embryos, Cryopreservation of embroys	1	5
3.5	Embryo transfer, embryo-splitting, embryo sexing	1	5
3.6	*In utero* testing of foetus for genetic defects	1	5
3.7	Animal cloning basic concept, cloning from embryonic cells and adult cells	1	6
3.8	Cloning of different animals, Cloning for conservation of endangered species	1	6
3.9	Ethical, social and moral issues related to cloning	1	7
3.10	Transgenic manipulation of animal embryo, Animal viral vectors	1	8
3.11	Different application of transgenic animal	1	8

	technology		
3.12	Transgenic animal production and application in expression of therapeutic proteins, biopharming.	1	8
3.13	Gene knock out technology and animal models for genetic disorders.	1	9
3.14	Gene therapy, somatic cell therapy, germline therapy,gene augmentation therapy, gene replacement therapy	1	9
3.15	Candidate diseases for Gene therapy	1	9
3.16	Methods of gene transfer, vectors used	1	9
3.17	Initial trials and observations, Current status of Gene therapy	1	9
4.0	**BIO-NANOTECHNOLOGY**	**20**	
4.1	**Introduction to Bio-macromolecules**	**10**	
4.1.1	The modern concepts to describe the conformation and dynamics of biological macromolecules	1	10
4.1.2	Scattering technique	2	10
4..1.3	Micromanipulation technique	1	10
4.1.4	Drug delivery applications	2	10
4.1.5	Cellular engineering: signal transduction in biological systems, feedback, control signalling pathways, cell-cell interactions etc	4	10
4.1.6	Effects of physical, chemical and electrical stimuli on cell function	1	10
4.2	**Biomaterials and bioresponse**	**3**	
4.2.1	Chemical, physical and biological properties of biomaterials and bioresponse	1	11
4.2.2	Biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides structure-property relationships in polymeric materials (synthetic polymers and structural proteins)	1	11
4.2.3	Aerosol, properties, ,application and dynamics Statistical Mechanics in Biological Systems	1	11
4.3	**Nanoparticles: Preparation and Application**	**4**	
4.3.1	Characteristics of nanoparticles: Preparation and characterization of nanoparticles	1	12
4.3.2	Biosynthesisofnanoparticles,Nanoparticularcarriersystems,Micro-andNano-fluidics,Drug and gene delivery system, Microfabrication, Biosensors, Chip technologies, Nano-imaging	2	12
4.3.3	Metabolic engineering and Gene therapy	1	12

Text Books for Reference

- Gordon I. 2005. Reproductive Techniques in Farm Animals. CABI.
- Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare.
- Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.

Text Books for Enrichment

- Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.
- Nalwa HS. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
- Niemeyer CM & Mirkin CA. 2005. *Nanobiotechnology*. Wiley

Course	Details			
Code	BT1814606			
Title	**ANIMAL BIOTECHNOLOGY AND NANO-BIOTECHNOLOGY (Practical)**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**2/IV**			
Type	**Core Course- Practical**			
Credits	**1**	Hrs/week	2	Total hours: 36

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Apply methods of preparation of reagents and media for cell culture	Ap	2
2	Illustrate the culturing of animal cell	Ap	3
3	Identify the cell number	An	2
4	Identify the cell nucleus	An	2

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1	preparation of reagents and media for cell culture	6	1
2	Sterilization techniques for cell culture	6	2
3	Cultivation of continuous cell lines	6	2
4	Sub culturing: Trypsinization	6	2
5	Cell counting	6	3
6	Nuclear staining	6	4

REFERENCE

- Readings in Mammalian cell culture. R. Pollack., Cold Spring Harbour Laboratory (1981).
- Experiments with Norma land Transformed cells. R. Crowe., H. Ozer and Dr.Rifkin. Cold Spring Harbour Laboratory (1978).
- Hand Book of cell and organ culture. D.J. Merchant., R.H. Kahn and W.H. Murphy., Burgess Publishing Company (1969).
- Culture of Animal Cells. R. Ian Freshney and R. Alan., Liss .Inc (1987).
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- A Practical Manual on Basic Techniques in Biotechnology&Nanotechnology (2003) Editedby R.Madhan Shankar&Dr. E.M. Rajesh. International E–Publication

Course	**Details**			
Code	BT1814107			
Title	**PLANT BIOTECHNOLOGY**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**2/IV**			
Type	**Core Course**			
Credits	**3**	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Recall the basic concepts of Biotechnology and explain fundamental cellular events during the process of plant cell culture development	**U**	**1**
2	Determine the factors influencing plant cell differentiation and thereby execute proper techniques/ procedures for the maintenance of sterile condition and proper plant growth	**AP**	**2**
3	Apply learned techniques in new or similar situations	**AZ**	**3**
4	Translate the concepts in future studies and debate on the issue related to GMOs and evaluate its significances	**AZ**	**4**
5	Express the concerns over modern plant biotechnology and analyze them according to the regulatory frame works	**E**	**5**
6	Differentiate various types of intellectual property rights and report measures for conservation of biodiversity	**U**	**1**
7	Design an experiment with step-by-step instructions to address a research problem	**C**	**3**

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Introduction to plant tissue culture**	**10**	
1.1	The concept of biotechnology, landmarks in biotechnology	1	1
1.2	Plant tissue culture – Principles and techniques.	1	1
1.3	Cellular totipotency, *in vitro* differentiation; dedifferentiation and redifferentiation	1	2
1.4	Callus induction organogenesis and somatic embryogenesis.	1	2
1.5	Tissue culture medium; Basic components in tissue culture medium – Solid and liquid medium	1	2
1.6	Murashige and Skoog medium – composition and preparation	1	2
1.7	Aseptic techniques in tissue culture – sterilization – different methods sterilization of instruments and glass wares, medium and explants	1	2
1.8	Working principle of laminar air flow and autoclave	1	2
1.9	Preparation of explants – surface sterilization, inoculation and incubation, sub culturing.	1	2
1.10	Establishment of axenic cultures production of suspension culture.	1	2
2.0	**Applications of Plant Tissue Culture**	**10**	
2.1	Concept of micropropagation; advantages and disadvantages, different methods – axillary bud proliferation, direct and indirect organogenesis and somatic embryogenesis	1	3
2.2	Different phases of micropropagation – hardening, transplantation and field evaluation.	1	3
2.3	Applications of tissue culture: Micropropagation of elite plants, Synthetic seed production	2	3, 4
2.4	Meristem culture for virus free plants	2	3, 4
2.5	Somaclonal variation and *in vitro* mutagenesis, Embryo rescue – embryo culture	1	3, 4
2.6	*In vitro* production of haploids – anther and pollen culture; *in vitro* fertilization	1	3, 4
2.7	Protoplast isolation culture and regeneration	1	3, 4
2.8	Somatic cell hybridization	1	3, 4
2.9	I*n vitro* secondary metabolite production — cell immobilization, bio reactors, hairy root culture	1	3, 4
2.10	Cryopreservation	1	3, 4
3.0	**Genetic Engineering in Plants**	**18**	
3.1	*Plant transformation*: Genetic engineering: Vectors for plant transformation	1	5
3.2	Different types of *Agrobacterium* based vectors	1	5
3.3	Methods of plant transformation; Gene cloning, methods of transformation – electroporation, particle bombardment and *Agrobacterium* mediated	2	5
3.4	Target traits and transgenic crops; Genetic and molecular analyses of transgenics	2	5
3.5	*Molecular Markers*: Role of molecular markers in characterization of transgenic crops, fingerprinting of cultivars	2	5
3.6	GMO: Achievements and issues	2	5
3.7	Future thrusts in horticultural biotechnology: Molecular approaches to control ethylene response, improving shelf life, improving resistance for environmental stress: virus and	1	5

	herbicide resistant crops		
3.8	Edible vaccines.	1	5
3.9	Biotechnology and floriculture: Achievements of bio-technology in flower crops: approaches to improve flower development	2	5
3.10	Bio-pigments: Extraction of biocolours, uses in food and textile industries	2	5
3.11	Examples of transgenic plants produced successfully: Bt crops, golden rice, Flavr Savr Tomato	2	5
4.0	**Concerns over modern plant biotechnology and *Intellectual property Rights (IPR)***	16	
4.1	*Biosafety and risk assessment issues*: General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance	2	6
4.2	Ecological aspects of GMOs and impact on biodiversity: Sources of gene escape, tolerance of target organisms, creation of super weeds/super viruses, etc.; Monitoring strategies	2	6
4.3	Cross border movement of germplasm; Risk management issues - containment.	2	6
4.4	*Biosafety Regulatory framework*: National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety	2	6
4.5	Intellectual property Rights (IPR): Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc	2	6
4.6	Indian patent act and amendments, patent filing	2	6
4.7	Protection of plant variety and farmers right act; Convention on biological diversity	2	6
4.8	Implications of intellectual property rights on the commercialization of biotechnology products.	2	6

References

- Razdan M.K. Introduction to Plant Tissue Culture. : 376 pages, Science Publishers Inc 2nd edition (2003), ISBN: 1578082374.
- Keshavachandran R & Peter KV. 2008. Plant Biotechnology: Methods in Tissue Culture and Gene Transfer. Orient & Longman (Universal Press)
- Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani Publications.

Course	Details			
Code	BT1814607			
Title	**PLANT BIOTECHNOLOGY - PRACTICAL**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**2/IV**			
Type	**Core Course**			
Credits	**1**	Hrs/week	2	Total hours: 36

Module	Course Description	Hrs	CO. No.
1.0	***In vitro* culture initiation**	**12**	
1.1	Preparation of nutrient medium – Murashige and Skoog medium, sterilization	6	3
1.2	Preparation of explants, Surface sterilization and inoculation	2	3
1.3	Establishment callus culture, shoot and suspension	4	3
2.0	**Applications of cell culture**	**18**	
2.1	Immobilization of whole cells or tissues in sodium alginate	4	3
2.2	Establishment of the suspension culture of one medicinal plant	4	3
2.3	Production of somatic embryos from one plant	3	3
2.4	Transformation of leaf discs using *Agrobacterium* and selection of transformed leaf discs	4	3
2.5	Induction of hairy root culture in any one plant	3	3
3.0	**Lab Visit**	**6**	
3.1	Visit a well equipped biotechnology lab and submit a report along with the practical record.	6	3

REFERENCES

- Debnath M. 2005. Tools and Techniques of Biotechnology. Pointer Publ.
- Brown T A. 2001. Gene Cloning and DNA Analysis and Introduction. Blackwell Publ.
- Chadha K L, Ravindran PN & Sahijram L. (Eds.). 2000. Biotechnology of Horticulture and Plantation Crops. Malhotra Publ. House.

Course	Details			
Code	BT1814204			
Title	NUTRITIONAL AND CLINICAL BIOCHEMISTRY			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	2/IV			
Type	Complementary Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Recognize the nutritional importance of principle foods.	R	1
2	Verify the sources, nutritional importance, diseases and manifestations associated with vitamins and minerals.	E	5
3	Categorize the constituents of blood.	An	6
4	Classify plasma components with functions.	Ap	2
5	Interpret the pathways of blood coagulation.	Ap	2
6	Draw the structure of haemoglobin.	R	1
7	List the different types of haemoglobins and the disorders associated with them.	R	1
8	Identify the clinical biochemistry tests with their results.	An	6
9	Combine the biochemical and clinical features of various metabolic disorders.	C	3

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**NUTRITIONAL BIOCHEMISTRY**	**12**	
1.1	Concepts of nutrition, Nutritional requirements.	1	1
1.2	Principle foods - cereals, pulses, vegetables, fruits.	1	1
1.3	Principle foods - nuts, milk, egg, meat, fish.	1	1
1.4	Calorific value of foods.	1	1
1.5	Respiratory quotient, Basal metabolic rate.	1	1
1.6	Biological value of proteins, essential and non-essential amino acids.	1	1
1.7	Biological value of essential and non-essential fatty acids	1	1
1.8	Sources, nutritional importance and deficiency disorders of vitamin A, D, E and K.	1	2
1.9	Sources, nutritional importance and deficiency disorders of vitamin C, B1, B2, and pyridoxine.	1	2
1.10	Sources, nutritional importance and deficiency disorders of vitamin B12, nicotinic acid and folic	1	2

	acid.		
1.11	Biological and nutritional importance of macro minerals-calcium, magnesium, sodium and potassium and their deficiency disorders.	1	2
1.12	Biological and nutritional importance of micro minerals-iron, copper and selenium and their deficiency disorders.	1	2
2.0	**BLOOD**	**10**	
2.1	Constituents of Blood.	1	3
2.2	Types of blood cells.	1	3
2.3	Components of plasma.	1	4
2.4	Types of plasma proteins and functions.	1	4
2.5	Mechanism of blood clotting – Extrinsic pathway.	1	5
2.6	Mechanism of blood clotting - Intrinsic pathway.	1	5
2.7	Anticoagulants.	1	5
2.8	Fibrinolysis.	1	5
2.9	Structure of hemoglobin.	1	6
2.10	Types of hemoglobin, sickle cell anemia.	1	7
3.0	**CLINICAL BIOCHEMISTRY**	**18**	
3.1	Basic concepts of clinical biochemistry.	1	8
3.2	Definition and scope of clinical biochemistry in diagnosis.	1	8
3.3	Sample collection and preservation of blood	1	8
3.4	Sample collection and preservation of plasma and serum.	1	8
3.5	Sample collection and preservation of urine.	1	8
3.6	Chemical analysis of blood.	1	8
3.7	Chemical analysis of urine.	1	8
3.8	Chemical analysis of CSF.	1	8
3.9	Liver function tests - Total protein, albumin, globulin, albumin-globulin ratio.	1	8
3.10	Liver function tests - Total bilirubin and conjugated bilirubin	1	8
3.11	Liver function tests - AST, ALT.	1	8
3.12	Liver function tests - ALP, GTT.	1	8
3.13	Thyroid function tests- T3 and T4.	1	8
3.14	Thyroid function tests- TSH.	1	8
3.15	Renal function tests – Urea.	1	8
3.16	Renal function tests –Creatinine.	1	8
3.17	Renal function tests - Urea clearance test.	1	8
3.18	Renal function tests - Creatinine clearance test.	1	8
4.0	**BIOCHEMICAL BASIS OF METABOLIC DISORDERS**	**14**	
4.1	Biochemical basis of Lactose intolerance.	1	9
4.2	Biochemical basis of Diabetes mellitus.	4	9
4.3	Biochemical basis of hypoglycaemia.	1	9
4.4	Biochemical basis of galactosemia	1	9

4.5	Biochemical basis of hyperlipidemia.	2	9
4.6	Biochemical basis of atherosclerosis.	1	9
4.7	Biochemical basis of ketosis.	2	9
4.8	Biochemical basis of obesity.	2	9

Text Books for Reference

- Lehninger Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008) 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and, Company, New York p:43-64.
- Clinical Biochemistry: Metabolic And Clinical Aspects by William J. Marshall, Stephan K. Bangert, Elizabeth S.M. Ed. S.M (ed) Marshall (2008) Publisher: Elsevier Science Health Science Div ISBN: 0443101868 ISBN-13: 9780443101861, 978-0443101861
- Biochemistry by John K. Joseph (2006) Publisher: Campus Books International ISBN: 8180301109 ISBN -13: 9788180301100, 978-8180301100.
- Basic Medical Biochemistry: A Clinical Approach by Dawn B PH.D. Marks, Allam D. Marks colleen M. Smith (1996) Publisher; Lippincott Williams & Wilkins; illustrated edition ISBN -10: 068305595X ISBN-13: 978-0683055955
- Notes on Clinical Biochemistry by John K. Candlish (1992) publisher: World Scientific Publishing Company ISBN: 9810210663 ISBN-13: 9789810210663, 978-9810210663

Text Books for Enrichment

- A Text Book of Biochemistry by E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, Oxford and IBH Publishing Co., New Delhi, 1974
- Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500
- Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis Evance Publisher: Mcgraw-hill Book Company Koga ISBN:0697142752 ISBN-13: 9780697142757, 978-0697142757
- Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, GrayScrimgeourK Publisher: Pearsarson ISBN: 0131977369, ISBN-13:9780131977365, 978-0131977365
- Biochemistry 6th Edition (2007) by Jeremy M.berg John L.TymoczkoLUbertStryer Publisher: B.I. Publications Pvt. Ltd ISBN:071676766X ISBN13: 9780716767664, 978-716767664
- Biochemistry (2008) by Rastogi Publisher: McgrawHill ISBN**:**0070527954 ISBN13**:** 978 0070527959**,** 978-0070527959

Course	Details			
Code	BT1814704			
Title	NUTRITIONAL AND CLINICAL BIOCHEMISTRY (Practical)			
Degree	B.Sc.			
Branch(s)	BOTANY & BIOTECHNOLOGY (Double core)			
Year/Semester	2/IV			
Type	Complementary Course			
Credits	1	Hrs/week	2	Total hours: 36

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Apply the methods of estimation of carbohydrates	Ap	2
2	Apply the methods of estimation of lipids	Ap	2
3	Apply the methods of estimation of proteins	Ap	2
4	Investigate the methods of estimation of minerals and vitamins	An	6
5	Analyze the urine qualitatively	An	6

Module	Course Description	Hrs	CO. No.
1.0	**Estimation of Carbohydrates, Lipids, Proteins, Minerals and Vitamins**	**20**	
1.1	Estimation of Carbohydrates – Part 1	2	1
1.2	Estimation of Carbohydrates – Part 2	2	1
1.3	Estimation of Carbohydrates – Part 3	2	1
1.4	Estimation of Lipids – Part 1	2	2
1.5	Estimation of Lipids – Part 2	2	2
1.6	Estimation of Lipids – Part 3	2	2
1.7	Estimation of Proteins – Part 1	2	3
1.8	Estimation of Proteins – Part 2	2	3
1.9	Estimation of Proteins – Part 3	2	3
1.10	Estimation of Minerals or Vitamins	2	4
2.0	**Qualitative Analysis of Urine**	**16**	
2.1	Detection of proteins	4	5
2.2	Detection of sugars	4	5
2.3	Detection of haemoglobin	2	5

2.4	Detection of ketone bodies	2	5
2.5	Detection of bile pigments or bile salts	2	5
2.6	Detection of bile salts	2	5

REFERENCE

- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8, p: p 81-126.
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p: 15 – 109.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed.), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p: 49- 181, 184 – 255.

SEMESTER V				
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Credits**
BY1815105	Anatomy, Reproductive botany, Microtechniques	Core Botany -6	3	3
BY1815605	Anatomy, Reproductive botany, Microtechniques	Core Botany -6 Practical	2	1
BY1815107	Plant Physiology & Biochemistry	Core Botany -7	3	3
BY1815607	Plant Physiology & Biochemistry	Core Botany -7 Practical	2.5	1
BY1815108	Environmental sciences and Human Rights	Core Botany -8	3	3
BY1815608	Environmental sciences and Human Rights	Core Botany -8 Practical	2	1
BT1815108	Applied Molecular Biology	Core Biotechnology -8	3	3
BT1815608	Applied Molecular Biology	Core Biotechnology -8 Practical	2.5	1
BT1815401	Ecotourism	Open	4	3
BT1815801	OJT (on the job training)	Core Biotechnology		1
	Total		**25**	**20**

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; 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**	**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**	**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**	**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**	**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**	**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**	
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**	**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 (*Polygonum* type).	01	3
7.4	Types of Embryo sac- Bisporic (*Allium* type).	01	3
7.5	Types of Embryo sac- Tetrasporic (*Peperomia* type).	01	3
8.0	**FERTILIZATION**	**02**	
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**	

9.1	Endosperm: Types– Cellular, Nuclear and Helobial.	01	4
9.2	Embryogeny,Structureof Dicot and Monocot Embryo.	01	4
9.3	Seed Formation.	01	4
9.4	Polyembryony.	01	4
MICROTECHNIQUE			
10.0	**PRESERVATION OF PLANT SPECIMENS, SECTIONING AND MOUNTING**	**09**	
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

- BhojwaniSS, Bhatnagar SP, 2011.The Embryology of Angiosperms (VEdn).Vikas Publishing House, Delhi.
- Coutler EG, 1969. *Plant Anatomy-Part 1: Cells and Tissues*. Edward Arnold, London.
- DickinsonW C, 2000.Integrative Plant Anatomy. Harcort Acdemic Press, USA.
- EasuK, 1977. *Anatomy of seed plants* (IIEdn). Wiley Eastern, New York.
- Fahn A, 1982. *Plant Anatom y*(IIIEdn). Pergamon Press, Oxford.
- Johnson D A, 1940.*Plant Microtechnique*, Mc Graw Hill Co.,New York.
- JohriB M, 1984. Embryology of Angiosperms.Springer-Verlag.
- KhasimS M, 2002. Botanical Microtechnique: Principles and Practice. Capital Publishing Company, NewDelhi.
- MaheshwariP, 1971. *An ntroduction to the Embryology of Angiosperms*. Tata Mc Graw Hill Publishing Company Ltd., NewDelhi.
- Pandey BP, 2015.Plant Anatomy. S Chand Publ.,NewDelhi.
- PatkiL R, BL Bhalchandra, IH Jeevaji,1983. An Introduction to microtechnique. S Chand&Co.
- Prasad MK, Krishna Prasad M, 1986. Outlines of microtechnique. Emkay Publishers, NewDelhi.
- Raghavan V, 2000. Developmental biology of flowering plants.Springer,Netherlands.
- Shivanna KR, 2003. Pollen Biologyand Biotechnology. Oxford and IBH, Delhi.
- Vashista P C, 1984. *Plant Anatomy.* Pradeep publication, Jalandhar.

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

Module	Course Description	Hrs	CO.No.
11	**PRACTICALS**	**36**	
	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 *Begonia* stem, *Boerhaavia* stem, *Dracaena* stem	3	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 (Cordate)	2	3
2.3	Identification of Anther types –Monothecous, Dithecous	1	3

2.4	Identify the different types of ovules	2	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

- BhojwaniSS, Bhatnagar SP, 2011.The Embryology of Angiosperms (VEdn).Vikas Publishing House, Delhi.
- Coutler EG, 1969. *Plant Anatomy-Part 1: Cells and Tissues*. Edward Arnold, London.
- DickinsonW C, 2000.Integrative Plant Anatomy. Harcort Acdemic Press, USA.
- EasuK, 1977. *Anatomy of seed plants* (IIEdn). Wiley Eastern, New York.
- Fahn A, 1982. *Plant Anatom y*(IIIEdn). Pergamon Press, Oxford.
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- JohriB M, 1984. Embryology of Angiosperms.Springer-Verlag.
- KhasimS M, 2002. Botanical Microtechnique: Principles and Practice. Capital Publishing Company, NewDelhi.
- MaheshwariP, 1971. *An ntroduction to the Embryology of Angiosperms*. Tata Mc Graw Hill Publishing Company Ltd., NewDelhi.

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 Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
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; 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 -	1	3

	physiological effect and practical application		
3.3	Plant hormones- ABA & ethylene - physiological effect and practical application	1	3
3.4	Plant movements: : tropic movements – geotropism and phototropism; nastic movements – seismonasticand nyctinastic movements	1	2
3.5	Physiology of flowering- phytochrome, Photoperiodism and vernalization	1	2
4.0	**STRESS PHYSIOLOGY**	**2**	
4.1	Conceptsofplantresponsestoabioticstresses(water,salt,temperature), bioticstress (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
6.0	**RESPIRATION**	**8**	
6.1	Respiration: Anaerobic and Aerobic	1	3
6.2	Glycolysis	1	3
6.3	Kreb'scycle	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

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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 Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	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; 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	Separationof plant pigments byTLC/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
1.6	DEMONSTRATION EXPERIMENTS	16	
1.7	Papaya petiole osmoscope.	2	2
1.8	Demonstration of tissue tension.	2	2
1.9	Relation between transpiration and absorption.	2	2
1.10	Necessity of chlorophyll, light and CO_2 in photosynthesis.	2	2
1.11	Simple respiroscope.	2	2
1.12	Respirometer and measurementof RQ.	2	2

1.13	Fermentation.	2	2
1.14	Measurement of transpiration rate using Ganong's potometer/Farmer's potometer.	2	2
	BIOCHEMISTRY EXPERIMENTS	**10**	
2.1	General test for carbohydrates – Molisch's test, Benedicts'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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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; 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	Biogeograhical 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, protocooperation, 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

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Environmental Science

- Clark. R.S. Marine Pollution, Clanderson Press Oxford.
- Cunningham, W.P. Cooper, T.H. Gorhani, Hepworth. M.T (2001). Environmental Encyclopedia, Jaico Publ. House. Mumbai. 1196p.
- Cormondy E.J (1985). Concepts of Ecology. Prentice Hall of India, New Delhi.
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Human Rights

- Amartya Sen (2009). The Idea Justice, New Delhi: Penguin Books, 2009.
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- Odum. E.P (1971). Fundamentals of Ecology. W.B. Saunders Co. USA 574p

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- Chatrath, K. J.S (1998) Education for Human Rights and Democracy
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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; 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 Coliform bacteria in water samples.	4	2,5
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

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Course	Details			
Code	BT1815108			
Title	**APPLIED MOLECULAR BIOLOGY**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**3/V**			
Type	**Core Course**			
Credits	**3**	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Identify the basic concepts of structural and functional aspects of genome and the omics techniques for possible application	**U**	**1**
2	Recall and differentiate the various applications of PCR and Molecular markers	**AP**	**2**
3	Recall and explain the techniques, underlying theory and applications of these advanced techniques in cancer, genetic disorders and related pathophysiology	**AP**	**2**
4	Recall and identify working principle and applications of various immunoassays and immuno-techniques in disease diagnosis	**AP**	**3**
5	Reproduce and design an experiment with step-by-step instructions to address a research problem or diagnostic situation	**C**	**6**

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Structural and functional aspects of genome:**	**12**	
1.1	Chromosomes	1	1
1.2	Packing of DNA, histones, Nucleosome model	2	1
1.3	Genome and gene	1	1
1.4	Introns and exons; pseudogenes	2	1
1.5	Repetitive DNA- tandem repeats	2	1
1.6	satellite DNA	1	1
1.7	Introduction to human genome project	1	1
1.8	Basic concepts of genomics, proteomics and	2	1

	metabolomics		
2.0	**Methods in Molecular Biology**	**18**	
2.1	DNA sequencing: Sanger's dideoxy method	2	2
2.2	Working of automated DNA sequencer	2	2
2.3	Working of automated nucleic acid synthesizer, Polymerase chain reaction: Isolation of Nucleic Acids for PCR Amplification	1	2
2.4	Primer Design, Components and Conditions for PCR Optimization	2	2
2.5	*Types of PCR*: Symmetric PCR, Asymmetric PCR, Inverse PCR, Anchored PCR, RT-PCR, RT-PCR.	3	2
2.6	*Applications of PCR*: RAPD, RFLP, AFLP, SNPs	3	2
2.7	DNA finger printing and DNA foot printing.	3	2
2.8	Nucleic acid hybridisation techniques.	3	2
3.0	**Molecular diagnostic techniques**	**14**	
3.1	Mutation analysis; detection of genetic disorders	3	3
3.2	Cancer cytogenetics; detection of biomarkers	3	3
3.3	Lab on a chip- Microarray techniques	2	3
3.4	Assays based on proteins and enzymes	3	3
3.5	Proteomics and mass spectroscopy- MALDI- TOF	3	3
4.0	**Enzyme Immunoassays**	**10**	
4.1	Enzymes available for enzyme immunoassays	1	4
4.2	Conjugation of enzymes; Solid phases used in enzyme immunoassays.	2	4
4.3	Enzyme immunoassays and immuno blotting techniques	2	4
4.4	Immunodiagnostic tests.	2	4
4.5	Use of polyclonal or monoclonal antibodies in enzymes immuno assays	2	4
4.6	Applications of enzyme immunoassays in diagnostic microbiology	1	4

Reference

- Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
- Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
- Molecular Cloning: a Laboratory Manual. Sambrook J, Russel D W & Maniatis T. 2001, Cold Spring Harbour Laboratory Press.
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Course	Details			
Code	BT1815608			
Title	**APPLIED MOLECULAR BIOLOGY (Practical)**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**3/V**			
Type	**Core Course- Practical**			
Credits	**1**	Hrs/week	2.5	Total hours: 45

Module	Course Description	Hrs	CO. No.
1	DNA Isolation/ Purification Methods	5	5
2	PCR Method: An overview • Assay design • Reaction component interactions • Troubleshooting • PCR amplification	5	5
3	Agarose gel electrophoresis and Photo-documentation	5	5
4	Demonstration of RAPD	5	5
5	Assay Design: An Overview • Define/ obtain target sequence • Primer design	5	5
6	DNA Sequence Analysis using online tools	5	5
7	ELISA	5	5
8	Radioimmunoassay	5	5
9	Laboratory Visit	5	5

REFERENCE

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- Molecular Diagnosis of Genetic Diseases, 2004. Editors: Elles, Rob (Ed.), Humana Press. ISBN 978-0-89603-932-2
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Course	Details			
Code	BT1815401			
Title	**ECOTOURISM**			
Degree	B.Sc			
Branch(s)	B.Sc BOTANY & Biotechnology (Double main)			
Year/Semester	3/V			
Type	OPEN COURSE			
Credits	3	Hrs/week	4	Total hours: 72

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Describe the concept, principles & relevance of ecotourism	U	4
2	Categorize various ecotourism types	An	4
3	Justify ecotourism as a means of sustainable tourism and recreation	E	4
4	Recognize the importance of eco-places and do's and don'ts in ecotravel	R	4
5	Outline ecotourism industry, stake holders, ecotourism activities, ecotourism resources, conservation enterprises and commercialization chain	U	4
6	List major ecosystems, ecoregions, vegetation types and endemic regions in India and Kerala	R	5
7	Describe the natural, cultural, monumental, archaeological, tribal resources in India and Kerala	U	5
8	Interpret the potential of Kerala to develop ecotourism industry	E	5
9	Explain the steps involved in ecotourism project designing and implementation	U	5
10	Identify positive and negative sides of ecotourism	An	5
11	Evaluate the need for ecotourism certification and ecolabelling to prevent ecotoursim"lite" activities	E	5
12	Relate the potential of community based ecotourism in ensuring livelihood security	U	5
13	Discuss the role of NGOs in ecotourism and capacity building	U	5
14	Design a travel brochure for an ecotourism destination	C	5

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Introduction to Ecotourism and its principles**	**17**	
1.1	Ecotourism-Definition, concept & introduction	1	1
1.2	History, Relevance and Scope of Ecotourism	2	1
1.3	Key principles and characteristics of ecotourism: Nature area focus &interpretation, environmental sustainability practice.	2	1,3
1.4	Key principles and characteristics of ecotourism : contribution to conservation, culture respect & benefits to local communities,	2	1
1.5	Key principles and characteristics of ecotourism: customer satisfaction & responsible marketing.	2	1
1.6	Understanding Nature tourism with case study	1	2
1.7	Understanding Agro-ecotourism	1	2
1.8	Understanding Geotourism sites	1	2
1.9	Understanding Cultural tourism attractions	1	2
1.10	Sustainable tourism and its principles for sustainable development	2	1,2,3
1.11	Formative assessment: Group discussion1- Ecotourism is different from mass tourism in its principles and practices	1	1,3
1.12	Formative assessment: Interactive writing 1- Ecotourism links recreation and sustainability	1	1,2,3
2.0	**Components of Ecotourism**	**14**	
2.1	Eco-places and Eco travel	1	4, 14
2.2	Do's & Dont's in eco-travel &Environmental awareness through ecotourism	2	4, 14
2.3	Ecotourism industry & Case studies	2	5
2.4	Stake holders in ecotourism industry	1	5
2.5	Role of Local people & their cultural diversity in ecotourism	1	5
2.6	Ecotourism activities	1	5
2.7	Ecotourism product, ecotourism resources, ecotourism services	2	5
2.8	Commercialization chain	1	5
2.9	Conservation enterprises	1	5
2.10	Formative assessment: Group discussion 2 : Role of various stake holders in ecotourism industry	1	5
2.11	Formative assessment: Test paper on Ecotourism concepts and components (Module I & II)	1	1-5
3.0	**Ecotourism resources in India and Kerala**	**18**	
3.1	Major ecosystems and vegetation types in India	1	6
3.2	Eco-regions, Endemism & Biodiversity hotspots	1	6
3.3	National parks, bird sanctuaries , wildlife sanctuaries, marine parks & biosphere reserves	2	6,7
3.4	Historical monuments, archaeological sites museums & temples	1	7
3.5	Tourism festivals and events	1	7
3.6	Famous hill stations, mountains, waterfalls, rivers, beaches & sacred groves	2	7
3.7	Adventure tourism destinations & adventure sports	1	7

3.8	Tribal areas, museums, arts ,handicrafts & traditional knowledge	2	7
3.9	Potential of ecotourism development in Kerala	1	8
3.10	Ecotourism destinations in Kerala	2	8
3.11	Seminars- Narrative descriptions of famous destinations	2	7
3.12	Formative assessment: Quiz 1 (Multiple choice)- Biodiversity and Conservation	1	6
3.13	Formative assessment: Quiz 2 (Multiple choice)- Ecotourism resources in Kerala	1	8
4.0	**Ecotourism Planning**	**16**	
4.1	Ecotourism planning process phases-objectives, site diagnostics	2	9
4.2	Stake holders involved and Funding options in ecotourism planning and management	1	9
4.3	Identifying target groups & designing ecotourism activities	1	9
4.4	Identifying benefits and beneficiaries & Capacity building in ecotourism	1	9
4.5	Ecotourism linkages, economics and auditing	2	9
4.6	Ecotourism management issues and development of Ecotourism management plan	1	9
4.7	Understanding Carrying capacity of ecotourism, strength and weakness	1	9
4.8	Positive and negative impacts of ecotourism	1	10
4.9	Leakages, ecotourism- lite operations & green washing	2	10,11
4.10	Green Report card, Ecolabelling &Ecotourism certification	2	11
4.11	Formative assessment: Interactive writing 2: Planning an ecotourism project	1	9
4.12	Formative assessment: Group discussion 3 : Impacts of ecotourism	1	10,11
5.0	**Ecotourism and Livelihood security**	**7**	
5.1	Community based ecotourism case studies	2	12
5.2	Role of community in biodiversity conservation development- JFM, EDCs, VSS	1	12
5.3	Role of NGOs in ecotourism and capacity building with case studies	2	13
5.4	Formative assessment: Group discussion 4: Ecotourism as an aid to livelihood enhancement	1	12
5.5	Formative assessment: Reciprocal questioning 1: Module I-V	1	1-13

Text Books for Reference

- Bhatacharya, A.K. (2005).Ecotourism and Livelihoods. Concept Publishing company, NewDelhi. ISBN:8180691748
- Page , S. J., & Dowling, R. K. (2002). Ecotourism. Prentice Hall, Pearson Education, Harlow. ISBN: 058235658X (pbk).

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- Weaver, D. (2008). Ecotourism, John Wiley & Sons, Milton.2nd edition, ISBN: 978-0470813041.

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- Bata, A.(2000).Tourism and environment. Indus Publishing Co.,New Delhi
- Wearing, S. and Neil, j. (2009). Ecotourism: Impacts, Potentials and Possibilities, 2nd edition, Butterworth-Heinemann, Oxford, ISBN: 978-0-7506-6249-9
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SEMESTER VI				
Course Code	**Title of the Course**	**Course Category**	**Hours/ week**	**Credits**
BY1816109	Genetics, Plant Breeding and Horticulture	Core Botany -9	3	3
BY1816609	Genetics, Plant Breeding and Horticulture	Core Botany -9 Practical	2.5	1
BY1816111	Angiosperm Morphology, Taxonomy & Economic Botany	Core Botany -10	4	3
BY1816611	Angiosperm Morphology, Taxonomy & Economic Botany	Core Botany -10 Practical	2.5	1
BT1816109	Recombinant DNA Technology	Core Biotechnology -9	3	3
BT1816609	Recombinant DNA Technology	Core Biotechnology -9 Practical	2	1
BT1816110	Bioinformatics	Core Biotechnology -10	3	3
BT1816610	Bioinformatics	Core Biotechnology -10 Practical	2	1
BT1816301	Phytochemistry & Pharmacognosy	Elective	3	3
BT1816802	Investigatory project work done individually or in groups	Project - Core Biotechnology -11		3
		Total	**25**	**22**

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; 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 ascience: origin – experiments of Mendel with *Pisum sativum*	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 - *Mirabilis*	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-	1	1

	sterilityin *Nicotiana*.		
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 (*Melandrium album*)	1	2
4.4	X – linked - Morgan's experiment e.g. eye colour in *Dorsophila*, 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-chromosomalinheritance: 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 *Paramecium*.	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,	1	5

	genetics of heterosis and inbreeding depression.		
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	1	9

	method of bonsai formation.		
16.5	Plant growing structures: green house, orchidarium, conservatory	1	9
16.6	Potting mixture – components	1	9

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- Adams CR, Bamford KM, Early MP, 2004. *Principles of Horticulture* (V Edn). Elsevier, Linacre House, Jordan Hill, Oxford OX28DP, UK.
- Edmond JB, Senn TL, Andrews FS, Halfacre PG, 1975. *Fundamentals of Horticulture* (IV Edn).TMHN, Delhi.
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- Randhawa G S, Mukhopadhyay A, 1986. *Floriculture in India*. Allied Publishers Pvt. Ltd. Ahmedabad.
- Sadhu MK, 1989. *Plant propagation*. New age international publishers, N. Delhi.
- Schilletter JC, Richey HW, 2005. *Text Book of General Horticulture*. Biotech Books, New Delhi.
- Shukla RS, Chandel PS, 2004. *Cytogenetics Evolution and Plantbreeding*. S. Chand &Co. Ltd. New Delhi.
- West R, 1999. *Practical Gardening InIndia*. Discovery Pub. House, New Delhi.
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- Swanson CP, 1957. Cytology and Genetics. Englewood cliffs, New York.
- Raven PH, Johnson GB, Losos JB, Singer SR, 2005. *Biology* (VII Edn). Tata Mc Graw-Hill, New Delhi.

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

Module	Course Description	Hrs	CO.No.
.0	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
	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

- Adams CR, Bamford KM, Early MP, 2004. *Principles of Horticulture* (V Edn). Elsevier, Linacre House, Jordan Hill, Oxford OX28DP, UK.
- Edmond JB, Senn TL, Andrews FS, Halfacre PG, 1975. *Fundamentals of Horticulture* (IV Edn).TMHN, Delhi.
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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 (T)	Hrs/week	4	Total hrs	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	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; 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, spike, spadix, head and catkin	1	1
1.9	Cymose types-simple cyme; monochasial – scorpoid and helicoid, dichasial and polychasial	1	1
1.10	Special type - cyathium, hypanthodium, verticillaster, thyrsus and panicle	1	1

1.11	Fruits: simple - fleshy	1	1
1.12	Dry-dehiscent, schizocarpic, indehiscent	1	1
1.13	Aggregate, multiple (sorosis 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-Caesalpiniaceae	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

REFERENCES

- Ashok Bendra and Ashok Kumar, 1980. Economic botany, Rastogi publications, Meerut.
- Cornquist A, 1968.The evolution and Classification of Flowering Plants.
- Davis PH and Heywood VH, 1967. Principles of Angiosperm Taxonomy. Oliver and Boyl, Edinburgh.
- Eames AJ, 1961.Morphology of Angiosperms. Mc GrawHill, NewYork.
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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* *Upon completion of this course, the students will be able to*:	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

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, hespiridium. 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 the guidance of a teacher and submit field report.	2	1
1.8	Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphologyof 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

REFERENCES

- Ashok Bendra and Ashok Kumar, 1980. Economic botany, Rastogi publications, Meerut.
- Cornquist A, 1968.The evolution and Classification of Flowering Plants.
- Davis PH and Heywood VH, 1967. Principles of Angiosperm Taxonomy. Oliver and Boyl, Edinburgh.
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Course	Details			
Code	BT1816109			
Title	**RECOMBINANT DNA TECHNOLOGY**			
Degree	B.Sc			
Branch(s)	B.Sc BOTANY & Biotechnology (Double main)			
Year/Semester	3/VI			
Type	CORE COURSE			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Outline the concept of gene cloning	U	1
2	Describe various laboratory protocols for isolation and purification of genomic DNA, RNA & plasmid	U	3
3	Determine the concentration and purity of nucleic acids using UV spectrophotometry	Ap	3
4	Compare different electrophoresis techniques	U	3
5	Demonstrate agarose gel electrophoresis	Ap	3
6	Describe the principles of nucleic acid hybridization techniques- Southern blot hybridization, Northern blot hybridization and insitu hybridization	U	3
7	Design a workflow to carry out recombinant DNA technology experiment	C	3
8	Discuss various cloning vectors-plasmid derived vectors, bacteriophage derived vectors hybrid vectors & high capacity vectors with suitable examples	U	3
9	Analyse enzymes used in recombinant technology	An	1
10	Explain various methods for obtaining a target gene for cloning	U	3
11	Describe various gene transfer techniques, bacterial transformation and screening of transformants.	U	3
12	Explain transgenics, antisense technology, RNAi technology and gene knock-out models	U	3
13	Summarize applications of rDNA technology	U	5
14	Evaluate the ethical, social and legal issues associated with recombinant technology	An	5

*****PSO- Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO. No.
1.0	**Isolation of Nucleic Acids**	**10**	
1.1	Introduction to gene cloning.	1	1
1.2	Basics of nucleic acid isolation: Lysis Buffers, DNase inhibitors, Protein removal by Kirby method and Marmur method; RNA removal.	2	2
1.3	Methods for concentrating DNA-ethanol or isopropanol precipitation & storage of nucleic acid samples	1	2
1.4	Protocols for Preparation of genomic DNA from bacterial cells	1	2
1.5	Protocols for Preparation of genomic DNA from animal cells & plant cells	1	2
1.6	Determination of the concentration and purity of DNA using UV spectrophotometry	1	3
1.7	Isolation of plasmid DNA	1	2
1.8	Isolation of RNA; Purification of total RNA: guanidinium hot phenol method, high salt lithium chloride method	2	2
2.0	**Nucleic acid analysis**	**14**	
2.1	Principle and application of electrophoresis technique	1	4
2.2	Principle and procedure of Agarose gel electrophoresis of DNA, gel staining, quantification of molecular weight using molecular size markers.	2	4,5
2.3	Elution of DNA from agarose gels, electro elution	1	5
2.4	Electrophoresis of RNA-special precautions and treatments required	1	4
2.5	Principles of Nucleic acid transfer and hybridization & applications	1	6
2.6	Blotting techniques-Southern blot transfer, Northern blot transfer	2	6
2.7	Blotting techniques -dot-blot transfer, plaque and colony transfer	1	6
2.8	Preparation of probes for hybridization, radioactive labeling	1	6
2.9	Southern blot hybridization	1	6
2.10	Northern blot hybridization	1	6
2.11	Plaque and colony hybridization	1	6
2.12	In situ hybridization principle and procedure	1	6
3.0	**Principles of gene cloning**	**22**	
3.1	Principle and general workflow in gene cloning	1	7
3.2	Cloning vectors; essential features of a cloning vector	1	8
3.3	Plasmid derived vectors	1	8
3.4	Bacteriophage derived vectors	1	8
3.5	Hybrid vectors	1	8
3.6	High capacity cloning vectors- BACs, PACs and YACs	1	8

3.7	Agrobacterium based vectors	1	8
3.8	Shuttle vectors	1	8
3.9	Expression vectors	1	8
3.10	Principal enzymes in recombinant DNA technology; type II restriction endonucleases.	1	9
3.11	Enzymes used in recombinant DNA technology; ligases, S1 nuclease, alkaline phosphatase, terminal transferase, DNA polymerase I, reverse transcriptase, exonuclease I, bacteriophages l exonuclease	1	9
3.12	Finding gene of interest: shotgun cloning followed by screening, construction and use of genomic DNA library and cDNA library, screening DNA libraries.	2	10
3.13	Finding gene of interest: chromosome walking, in silico gene discovery	1	10
3.14	Cloning of the gene of interest, Altering the gene of interest through site directed mutagenesis	1	1
3.15	Preparation of recombinant DNA molecule	1	1,7,10
3.16	Methods to transfer the recombinant DNA molecule into the cloning host; transformation, transfection, transduction,	1	11
3.17	Methods of gene transfer- electroporation, microinjection, micro projectiles and gene gun	1	11
3.18	Agrobacterium mediated gene transfer	1	11
3.19	Methods to select the recombinants; antibiotic markers, insertional inactivation, replica plating, blue- white selection	2	11
3.20	Methods to select the recombinants; use of reporter genes; GUS, luciferase and GFP genes	1	11
4.0	**GMOs and Applications**	**8**	
4.1	Transgenesis: introduction to transgenic organisms and their applications	1	12
4.2	Mechanism of gene transfer into eukaryotic cells	1	11
4.3	Examples of transgenic crop plants and animals	1	12,13
4.3	Antisense and RNAi technology	2	12
4.4	Production of knock out models and their use	1	12
4.5	Applications of recombinant DNA technology	1	13
4.6	Ethical, Social and legal issues associated with recombinant DNA technology.	1	14

Text Books for Reference

- Brown, T. A. (2016). Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell, 7th edn, ISBN:978-1-11907256-0
- Watson, J.D. (2006) Recombinant DNA: genes and genomes;a short course. WH Freeman &Co, 3rd edn. ISBN: 978-0716728665
- SambrookJ, RusselDW & Maniatis T. (2001). MolecularCloning: A Laboratory Manual. Cold Spring Harbour Laboratory Press.
- Glick, B.J., Pasternak, J.J. and Patten, C.L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th edn.
- Old, R.W. and Primrose, S.B.P. (2006). Principles of Gene Manipulation: An Introduction to Genetic Engineering, Blackwel Scientific, 6th edn.

Course	Details			
Code	BT1816609			
Title	**RECOMBINANT DNA TECHNOLOGY(Practical)**			
Degree	**B.Sc.**			
Branch(s)	**BOTANY & BIOTECHNOLOGY (Double core)**			
Year/Semester	**3/VI**			
Type	**Core course practical**			
Credits	**1**	Hrs/week	2	Total hours: 36

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to:	Cognitive Level	PSO No.
1	Apply learned protocols to perform genomic DNA and plasmid DNA isolation	Ap	1
2	Plan and conduct qualitative analysis of DNA by agarose electrophoresis	Ap	3
3	Predict the role of restriction enzymes in RFLP by in silico analysis	C	2
4	Analyze restriction digestion profile by conducting RFLP experiment	An	3
5	Design a bacterial transformation experiment	C	3

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Bacterial genomic DNA Isolation**	**6**	1
1.1	Autoclaving microtips, microcentrifuge tubes and water for DNA extraction	1	
1.2	Preparation of solutions for DNA isolation	1	
1.3	Performing protocol based isolation(Including various centrifugation and incubation steps)	4	
2.0	**Plasmid isolation**	**6**	1
2.1	Preparation of solutions for plasmid isolation	1	
2.2	Performing protocol based isolation (Including various centrifugation and incubation steps)	5	
3.0	**Agarose gel electrophoresis (AGE) and Photodocumetation**	**4**	2
3.1	Preparation of TBE buffer, staining dye, and Ethidium bromide stock soutions and working solutions	1	
3.2	Preparation of agarose gel, casting the gel and loading samples	1	
3.3	Running AGE and photodocumentation of DNA bands	2	
4.0	**Restriction digestion Analysis**	**6**	3 & 4
4.1	Practicing NEB cutter - a tool to cleave DNA using	2	

	restriction enzymes		
4.2	Selection of restriction enzymes and preparation of reaction buffer	1	
4.3	Performing restriction digestion by incubation step	1	
4.4	Perform gel electrophoresis to visualize the restriction digestion profile	2	
5.0	**Bacterial transformation experiment**	**14**	5
5.1	Competent *E.coli* cell preparation - Autoclaving, Preparation of strater culture, media preparation & inoculation (*overnight incubation) - Estimating mid phase growth by OD measurement & Harvesting cells by centrifugation - Competent cell preparation by treatment with $CaCl_2$ at 4^0C	2 1 1	
5.2	Perform Heatshock transformation of plasmid DNA into competent cells	2	
5.3	Culturing in SOC media for maximal transformation efficiency	2	
5.4	Selection of transformants -Growing cells on appropriate LB media with suitable agents for identification	4	
5.5	Examination of transformed colony and Calculation of transformation efficiency	2	

REFERENCE

- Molecular Cloning: a Laboratory Manual. Sambrook J, Russel D W & Maniatis T. 2001, Cold Spring Harbour Laboratory Press.
- Molecular Biology Techniques, 3rd Edition, 2011. A Classroom Laboratory

Course	Details			
Code	BT1816110			
Title	BIOINFORMATICS			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	3/VI			
Type	Core Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Describe the basic usage of computer and types of computer	U	1
2	Summarize Operating Systems and Computer Viruses	U	1
3	Explain about algorithm and programming and database concept.	U	1
4	Use MS office programs to create personal and academic documents.	Ap	6
5	Outline recent developments and application in the field of bioinformatics.	U	1
6	Apply online resources and databases to gain access to biological data and literature information.	Ap	2
7	Manipulate online and offline tools for sequence analysis and result.	Ap	2
8	Discuss the use and methods in phylogenetic analysis.	U	1
9	Construct a phylogenetic tree using biological sequence.	C	6
10	Demonstrate the key concepts for protein structure prediction and protein modelling.	U	1
11	Use major protein prediction tools and protein visualization tool.	Ap	2
12	Summarize the procedure of CADD and standard tools in CADD	U	1

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Introduction to Information Technology**	**10hr**	
1.1	Characteristics and parts of a computer	1	1
1.2	Types of computer	1	1
1.3	Operating systems	1	2
1.4	Computer Viruses	1	2
1.5	MS office: - MS word, Excel	1	4
1.6	MS Office:-Power Point and MS Access.	1	4
1.7	Concept of algorithm	1	3
1.8	Concept of programming	1	3
1.9	Databases-Introduction, Types of databases	1	3
1.10	Concept of Data Abstraction.	1	3
2.0	**An Introduction to Bioinformatics**	**15**	
2.1	Scope and relevance of bioinformatics	1	5
2.2	Application of bioinformatics	1	5
2.3	Genomics: Definition: Sequencing genes to sequencing genomes.	2	5
2.4	Sequence assembly	1	5
2.5	Major findings of the following genome projects: Human, Arabidopsis thaliana.	1	5
2.6	Major findings of the following genome projects: Drosophila melanogaster, Caenorhabditis elegans	1	5
2.7	Introduction to Biological Data bases	1	6
2.8	Bibliographic databases-PubMed,	1	6
2.9	Nucleic acid sequence databases: GenBank,	1	6
2.10	Protein sequence databases: Uniprot,	1	6
2.11	Protein structure database: Protein Data Bank	1	6
2.12	Specialised Databases,	1	6
2.13	Genome Database and Gene Expression Databases	1	6
2.14	Biological Data formats:- FASTA format, ASN.1 format, PDB flat file format, mmCIF format	1	6
3.0	**Sequence alignment**	**15**	
3.1	Intoduction to Sequence comparison	1	7
3.2	Pair wise sequence alignment	2	7
3.3	Global alignment and Local alignment.	1	7
3.4	Use of BLAST	2	7
3.5	Use of FASTA	1	7
3.6	Multiple sequence alignment	2	8
3.7	Use of Clustal W	1	9
3.8	Phylogenetic analysis	4	8
3.9	Use of PHYLIP	1	9
4.0	**Molecular visualization tools**	**14**	
4.1	Introduction to Structure visualization	1	11
4.2	Molecular structure viewers: RasMol and SWISS-PDB Viewer	2	11
4.3	Predicting protein structure	2	10

4.4	Predicting protein function from sequence	2	10
4.5	Protein modeling	2	10
4.6	Molecular Docking	2	12
4.7	Drug discovery	3	12

Text Books for Reference

- C. A. Orengo, D.T. Jones and J. M. Thornton, Bioinformatics- Genes, Proteins and Computers, Taylor & Francis Publishers.
- Dan E. Krane and Michael L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education.
- Claverie&Notredame, Bioinformatics - A Beginners Guide, Wiley-Dreamtech India Pvt Ltd.
- Lesk, Introduction to Bioinformatics, Oxford University Press.
- Rastogi et. al., Bioinformatics: Methods and Applications, Prentice Hall of India.

Text Books for Enrichment

- Jiang, Xu and Zhang, Current topics in Computational Molecular Biology, Ane Books.
- D. Mount, Bioinformatics: Sequence & Genome Analysis, Cold spring Harbor press

Course	Details			
Code	BT1816610			
Title	BIOINFORMATICS (Practical)			
Degree	B.Sc.			
Branch(s)	BOTANY & BIOTECHNOLOGY (Double core)			
Year/Semester	3/VI			
Type	Core Course			
Credits	1	Hrs/week	2	Total hours: 36

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Apply MS-Office Tools for creating academic data.	Ap	6
2	Use bioinformatics databases on the internet for mining data.	An	2
3	Compare similarity of species using sequence analysis.	An	2
4	Construct a phylogenetic tree for different species	C	6
5	Predict the molecular structure of protein and visualize that in rasmol tool	C	6

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**MS OFFICE**	**8**	
1.1	MS-Word	2	1
1.2	MS-Excel	2	1
1.3	MS-Power Point	2	1
1.4	MS-Access	2	1
2	**Familiarize with the various databases given in the syllabus**	**8**	
2.1	Primary Databases	2	2
2.2	Secondary Databases	2	2
2.3	Specialized Databases	2	2
2.4	Learn how to store the retrieved data	2	2
3	**Practice retrieving data from the various databases**	**2**	**2**
4	**Sequence Analysis**	**6**	
4.1	Familiarize sequence analysis tool	2	3
4.2	BLAST and FASTA tool	2	3
4.3	Practice the use of BLAST.	2	3

5	**Study Evolutionary Relationship**	**8**	
5.1	Introduction of methods in phylogeny	2	4
5.2	Familiarize different phylogenetic tools	2	4
5.3	Construct a phylogenetic tree using PHYLIP	2	4
5.4	Show Evolutionary tree with visualizing tool	2	4
6	**Familiarize Molecular Visualizing Tool**	**4**	
6.1	Practise RASMOL	2	5
6.2	Practise SwisspdbV	2	5

REFERENCES

- Rastogi et. al., Bioinformatics: Methods and Applications, Prentice Hall of India.
- Jeremy J. Ramsden, Bioinformatics: An Introduction, Springer.

Course	Details			
Code	BT1816301			
Title	PHYTOCHEMISTRY AND PHARMACOGNOSY			
Degree	B.Sc.			
Branch(s)	Botany and Biotechnology			
Year/Semester	3/VI			
Type	Elective Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	Expected Course Outcomes *Upon completion of this course, the students will be able to:*	Cognitive Level	PSO No.
1	Explain the morphological, organoleptic and microscopic analysis of medicinal plants	U	1
2	Investigate herbal drugs and new formulations	K	3
3	Explain different procedures for the extraction and separation of phytoconstituents in drug plants.	U	2
4	Distinguish drug plants and its adulterants	AP	5
5	Distinguish the starch grains of Maize, wheat, rice, potato and curcuma.	U	3
6	Classify various phytoconstituents according to their structure, function and uses.	AZ	6
7	Identify major medicinal plants, morphology and structure of useful part and their medicinal importance.	U	5
8	Explain the ingredients of important ayurvedic formulations.	AP	4
9	Identify major aromatic plants and explain methods of oil extraction.	U	6
10	Formulate and relate drug discovery based on ethnopharmacological approach.	C	6

*****PSO - Program Specific Outcome; R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Introduction to Phytochemistry and Pharmacognosy**	**4**	
1.1	Introduction to phytochemical approaches	1	1
1.2	Morphological, organoleptic, microscopic study of drug and aromatic plants	1	1
1.3	Herbal medicine and modern drug discovery	1	2
1.4	Identification of lead molecules	1	2
2.0	**Extraction and characterization techniques**	**12**	
2.1	Extraction and characterization techniques	1	3
2.2	Cold extraction, hot extraction, Soxhlet apparatus	1	3
2.3	Clevenger apparatus	1	3
2.4	Solvents : Petroleum ether, chloroform, ethanol, water	1	3
2.5	Separation techniques : TLC, column, HPLC	1	3
2.6	Characterization techniques : GC/MS, HPTLC	1	3
2.7	UV Spectra, IR Spectra.	1	3
2.8	Tools for identifying adulteration in herbal drugs	1	4
2.9	Methods in pharmacognosy	1	4
2.10	Microscopy	1	4
2.11	Phytochemical methods	1	4
2.12	Study of starch grains of maize, wheat, rice, potato and *Curcuma*	1	5
3.0	**Major phytochemical classes**	**10**	
3.1	Study of drug plants and their active principles	1	6
3.2	Alkaloids – introduction, properties, occurrence	1	6
3.3	Alkaloids –structure, classification and functions	1	6
3.4	Alkaloids – pharmacological uses	1	6
3.5	Triterpenoids – introduction, properties, occurrence	1	6
3.6	Triterpenoids – classification and functions	1	6
3.7	Triterpenoids – pharmacological uses	1	6
3.8	Phenolics	1	6
3.9	Quinines – benzoquinones, napthoquinones	1	6
3.10	Anthraquinones and coumarins	1	6

4.0	**Medicinal plants and their uses**	**20**	
4.1	Study of medicinal plants with special reference to habit, habitat, systematic position and morphology of useful part	1	7
4.2	Organoleptic, anatomical and chemical evaluation of officinal part	1	7
4.3	Phytochemistry and major pharmacological action of plant drugs	1	7
4.4	Ayurvedic formulations made using the plant	1	8
4.5	*Tinospora cordifolia, Papaver somniferum*	1	7
4.6	*Aegle marmelos, Punica granatum*	1	7
4.7	*Adhatoda vasica, Withania somnifera*	1	7
4.8	*Achyranthes aspera, Asparagus racemosus*	1	7
4.9	*Sida acuta, Carica papaya*	1	7
4.10	*Azadirachta indica, Phyllanthus niruri*	1	7
4.11	*Datura stramonium, Aloe vera*	1	7
4.12	*Tylophora indica,, Acorus calamus*	1	7
4.13	Study of aromatic plants, volatile oils	1	9
4.14	Methods of extraction of volatile oils	1	9
4.15	*Vetiveria zizanoides, Cinnamomum zeylanicum*	1	9
4.16	*Syzygium aromaticum, Santalum album*	1	9
4.17	*Eucalyptus globulus, Ocimum basilicum*	1	9
4.18	*Rosa indica, Mentha piperita*	1	9
4.19	*Cympopogon citratus, Cananga odorata*	1	9
4.20	*Pelargonium graveolens*	1	9
5.0	**Ethnomedicine and pharmacognosy**	**8**	
5.1	Traditional plant medicines	1	10
5.2	Traditional plant medicines as a source of new drugs	1	10
5.3	The process of modern drug discovery using ethnopharmacology	1	10
5.4	Examples of drug discovery based on ethnopharmacological approach	1	10
5.5	Taxol	1	10
5.6	Artemisinin	1	10
5.7	Galathaminean	1	10
5.8	Flavopyridoleas	1	10

Text Books for Reference

- Ashutosh Kar, 2006. Pharmacognosy and Pharmacobiotechnology. New Age International, New Delhi.
- Daniel, M., 1991. Methods in Plant chemistry and Economic Botany. Kalyani publishers, New Delhi.

- Glossary of Indian Medicinal Plants with Active Principles Part I & II, 1980. CSIR, New Delhi.
- Indian Medicinal Plants (5Vols)1994. Arya Vaidya Sala, Kottackal, Orient Longman, New Delhi.
- Irfan Ali Khan, 2008. Medicinal and Aromatic plants of India. Ukaaz Publishers, Hyderabad.

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- Atal, C.K. and Kapur, B.M.,1982. Cultivation and Utilization of Medicinal plants.
- Bhattacharjee, S.K., 2003. Hand Book of Medicinal Plants. Pointer Publishers, Jaipur.
- Krishnaswamy, N. R., 2003. Chemistry of Natural Products. Universities press, Hyderabad
- Trease and Evans, 2002. Pharmacognosy, W.B. Saunders Co. Ltd.