Foundation Courses, Core Courses, Complementary Courses. Open Courses and Elective Courses

2015

Aim and Objective

The Career related first degree programme in Group 2(b) Biotechnology as one of the core subjects is designed to develop a scientific attitude and an interest towards the modern areas of biotechnology in particular and life science in general. It will help the students to become critical and curious in their outlook. The courses are designed to impart the essential basics in chemistry, Botany, Zoology and Biotechnology. There are two foundation courses, one is focused on the modern information technology, statistics and its application in modern life sciences, and a general introduction and awareness on Biotechnology and its influence in human life.

The various courses in the programme is aimed to develop proficiency in the theory as well as practical experiments, common equipments, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. In addition to this, the students will be equipped with knowledge in the modern areas of biotechnology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nanobiotechnology etc. Apart from understanding biotechnology and its power in developing the nation, it will create awareness about biotechnology and will help in eliminating public fear about the contribution of biotechnology and confusion on GM crops, GM foods and transgenic organisms. Students, who pursue this programme and pass out successfully, will surely have an urge to continue higher studies in Biotechnology and contribute significantly in its development.

The total minimum credits of the programme is 120 and the various courses and its corresponding credits are depicted in the following table.

Summary of Courses

Botany / Zoology, Chemistry and Biotechnology Under CBCSS

	Study Components		No. of course	Credits/ course		Max/ Total Credits
1	**Languages**					
	1	**English**	**2**	**2**		**4**
2	**Foundation Course**		**2**	**2**		
	1	Methodology and Perspective of Biotechnology		3		**5**
	2	Biophysics and Instrumentation		2		
3	**Complementary Courses (Botany / Zoology)**		**4**	**3**		**12**
	Botany			**T**	**P**	
	1	Phycology, Mycology, Lichenology, Bryology Pteridology, Gymnosperms and Plant Pathology		3		
	2	Plant Physiology, Angiosperm Anatomy & Reproductive Botany		3		
	3	Angiosperm Morphology and Systematic Botany		3		
	4	Practical COM II (Practical of 1, 2 & 3)			3	

	Study Components		No. of course	Credits/ course		Max/ Total Credits
	Zoology					
	1	Animal Diversity- Non-Chordata & Chordata		3		
	2	Animal Physiology, & Anatomy		3		
	3	Developmental Biology, Human Genetics & Applied Zoology		3		
	4	Practical COM II(Practical of 1, 2 & 3)			3	
4	**Core Courses (Botany / Zoology , Chemistry & Biotechnology)**		**32**	**2-4**		**90**
	Botany		**12**	**2-4**		31
				L	**P**	
	1	Phycology, Mycology, Lichenology & Plant Pathology		2		
	2	Environmental Studies		4		
	3	Practical Botany-I (Practical of 1& 2)			2	
	4	Angiosperm Anatomy, Reproductive Botany and Palynology		3		
	5	Bryology, Pteridology , Gymnosperms & Paleobotany		2		
	6	Plant Physiology		2		
	7	Cell Biology , Plant breeding & Evolutionary Biology		2		
	8	Practical Botany-II (Practical of 4,5,6&7)			2	
	9	Angiosperm Morphology & Systematic Botany,		4		
	10	Economic Botany, Ethnobotany & Pharmacognosy		3		
	11	Genetics		2		
	12	Practical Botany-III (Practical of 9,10 & 11)			3	
	Zoology		12			
	1	Animal Diversity I- Non-Chordata		2		
	2	Environmental Studies		4		
	3	Practical Zoology-I (Practical of 1& 2)			2	
	4	Developmental Biology & Reproductive Biology		3		
	5	Animal Diversity II- Chordata		2		
	6	Animal Physiology		2		
	7	Cell Biology		2		
	8	Practical Zoology-II (Practical of 4,5,6&7)			2	
	9	Systematics, Biodiversity & Animal Behaviour		3		
	10	Genetics		4		
	11	Evolution		2		
	12	Practical Zoology-III (Practical of 9,10 & 11)			3	

	Study Components		No. of course	Credits/ course		Max/ Total Credits
	Chemistry		**9**	**2-4**		28
	1	Inorganic Chemistry-I	1	4		
	2	Inorganic Chemistry-II	1	3		
	3	Practical Chemistry –I (Practical of 1& 2)	1		2	
	4	Physical chemistry-I	1	4		
	5	Physical chemistry II	1		3	
	6	Practical Chemistry-II (Practical of 4& 5)	1	0	2	
	7	Organic chemistry-I	1	4	0	
	8	Organic chemistry-II	1	3	0	
	9	Practical Chemistry- III (Practical of 7 &8)	1	0	3	
	Biotechnology		**11**	**2-4**		**31**
	1	Biochemistry & Metabolism		4		
	2	Microbiology		2		
	3	Biotechniques –I (Practical of 1& 2)			2	
	4	Food and Industrial Biotechnology		4		
	5	Molecular Biology		4		
	6	Immunology		2		
	7	Recombinant DNA Technology		2		
	8	Biotechniques –II (Practical of 4,5,6 & 7)			2	
	9	Environmental Biotechnology		3		
	10	Plant Biotechnology and Animal Biotechnology		4		
	11	Biotechniques –III (Practical of 9,10 & 11)			2	
	Open Course (semester V)		**1**	**2**		**2**
5	**Elective Courses of Core (Semester VI)**		**1**	**2**		**2**
	Botany					
	1 2 3	Horticulture Mushroom cultivation & marketing Forestry (*One of the Three Elective Courses as per the syllabus of BSc Botany)*		2		
	Zoology					
	1	*One of the Three Elective Courses as per the syllabus of B.Sc. Zoology*		2		
	Biotechnology					
	Open (semester V) / Elective Courses (Semester VI)		**1**	**2**		2
	1	Bioinformatics/Bioinformatics and Nanobiotechnology		2		
	2	Food & Dairy Biotechnology		2		
	3	Genetic Engineering		2		
	4	Basics of Environmental Biotechnology		2		
6		**Project**				**3**
		Total Credits				**120**
	T- Theory			**P- Practical**		

Course structure and syllabus of Career Related First Degree in Biotechnology (2b) as per the regulations of CBCS

The Career related first degree programme in Group 2(b) Biotechnology as one of the core subjects, consists of a total of 57 courses distributed in six categories. They are Language courses, Foundation courses, Complementary courses, Core courses, Open course of core subjects, and a Project. The project is compulsory and the students may be assigned a topic for the project in the 5th semester itself and should be completed and submitted during the practical assessment at the end of VI semester.

There are two programmes within the group 2(b) of the career related First Degree Programme, which differ in one of the core subjects and complementary Courses. In one Programme one of the core subjects is Botany and its complementary courses will be from Zoology; and in the second programme one of the core subjects is Zoology and its Complentary courses are from Botany.

Each course title is represented by a course code consisting of a two letter subject code followed by four digits. The first digit indicates the first degree programme, which is always one. The second digit indicated the semester number which is 1-6, the 3rd digit denotes the category of the course which ranges from 1-6, since there are six categories and the last digit indicates the serial number of the course with in a semester. But in the case of Botany and Zoology, which are optional core courses, the course code consists of a 5th digit- .1 to denote the courses for optional botany and .2 for optional Zoology. The following are the category of courses included in this first degree programme of 2(b) group.

The subject code is BV (Biotechnology Vocational)

1 Language
2 Foundation course subject
3 Complementary courses
4 Core Courses
5 Open course
6 Elective course for Core
7. Project

CHOICE OF ELECTIVE COURSES

Students of Biotechnology should take up Two Internal Elective courses during the Sixth semester as given below:

First Elective (All students)

One Elective course from Biotechnology

Second Elective

(a) Students of Botany, Chemistry, Biotechnology: One elective course from Botany

(b) Students of Zoology, Chemistry, Biotechnology: One Elective course from Zoology

Note

To Govt. College Kariavattom, Thiruvananthapuram

Course BV1143 Biochemistry and Metabolism of Core subject Biotechnology may be handled by faculty from Biochemistry Department, in the Govt. College Kariavattom, as it has been handled by them previously. This is applicable only in the Govt.College, Kariavattom, Thiruvananthapuram.

ourse Structure

Biotechnology (Multimajor)

Botany, Chemistry & Biotechnology

Semester I

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
EN1111	English	2	36	2	3 Hrs.	20	80
BV1121	Methodology and Perspective of Biotechnology	4	72	3	3 Hrs.	20	80
BV1131.1	Animal Diversity- Non-Chordata & Chordata	3	54	3	3 Hrs.	20	80
BV1141.1	Phycology, Mycology, Lichenology & Plant Pathology	3	54	2	3 Hrs.	20	80
	Practical	2	36				
BV1142	Inorganic Chemistry-I	5	90	4	3 Hrs.	20	80
	Practical	2	36				
BV1143	Biochemistry & Metabolism	3	54	4	3 Hrs.	20	80
	Practical	6	108				
	Total	**30**	**540**	**18**			

Total Hrs: CH- 7, BO-8 (Core 5 + Compl. 3), BT- (BC) 9+4, EN-2 = 30

Semester II

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
EN1211	English	2	36	2	3 Hrs.	20	80
BV1221	Biophysics and Instrumentation	2	36	2	3 Hrs.	20	80
	Practical	1	18				
BV1231.1	Animal Physiology & Anatomy	3	54	3	3 Hrs.	20	80
BV1241.1	Environmental Studies	4	72	4	3 Hrs.	20	80
	Practical	2	36				
BV1242.1	**Practical Botany I (Practical of BV1141.1, BV1241.1)**			2	3 Hrs.	20	80
BV1243	Inorganic Chemistry –II	6	108	3	3 Hrs.	20	80
	Practical	3	54				
BV1244	**Practical Chemistry-I (Practical of BV1142 & BV1243)**			2	3 Hrs.	20	80
BV1245	Microbiology	4	72	2	3 Hrs.	20	80
	Practical	3	54				
BV1246	**Biotechniques-I (Practical of BV1143 & BV1245**			2	3 Hrs.	20	80
	Total	**30**	**540**	**22**			

Total Hrs: CH-9, BO- 9 (core 6 + compl. 3), BT- 10, EN-2= 30

Semester III

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1331.1	Developmental Biology, Human Genetics & Applied Zoology	3	54	3	3 Hrs.	20	BV1331.1
BV1341.1	Angiosperm Anatomy, Reproductive Botany and Palynology	2	36	3	3 Hrs.	20	BV1341.1
	Practical	2	36				
BV1342.1	Bryology, Pteridology , Gymnosperms & Paleobotany	2	36	2	3 Hrs.	20	BV1342.1
	Practical	1	18				
BV1343	Physical chemistry-I	7	126	4	3 Hrs.	20	BV1343
	Practical	3	54				
BV1344	Food and Industrial Biotechnology	3	54	4	3 Hrs.	20	BV1344
	Practical	2	36				
BV1345	Molecular Biology	3	54	4	3 Hrs.	20	BV1345
	Practical	2	36				
	Total	**30**	**540**	**20**			

Total Hrs: CH- 10, BO- 10 (core 7 + compl. 3), BT- 10, = 30

Semester IV

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1431.1	**Practical COMP** (Practical of BV1131.1, BV1231.1 &BV1331.1)	3	54	3	3 Hrs.	20	80
BV1441.1	Plant Physiology	3	54	2	3 Hrs.	20	80
	Practical	1	18				
BV1442.1	Cell Biology , Plant breeding & Evolutionary Biology	2	36	2	3 Hrs.	20	80
	Practical	1	18				
BV1443.1	**Practical Botany-II** (Practical of BV1341.1, BV1342.1, BV1441.1 & BV1442.1)			2	3 Hrs.	20	80
BV1444	Physical chemistry-II	7	126	3	3 Hrs.	20	80
	Practical	3	54				
BV1445	**Practical Chemistry II** (Practical of BV1343 & BV1444)			2	3 Hrs.	20	80
BV1446	Recombinant DNA Technology	3	54	2	3 Hrs	20	80
	Practical	2	36				
BV1447	Immunology	3	54	2	3 Hrs	20	80
	Practical	2	36				
BV1448	**Biotechniques II** (Practical of BV-1344, BV1345, BV1446 & BV1447)			2	3 Hrs.	20	80
		30	**540**	**20**			

Total Hrs: CH-10, BO- 10 (core 7 + compl. 3) , BT-10= 30

Semester V

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1431.1	**Practical COMP** (Practical of BV1131.1, BV1231.1 &BV1331.1)	3	54	3	3 Hrs.	20	80
BV1541.1	Angiosperm Morphology, Systematic Botany,	4	72	4	3 Hrs.	20	80
	Practical	2	36				
BV1542.1	Economic Botany, Ethnobotany & Pharmacognosy	3	54	3	3 Hrs.	20	80
	Practical	1	18				
BV1543	Organic chemistry-I	6	108	4	3 Hrs.	20	80
	Practical	4	72				
BV1544	Environmental Biotechnology	2	36	3	3 Hrs.	20	80
	Practical	1	18				
BV-1545	Plant Biotechnology & Animal Biotechnology	3	54	4	3 Hrs.	20	80
	Practical	1	18				
	OPEN COURSES (For non –Biotechnology students)						
BV1551	Bioinformatics	3	54	2	3 Hrs.	20	80
BV 1552	Food and Dairy Biotechnology						
BV 1553	Genetic Engineering						
BV 1554	Basics of Environmental Biotechnology (Any one course shall be offered as open course for non-Biotechnology students)						
	Total	**30**	**540**	**20**			

CH-10, BO- 10, BT-(7 +OC-3) – 10 = Total = 30

Semester VI

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1641.1	Genetics	5	90	2	3 Hrs.	20	BV1641.1
	Practical	2	36				
	ELECTIVE COURSE IN BOTANY (Any one out of the three courses)						
BV 1642.1	Horticulture						
BV 1643.1	Mushroom cultivation & Marketing						
BV 1644.1	Forestry	3	54	2	3 Hrs	20	BV 1642.1 BV 1643.1 BV 1644.1
BV1645.1	**Practical Botany III** (Practical of BV1541.1, BV1542.1 &BV1641.1)			3	3 Hrs.	20	BV1645.1
BV1646	Organic Chemistry-II	7	126	3	3 Hrs.	20	BV1646
	Practical	3	54				
BV1647	**Practical Chemistry-III** (Practical of BV1543 & BV1643)			3	3 Hrs.	20	BV1647

ELECTIVE COURSE IN BIOTECHNOLOGY (Any one out of the three courses)

BV1648	Bioinformatics & Nano						BV1648
BV1649	Biotechnology						BV1649
BV1650	Food and Dairy Biotechnology Genetic Engineering	3	54	2	3 Hrs.	20	BV1650
BV1651	Biotechniques III (Practical of BV1544 & BV1545)	2	36	2	3 Hrs.	20	BV1651
BV1652	Project	5	90	3	Viva-voce	20	BV1652
	Total	**30**	**540**	**20**			

CH-10, BO- 10, BT- 10 (5+ Project-5) = 30

Course Structure

Career Related First Degree Programme

Group 2(b)

Biotechnology (Multimajor)

Zoology, Chemistry & Biotechnology

Semester I

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
EN1111	English	2	36	2	3 Hrs.	20	80
BV1121	Methodology and Perspective of Biotechnology	4	72	3	3 Hrs.	20	80
BV1131.2	Phycology Mycology, Lichenology, Bryology Pteridology, Gymnosperms and Plant Pathology	3	54	3	3 Hrs.	20	80
BV1141.2	Animal Diversity I- Non-Chordata	3	54	2	3 Hrs.	20	80
	Practical Zoology-I	2	36	-	-	-	-
BV1142	Inorganic Chemistry-I	5	90	4	3 Hrs.	20	80
	Practical	2	36				
BV1143	Biochemistry & Metabolism	3	54	4	3 Hrs.	20	80
	Practical	6	108				
	Total	**30**	**540**	**18**			

CH- 7, ZO- 8 (5+Comp. 3), BT- 9(BC) + 4, EN-2 = 30

Semester II

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1211	English	2	36	2	3 Hrs.	20	80
BV1221	Biophysics and Instrumentation	2	36	2	3 Hrs.	20	80
	Practical	1	18				
BV1231.2	Plant Physiology, Angiosperm Anatomy & Reproductive Botany	3	54	3	3 Hrs.	20	80
BV1241.2	Environmental Studies	4	72	4	3 Hrs.	20	80
BV1242.2	Practical Zoology-I (Practical of BV1141.2, BV1241.2)	2	36	2	3 Hrs.	20	80
BV1243	Inorganic Chemistry –II	6	108	3	3 Hrs.	20	80
	Practical	3	54				
BV1244	Practical Chemistry-I (Practical of BV1142 & BV1243)			2	3 Hrs.	20	80
BV1245	Microbiology	4	72	2	3 Hrs.	20	80
	Practical	3	54				
BV1246	Biotechniques-I (Practical of BV1143 & BV1245			2	3 Hrs.	20	80
	Total	**30**	**540**	**22**			

Total Hrs: CH-9, ZO- 9(6+Comp 3), BT- 10, EN-2= 30

Semester III

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1331.2	Angiosperm Morphology and Systematic Botany	3	54	3	3 Hrs.	20	80
BV1341.2	Developmental Biology & Reproductive Biology	3	54	3	3 Hrs.	20	80
BV1342.2	Animal Diversity –II: Chordata	2	36	2	3 Hrs.	20	80
	Practical Zoology-II	2	36	-	-	-	-
BV1343	Physical chemistry-I	7	126	4	3 Hrs.	20	80
	Practical	3	54				
BV1344	Food and Industrial Biotechnology	3	54	4	3 Hrs.	20	80
	Practical	2	36		-	-	-
BV1345	Molecular Biology	3	54	4	3 Hrs.	20	80
	Practical	2	36	-	-	-	-
	Total	**30**	**540**	**20**	-	-	-

Total Hrs: CH- 10, ZO- 10(7+ Comp 3), BT- 10, = 30

Semester IV

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1431.2	Practical COMP (Practical of BV1131.2, BV1231.2 &BV1331.2)	3	54	3	3 Hrs.	20	80
BV1441.2	Animal Physiology	3	54	2	3 Hrs.	20	80
BV1442.2	Cell Biology	2	36	2	3 Hrs.	20	80
BV1443.2	Practical Zoology-II (Practical of BV1341.2, BV1342.2, BV1441.2, BV1442.2)	2	36	2	3 Hrs.	20	80
BV1444	Physical chemistry-II	7	126	3	3 Hrs.	20	80
	Practical	3	54				
BV1445	Practical Chemistry II(Practical of BV1344 & BV1444)			2	3 Hrs.	20	80
BV1446	Recombinant DNA Technology	3	54	2	3 Hrs	20	80
	Practical	2	36				
BV1447	Immunology	3	54	2	3 Hrs	20	80
	Practical	2	36				
BV1448	Biotechniques II (Practical of BV-1344, BV1345, BV1446, BV1447)			2	3 Hrs.	20	80
		30	**540**	**20**			

Total Hrs: CH- 10, ZO- 10(7+Comp. 3), BT-10= 30

Semester V

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1541.2	Systematics, Biodiversity & Animal Behaviour	3	54	3	3 Hrs.	20	80
BV1542.2	Genetics	5	90	4	3 Hrs.	20	80
	Practical Zoology-III	2	36	-	-	-	-
BV1543	Organic chemistry-I	6	108	4	3 Hrs.	20	80
	Practical	4	72	-	-	-	-
BV1544	Environmental Biotechnology	2	36	3	3 Hrs.	20	80
	Practical	1	18	-	-	-	-
BV-1545	Plant Biotechnology & Animal Biotechnology	3	54	4	3 Hrs.	20	80
	Practical	1	18	-	-	-	-
	OPEN COURSES (For non- Biotechnology students)						
BV1551 /	Bioinformatics						
BV1552	Food and Dairy Biotechnology						
BV1553	Genetic Engineering						
BV1554	Basics of Environmental Biotechnology (Any one course shall be offered as an Open course for non-Biotechnology students)	3	54	2	3 Hrs.	20	80
	Total	**30**	**540**	**20**			

CH-10, ZO- 10, BT- 10(7 +OC-3) =30

Semester VI

Course code	Course Title	Contact Hrs/ Week	Total contact Hrs	Credits	Duration of University Exam	Marks for Evaluation	
						CE	ESE
BV1641.2	Evolution	5	90	2	3 Hrs.	20	80
BV1642.2	Practical Zoology-III (Practical of BV1541.2, BV1542.2 &BV1641.2)	2	36	3	3 Hrs.	20	80
BV1643	Organic Chemistry-II	7	126	3	3 Hrs.	20	80
	Practical	3	54	-	-	-	-
BV1644	Practical Chemistry-III (Practical of BV1543 & BV1643)	-	-	3	3 Hrs.	20	80
	ELECTIVE COURSE IN ZOOLOGY						
ZO1651.1	One of the Elective Courses as per the						
ZO1651.2	Syllabus of B.Sc. Zoology						
ZO1651.3		3	54	2	3 Hrs	20	80
	ELECTIVE COURSE IN BIOTECHNOLOGY						
BV1648	Bioinformatics & Nano-Biotechnology						
BV1649	Food and Dairy Biotechnology						
BV1650	Genetic Engineering	3	54	2	3 Hrs.	20	80
BV1645	Biotechniques III (Practical of BV1544 & BV1545)	2	36	2	3 Hrs.	20	80
BV1661	Project	5	90	3	3 Hrs.	20	80
	Total	**30**	**540**	**20**			

CH-10, ZO- 10(7+ EC-3), BT- 5 + Project-5 = 30

Distribution of Teaching Hrs. for the Major Subjects – Botany / Zoology, Biotechnology, and Chemistry

Course	I S	II S	III S	IV	V	VI	Total
EN	2	2	0	0			4
BT	9+4	7+3	10	10	7+3	10	63
BO/ZO	5+3	6+3	10 (7+3)	10 (7+3)	10	7+3	57
CH	7	9	10	10	10	10	56
FC	(4)	(3)					
CC	(3)	(3)	(3)	(3)	0		
OC/EC	0				(3)	(3)	
Project						(10)	
Total	**30**	**30**	**30**	**30**	**30**	**30**	**180**

FOUNDATION COURSES

SEMESTER I

Foundation Course I

BV 1121 Methodology and Perspective of Biotechnology

Credits 3 **Contact hours- 72**

Aim of the course

The aim is to introduce the modern scientific methods and to familiarize biotechnology and its various applications in various fields of human life.

Objective of the course

The students will be able to understand how science works. Students will learn how to apply statistics and IT in Biological science. They will receive a general awareness about biotechnology and its application in various fields.

Module I

Science and Scientific studies- **6 hrs**

Types of Knowledge: practical, theoretical and scientific knowledge.

Information

What is science and what is not science, science vocabulary and science disciplines. Revolution in science

Experimentation in Science **12 hrs**

Design of an experiment; experimentation; observation; data collection; interpretation and deduction. Necessity of units and dimensions; repeatability and replication; Documentation of experiments, record keeping, Connection between measurements and underlying theory.

Types of experiments. Experiments to test a hypothesis, to measure a variable, or to gather data by preliminary and explorative experiments.

Planning of experiments: Design, selection of controls, observational requirements, and instrumental requirements Scientific instruments; sensory extension, choice and selection of instruments, sensitivity of instruments; Accuracy and precision and errors.Types of instruments- Historical development and evolution of scientific instruments. Robotics.

(Only a general orientation of scientific instruments required)

Making observations; direct and indirect observations, controlled and uncontrolled observations, human and machine observations, human error

Module II

Data handling in science and Biostatistics **12 hrs**

Documentation of experiments – Nature and types of Data- typical examples, data interpretation, significance of statistical methods in biological investigations,

Sampling techniques, statistical evaluation of results, probability theory, Probability calculation (classical and axiomatic definition of probability, theorem on total and compound probability), variables in biological data, standard distribution with important properties, simple problems involving binomial, Poisson and normal variables, methods of sampling, collection of data; primary and secondary data, classification and tabulation, graphical and diagrammatic representation, confidence level, idea of sampling, distribution, standard deviation and standard error, large samples, normal tests, measurement of dispersion (measures of location and dispersion), basic idea of significance test, hypothesis testing, level of significance.

Module III

Overview of Information of Technology **12 hrs**

Features of modern personal computers and peripherals, computer networks and Internet, Introduction to mobile phone technology, Introduction to ATM, Purchase of technology-license, guarantee, warrantee, Overview of Operating systems and major application software.

Data, information and knowledge-knowledge management- internet as knowledge repository, academic search techniques, - creating your cyber presence, Introduction to use of IT in teaching and learning- case study of educational software, INFLIBNET, NICNET, BRNET-academic services.

Social Informatics **6 hrs**

IT and Society, Cyber ethics, cyber crime, security privacy issues, Overview of IT- application in medicine, healthcare Business, Commerce , Industry, Defense, Law, crime detection, publishing, communication, resource management, weather forecasting, education, film and media Typesetting with latex, Introduction to Scilab and Metlab

Module IV

Origin and development of Biotechnology- **8 hrs**

Introduction and definitions, Historic perspectives- biotechnology in prehistoric times, microorganisms and fermentation, Origin of genetics, DNA and genetic Engineering, Hybridoma technology, Beginning of modern Biotechnology Classical and modern concepts of Biotechnology Scope of Biotechnology- Commercial potential, Biotechnology in India and its global trends, Major Biotechnology institutes and companies in India,

Application of biotechnology **10 hrs**

Industrial Biotechnology- Bioprocess and Fermentation Technology, Environmental Biotechnology- Biological fuel generation, Single cell protein, sewage and Effluent treatment; Medical Biotechnology- safer and cheaper medicines by biotechnology, antibiotics, medicines from cell cultures, New medicines through genetic engineering, Biopharming; Agriculture and Forest Biotechnology- Traditional methods of Crop improvement, Crop improvement through Biotechnology, Genetically Modified crops- Herbicide tolerance, Insect resistance, Virus tolerance, other engineered products, Genetically modified Livestock and poultry; Food and Beverage Biotechnology- Food and health, application of biotechnology in food processing, Traditional and modern food processing,

Module V

Safety and Ethics in Biotechnology- **6 hrs**

Good Laboratory Practices (GLP), Good Laboratory Practices for Students, Quality control in manufacturing, Good manufacturing Practices (GMP), Marketing of Biotechnology Products. Impact of Biotechnology on Society, IPR and Patents in Biotechnology- basic concepts of IPR, patents and copyrights, plagiarism.

Suggested Readings

1. Biotechnology and Ethics: A Blueprint for the Future, Daniel Callahan President, Hastings Center, Center for Biotechnology, Northwestern University.
2. Cultural Boundaries of Science, Gieryn, T.F. University of Chicago Press, 1999.
3. Social issues in Science and Technology: An Encyclopedia, David E. Newton (ABC-CLIO, Santa Barbara), 1999.
4. The Golem: What everyone should know about science, Collins H. and T. Pinch, Cambridge University Press, 1993.
5. Conceptual Integrated science, Hewitt, Paul G, Suzanne Lyons, ohn A. Suchocki & ennifer Yeh., Addison-Wesley.2007.
6. Methods for Teaching Science as Inquiry, Bass, Joel,E and et. al., Allyn & Bacon, 2009 The truth of science, Newton R.G.,
7. Biotechnology: Issues, Ethics and Regulations, Tina M. Prow, Communications Specialist, Office of Agricultural Communications and Education.
8. Biotechnologies and the Public: An International Study of Policy, Media Coverage and Public Attitudes from 1973 to 1996 (1995-1998), Helge Torqersen, Institute of Technology Assessment.
9. Introduction to Genetic Engineering & biotechn9ology, Nair, A.J., Infinity Science Press, USA.
10. People's Perception of Biotechnology, Renato Schibeci, Ian Barns.
11. Patenting in Biotechnology - Part I, R. Stephen Crespi, Tibtech, Vol. 9, 117-122, 1991.
12. Plant Biotechnology: Facts and Public Perception, D. Boulter, Department of Biological Sciences, University of Durham, South Road, Durham DH1 3LE, U.K. *'Phytochemistry' (Vol. 40, No.1, pp.1-9, 1995).*
13. Public Attitudes to Genetically Engineered Products, Wendy Ross, Katy Marsh, Alexi Jackson, Jaqui Skoyles, (1998), John Innes Centre, Norwich, U.K.
14. Computers Today, Alexis Leon and Mathews Leon., Leon Vikas.
15. Introduction to Information Technology, V.Rajaraman., Prentice Hll.
16. An Introduction to Biostatistics: A Manual for studies in Health Sciences., P. Sundar Rao, and J.Richard., Prentice Hall .
17. Fundamentals of Information Technology, Alexis and Mathew Leon., Leon Vikas
18. Learning Computer Fundamentals., Ramesh Bangia ., Khanna Book Publishers.

SEMESTER II

Foundation Course II

BV1221 Biophysics & Instrumentation

Credits- 2 **Contact hours 54 (Theory – 36 + Practical – 18)**

Aim of the course

The aim is to introduce the physical aspects and bioenergetics of the living system and to familiarize the principle and working of various instruments used in biotechnology experiments.

Objectives of the Course

The students will be able to understand the fundamentals of biophysics and the general instrumental techniques used in biotechnology.

Module I

Principles of thermodynamics: 6 hrs

Laws of conservation of energy- first and second laws and its relevance in the biological system, entropy and enthalpy, Gibbs free energy, bioenergetics- endothermic and exothermic reactions of biological systems, energy change in the biochemical reactions, sources of heat limits to temperature, heat dissipation and conservation.

Electrical properties of biological compartments: 4 hrs

Electricity as a potential signal, electrochemical gradients, membrane potential, ATP synthesis, and chemi-osmotic hypothesis

Module II

Biophysics of Photosynthesis 6 hrs

Primary events in photosynthesis, light harvesting pigments, resonance energy transfer in photosynthetic pigments, fluorescence and phosphorescence, absorption spectra and action spectra of photosynthetic pigments, photosynthetic reaction center and accessory pigments, light reception in microbes, plants and animals,

Biophysics of Vision, Muscle movements and Hearing: 2 hrs

Mechanism of vision, muscular movements and hearing, correction of vision faults, generation and reception of sonic vibrations, hearing aids.

Intra and intermolecular interactions in biological systems: **4 hrs**

Various types of molecular interactions, inter and intra molecular interactions, special and charge compatibility in molecular interactions.

Module III

Microscopy: 4 hrs

Principle of Microscopy, various types of Microscopy- Simple, phase contrast, fluorescence and electron microscopy (TEM and SEM), Modern developments in Microscopy.

Basic principles and working of instruments: 6 hrs

pH meter, spectrophotometer (UV and Visible) and colorimeter- Beer-Lambert law, Brief account of densitometry, fluorimetry, manometry, polarography, centrifugation, atomic absorption spectroscopy, IR, NMR and X-ray crystallography and Mass spectrometry.

Electrophoresis: 4 hrs

Principle of electrophoresis, native gel electrophoresis, SDS electrophoresis, immuno electrophoresis, isoelectric focusing, polymerization of acrylamide and bis-acrylamide, electrophoresis in agarose gel and Submarine electrophoresis

Isotopes and radioisotopes: **4 hrs**

Isotopes and radioisotopes, radiations- ionizing radiations, Application of isotopes and radioisotopes in biological research, radioisotope tracer technique and autoradiography.

Practicals- **18 hrs**

Familiarizing the working of the following instruments

1. pH Meter – Use of pH Meter, Familiarization of the instrument and Preparation Phosphate buffers and determination of pH.
2. Spectrophotometer – Familiarization of the working of the instrument , Quantitative estimation of Sugars by Dinitrosalysilic acid and Proteins by Lowry's Method
3. Development of absorption spectra of chlorophyll or any other biological sample
4. Electrophoresis – demonstration of PAGE and Agarose Gel Electrophoresis

Suggested Readings

1. Lehninger's Biochemistry , Nelson D.L and Cox, M.M., Worth Publishers, New York
2. Biochemistry ., Voet,D & Voet, J.G
3. A Textbook of Biophysics- R N Roy, New central Book Agency Pvt. Ltd, Calcutta.
4. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
5. Biophysics, Volkenstein, M.V
6. Biophysics- S.Thiruvia Raj , Saras Publications , Tamilnadu.
7. Molecular Biology of the gene, Watson et al.
8. Principles of Biotechnology- AJ Nair, Laxmi Publications, New delhi
9. Introduction to biophysical chemistry Martin.

Complementary Courses in Zoology for Botany, Chemistry & Biotechnology

SEMESTER I

Complementary Course I

BV-1131.1 Animal Diversity

Credits: 3 **Contact Hours: 54**

Aim and Objective

This course is aimed to communicate a basic understanding about the biodiversity of animals and its systematic position. It should give very good information about the morphological diversity and adaptation of the animal world. It should also provide basic information about the animal resources of the globe.

Module I **6 hours**

KINGDOM PROTISTA

General features

Plasmodium (detailed study of life history and pathogenicity)

eg. *Entamoeba, Noctiluca, Trichonympha, Paramecium*

Module II **6 hours**

KINGDOM ANIMALIA

Salient features

Phylum Porifera

General characters

e.g. Sycon

Phylum Cnidaria (Coelenterata)

General characters

Class Hydrozoa: *Obelia* (structure of colony and medusa, polymorphism and alternation of generation)

Class Scyphozoa: e.g. *Aurelia*

Class Anthozoa: e.g. sea anemone

Corals and coral reefs

Module III

Phylum Platyhelminthes **6 hours**

General characters

Class Turbellaria: e.g. *Bipalium*

Class Cestoda: e.g. *Taenia solium*

Class Trematoda; e.g. *Fasciola*

Phylum Nematoda

General characters

e.g. *Ascaris*

Human nematode parasites (*Ascaris*, *Ancylostoma*, *Wuchereria*, *Enterobius*)

Phylum Annelida

General characters

Class Polychaeta: e.g. *Nereis* (mention parapodium and heteronereis)

Class Oligochaeta; e.g. earthworm

Class Hirudunea: e.g. *Hirudunaria*

Module IV **12 hours**

Phylum Arthropoda

General characters

Type: *Penaeus*

Class Crustacea: *Sacculina*

Class Myriapoda: e.g. *Scolopendra*

Class Insecta: e.g. Cockroach (external features, mouth parts and digestive system); mosquitoes (*Anopheles*, *Culex* and *Aedes*), *Leptocorisa acuta, Oryctes rhinoceros*.

Module V **6 hours**

Phylum Mollusca

General characters

Class Polyplacophora: e.g. C*hiton*

Class Scaphopoda: e.g. *Dentalium*

Class Pelecypoda (Bivalvia): e.g. freshwater mussel, *Perna* and pearl oyster

Class Gastropoda: e.g. *Pila*

Class Cephalopoda: e.g. *Sepia*

Pearl culture

Phylum Echinodermata

General characters

Class Asteroidea: e.g. star fish

Class Ophiuroidea: e.g. brittle star

Class Echinoidea: e.g. sea urchin

Class Holothuroidea: e.g. sea cucumber

Class Crinoidea: e.g. sea lily

Module VI **18 hours**

CHORDATA

Diagnostic characters and salient features of the phylum Chordata.

Subphylum Urochordata: General characters

e.g. *Ascidia* (morphology and retrogressive metamorphosis)

Subphylum Cephalochordata: General characters; e.g. *Amphioxus*

Subphylum Vertebrata

General characters

Superclass Agnatha: e.g. *Petromyzon*

Superclass Pisces: e.g. *Scoliodon*, *Narcine*, *Etroplus*, *Anguilla*, *Echeneis,Hippocampus*, mackerel and sardine.

Superclass Tetrapoda

Class Amphibia

General characters

e.g. *Rana*, *Bufo*, *Ichthyophis*, *Amblystoma* , axolotl larva and *Rhacophorus*

Class Reptilia

General characters

e.g. *Calotes*, *Draco*, *Chameleon* and *Chelone*

Snakes: (1) Non-poisonous snakes: e.g. *Lycodon* and *Ptyas;*

(2) Poisonous snakes: e.g. *Naja*, Viper, *Bungarus* and *Enhydrina*

Identification of non-poisonous and poisonous snakes

Class Aves

General characters

Flightless birds: e.g. Ostrich and Kiwi

Flying birds: e.g. Pigeon (mention different types of feathers) and peafowl

Flight adaptations of birds

Class Mammalia

General characters

Homo sapiens: Detailed study of anatomy (exclude skeleton, arteries and veins)

e.g. *Echidna*, kangaroo, bat, loris, tiger and whale

Adaptations of aquatic mammals

Suggested readings

- Brusca, R.C. and Brusca, G.J. *Invertebrates*. Sinauer Associates.
- Chaudhury, S.K. *Concise Medical Physiology*, NCBA
- Dhami, P.S. and Dhami, J.K. *Invertebrate Zoology*. R.\Chand & Co.
- Dhami, P.S. and Dhami, J.K. *Vertebrate Zoology*. R.\Chand & Co.
- Ekambaranatha Ayyar, M. and Ananthakrishnan, T.N. *A Manual of Zoology, Vol. I*
- Ekambaranatha Ayyar, M. and Ananthakrishnan, T.N. *A Manual of Zoology, Vol. II*
- Guyton and Hall *A Textbook of Medical Physiology*
- Jordan, E.L. and Verma, P.S. *Invertebrate Zoology*. S.Chand and Co.
- Jordan, E.L. and Verma, P.S. *Vertebrate Zoology*. S.Chand and Co.
- Kotpal, R.L. *Modern Textbook of Zoology: Invertebrates*. Rastogi Publications
- Kotpal, R.L. *Modern Textbook of Zoology: Vertebrates*. Rastogi Publications
- Nair, N.C. et al. *A Textbook of Invertebrates* SARAS Publications
- Nigam, H.C. *Biology of Chordates*. Vishal Pub.Co.
- Parker and Haswell. *A Textbook of Zoology Vol. II*
- Ruppert, E.E., Fox, R. and Barnes, R.D. *Invertebrate Zoology*. Thomson Books
- Sherwood, L. *Principles of Human Physiology*, Brooks/Cole
- Thangamani, A. et al. A Textbook of Chordates, SARAS Pub

SEMESTER II

Complementary Course II

BV-1231.1 Animal Physiology

Credits: 3 **Contact Hours: 54**

Aim and Objective

This course is to complement the students with the basic information on the general physiology of animals.

Module I **18 hours**

Nutrition

Types of Nutrition – autotrophy and heterotrophy; outline classification of food components; brief mention of malnutrition disorders.

Vitamins - physiological role and disorders (deficiency diseases).

Respiration

Respiratory pigments and their functions with special emphasis on haemoglobin; transport of oxygen and carbon dioxide; neural and hormonal control of respiration in man; respiratory disturbances – very brief mention of apnoea, dyspnoea, hypoxia, hypocapnia and hypercapnia, asphyxia and carbon monoxide poisoning. Smoking and its physiological effects

Circulation

Blood - composition and functions; blood groups: mechanism of blood clotting (intrinsic and extrinsic pathways); anticoagulants; disorders of blood clotting (haemophilia and thrombosis). Heart (neurogenic and myogenic); heart beat; pace maker; blood pressure; ECG; angiogram and angioplasty. Cardiovascular disorders (hypertension, arteriosclerosis and myocardial infarction).

Module II **18 hours**

Excretion and Osmoregulation

Classification of animals based on excretory wastes; human nephron – structure and urine formation (ultrafiltration, selective reabsorption, tubular secretion and countercurrent mechanism); hormonal control of renal function; composition of urine; kidney diseases (proteinuria, uremia, acidosis and alkalosis). Dialysis and artificial kidney

Muscle Physiology

Striated, non-striated and cardiac muscle; ultrastructure of a striated muscle fibre; mechanism of muscle contraction; latent and refractory periods; muscle twitch, summation, tetanus and tonus; all or none law; fatigue and rigor mortis.

Module III **18 hours**

Nerve Physiology

Neuron – structure; nerve impulse and its transmission; synapse and synaptic transmission; all or none law; refractory period; neurotransmitters; saltatory transmission; EEG.

Endocrinology

Various endocrine glands and their corresponding hormones. Very brief description of hormonal influence/ action and hormonal disorders such as goitre, cretinism, exophthalmic goitre, diabetes mellitus, diabetes insipidus, dwarfism, gigantism, and acromegaly. Hormonal disorders in man

Suggested Readings

- Arora, M. *Animal Physiology*, Himalaya Pub.
- Ganong, W.F. *Review of Medical Physiology*, McGrawHill
- Eckert, R. and Randall, D. *Animal Physiology*. CBS Publishers and Distributors
- Hoar, W.S. *General and Comparative Physiology*. Prentice Hall
- Guyton, A.C. *Textbook of Medical Physiology*. W.B.Saunders Co.
- Mariakuttikan and Arumugam, N. *Animal Physiology.* Saras Publication
- Nagabhushanam R., Kodarkar, M.S. and Sarojini, R. *A Textbook of Animal Physiology*. Oxford IBH
- Sebastian, M.M. *Animal Physiology*. Madonna Books, Kottayam
- Schmidt-Nielson, K. *Animal Physiology*. PHI
- Verma P.S. *et al Animal Physiology*

SEMESTER III

Complementary Course III

BV-1331.1 Developmental Biology, Human Genetics and Animal Behaviour

Credits: 3 **Contact Hours: 54**

Aim and Objective

This complementary course will help to develop general undrstanding on animal development, human genetics and animal behaviour for non-zoology students.

Module I 18 hours

DEVELOPMENTAL BIOLOGY

Egg: types and classification of eggs. Fertilization: events and changes in fertilization. Cleavage: types and patterns of cleavage. Blastulation: the process of blastulation; different types of blastulae. Gastrulation: morphogenetic movements (invagination, involution, epiboly and delamination); Embryonic induction: very brief description of organizers and embryonic induction. Nuclear transplantation experiments in amphibians. Prenatal diagnostic technique: amniocentesis, chorionic villus sampling and ultrasound scanning. Embryonic stem cell research. Animal cloning; Test tube babies

Module II 18 hours

HUMAN GENETICS

Normal chromosome complement; karyotype study. Mendelian traits: skin spotting; brown and blue eye colours. Polygenic inheritance: skin colour in man. Multiple alleles in man: genetics of ABO blood groups. Sex determination: autosomes and sex chromosomes; Barr bodies and Lyon's hypothesis; chromosomal basis of sex determination; XYY male, XXX syndrome and intersex. Sex-linked, sex-limited and sex-influenced inheritance. Syndromes: autosomal syndromes (Down syndrome and Edwards syndrome), sex chromosomal syndromes (Turner syndrome and Klinefelter syndrome) Genetic disorders: sickle cell anaemia and phenylketonuria Genetics of cancer: oncogenes and tumour suppressor genes Genetics and human welfare: eugenics and genetic counselling; human gene therapy.

Module III 18 hours

ANIMAL BEHAVIOUR

Stimulus and Response: Stimulus-response theory; stimulus filtering; fixed action pattern; innate releasing mechanism; sign stimulus and social signals (social releasers). Instinctive behaviour: definition; characteristics of instinctive behaviour; comparison of instinct and learning; adaptive advantage. Learning: types of learning; habituation; reflexes, latent learning, insight learning and imprinting; physiology of learning. Motivation: goal oriented behaviour and drive; (models of motivation not required). Sociobiology: social groups – merits and demerits; properties of societies; Societies in honey bee and elephants. Pheromones: types of pheromones; chemical nature of pheromones; human pheromones.

Suggested Readings

Developmental Biology

1. Arora, Mohan P. *Embryology. 1E*. Himalaya Publishing House.
2. Balinsky, B.I. *An Introduction to Embryology. 5E*. Thomson Books/cole
3. Gilbert, S.F. *Developmental Biology. 5E*. Sinauer Associates.

4. Majumdar, N.N. *Textbook of Vertebrate Embryology*. TMH
5. Rao, K. Vasudeva. *Developmental Biology A Modern Synthesis*. Oxford IBH
6. Verma, P.S. and Agarwal V.K. *Chordate Embryology*. S.Chand and Co.

Genetics

1. Ahluwalia, K.B. *Genetics*. New Age International (P) Ltd. Publishers
2. Burns, G. W. & Bottino, P. J. *The Science of Genetics*. Maxwell McMillan
3. Curt Stein. *Principles of Human Genetics*. Euresia Publishing House
4. Gardner, E. J. *et al*. *Principles of Genetics*. John Wiley & Sons.
5. Goodenough, U. *Genetics*. Halt, Reinharts & Winston
6. Gupta, P.K. *Cytogenetics*. Rastogi & Co.
7. Sinnott, W.E., Dunn, L.C. and Dobzhansky, T. *Principles of Genetics*, TMH
8. Verma, P.S. and Agarwal V.K. *Genetics*. S.Chand and Co.

Animal Behaviour

1. Arora, Mohan P. *Animal Behaviour*. Himalaya Publishing House
2. Kumar, Vinod. *Animal Behaviour*. Himalaya Publishing HouseReena Mathur.
3. Singh, Harjindra. *Textbook of Animal Behaviour*. Anmol Publishers
4. Alcock, J. *Animal Behaviour*. Sinauer Associates.
5. Manning, A. and Dawkins, M.S. *An Introduction to Animal Behaviour*. Cambridge University Press.
6. Ranga, M.M. *Animal Behaviour*. Agrobios
7. Scott, John Paul. *Animal Behaviour*.
8. Slater, P.J.B. *Essentials of Animal Behaviour*. Cambridge University Press
9. Wood Gush, D.G.M. *Elements of Ethology*

SEMESTER IV

Complementary Course IV

BV-1431.1 Practical COMP

Credits: 3 **Contact hours: 54**

Aim and Objective

This course is to introduce and train the students on the practical components of the theory courses which were covered in the previous semesters.

Animal Diversity

Study of specimens

1. Protista : *Noctiluca*, *Paramecium*, *Entamoeba*, *Trichonympha* (any 2)
2. Porifera : Sycon
3. Cnidaria : *Obelia*, *Aurelia*, sea anemone (*Adamsia*)
4. Platyhelminthes: *Bipalium*, *Fasciola*, *Taenia solium*
5. Nematoda : *Ascaris* (male and female)
6. Annelida : *Nereis*, *Hirudinaria*

7.	Arthropoda	:	*Limulus*, Scorpion, *Scolopendra*, *Sacculina*, *Leptocorisa*, *Oryctes*, larval stages of prawn (any 5)
8.	Mollusca	:	Freshwater mussel, *Sepia, Pila*
9.	Echinodermata	:	starfish, sea urchin, brittle star, sea cucumber, sea lily (any 3)
10.	Chordates	:	*Amphioxus* (entire), *Ascidia*
		:	*Petromyzon*
		:	*Scoliodon*, *Narcine*, *Echeneis*, *Hippocampus*, *Anguilla* (any 3)
		:	*Ichthyophis*, *Amblystoma*, *axolotl larva*, *Rhacophorus* (any 2)
		:	*Chameleon*, *Bungarus*, *Naja*, *Vipera*, *Chelone* (any 3)
		:	Pigeon – different types of feathers
		:	*Pteropus*

Mounting (Minor) [any three]

1. Earthworm – setae (in situ)
2. *Nereis* – Parapodium
3. *Panaeus* – Appendages
4. Shark – Placoid scale

Dissection (Major) [any two]

1. Earthworm – Digestive system
2. *Penaeus* – Nervous system
3. Cockroach – Digestive system (Alimentary canal and salivary apparatus)

Animal Physiology

1. Preparation of human blood smear to study different types of leucocytes.
2. Human blood grouping: ABO and Rh systems.
3. Urine analysis for abnormal constituents: albumin and glucose.

Developmental Biology

Study of slides/models of different types of eggs, blastula and gastrula.

Human Genetics

1. Study of normal human karyotype.
2. Study of abnormal human karyotypes (Klinefelter, Turner, Down syndromes)

Applied Zoology

1. Study of beneficial insects: *Apis* (worker, drone and queen), *Bombyx* (life cycle, silk) Study of the following items of economic importance: *Perna*, *Pinctada*, *Penaeus*, *Sardinella*, *Rastrelliger*

Complementary Courses In Botany

For Zoology, Chemistry & Biotechnology

Semester I

BV1131.2 Phycology Mycology, Lichenology, Bryology Pteridology, Gymnosperms and Plant Pathology

Credits: 3 **Contact hours: 54**

Module I **12 hrs**

Phycology

Salient features of the following major groups with reference to the structure, reproduction and life cycle of the types given below (Excluding the developmental details) –

a. Cyanophyceae - *Nostoc*
b. Chlorophyceae - *Chlorella*, *Oedogonium* and *Chara*
c. Phaeophyceae - *Sargassum*
d. Rhodophyceae – *Polysiphonia*

Module II

Mycology

14 hrs

Characteristic features of the following major groups with reference to the structure, reproduction and life cycle of the types given below (Excluding the developmental details) –

a. Zygomycotina - *Rhizopus*
b. Ascomycotina
c. Plectomycetes - *Penicillium*
d. Discomycetes - *Peziza*
e. Basidiomycotina
f. Teliomycetes – *Puccinia*
g. Economic importance of Fungi

Lichenology

General account and economic importance; the structure, reproduction and life cycle of *Usnea*

Module III

Bryology **10 hrs**

1. Introduction and Classification
2. Study of the habit, thallus organization, vegetative and sexual reproduction and alternation of generation of the following types (Developmental details are not required). *Riccia, Funaria*
3. Economic Importance of Bryophytes.

Pteridology **8 hrs**

1. Introduction: General characters morphological and phylogenetic classification.
2. Study of the habitat, habit, internal structure, reproduction and life cycle of the following types (Developmental details not required).
   a. Selaginella
   b. Pteris

Module IV

Gymnosperms **5 hrs**

1. Introduction and classification of gymnosperms.
2. Study of the Habit, Anatomy, Reproduction and life cycle of - *Pinus* (Developmental details are not required*)*

Plant Pathology **5 hrs**

a. A brief account on the following plant diseases with reference to the symptoms, causative organism, spread of the disease and effective control measures.

a. Brown spot disease of Paddy

b. Powdery mildew of Rubber

c. Yellow vein mosaic of Lady's finger

d. Quick wilt of Pepper

b. Method of preparation and mode of action of the following fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake & oil.

Suggested Readings

1. Alexopoulos C.J & MIMS C.V (1988). Introductory Mycology, John Wiley & Sons.
2. Andrews H.N. (1967) - Studies on Palaeobotany – C .J. Felix.
3. Arnold C. A (1947) - Introduction to Palaeobotany - McGraw Hill Co. New Delhi.
4. Bower F.O. (1935) - Primitive Land Plants - Cambridge, London.
5. Fritsch F. B (1945) Structure and Reproduction of Algae Vol.I & II. Cambridge University Press.
6. Gupta V .K. and Varshneya U. D (1967) – An Introduction to Gymnosperms – Kedarnath, Ramnath – Meerut.
7. Jim Deacon (2007) Fungal Biology, 4th edition, Blackwell Publishing, Ane Books Pvt. Ltd.
8. Kanika Sharma (2009) Manual of Microbiology, Ane Books Pvt. Ltd.
9. Mamatha Rao (2009) Microbes and Non flowering plants, Impact and applications; Ane Books Pvt. Ltd.
10. Parihar N .S. – An introduction to Bryophyta - Central Book Depot. Alahabad
11. Singh V, Pandey PC and Jam D.K (1998) A Text Book of Botany for Under Graduate Students, Rastogi Publications.
12. Singh V., Pandey P.C and Jain D.K (1998) A Text book of Botany for Undergraduate Students, Rastogi Publications.
13. Smith G. M (1955) Cryptogamic Botany, Vol.I McGraw Hill.
14. Smith G. M (1955) Cryptogamic Botany Vol.I, McGraw Hill
15. Smith G. M. (1955) - Cryptogamic Botany – Vol.II – Mc Graw Hill Co. New Delhi
16. Sporne K. R. (1966) - Morphology of Pteridophytes - Hutchin University Library , London
17. Sporne K. R. (1967) - Morphology of Gymnosperms - Hutchin University Library , London
18. Vashishta B.R. (1990) Botany for Degree Students, Fungi, S.Chand & Co.
19. Vashista B. R. (1993) - Pteridophyta – S.Chand and co. New Delhi
20. Vashista B. R. (1993) Gymnosperms - S. Chand and co. New Delhi
21. Vashishta B. R. - Bryophyta - S. Chand and Co. New Delhi
22. Vashishta B.R (1990) Botany for Degree Students, Algae, S.Chand & Co.
23. Webster J (1970) Introduction to Fungi, Cambridge University Press.

Complementary Course-II

Semester II

BV1231.2 Plant Physiology, Angiosperm Anatomy & Reproductive Botany

Credits: 3 **Contact Hours: 54**

Module I

Plant Physiology **22 hrs**

1. General introduction: physiological processes, their significance and applications.
2. Water relations of plants: Importance of water to plant life.
   a. Absorption of water- organs of absorption, root and root hair. Physical aspects of absorption- imbibition, diffusion and osmosis. Plant cell as an osmotic system; water potential and osmotic potential. Plasmolysis and its significance, practical applications. Mechanism of water absorption – active and passive absorption, root pressure. Pathway of water across root cells.
   b. Ascent of sap- vital and physical theories.
   c. Loss of water from plants: transpiration - cuticular, lenticular and stomatal mechanism - theories – starch sugar hypothesis, potassium - ion theory. Significance of transpiration - guttation, anti - transpirants, factors affecting transpiration.
   d. Water stress and its physiological consequences to drought.
3. Photosynthesis: Introduction, significance and general equation. Photosynthetic apparatus, structure and function of chloroplast, quantasomes - solar spectrum and its importance - Fluorescence and Two pigment systems- raw material for photosynthesis- Mechanism of photosynthesis- Light reaction - cyclic and non cyclic photophosphorylation. Hill reaction - Dark reaction: Calvin cycle. Comparative study of C3, C4, and CAM plants. Photorespiration - Bacterial photosynthesis and chemosynthesis - 4.Factors affecting photosynthesis - Law of limiting factor.
5. Translocation of solutes: Path way of movement, phloem transport, mechanism of transport - Munch hypothesis, protoplasmic streaming theory - activated diffusion hypothesis, electro osmotic theory.
6. Growth: Phases of growth - vegetative and reproductive growth - growth curve - plant growth regulators - Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid - synthetic plant hormones - practical applications. Senescence and abscission. Photoperiodism.

Module II

Angiosperm anatomy **22 hrs**

1. Objective and scopes of plant anatomy
2. Tissues – Meristems, Definition, Classification based on origin, position, growth patterns, functions.
3. Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Organization of root apex in dicots & monocots.
4. Permanent tissues – Definition, classification - simple, complex and secretory.
5. Tissue systems – Epidermal tissue systems, Ground tissue systems & vascular tissue systems. Different types of vascular arrangements
6. Primary structure – Root, stem and leaf [Dicot & Monocot]. Secondary growth (stelar and extra stelar) Root and stem- cambium (structure and function) annular rings, heart wood and sap wood, tyloses, ring porous wood and diffuse porous wood, perderm formation-phellem, phellogen and phelloderm; lenticels
7. Anomalous secondary growth –*Boerhaavia*

Module III

Reproductive Botany **10 hrs**

1. Micro sporogenesis - structure and functions of wall layers.
2. Development of male gametophyte - Dehiscence of anther.
3. Megasporogenesis - Development of female gametophyte - Embryo sac - Development and types - Monosporic – *Polygonum* type
4. Pollination - Fertilization - Double fertilization. Structure of Embryo- Dicot [*Capsella*]

Suggested Readings

1. Kochhar P. L. & Krishnamoorthy H. N. – Plant Physiology. (Atmaram & Sons- Delhi, Lucknow).
2. Devlin & Witham – Plant Physiology (C B S publishers).
3. Esau K. (1965) - Plant Anatomy – Wiley Eastern, New York.
4. Esau K. (1965) - Plant Anatomy – Wiley Eastern, New York.
5. Fahn A. (1985) - Plant Anatomy – Pergamon Press, Oxford.
6. Fahn A. (1985) - Plant Anatomy – Pergamon Press, Oxford.
7. Kumar & Purohit – Plant Physiology - Fundamentals and Applications (Agrobotanical publishers)
8. Maheswari P. - Embryology of Angiosperms - Vikas Pub:
9. Malic C. P. & Srivastava A. K. – Textbook of Plant Physiology (Kalyani Publishers- New Delhi).
10. Nair PKK Palynology of Angiosperms
11. Noggle G R & Fritz G J – Introductory Plant physiology (Prentice Hall of India).
12. P. Maheswari - Embryology of Angiosperms - Vikas Pub:
13. Pandey S.N. & Sinha B. K. – Plant physiology (Vikas publishing House- New Delhi).
14. Pandey, B .P. (1997) - Plant Anatomy - S.Chand and co. New Delhi Biology - McGraw Hill Co, New York.
15. Pandey, B .P. (1997) - Plant Anatomy - S.Chand and co. New Delhi Biology - McGraw Hill Co , New York.
16. Prasad and Prasad (1972) Out lines of Botanical Micro technique, Emkay publishers, New Delhi Coutler E. G. (1969) Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
17. Richard F Venn 2004, Principles and Practice of Bioanalysis, Taylor & Francis, Ane Books Pvt. Ltd
18. Salisbury F. B. & Ross C. W. - Plant physiology. (Wadsworth publishing company).
19. Vashista .P. C (1984) - Plant Anatomy – Pradeep Publications – Jalandhar
20. Vashista .P. C (1984) - Plant Anatomy – Pradeep Publications – Jalandhar
21. Verma V 2007, Text Book of Plant Physiology. Ane Books Pvt. Ltd22. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.

Complementary Course-III

1331.2 Angiosperm Morphology, Systematic Botany, & Economic Botany

Credits: 3 **Contact Hours: 54**

Module I

Morphology **4 hrs**

Brief account on the various types of inflorescence including special types (Cyathium, Verticillaster, Hypanthodium, Coenanthium and Thyrsus) with examples; floral morphology- Flower-as a modified shoot, Flower parts, their arrangements, relative position, numeric- plan, cohesion, adhesion, symmetry of flower, aestivation types, placentation types; floral diagram and floral formula Fruit types: simple, aggregate and multiple. Seeds: albuminous and exalbuminous .

Module II

Systematic Botany **8 hrs**

Definition, scope and significance of Taxonomy, Systems of classification:

1. Artificial- Linnaeus sexual system
2. Natural - Bentham and Hooker (detailed account)
3 Phylogenetic- Engler and Prantl (Brief account only)

Basic rules of Binomial Nomenclature and International Code of Botanical nomenclature (ICBN). Importance of Herbarium, Herbarium techniques and Botanical gardens. A brief account on the modem trends in taxonomy; Chemotaxonomy, Numerical Taxonomy, Cytotaxonomy and Molecular taxonomy

Module III **30 Hrs**

A study of the following families with emphasis on the morphological peculiarities and economic importance of its members. (Based on Bentham and Hooker's System)

1. Annonaceae
2. Malvaceae
3. Rutaceae
4. Leguminosae
5. Rubiaceae
6. Asteraceae
7. Apocynaceae
8. Solanaceae
9. Verbenaceae
10. Euphorbiaceae
11. Poaceae

Module III **12 hrs**

Economic botany

Study of the Botanical name, Family, Morphology of useful parts, and utility of the following;

- Cereals and Millets - Paddy and Ragi
- Legumes - Ground nut, Black gram.
- Sugar yielding plants - Sugarcane.
- Spices & condiments - Cumin, Clove, Cardamom and Pepper
- Fibre - Cotton
- Dyes - Henna

- Resins - Asafoetida.
- Tuber crops - Tapioca, Colocasia.
- Tropical Fruits - Banana, Jack Fruit.
- Oil yielding - Sesame oil, Coconut.
- Medicinal plants - *Ocimum , Adhatoda, Sida,* Turmeric.

Suggested readings

1. Davis, P.H. and Haywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Royd, London.
2. Heywood, V.H. and Moore D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
3. Jefftey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge London.
4. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-Hill Book Co., New York
5. Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York, Ane Books Pvt. Ltd.
6. Lawrence. G.H.M. 1951. Taxonomy of Vascular Plants. Macmillan, New York.
7. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New York.
8. Nordenstam. B.., El-Gazaly, G. and Kassas. M. 2000. Plant Systematics for 21st Century Portland Press Ltd., London.
9. Pandey SN and Misra SP, 2008 Taxonomy of Angiosperms; Ane Books Pvt.Ltd.
10. Pandey, B .P. (1997) - Plant Anatomy - S.Chand and co. New Delhi Biology - McGraw Hill Co., New York.
11. Radford. A.E. 1986. Fundamentals of Plant Systematics Harper and Row, New York.
12. Singh. G. 1999. Plant Systematics: Theory and practice Oxford & IBH Pvt, Ltd. New Delhi.
13. Sivarajan,V.V. Introduction to the principle of plant taxonomy, Oxford and IBH 14.Stace. C.A. 1989. Plant Taxonomy and Biosystematics. 2nd ed. Edward Arnold, London.
14. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.

Complementary Course-IV

Semester IV 1431.2

Practical COMP

(Practical of BV1131.2, BV1231.2 & BV1331.2)

Credits: 3 **Contact hours: 54**

Practical of 1131.2

Phycology **6 hrs**

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labelled sketches of the specimens observed

   a. Cyanophyceae - *Nostoc*
   b. Chlorophyceae - *Chlorella*, *Oedogonium* and *Chara*
   c. Phaeophyceae - *Sargassum*
   d. Rhodophyceae – *Polysiphonia*

Mycology **6 hrs**

A detailed study of structure and reproductive structures of types given in the syllabus and submission of record. Rhizopus, Penicillium, Peziza. Puccinia. and Usnea.

Bryology **2 hrs**

1 *Riccia* – Habit - Internal structure of thallus – V. S. of thallus through archegonia, antheridia and sporophyte

2. *Funaria* – Habit, V. S. of archegonial cluster, V .S. of antheridial cluster, Sporophyte V. S.

Pteridology **4 hrs**

1. *Selaginella* : Habit , rhizophore T. S , stem T . S, axis with strobilus, V .S. of strobilus, Megasporophyll and microsporophyll.
2. Pteris - Habit, Rhizome and petiole T. S., sporophyll T.S

Gymnosperms **2 hrs**

3. *Pinus* - Branch of indefinite growth, spur shoot, T. S of old stem and needle, male and female cone, V .S. of male and female cone.

Plant Pathology **2 Hr**

4. Students are expected to observe the symptoms and causal organisms of all plant diseases mentioned below.
   - Brown spot disease of Paddy
   - Powdery mildew of Rubber
   - Yellow vein mosaic of Lady's finger
   - Quick wilt of Pepper

Practical of BV1231.2 **4 hrs.**

Plant Physiology

1. Water potential of onion peel / *Rhoeo* peel by plasmolytic method...
2. Papaya petiole osmoscope.
3. Determination of water absorption and transpiration ratio.
4. Measurement of rate of transpiration using Ganong's potometer or Farmer's potometer.
5. Evolution of oxygen during photosynthesis.
6. Geotropism using clinostat.
7. Measurement of growth using Arc auxanometer.

Angiosperm Anatomy **10 hrs**

1. Simple permanent tissue – Parenchyma, Chlorenchyma , Aerenchyma , Collenchyma and Sclerenchyma
2. Primary structure – Dicot stem : *Hydrocotyle*
3. Monocot stem : Grass
4. Dicot root : Pea*, Limnanthemum*
5. Monocot root: *Colocasia*.
6. Secondary structure - Stem [Normal type]- *Vernonia* or any normal type
7. Secondary structure - Root [Normal type]- *Tinospora, Ficus*, *Carica papaya*, or any normal type
8. Anomalous secondary thickening –*Boerhaavia*

Practical of BV1331.2

Practicals of Angiosperm Taxonomy **16 Hrs**

1. Students must be able to identify the angiosperm members included in the syllabus (listed below).
   1. Annonaceae
   2. Malvaceae
   3. Rutaceae
   4. Leguminosae
   5. Rubiaceae
   6. Asteraceae
   7. Apocynaceae
   8. Solanaceae
   9. Verbenaceae
   10. Euphorbiaceae
   11. Poaceae

Draw labeled diagram of the habit, floral parts, L.S of flower, T.S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms.

Students must submit the practical records at the time of practical examination.

Practical of Economic Botany **2 hrs.**

Identify the economic products obtained from the plants mentioned under Economic Botany

- Cereals and Millets - Paddy and Ragi
- Legumes - Ground nut, Black gram.
- Sugar yielding plants - Sugarcane.
- Spices & condiments - Cumin, Clove, Cardamom and Pepper
- Fibre - Cotton
- Dyes - Henna
- Resins - Asafoetida.
- Tuber crops - Tapioca, Colocasia.
- Tropical Fruits - Banana, Jack Fruit.
- Oil yielding - Sesame oil, Coconut.
- Medicinal plants - *Ocimum , Adhatoda, Sida,* Turmeric

Core Courses

Core Courses of Botany

SEMESTER 1

Core Course-I

BV1141.1 Phycology, Mycology, Lichenology & Phytopathology

Credit 2 **Contact hours 90 (T 54 + P 36)**

Aim and Objective: This course is to expose the world of cryptogams and other lower forms of plants such as alge, fungi, lichens etc and also plant diseas3es caused by virus and fungi, including there control measures.

Module - I **22 hrs**

Phycology

1. Introduction – Range of thallus structure – Phylogenic trends – Pigments – Reproduction –Life cycle – Classification based on F .E Fritsch

2. Salient features of the following major groups with reference to the structure, reproduction and life cycle of the types given below ***(Excluding the developmental details)*** –
   a. Cyanophyceae – *Nostoc*
   b. Chlorophyceae - *Chlorella*, *Volvox, Oedogonium, Cladophora,* and *Chara*
   c. Xanthophyceae – *Vaucheria*
   d. Bacillariophyceae – *Pinnularia*
   e. Phaeophyceae – *Sargassum*
   f. Rhodophyceae - *Polysiphonia*

Economic importance of algae

   a. Role of algae in soil fertility- Fertilizer – Nitrogen fixation- Symbiosis
   b. Commercial products of algae – Agar, Alginates, Carrageenin, Diatomaceous earth
   c. Algae - medicinal aspects, algal blooms and red tides

Module -II **22 hrs**

Mycology

1. Introduction, structure, reproduction, life cycle, evolutionary trends, Classification based on Ainsworth
2. Distinguishing characters of different classes of fungi representing the following genera

(Excluding Developmental details)

   a. Myxomycotina -General characters.
   b. Zygomycotina - *Rhizopus*
   c. Ascomycotina
      - Hemiascomycetes - *Saccharomyces*
      - Plectomycetes - *Penicillium*
      - Pyrenomycetes - *Xylaria*
      - Discomycetes – *Peziza*
   d. Basidiomycotina
      - Teliomycetes - *Puccinia*
      - Hymenomycetes - *Agaricus*
   e. Deuteromycotina - *Cercospora*.

3. Economic importance of Fungi

Module-III

Lichenology **3 hrs**

Lichens - nature of association-classification-habit and habitat- Type Usnea - thallus morphology – internal structure –reproduction-economic importance.

Module-IV

Plant Pathology **7 hrs**

1. Introduction to Pathology – Classification of plant diseases on the basis of causative organisms and symptoms – Host parasite interaction.

2. Study of the following diseases with emphasis on symptoms, disease cycle and control measures of Leaf mosaic of Tapioca, Citrus Canker, Blast disease of Paddy, Root wilt of Coconut
3. Brief account of the following fungicides- Bordeaux mixture, Lime sulphur, Tobacco decoction, Neem cake & oil.

Practical **36 Hrs**

Phycolcogy **16 hrs**

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labelled sketches of the specimens observed

Mycology **14 hrs**

A detailed study of structure and reproductive structures of types given in the syllabus and submission of record.

Rhizopus, Saccharomyces, Penicillium, Xylaria, Peziza. Puccinia. Agaricus and *Cercospora*

Lichenology **2 hrs**

Make micro preparation of vegetative and reproductive parts of Usnea. Make sketches of the specimens observed.

Plant Pathology **4 hrs**

1. Identify the Diseases mentioned with respect to causal organism and symptoms
2. Students should be trained to prepare the fungicide Bordeaux mixture &Tobacco decoction.

Suggested Readings

1. Kanika Sharma 2009, Manual of Microbiology, Ane Books Pvt. Ltd.
2. Alain Durieux 2009, Applied Microbiology, Springer International Edition
3. Schlegel ,2008 General Microbiology , Cambridge University Press India Pvt Ltd
4. Heritage. L. 2007, Introductory Microbiology, Cambridge University Press India Pvt Ltd
5. Mamatha Rao 2009, Microbes and Non flowering plants, Impact and applications; Ane Books Pvt. Ltd.
6. Dr. G. Gunasekharan - Labortary Manual of Microbiology – New Age Pub:
7. R .C .Dubey & D .K .Maheswari - A text Book of Microbiology – Chand & Co:
8. Alexopoulos C.J & MIMS C.V 1988. Introductory Mycology, John Wiley & Sons.
9. Jim Deacon 2007, Fungal Biology, 4th edition, Blackwell Publishing, Ane Books Pvt. Ltd.
10. Smith G.M 1955, Cryptogamic Botany, Vol.I McGraw Hill.
11. Vashishta B.R. 1990, Botany for Degree Students, Fungi, S.Chand & Co.
12. Singh V, Pandey PC and Jam D.K 1998, A Text Book of Botany for Under Graduate Students, Rastogi Publications.
13. Chapman V.J & Chapman D.J, The Algae, Macmillan.
14. Fritsch F. B 1945, Structure and Reproduction of Algae Vol.I & II. Cambridge University Press.
15. Smith G.M 1955, Cryptogamic Botany Vol.I, McGraw Hill
16. Vasishta B.R 1990, Botany for Degree Students, Algae, S.Chand & Co.
17. Singh V., Pandey P.C and Jain D.K 1998, A Text book of Botany for Undergraduate Students, Rastogi Publications.
18. Webster J 1970, Introduction to Fungi, Cambridge University Press.

SEMESTER II

Core Course-II

BV1241.1 Environmental Studies

Credit: 4 **Contact hours: 108 (Theory 72 + Practical 36)**

Aim and Objective: Students should acquire a basic understanding about the structure function of the environment and its interaction with the living systems. It will impart the geographical distribution of plants and the impact of human intervention in the environment and the delicate balance of various factors in the environment. It gives an idea about the various types of biodiversity and the influence of environmental pollution on the biodiversity.

Module I **18 hrs**

1. Definition- Scope and relevance to society and human environment. Need for public awareness

Natural Resources

1. Renewable and non-renewable resources.
2. Forest resources: Use and over exploitation. Deforestation,
3. Mineral resources: Use and exploitation, Environmental effects of extracting and using mineral resources.
4. Water resources: Use and over exploitation of surface water and ground water, floods, drought.
5. Food resources: Changes caused by agriculture and over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging and salinity.
6. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.
7. Land resources: Land as a resource, land degradation, Man induced landslides, soil erosion and desertification.
8. Role of an individual in conservation of natural resources.

Module II **14 Hrs**

9. Ecosystems-Concept of an ecosystem- structure and function of an ecosystem
10. Biotic and abiotic components- Energy flow in an ecosystem.
11. Ecological succession-Definition & types.
12. Food chains -Food web & ecological Pyramids.
13. Introduction- types, characteristic features, structure and functions of the following ecosystems.

- A 1. Forest ecosystem 2. Grassland ecosystem 3. Desert ecosystem 4 .Aquatic ecosystems- Ponds, Streams, Rivers, Oceans, Estuaries.
- B Morphological, anatomical& physiological adaptations of –Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites.

Module III **18 hrs**

Biodiversity and its conservation-

1. Introduction –
2. Definition- genetic, species and ecosystem diversity.
3. Bio-geographical classification of India.

4. Value of bio-diversity: social, ethical, aesthetic and option values.
5. Biodiversity at global, National and local levels. India as mega-diversity nation.
6. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wild life, man-wild life conflicts.
7. Endangered and endemic species of India. Conservation of biodiversity: *In-situ* and

Ex-situ conservation of biodiversity. National parks and wildlife sanctuaries. Ecological niche, eco-types & ecological indicators.

Environmental pollution

1. Definition causes, effects and control measures of – 1. Air pollution 2. Water pollution 3. Soil pollution 4. Marine pollution 5. Noise pollution 6. Thermal pollution 7. Nuclear hazards.
2. Solid waste Management (brief account only):Causes, effects and control measures of urban and industrial wastes.
3. Disaster management (brief account only): Floods, earthquake, cyclone and land slides

Module IV **16 hrs**

Social issues and the Environment

1. From unsustainable to sustainable development. Urban problems related to energy. Water conservation, Rain water harvesting, water shed management.
2. Environmental ethics: Issues and possible solutions.
3. Climate change. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.
4. Environment protection Act. Air [prevention and control of pollution] Act. Water [prevention and control of pollution] Act. Wildlife Protection Act. Forest conservation Act. Hill preservation Act.
5. Public awareness .Forest Management.
6. Brief study of the major forests in India. Influence of forest on environment. Social forestry.
7. Mangrove vegetation of Kerala
8. Need of protection of mangrove vegetation.

Module V

Phytogeography **6 hrs**

Principles and vegetational types of India-tropical rain forest, sholas and deciduous forest-sand dunes and mangroves, scrub jungle, phytogeographical regions of India.

Practical **36 hrs**

1. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, halophytes, epiphytes and Parasites.
2. Study of plant community by quadrat method.
3. Observation and study of different ecosystems mentioned in the syllabus.
4. Determination of frequency and density constituent of plant species in a terrestrial community through quadrate and transect (line, belt).
5. Phytogeographical regions of India.

Suggested Reading

1. Misra SP and Pandey SN, 2009, Essential Environmental studies, Ane Books Pvt. Ltd.
2. Erach Bharucha – Text book of environmental Studies for undergraduate Courses, Universities Press, University Grants Commission

3. Ahluwalia VK and Sunitha Malhotra 2009, Environmental science, Ane Books Pvt. Ltd.
4. Chapman J.L. (2006) Ecology-Principles and Application. Cambridge University Press India Pvt. Ltd
5. Chandoco.S Weaver and Clements – Plant Ecology, McGraw Hill Publications, New York.
6. Verma, P. S. and V. K. Agrawal. 2004. *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology.* S. Chand & Company Ltd., New Delhi.
7. Prithipal Singh 2007- An Introduction to Biodiversity. Ane Books Pvt. Ltd
8. Verma and Agarwal – Principles of Ecology, S. Chand and Co.
9. Ambasht R.S. – Text book of Plant Ecology, Students and Friends & Co. Varanashi.
10. Odum Eugene P – Fundamentals of Ecology, Edn. Philladephia & Saunders, Tokyo, Toppon.
11. Sharma, P.D. – Elements of Ecology (Rastogi's Company Ltd., Publications).
12. Vashista P.C – Plant Ecology Edu. Vishali Publications.
13. Periasamy, K. – Elements of Plant Ecology, (M.K. Publications).
14. The Geography of Flowering Plants - Good
15. Kumaresan B. – *Plant Ecology & Phytogeography* – Rastrogi Pub:

SEMESTER II

Core Course III

BV1242.1Practical Botany- I

(Practical of BV1141.1 & BV1241.1)

Credit 2 **Contact Hours: Practical hours of the above courses**

Practical of BV 1141.1 **36 Hrs**

Phycolcogy **16 hrs**

1. Make micro preparations of vegetative and reproductive structures of the types mentioned in the syllabus.
2. Identify the algal specimens up to the generic level and make labelled sketches of the specimens observed

Mycology **14 hrs**

1. A detailed study of structure and reproductive structures of types given in the syllabus and submission of record.
2. *Rhizopus, Saccharomyces, Penicillium, Xylaria, Peziza. Puccinia. Agaricus* and *Cercospora*

Lichenology **2 hrs**

Make micropreparation of vegetative and reproductive parts of Usnea. Make sketches of the specimens observed.

Plant Pathology **4 hrs**

1. Identify the Diseases mentioned with respect to causal organism and symptoms
2. Students should be trained to prepare the fungicide Bordeaux mixture &Tobacco decoction.

Practical of BV1241.1 **36 Hrs**

Environmental Studies

1. Study of ecological and anatomical modifications of Xerophytes, Hydrophytes, halophytes, epiphytes and Parasites.
2. Study of plant community by quadrat method.
3. Observation and study of different ecosystems mentioned in the syllabus.
4. Determination of frequency and density constituent of plant species in a terrestrial community through quadrate and transect (line, belt).
5. Phytogeographical regions of India.

Semester III

Core Course IV

BV1341.1 Angiosperm Anatomy and Reproductive Botany

Credits 3 **Contact Hours 72 (T 36 +P 36)**

Aim and objective: The course is aimed to bring the basic concept and understanding about the anatomy of the flowering plants and its relationship to the physiology and environmental adaptability of the plants. It also gives a basic idea on the reproduction and development of the flowering plants and its adaptation to suit to its environment.

Module- I

Angiosperm Anatomy **4 hrs**

1. Objective and scope of plant anatomy
2. Cell wall organization - Gross structure - Primary and secondary wall pits – plasmodesmata -microscopic and sub microscopic structures – Extra cell wall material. Non living inclusions of the cell – Reserve food - secretary products, by products.

Module –II **10 hrs**

3. Tissues – Meristems, Definition, Classification based on origin, position, growth patterns, functions.
4. Apical meristems & theories on apical organization - Apical cell theory, Histogen theory, Tunica - Corpus theory. Organization of root apex in dicots & monocots.
5. Permanent tissues – Definition, classification - simple, complex and secretory.
6. Tissue systems – Epidermal tissue systems-stomata, structure and functions, Ground tissue systems & vascular tissue systems. Different types of vascular arrangements

ModuleIII **8 hrs**

7. Primary structure – Root, stem and leaf [Dicot & Monocot].
8. Secondary growth - Root and stem- cambium (structure and function) annular rings, heart wood and sap wood, tyloses, ring porous wood and diffuse porous wood, periderm formation-phellum, phellogen and phelloderm ; lenticels
9. Anomalous secondary growth - *Bignonia*, *Boerhaavia*.

Module IV

ReproductiveBotany **10 hrs**

1. Introduction to angiosperm embryology.
2. Micro sporogenesis - structure and functions of wall layers.
3. Development of male gametophyte - Dehiscence of anther.
4. Megasporogenesis - Development of female gametophyte - Embryo sac - Development and types - Monosporic – *Polygonum* type, Bisporic - *Allium* type, Tetrasporic – *Adoxa* type.
5. Pollination - Fertilization - Barriers of fertilization - Germination of pollen grains – Double fertilization.
6. Structure of Embryo- Dicot [*Capsella*], Monocot [*Sagittaria*] Endosperm types, its development and functions.

Module V **4 hrs**

Palynology: Pollen structure, pollen morphology, pollen allergy - viability test for pollen grains, Economic importance and its importance in taxonomy

Practical **36 hrs**

Anatomy **30 hrs**

Non living inclusions - Cystolith, Raphide, Sphaero-raphide, Aleurone grains.

1. Starch grains (Eccentric, concentric, compound)
2. Simple permanent tissue – Parenchyma, Chlorenchyma , Aerenchyma , Collenchyma and Sclerenchyma
3. Primary structure – Dicot stem: *Hydrocotyle, Eupatorium.*
4. Monocot stem: Grass and *Asparagus*.
5. Dicot root: Pea and *Limnanthemum*
6. Monocot root: *Colocasia* or any monocot root.
7. Secondary structure - Stem [Normal type]- *Vernonia*
8. Secondary structure - Root [Normal type]- *Tinospora, Carica papaya*, or any normal type
9. Secretory tissue: Resin canal, Nectary, Latex vessel, Lysigenous and Schizogenous cavities. Laticifers – Articulated and non articulated.
10. Epidermal structures –Stomata.
11. Anomalous secondary thickening - *Bignonia, Boerhaavia*
12. Leaf anatomy - Dicot leaf: *Ixora*. Monocot leaf : Grass

Reproductive Botany **2 hrs**

Students should be familiar with the structure of anther and embryo (Permanent slides can be used)

Palynology **4 hrs**

Study of pollen morphology of the following plants –*Hibiscus*, *Vinca*, *Balsam, Ixora, Crotalaria, Bougainvillea.* by microscopic observation

Suggested Readings

1. Prasad and Prasad (1972) Out lines of Botanical Micro technique, Emkay publishers, New Delhi Coutler E. G. (1969) Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
2. Esau K. (1965) - Plant Anatomy – Wiley Eastern, New York.

3. Fahn A. (1985) - Plant Anatomy – Pergamon Press, Oxford.
4. Pandey, B .P. (1997) - Plant Anatomy - S.Chand and co. New Delhi Biology - McGraw Hill Co, New York.
5. Vashista .P. C (1984) - Plant Anatomy – Pradeep Publications – Jalandhar
6. Maheswari P. - Embryology of Angiosperms - Vikas Pub: 29.Nair PKK Palynology of Angiosperms

SEMESTER III

Core Course V

BV1342.1

Bryology, Pteridology, Gymnosperms & Paleobotany

Credits: 2 **Contact Hourse: 54 (Theory 36 + Practical 18)**

Aim and Objective: It's a course on lower plants such as bryophytes, pteridophytes and gymnosperms. It will give the students the fundamentals on the systematics, morphology and anatomy and life cycle of these lowerplants, which are essential for the proper understanding of the biosphere**.**

Module -I

Bryology **10 hrs**

1. Introduction and Classification
2. Study of the habit, thallus organization, vegetative and sexual reproduction and alternation of generation of the following types ***(Developmental details are not required)***. *Riccia, Marchantia, Funaria*
3. Economic Importance of Bryophytes.

Module- II **12 hrs**

Pteridology

1. Introduction: General characters morphological features and classification by Smith.
2. Study of the habitat, habit, internal structure, reproduction and life cycle of the following types ***(Developmental details not required)***. *Psilotum, Lycopodium, Selaginella, Equisetum, Pteris* and *Marsilea.*

Module- III **2 hrs**

3. General Topics: Stelar evolution in Pteridophytes, heterospory and seed habit, relationships of pteridophytes with bryophytes and gymnosperms, economic importance of pteridophytes.

Module- IV **8 hrs**

Gymnosperms

1. Introduction and classification of gymnosperms.
2. Study of the Habit, Anatomy, Reproduction and life cycle of the following types ***(Developmental details are not required)*** – *Cycas, Pinus* and *Gnetum*
3. Evolutionary trends in gymnosperms - Relationship of gymnosperm with pteridophytes and angiosperms
4. Economic importance of gymnosperms.

Module-V

Palaeobotany **4 hrs**

1. Introduction to palaeo botany. Fossil formation – Techniques of study.
2. Geological time scale. Evolutionary trends
3. Fossil pteridophytes – *Rhynia* , *Lepidodendron*, *Lepidocarpon* . Fossil Gymnosperm *Lyginopteris*.
4. Applied aspects of Palaeobotany - Exploration of fossils

Practical **18 Hrs**

Bryology **4 Hrs**

1. *Riccia* – Habit - Internal structure of thallus – V. S. of thallus through archegonia, antheridia and sporophyte
2. *Marchantia* –Habit- thallus T. S., thallus with Archegonial receptacle, Antheridial receptacle, Male receptacle V .S., Female receptacle e VS., T.S . of thallus through gemma, Sporophyte V. S .
3. *Funaria* – Habit, V. S. of archegonial cluster, V .S. of antheridial cluster, Sporophyte V. S.

Pteridology **8 hrs**

1. *Psilotum* : External features , stem T .S ., synangium T. S .
2. *Lycopodium* : Habit, stem T. S. , strobilus V. S.
3. *Selaginella* : Habit , rhizophore T. S , stem T . S, axis with strobilus, V .S. of strobilus, Megasporophyll and microsporophyll.
4. *Equisetum* - Habit, rhizome and stem T .S. and V. S. of strobilus.
5. *Pteris* - Habit, Petiole T. S., sporophyll T. S. , prothallus
6. *Marsilea* - Habit, Rhizome and petiole T. S., sporocarp T.S, V. S. & R.L .S.

Gymnosperms **5 hrs**

1. *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and petiole, micro and mega sporophyll, male cone V. S., micro sporophyll T. S. , entire and V. S of ovule.
2. *Pinus* – Dwarf shoot, T. S of needle, male and female cone, V .S. of male and female cone.
3. *Gnetum* -: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, V. S. of male and female cone, ovule V. S. and seed

Paleobotany **1 hr**

1. Fossil pteridophytes – *Rhynia* Stem, *Lepidodendron*, *Lepidocarpon*.
2. Gymnosperm - *Lyginopteris*

Suggested Reading

1. Chopra RN and P. K. – Biology of Bryophytes - Wiley Eastern Ltd. New Delhi
2. Parihar N .S. – An introduction to Bryophyta - Central Book Depot. Alahabad
3. Vasishta B. R. - Bryophyta - S. Chand and Co. New Delhi
4. Coutler. J. M. - and Chamberlain C. J. (1958) – Morphology of Gymnosperms - Central Book Depot, Allahabad
5. Gupta V .K. and Varshneya U. D (1967) – An Introduction to Gymnosperms – Kedarnath, Ramnath – Meerut.
6. Smith G.M. (1955) - Cryptogamic Botany – Vol.II – Mc Graw Hill Co. New Delhi

7. Sporne K. R. (1966) - Morphology of Pteridophytes - Hutchin University Library , London
8. Sporne K. R. (1967) - Morphology of Gymnosperms - Hutchin University Library , London
9. Vashista B. R. (1993) - Pteridophyta – S.Chand and co. New Delhi 10.Vashista B. R. (1993) Gymnosperms - S. Chand and co. New Delhi
11. Andrews H.N. (1967) - Studies on Palaeobotany – C .J. Felix.
12. Arnold C. A (1947) - Introduction to Palaeobotany - McGraw Hill Co. New Delhi.

EMESTER IV

Core Course VI

BV1441.1 Plant Physiology

Credits: 2 **Contact hours: 54 (Theory36 + Practical 18)**

Aim and Objective: The course should give the fundamentals about the biophysical and biochemical aspects on the functioning of the plant system. Students should learn the functions of various plant system through very specific experiments, which are very important to understand the basis of life activities. It should prepare the students pursue higher studies in plant science as well as in Biotechnology.

Module I **10 hrs**

General introduction- physiological processes, their significance and applications.

Water relations of plants: Importance of water to plant life.

a. Absorption of water- organs of absorption, root and root hair. Physical aspects of absorption- imbibition, diffusion and osmosis. Plant cell as an osmotic system; water potential and osmotic potential. Plasmolysis and its significance, practical applications. Mechanism of water absorption – active and passive absorption, root pressure. Pathway of water across root cells.

b. Ascent of sap- vital and physical theories.

c. Loss of water from plants: transpiration - cuticular, lenticular and stomatal mechanism - theories – starch sugar hypothesis, potassium - ion theory. Significance of transpiration - guttation, anti - transpirants, factors affecting transpiration.

d. Water stress and its physiological consequences to drought.

Mineral nutrition: Gross chemical analysis of the plant body, ash analysis, criteria for essentiality of elements, macro and micro elements, role of essential elements and their deficiency symptoms. Culture methods - sand culture, hydroponics and aeroponics. Mechanism of mineral absorption (a) passive absorption- ion exchange and Donnan equilibrium (b) active absorption- carrier concept, Lundegardh hypothesis.

Module II **8 hrs**

Photosynthesis: Introduction, significance and general equation. Photosynthetic apparatus, structure and function of chloroplast, quantasomes - solar spectrum and its importance - Fluorescence and phosphorescence. Red drop, Emerson effect- Two pigment systems- raw material for photosynthesis- Mechanism of photosynthesis- Light reaction - cyclic and non cyclic photophosphorylation. Hill reaction - Dark reaction: Calvin cycle. Comparative study of C3, C4, and CAM plants. Photorespiration. Factors affecting photosynthesis - Law of limiting factor.

Module III **6 hrs**

Respiration: Introduction, definition and significance and general equation. Respiratory substances, types of respiration- aerobic and anaerobic. Aerobic respiration - glycolysis, Krebs's cycle, terminal oxidation. Anaerobic respiration – fermentation: alcoholic and lactic acid fermentation. Energy relation of respiration - R .Q and its significance - Factors affecting respiration.

Module IV **7 hrs**

Translocation of solutes: Path way of movement, phloem transport, mechanism of transport - Munch hypothesis, protoplasmic streaming theory

Nitrogen metabolism: Source of nitrogen - Biological nitrogen fixation - symbiotic and asymbiotic. Reduction of nitrate - reductive amination and transamination. Nif genes - Leghaemoglobin.

Enzymes - general account - structure, classification and nomenclature (recommended by Commission on Enzymes). Mechanism of enzyme action - inhibition of enzymes - regulation of enzymes - allosteric inhibition - Iso - enzymes, coenzymes and cofactors - effect of temperature on enzyme action – effect of pH.

Module IV **5 hrs**

Growth: Phases of growth - vegetative and reproductive growth - growth curve - plant growth regulators - Auxins, Gibberellins, Cytokinins, Ethylene, Absciscic acid - synthetic plant hormones - practical applications. Senescence and abscission. **Photoperiodism** and

Vernalization - phytochrome and its significance.

Plant movements: Tropic and nastic movements. Circadian rhythm and biological clock. **Stress physiology**: water stress, salt stress.

Practical **18 hrs**

1. Water potential of onion peel / *Rhoeo* peel by plasmolytic method.
2. Imbibition of water by different types of seeds.
3. Effect of temperature on permeability.
4. Papaya petiole osmoscope.
5. Determination of stomatal index.
6. Compare the rate of transpiration by the upper and lower surface of the leaf by cobalt chloride method.
7. Determination of water absorption and transpiration ratio.
8. Measurement of rate of transpiration using Ganong's potometer or Farmer's potometer.
9. Separation of plant pigments by paper chromatography.
10. Evolution of oxygen during photosynthesis.
11. Measurement of photosynthesis by Wilmot's bubbler.
12. Evolution of CO_2 during respiration.
13. Ganong's respirometer and measurement of R .Q.
14. Simple respiroscope.
15. Alcoholic fermentation using Kuhn en's fermentation vessel.
16. Geotropism using clinostat.
17. Measurement of growth using Arc auxanometer.

Suggested readings

1. Verma V 2007, Text Book of Plant Physiology. Ane Books Pvt. Ltd
2. Devlin & Witham – Plant Physiology (C B S publishers).
3. Kochhar P. L. & Krishnamoorthy H. N. – Plant Physiology. (Atmaram & Sons- Delhi, Lucknow).
4. Richard F Venn 2004, Principles and Practice of Bioanalysis, Taylor & Francis, Ane Books Pvt. Ltd
5. Kumar & Purohit – Plant Physiology - Fundamentals and Applications

(Agrobotanical publishers]

6. Malic C. P. & Srivastava A. K. – Textbook of Plant Physiology (Kalyani Publishers- New Delhi).
7. Noggle G R & Fritz G J – Introductory Plant physiology (Prentice Hall of India).
8. Pandey S.N. & Sinha B. K. – Plant physiology (Vikas publishing House- New Delhi).
9. Salisbury F. B. & Ross C. W. - Plant physiology. (Wadsworth publishing company).
10. Sundara Rajan S. – College Botany Vol.IV (Himalaya publishing House).
11. William G. Hopkins – Introduction to Plant Physiology (John Wiley & Sons, New York).

SEMESTER IV

Core Course VII

BV 1442.1 Cell Biology, Plant Breeding & Evolutionary Biology

Credits: 2 **Contact Hours: 54 (Theory 36 + Practical 18)**

Aim and Objective: The course should impart the basics of the biology plant cell and its structural and functional relationship. It should equip the students to understand the fine cellular and molecular details of the4 plant system in total.

Module-I

Cell biology **20 hrs**

1. History and progress of cell biology
2. Ultra structure and functions of the cell components and organelles (A brief account only)-Cell wall; The cell membrane, Endoplasmic reticulum, Ribosomes, Golgi apparatus, Lysosomes, Peroxisomes, Vacuole, Mitochondria, Chloroplast & Nucleus
3. The chromosomes- Chromosome morphology- Eukaryotic chromosomes and its molecular organization. Chromatin - composition and structure; hetero chromatin and euchromatin; Chemical organization. Nucleoproteins – histones and non – histones. Nucleosome model of DNA organization.
4. Special types of chromosomes- Salivary gland, Lamp brush and B chromosomes
5. Variation in Chromosome number (Numerical aberrations)- anueploidy and Euploidy- haploidy , polyploidy- significance.
6. Variation in Chromosome structure (Structural aberrations) - deletion, duplication, inversion and translocation; significance.
7. Mitosis and Meiosis: Transmission of genetic information - cell cycle : Significance of mitosis and meiosis

Module II **10 hrs**

Plant breeding

1. **Introduction**, objectives in plant breeding**.**

2. **Plant introduction**. Agencies of plant introduction in India, Procedure of introduction - Acclimatization - Achievements.
3. **Selection** - mass selection, pure line selection and clonal selection. Genetic basis of selection methods.
4. **Hybridization**: Procedure of hybridisation, inter generic, inter specific, inter varietal hybridisation with examples. Composite and synthetic varieties.
5. **Heterosis** and its exploitation in plant breeding.
6. **Mutation breeding** – method – achievements in India.
7. **Breeding for pest**, diseases and stress resistance.

Module -III

EvolutionaryBiology **6 hrs**

1. Progressive and Retrogressive evolution.
2. Parallel and Convergent evolution.
3. Micro and Macro evolution.
4. Theory of Lamarck, Wiesman and De Vries, Darwinism, Neo- Darwinism
5. Isolation, Mutation, Genetic drift, Speciation
6. Variation and Evolution – Hybridization and Evolution – Polyploidy and evolution – Mutation and evolution.

Practical **18 Hrs**

1. Study of Microscopes- different magnification of light microscopes
2. Examination of different types of cells- single celled and multicellular systems
3. Make acetocarmine squash preparation of onion root tip and to identify different stages of mitosis
4. Determination of Mitotic Index
5. Make squash preparation of the flower buds of any of the following plants. *Rhoeo, Capsicum* (To identify Meiosis)
6. Preparation of Karyotype
7. Microscopical examination and assessment of starch granules from potato, rice, tapioca etc
8. Fixation of specimens for cytological studies, Preparation of cytological stains like acetocarmine and safranin.

Suggested Readings

1. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
2. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books, Pvt. Ltd
3. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
3. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
4. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
5. Darnel, J.Lodish, Hand Baltimore, D. (1991) Cell and molecular biology. Lea and Fibiger, Washington.
6. De Robertis, E.D.P and Robertis, E.M.P (1991) Cell and molecular biology Scientific American books.
7. Cohn, N.S. (1964) Elements of Cytology. Brace and World Inc, New Delhi
8. Dobzhansky, B (1961) Genetic and origin of species, Columbia university Press New York
9. Gerald Karp (1985) Cell biology, Mc Graw Hill company..
10. Lewin, B, (1994) Genes, Oxford University Press, New York.

11. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
12. Roy S.C. and Kalayan kumar De (1997) Cell biology. New central Boos Calcutta
13. Sharma, A.K and Sharma a (1980) Chromosome technique Theory and practice, Aditya Books, New York
14. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
15. Sandhya mitra,(1998)Elements of molecular biology. Macmillan, India Ltd.
16. Twymann, R.M. (1998) Advanced molecular biology Viva books New Delhi.
17. Allard RW (1960) Principles of Plant Breeding. John willey and Sons. Inc. New York
18. Sharma JR (1994) Principles and Practices of Plant Breeding. Tata McGraw-Hill Pub. Co. New Delhi
19. BD Singh (2003) Plant Breeding. Kalyani Publishers

Semester IV

Core Course VIII

BV1443.1

Practical Botany II

(Practical of BV1341.1, BV1342.1, BV1441.1 & BV1442.1)

Credits: 2 **Contact Hours: Practical hours of the above courses**

BV1341.1 Angiosperm Anatomy and Reproductive Botany **36 Hrs**

Anatomy **30 hrs**

1. Non living inclusions - Cystolith, Raphide, Sphaero-raphide, Aleurone grains.
2. Starch grains (Eccentric, concentric, compound)
3. Simple permanent tissue – Parenchyma, Chlorenchyma , Aerenchyma , Collenchyma and Sclerenchyma
4. Primary structure – Dicot stem: Hydrocotyle, Eupatorium.
5. Monocot stem: Grass and Asparagus.
6. Dicot root: Pea and Limnanthemum
7. Monocot root: Colocasia or any monocot root.
8. Secondary structure - Stem [Normal type]- Vernonia
9. Secondary structure - Root [Normal type]- Tinospora, Carica papaya, or any normal type
10. Secretory tissue: Resin canal, Nectary, Latex vessel, Lysigenous and Schizogenous cavities. Laticifers – Articulated and non articulated.
11. Epidermal structures –Stomata.
12. Anomalous secondary thickening - Bignonia, Boerhaavia
13. Leaf anatomy - Dicot leaf: Ixora. Monocot leaf : Grass

Reproductive Botany **2 hrs**

Students should be familiar with the structure of anther and embryo (Permanent slides can be used)

Palynology **4 hrs**

Study of pollen morphology of the following plants –*Hibiscus*, *Vinca*, *Balsam, Ixora, Crotalaria, Bougainvillea* by microscopic observation.

BV1342.1 Bryology, Pteridology, Gymnosperms & Paleobotany **18 hrs**

Bryology **4 Hrs**

4. *Riccia* – Habit - Internal structure of thallus – V. S. of thallus through archegonia, antheridia and sporophyte
5. *Marchantia* –Habit- thallus T. S., thallus with Archegonial receptacle, Antheridial receptacle, Male receptacle V .S., Female receptacle e VS., T.S . of thallus through gemma, Sporophyte V. S .
6. *Funaria* – Habit, V. S. of archegonial cluster, V .S. of antheridial cluster, Sporophyte V. S.

Pteridology **8 hrs**

7. *Psilotum* : External features , stem T .S . , synangium T. S .
8. *Lycopodium* : Habit, stem T. S. , stobilus V. S.
9. *Selaginella* : Habit , rhizophore T. S , stem T . S, axis with strobilus, V .S. of strobilus, Megasporophyll and microsporophyll.
10. *Equisetum* - Habit, rhizome and stem T .S. and V. S. of strobilus.
11. *Pteris* - Habit, Petiole T. S., sporophyll T. S. , prothallus
12. *Marsilea* - Habit, Rhizome and petiole T. S., sporocarp T.S, V. S. & R.L .S.

Gymnosperms **5 hrs**

4. *Cycas* – seedling, coralloid root and coralloid root T. S., T. S. of leaflet and petiole, micro and mega sporophyll, male cone V. S., micro sporophyll T. S. , entire and V. S of ovule.
5. *Pinus* – Dwarf shoot, T. S of needle, male and female cone, V .S. of male and female cone.
6. *Gnetum* -: Habit, stem T. S (young and mature), leaf T. S, male and female strobilus, W. S. of male and female cone, ovule V. S. and seed

Palaeobotany **1 hr**

3. Fossil pteridophytes – *Rhynia* Stem, *Lepidodendron*, *Lepidocarpon*.
4. Gymnosperm - *Lyginopteris*

BV1441.1 Plant Physiology **18 hrs**

1. Water potential of onion peel / Rhoeo peel by plasmolytic method.
2. Imbibition of water by different types of seeds.
3. Effect of temperature on permeability.
4. Papaya petiole osmoscope.
5. Determination of stomatal index.
6. Compare the rate of transpiration by the upper and lower surface of the leaf by cobalt chloride method.
7. Determination of water absorption and transpiration ratio.
8. Measurement of rate of transpiration using Ganong's potometer or Farmer's potometer.
9. Separation of plant pigments by paper chromatography.
10. Evolution of oxygen during photosynthesis.
11. Measurement of photosynthesis by Wilmot's bubbler.
12. Evolution of CO2 during respiration.
13. Ganong's respirometer and measurement of R .Q.
14. Simple respiroscope.
15. Alcoholic fermentation using Kuhn en's fermentation vessel.

16. Geotropism using clinostat.
17. Measurement of growth using Arc auxanometer.

BV1442.1 Cell Biology, Plant Breeding and Evolutionary Biology **18 Hrs**

1. Study of Microscopes- different magnification of light microscopes
2. Examination of different types of cells- single celled and multicellular systems
3. Make acetocarmine squash preparation of onion root tip and to identify different stages of mitosis
4. Determination of Mitotic Index
5. Make squash preparation of the flower buds of any of the following plants. *Rhoeo, Capsicum* (To identify Meiosis)
6. Preparation of Karyotype
7. Microscopical examination and assessment of starch granules from potato, rice, tapioca etc
8. Fixation of specimens for cytological studies, Preparation of cytological stains like acetocarmine and safranin.

SEMESTER V

Core Course IX

BV1541.1 Angiosperm Morphology and Systematic Botany

Credits: 4 **Contact hours: 108 (T 72 + P 36)**

Aim and Objective: The course is designed to give a basic awareness in systematic botany and morphology of higher plants and the course will generate interest on students to pursue continuous studies in systematic botany.

Module I

Morphology **12 hrs**

Brief account on the various types of inflorescence including special types (Cyathium, Verticillaster, Hypanthodium, Coenanthium and Thyrsus) with examples; floral morphology- Flower-as a modified shoot, Flower parts, their arrangements, relative position, numeric- plan, cohesion, adhesion, symmetry of flower, aestivation types, placentation types; floral diagram and floral formula Fruit types: simple, aggregate and multiple. Seeds: albuminous and exalbuminous.

Module –II **8 hrs**

Systematic Botany

Definition, scope and significance of Taxonomy, Systems of classification

1. Artificial- Linnaeus sexual system
2. Natural - Bentham and Hooker (detailed account)
3 Phylogenetic- Engler and Prantl (Brief account only)

Module –III **7 hrs**

Basic rules of Binomial Nomenclature and International Code of Botanical nomenclature (ICBN). Importance of Herbarium, Herbarium techniques and Botanical gardens. A brief account on the modern trends in taxonomy; Chemotaxonomy, Numerical Taxonomy, Cytotaxonomy and Molecular taxonomy

Module –IV **45 hrs**

A study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker's system)

1	Annonaceae	8	Cucurbitaceae	15	Solanaceae	22	Arecaceae
2	Nymphaeaceae	9	Apiaceae	16	Acanthaceae	23	Poaceae
3	Malvaceae	10	Rubiaceae	17	Verbenaceae		
4	Rutaceae	11	Asteraceae	18	Amaranthaceae		
5	Anacardiaceae	12	Sapotaceae	19	Euphorbiaceae		
6	Leguminosae	13	Apocynaceae	20	Orchidaceae		
7	Myrtaceae	14	Asclepiadiaceae	21	Liliaceae		

Practical **36 hrs**

1. Study on various types of inflorescences with vivid record of practical work.
2. Students must be able to identify the angiosperm members included in the syllabus up to the level of families.
3. Draw labeled diagram of the habit, floral parts, L S of flower, T S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms
4. Students must submit practical records, Herbarium sheets (25 Nos:) and Field book at the time of practical examination.
5. Field trips are to be conducted for three days either as continuous or one day trips.

Suggested Readings

3. Sivarajan,V.V. Introduction to the principle of plant taxonomy, Oxford and IBH Publishing Company
4. Pandey SN and Misra SP, 2008 Taxonomy of Angiosperms; Ane Books Pvt. Ltd.
5. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.
6. Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York, Ane Books Pvt. Ltd
7. Davis, P.11. and Haywood, V.H, 1963. Principles of Angiosperm Taxonomy. Oliver and Royd, London.
8. Heywood, V.H. and Moore D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
9. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-Hill Book Co., New York.
10. Lawrence. G.H.M. 1951. Taxonomy of Vascular Plants. Macmillan, New York.
11. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New York.
12. Radford. A.E.1986. Fundamentals of Plant Systematics Harper and Row, New York.
13. Singh. G. 1999. Plant Systematics: Theory and practice Oxford & IBH Pvt, Ltd. New Delhi.
14. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge London.
15. Stace. C.A. 1989. Plant Taxonomy and Biosystematics. 2nd ed. Edward Arnold,London.
16. Woodland. D.E. 1991. Contemporary Plant Systematics. Prentice Hall, NewJersay.
17. Nordenstam. B., El-Gazaly, G. and Kassas. M. 2000. Plant Systematics for 21st Century

SEMESTER V

Core Course X

BV1542.1 Economic Botany, Ethnobotany & Medicinal Botany

Credits 3 **Contact Hours 72 (Theory 54 + P 18)**

Module I **5 hrs**

Economic botany

1. Study of the major crops in Kerala with special reference to their Methods of cultivation, Botanical description, morphology of the useful part and economic importance – Coconut and Paddy.

2. A brief account on the utility of the following plants, specifying the Binomial, family and morphology of the useful parts. **12 hrs.**

Fruits & Vegetables- Banana, Jackfruit, Pineapple, citrus, Apple, Cashew, Watermelon, Tomato, Brinjal, Common bean, Sword bean, Pumpkin, Cucumber, Snake gourd, Bitter gourd, Ash gourd, Bottle gourd.

Cereals and millets	-	Wheat and Ragi
Pulses	-	Black gram and Bengal gram
Sugar yielding Plants	-	Sugar cane
Spices	-	Pepper and Cardamom
Beverages	-	Coffee
Fibre yielding plant	-	Cotton
Dye Yielding plants	-	Henna and *Bixa orellana*
Resins	-	Asafoetida
Tuber crops	-	Tapioca
Oil yielding Plants	-	Sesame and Coconut
Insecticides	-	Neem

Module II

Ethnobotany **12 hrs**

1. Definition - importance, scope, categories and significance.
2. Study of various methods to collect Ethno botanical data.
3. Plant parts used by tribes in their daily life as food, clothing, shelter, agriculture and medicine.
4. Study of common plants used by tribes. *Aegle marmelos*, *Ficus religiosa*, *Cynodon dactylon, Ocimum sanctum* and *Trichopus zeylanicus*
5. Ethnobotanic aspect of conservation and management of plant resources
6. Preservation of primeval forests in the form of sacred groves of individual species

Module III **15 hrs**

Medicinal botany

1. Importance and the need for its conservation- Sacred groves. Role of ICAR, IMPB, BSI, NBGRI in conservation and cultivation of medicinal plants

2. A general account of the medicinal value of plant parts - Rhizome-*Curcuma* and *Zingiber;* Bulb-*Allium cepa* and *A. sativum*; Root- *Asparagus, Hemidesmis , Acorus calamus; Adhatoda vasica,*

Ctharanthus roseus, Phyllanthus amarus, Andrographis paniculata; Leaves-*Aloe vera, Centella asiatica* Asoka (*Saraca indica*) and Brahmi (*Bacopa monnieri*) Aswagandha (*Withania somnifera*), Sarpagandha (*Rauvolfia serpentina*)

3. Production of herbal drugs. Extraction procedure-Adulteration of drugs

Module IV **10 hrs**

Definition and scope of Pharmacognosy –Ancient and modern medicines -Sidha, Ayurveda, Unani , Acupuncture, Homoeopathy and Allopathy

1. Sources of crude drugs – roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds

Practical **18 hrs**

2. Collection and study of economically important plants and morphology of the useful parts.
3. Identify the economic products obtained from the plants mentioned under Economic Botany
4. Visit a tribal area and collect information on their traditional method of treatment using crude drugs.
5. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application.
6. Observe the plants of ethno botanical importance in your area
7. Visit to an Ayurveda college or Ayurvedic institution/Research centre

Suggested Readings

1. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.
2. Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York,
3. Davis, P.11. and Haywood, V.H, 1963. Principles of Angiosperm Taxonomy, Oliver and Royd , London.
4. K. Jain. Glimpses of Ethnobotany. Oxford and IBH Publishing Company, New Delhi.
5. S.K. Jain, 1987. A Manual of Ethno botany. Scientific Publishers, Jodhpur 6.T.E Walles. Text book of Pharmacognosy,
7. Rajiv K Sinha. Ethnobotany.

SEMESTER VI

Core Course XI

BV1641.1 - GENETICS

Credits 2 **Contact Hours 126 (T 90 + P 36)**

Aim and Objective: This course is giving a thorough knowledge in classical genetics, which is the base of all genetica studies –basic as well as applied science including genetic engineering and gene therapy. This will prepare the students to pursue higher studies in genetics and molecular biology

Module I

Classical Genetics **50 hrs**

1. Mendelian Genetics- Mendel and his experiments, Mendel's success, Mendelian principles,
2. Mendelian ratios, monohybrid and dihybrid crosses, back cross and test cross Genetics after Mendel-Modified Mendelian ratios; Incomplete dominance -Flower color in Mirabilis ; Interaction of genes-Comb pattern in poultry. 9:3:3:1. Epistasis - Recessive. Coat color in mice. 9:3:4; Dominant epistasis.

Fruit colour in summer squash. 12:3:1; Complementary genes. Flower color in Lathyrus 9:7; Duplicate gene with cumulative effect. Fruit shape in summer squash. 9:6:1; Duplicate dominant genes in shepherd's purse. 15:1; Inhibitory factor. Leaf color in Paddy. 13:3

3. Multiple alleles-General account. ABO blood group in man. Rh factor. Self sterility in *Nicotiana*.

4. Quantitative characters- General characters of quantitative inheritance, polygenic inheritance; Skin color in man, ear size in Maize.

5. Linkage and crossing over- Linkage and its importance, linkage and independent assortment. Complete and incomplete linkage. Crossing over – a general account, two point and three point test cross. Determination of gene sequence. Interference and coincidence. Mapping of chromosomes.

6. Sex determination- Sex chromosomes, chromosomal basis of sex determination XX- XY, XX-XO mechanism. Sex determination in higher plants (*Melandrium album*) Genic balance theory of sex determination in *Drosophila.* Sex chromosomal abnormalities in man. Klinefelter's syndrome, Turner's syndrome. Sex linked inheritance. Sex influenced and sex limited traits, Eye color in *Drosophila*, Hemophilia in man. Y- Linked inheritance.

7. Extra nuclear inheritance- General account, maternal influence. Plastid inheritance in *Mirabilis*. Shell coiling in snails, kappa particle in *Paramecium*.

MODULE-III

Molecular Genetics **30 hrs**

1. **DNA as genetic material**- Structure of DNA; A, B and Z forms of DNA, satellite and repetitive DNA

2. **Replication of DNA**, Circular and helical DNA. Semi conservative model, experimental support, Meselson and Stahl experiment. Enzymology of replication: topoisomerase, helicase, primase, polymerase and ligase. DNA repairing mechanism.

3. **RNA structure**- Properties and functions of tRNA, mRNA and rRNA. Genetic code.

4. **Synthesis of protein**: Transcription, translation -Central dogma-reverse transcription

5. **Concept of gene**-Units of a gene, cistron, recon, muton; Types of genes- House keeping genes (constitutive genes), Luxury genes (non constitutive genes), interrupted genes (Split genes) - introns, overlapping gene.

6. **Transposable genetic elements**- General account, Characteristic, Transposons (jumping genes), Cellular oncogenes (general account only).

Module IV **10Hrs**

Population Genetics

Gene frequency and genotype frequency, Hardy Weinberg Law, factors affecting equilibrium – Mutation, migration and selection.

Practicals **36 hrs**

Work out problems in

1. Monohybrid cross (Dominance and incomplete dominance)
2. Dihybrid cross (Dominance and incomplete dominance)
3. Gene interactions (All types of gene interactions mentioned in the syllabus)

a. Recessive epistasis 9: 3: 4.
b. Dominant epistasis 12: 3: I
c. Complementary genes 9: 7
d. Duplicate genes with cumulative effect 9: 6: 1
e. Inhibitory genes 13: 3
f. Duplicate dominant gene 15: 1
g. Comb pattern in poultry 9:3: 3:1

4. Linkage and crossing over
5. .Two point and three point crosses
6. Construction of genetic map.
7. Application of Hardy Weinberg formula to population genetics

Suggested Readings

1. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
2. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd
3. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
4. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
5. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
6. John Ringo (2004) Fundamental Genetics. Cambridge University Press India Pvt. Ltd.
7. Dobzhansky, B (1961) Genetic and origin of species, Columbia university Press New York 8.Gardner,E.J and Snustad,D.P(1984) Principles of Genetics. John Wiley, New York.
9. Gupta, P. K. Genetics, Rastogi Publications.
10. Lewin, B, (1994) Genes, Oxford University Press, New York.
11. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
12. Gupta P. K. – Genetics (Rastogi publications).
13. Sharma, A.K and Sharma a (1980) Chromosome technique Theory and practice, Aditya Books, New York 14. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.

SEMESTER VI

Core Course XII

BV1642.1 Practical Botany III

(Practical of BV1541.1, BV1542.1 & BV1641.1)

Credit 3 **Contact Hours: 72 (Practical Hours of the above courses)**

BV1541.1 Angiosperm Morphology and Systematic Botany **36 hrs**

1. Study on various types of inflorescences with vivid record of practical work.
2. Students must be able to identify the angiosperm members included in the syllabus up to the level of families.
3. Draw labeled diagram of the habit, floral parts, L S of flower, T S of ovary, floral diagram, floral formula and describe the salient features of the member in technical terms

4. Students must submit practical records, Herbarium sheets (25 Nos:) and Field book at the time of practical examination.

5. Field trips are to be conducted for three days either as continuous or one day trips.

The members of the following families should be studies in detail with its floral and other morphological characters; plants should be collected and submitted in the form of a herbarium

1	Annonaceae	9	Apiaceae	17	Verbenaceae
2	Nymphaeaceae	10	Rubiaceae	18	Amaranthaceae
3	Malvaceae	11	Asteraceae	19	Euphorbiaceae
4	Rutaceae	12	Sapotaceae	20	Orchidaceae
5	Anacardiaceae	13	Apocynaceae	21	Liliaceae
6	Leguminosae	14	Asclepiadiaceae	22	Arecaceae
7	Myrtaceae	15	Solanaceae	23	Poaceae
8	Cucurbitaceae	16	Acanthaceae		

BV1542.1 Economic Botany, Ethnobotany & Medicinal Botany **18 hrs**

2 Collection and study of economically important plants and morphology of the useful parts.

3 Identify the economic products obtained from the plants mentioned under Economic Botany

4 Visit a tribal area and collect information on their traditional method of treatment using crude drugs.

5 Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application.

6 Observe the plants of ethno botanical importance in your area

7 Visit to an Ayurveda college or Ayurvedic institution/Research centre

BV1641.1 Genetics **36 hrs**

Work out the following problems in

1. Monohybrid cross (Dominance and incomplete dominance)
2. Dihybrid cross (Dominance and incomplete dominance)
3. Gene interactions (All types of gene interactions mentioned in the syllabus)
    a. Recessive epistasis 9: 3: 4.
    b. Dominant epistasis 12: 3: I
    c. Complementary genes 9: 7
    d. Duplicate genes with cumulative effect 9: 6: 1
    e. Inhibitory genes 13: 3
    f. Duplicate dominant gene 15: 1
    g. Comb pattern in poultry 9:3: 3:1
4. Linkage and crossing over
5. Two point and three point crosses
6. Construction of genetic map.
7. Application of Hardy Weinberg formula to population genetics

Core Courses of Zoology

SEMESTER I

Core Course

BV1141.2 Animal Diversity – I: Nonchordata

Credits: 2 **Contact Hours: 54**

Module I **10 hours**

Kingdom Protista

General characters

Types: Morphology, life history, pathogenicity and prophylaxis of (1) *Entamoeba* and (2) *Plasmodium*
Examples: *Trypanosoma*, *Noctiluca, Paramecium*, *Opalina*

Kingdom Animalia

Outline classification – Subkingdom Mesozoa, (e.g. *Rhopalura*), Subkingdom Parazoa, Subkingdom Eumetazoa.

Levels of organization – cellular, tissue, organ and organ system

Divisions of Eumetazoa – Radiata, Bilateria, Acoelomata, Pseudocoelomata, Eucoelomata, Protostomia, Deuterostomia.

Module II **6 hours**

Phylum Porifera

General characters

Examples: *Sycon, Spongilla and Euplectella;* mention gemmule.

Phylum Coelenterata [= Cnidaria]

General characters

Type: *Obelia* (Structure of colony and medusa, polymorphism, life cycle and alternation of generation)

Class Hydrozoa – e.g. *Hydra, Obelia, Physalia*

Class Scyphozoa – e.g. *Aurelia*

Class Anthozoa – e.g. sea anemone and *Madrepora.*

Corals and coral reefs.

Module III **8 hours**

Phylum Platyhelminthes

General characters

Class Turbellaria – e.g. *Planaria*

Class Trematoda – e.g. *Fasciola*

Class Cestoda – e.g. *Taenia solium*

Phylum AschelmInthes [=Nematoda]

General characters

Examples: *Ascaris*, *Ancylostoma,* and *Wuchereria*

Module IV **4 hours**

Phylum Annelida

General characters

Class Polychaeta: e.g. *Nereis* (structure of parapodium, heteronereis), *Aphrodite*, *Arenicola.*

Class Oligochaeta: e.g. Earthworm (Morphology, structure of seta, digestive system and nervous system)

Class Hirudinea – e.g. leech (*Hirudinaria*)

Vermiculture

Module V **12 hours**

Phylum Onychophora

General characters

Example: *Peripatus* (distribution, morphology and affinities)

Phylum Arthropoda

General characters

Type: *Penaeus*

Class Crustacea – e.g. *Penaeus*, Hermit crab (*Eupagurus*), *Sacculina*

Class Myriapoda – e.g. Millipede, Centipede

Class Insecta – e.g. Cockroach (morphology, mouth parts, digestive system, and nervous system), *Lepisma,* termite, honey bee, silk moth, *Belostoma, Leptocoriza, Oryctes.*

Class Arachnida – e.g. spider, scorpion, *Limulus*

Sericulture

Module VI **8 hours**

Phylum Mollusca

General characters

Class Monoplacophora: e.g. *Neopilina*

Class Aplacophora: e.g. *Neomenia*

Class Amphineura: *Chiton*

Class Scaphopoda: *Dentalium*

Class Pelecypoda: e.g. *Lamellidens, Perna,* pearl oyster.

Class Gastropoda: e.g. *Pila*, *Xancus*

Class Cephalopoda: e.g. *Sepia, Loligo, Octopus and Nautilus.*

Pearl culture

Module VII **6 hours**

Phylum Echinodermata

General characters

Class Crinoidea: e.g. sea lily (*Antedon*)

Class Asteroidea: e.g. starfish (*Asterias*)

Class Ophiuroidea: e.g. brittle star (*Ophiothrix*)

Class Echinoidea; e.g. sea urchin (*Echinus*)

Class Holothuroidea: e.g. sea cucumber (*Holothuria*)

Phylum Hemichordata

General characters (Classification not required)

E.g. *Balanoglossus* (morphology, tornaria larva and affinities)

Suggested Readings

- Dhami, P.S. & Dhami, J.K. *Invertebrate Zoology*. R.Chand & Co, New Delhi
- Ekambaranatha Ayyar, M. & Ananthakrishnan, T. N. *A Manual of Zoology Vol. I (Part I & II)*, S. Viswanathan, Madras
- Jordan, E. L. & Verma, P. S. *Invertebrate Zoology*. S. Chand & Co, New Delhi
- Kotpal, R. L. *Modern Textbook of Zoology: Invertebrates*. Rastogi Pub.
- Nair, N.C. et al. *A Textbook of Invertebrates* SARAS Publications
- Anderson, D. T. (Ed.) *Invertebrate Zoology*. Oxford Uty. Press
- Barrington, E.W.J. *Invertebrate Structure and Function*
- Borradaile, L.A. et al. *The Inveretebrates*. Cambridge University Press.
- Hyman, L.H. *Invertebrate Volumes*, McGraw Hill Book Co.
- Parker and Haswell (Ed. Marshall and Williams). *A Textbook of Zoology, Invertebbrates Vol. I*. CBS Pub. & Distributors, New Delhi
- Ruppert, E.E., Fox, R.S. and Barnes, B.D. *Invertebrate Zoology*, Thomson Books.

SEMESTER II

Core Course

BV1241.2: Environmental Studies

Credits: 4 **Contact Hours: 72**

Environmental Biology

Module I **8 hours**

Introduction: Ecology- definition and relation to humanity; subdivisions- autecology and synecology; definitions of ecological niche, habitat, population, community, ecosystem and biosphere.

Module II **14 hours**

1. Components of ecosystem: abiotic and biotic components; autotrophs and heterotrophs; producers, consumers, decomposers and transformers.
2. Ecosystem function: production, consumption, decomposition and transformation; productivity- primary and secondary productivity; trophic structure, food chain and food web; ecological pyramids; keystone species.
3. Ecological energetics: energy flow in ecosystem and the laws of thermodynamics.
4. Pond as an ecosystem.

Module III **10 hours**

1. Biogeochemical cycles: Types of cycles – gaseous and sedimentary cycles with examples; carbon cycle and nitrogen cycle.
2. Limiting factors: concept of limiting factor – Leibig's law of minimum, Shelford's law of tolerance and Combined concept of limiting factors.

3. Ecological factors: Light and temperature
4. Light as a limiting factor
5. Temperature as a limiting factor

Module IV **10 hours**

1. Community ecology: concept of biotic community with examples; community structure; species diversity; dominance; composition and stratification; ecotone and edge effect; Gause's competition exclusion principle; ecological indicators.
2. Ecological succession: definition; types of succession with examples; seral stages and concept of climax.
3. Ecological succession in a pond.

Module V **12 hours**

1. Population ecology: Population – definition and properties- density, mortality, natality, age distribution; biotic potential, intrinsic rate of natural increase, environmental resistance and carrying capacity; growth forms- J- and S-shaped curves; life history immigration; population regulation – density-independent and density-dependent.
2. Population interactions (positive and negative)

Module VI **18 hours**

1. Habitat Ecology: physicochemical features, characteristic flora and fauna and adaptations of the following:
   (a) Terrestrial habitat: concept of biomes; Arctic tundra, deserts, grasslands and forests (various types)
   (b) Freshwater habitat: lentic and lotic habitats; ponds, lakes, rivers and streams.
   (c) Marine habitat: pelagic and benthic; littoral and deep sea; estuaries.
2. Global Ecology: global environmental change – global warming; greenhouse effect.
3. Pollution: Air pollution; Water pollution

Module VIII **18 hours**

Conservation Biology

1. Introduction: Need of conservation biology and its philosophical background.
2. Extinction: causes of extinction; rates of extinction; human caused extinction.
3. Conservation of Biodiversity: in situ and ex situ conservation; gene bank.
4. Environmental conservation: natural resources- various types; reasons for conservation of natural resources; forest and wildlife – importance and conservation; importance of wet lands with special reference to mangroves.
5. Protected areas – biosphere reserves, national parks and sanctuaries;
6. Conservation and sustainable development.
7. Conservation of Natural resources
8. Deforestation and consequences
9. Biosphere reserves, National parks and Sanctuaries in Kerala

Suggested readings

· Arumugam, N. Concepts of Ecology. Saras Publications.

· Kumar, H.D. Modern Concepts of Ecology. Vikas Publishing House.

· Sharma, P.D. Ecology and Environment. Rastogi.
· Sing, H.R. Introduction of Animal Ecology. S.Chand & Co.
· Verma, P.S. and Agarwal, V.K. Environmental Biology. S. Chand & Co.
· Chapman, J.L. and Reiss, M.J. Ecology. Cambridge University Press.
· Dash, M.C. Fundamentals of Ecology. TMH
· Kendeigh. Animal Ecology. Prentice Hall
· Kormondy. E.J. Concepts of Ecology. Prentice Hall
· Mukherjee, B. Environmental Biology. TMH
· Odum, E.P. Ecology. Amerind Pub. Co.
· Odum, E.P. Fundamentals of Ecology. Natraj Publishers
· Stiling, P. Ecology Theories and Applications. PHI
· Wright, R.T. Environmental Science. PHI

SEMESTER I & II

Core Course

BV1244.2: Practical Zoology – I

[Practical of BV1141.2 & BV1241.2]

Credits: 2 **Contact Hours: Semester I: 36; Semester II: 36; Total: 72**

I. Study of permanent slides / specimens

Protista (2), Sponges (1), Coelenterata (4), Platyhelminthes (2), Aschelminthes (2), Annelida (2), Arthropoda (4), Mollusca (2), Echinodermata (2), Hemichordata (1), Prochordates (2), Cyclostomata (1), Pisces (8), Amphibia (3), Reptilia (4), Aves (2), quill feather, Mammalia (2).

II. Osteology

Human skeleton: pectoral girdle, pelvic girdle, typical vertebra, atlas, axis.

III. Study of Animal anatomy

Minor practical (any five)

1.	Nereis	:	Parapodium mounting
2.	Earthworm	:	mounting of setae
3.	Penaeus	:	mounting of appendages
4.	Cockroach	:	mounting of mouth parts, salivary apparatus (in situ)
5.	Shark	:	Placoid scale mounting
6.	Mackerel	:	Cycloid scale mounting (minor)
7.	Mullet	:	Ctenoid scale mounting (minor)

Major practical (any two)

1.	Earthworm	-	Nervous system
2.	Cockroach	-	Digestive system
3.	Prawn	-	Nervous system

SEMESTER III

Core Course

BV1341.2 Developmental Biology and Reproductive Biology

Credits: 3 **Contact Hours: 36**

Module I **8 hours**

Introduction and developmental processes

1. Historical perspective- preformation, epigenesis, germplasm and biogenetic law; aim and scope of Developmental Biology
2. Egg: structure of a typical egg; classifications based on the amount and distribution of yolk; polarity and egg envelopes.
3. Cleavage: types – holoblastic and meroblastic; meridional, equatorial, vertical and latitudinal; patterns – radial, spiral, bilateral, rotational; morula stage; cell lineage.
4. Blastulation: types of blastula – stereoblastula, coeloblastula, discoblastula, periblastula, blastocyst.
5. Fate map: Definition, presumptive organ forming areas.
6. Gastrulation: Definition; definition and types of morphogenetic movements – epiboly, emboly, invagination, involution, delamination, convergence, divergence. Germ layers and fate of germ layers.
7. Cell Differentiation: potency-unipotency, pluripotency and totipotency of embryonic cells, commitment, competence, determination and differentiation; stem cells.
8. Parthenogenesis

Module II **10 hours**

Animal development

1. Development of Amphioxus: cleavage, morula, blastulation, gastrulation.
2. Development of Frog: cleavage, morula, blastulation, gastrulation, neurulation, formation of notochord and mesoderm; organogeny of brain, eye and, heart.
3. Development of Chick: cleavage, blastulation, gastrulation; Study of Primitive streak stage and 24 hour embryo.
4. Embryonic membranes in mammals: Types and functions (development not required)
5. Senescence

Module III **6 hours**

Experimental Embryology

1. Fate map construction: vital staining, carbon particle marking and radioactive tracers.
2. Spemann's constriction experiments.
3. Nuclear transplantation in amphibians.
4. Embryonic induction: concept of induction and organizer; primary, secondary and tertiary induction and organizers.
5. Embryonic stem cells and stem cell research.
6. Cloning in animals

Module IV **12 hours**

Reproductive Biology

1. Reproductive cycles: oestrous and menstrual cycles and their hormonal control.
2. Gonads: Ovary, Graafian follicle, ovulation.
3. Gametes: structure of ovum and spermatozoan.
4. Gametogenesis: Spermatogenesis and oogenesis.
5. Fertilization: agglutination; activation of spermatozoan; activation of ovum; cell surface molecules in sperm-egg recognition; amphimixis; polyspermy.
6. Development of man: fertilisation, blastocyst; implantation; brief account of pregnancy, gestation, parturition and lactation; teratology (definition).
7. Prenatal diagnosis- amniocentesis, chorionic villus sampling, ultrasound scanning.
8. Infertility: causes (male and female); Assisted Reproductive techniques – artificial insemination, in vitro fertilization, surrogate birth, and embryo transfer (in farm animals and man); test tube babies.
9. Fertility control: contraception, birth control methods; abortion and MTP.

Suggested readings

- Arora, Mohan P. Embryology. Himalaya Publishing House.
- Arumugam, N. Developmental Zoology. SARAS Pub.
- Gayatri Prakash. Reproductive Biology. Narosa Pub. House
- Majumdar, N.N. Textbook of Vertebrate Embryology. TMH
- Rao, K. Vasudeva. Developmental Biology A Modern Synthesis. Oxford IBH
- Verma, P.S. and Agarwal V.K. Chordate Embryology. S.Chand and Co.
- Balinsky, B.I. An Introduction to Embryology. Thomson Books
- Bejley, D.J. et al. Human Reproduction & Developmental Biology. McMillan
- Berril, N.J. & Karp, G. *Development*. TMH.
- Gilbert, S.F. *Developmental Biology*. Sinauer Associates.
- McEven. *Vertebrate Embryology*. Oxford and IBH
- Patten, B.M. *Early Embryology of the Chick*. TMH.
- Patten, B.M. *Foundations of Embryology*. McGraw Hill.
- Rugh, R. *Frog Reproduction and Development*.

SEMESTER III

Core Course

BV1342.2: Animal Diversity – II: Chordata

Credits: 2 **Contact Hours: 36**

Module I **2 hours**

Introduction

Chordate characters (diagnostic, general and advanced); comparison of chordates and non-chordates. Subphylum 1. Urochordata (Tunicata)

General characters

Examples : *Ascidia* (morphology and metamorphosis), *Oikopleura*, *Salpa*

Subphylum 2. Cephalochordata

General characters

Eg. *Amphioxus*

Module II **6 hours**

Subphylum 3. Vertebrata

General characters

Division 1 Agnatha

General Characters

Class Cyclostomata: e.g.: *Petromyzon* (mention ammocoete larva)

Division 2 Gnathostomata

General characters

Superclass Pisces

General characters

Class Chondrichthyes (Cartilaginous fishes)

Subclass Elasmobranchii: *Scoliodon* (morphology, structure of placoid scale and development), *Narcine,*

Subclass Holocephali: *Chimaera*

Class Osteichthyes (Bony fishes)

Subclass Choanichthyes

Order 1. Crossopterygii (coelacanths): *Latimeria*

Order 2. Dipnoi (lung fishes): *Protopterus, Lepidosiren*, and *Neoceratodus* (comment on distribution of lung fishes)

Subclass Actinopterygii

Superorder 1. Chondrostei*: Acipenser*

Superorder 2. Holostei: *Lepidosteus*

Superorder 3. Teleostei: *Clarias, Anabas, Saccobranchus, Etroplus*, *Mugil, Echeneis, Sardinella, Rastrelliger*

Accessory respiratory organs in fishes

Module III **2 hours**

Superclass Tetrapoda

General characters

Class Amphibia

General characters

Order Apoda: *Ichthyophis*

Order Urodela (Caudata): *Ambystoma* (mention Axolotl larva and neoteny)

Order Anura: Frog (*Rana*), *Bufo, Hyla, Rhacophorus*

Module IV **4 hours**

Class Reptilia

General characters

Subclass 1. Anapsida

Order Chelonia: *Chelone*

Subclass 2. Parapsida: *Ichthyosaurus*

Subclass 3. Diapsida

Order 1. Rhynchocephalia: *Sphenodon*

Order 2. Squamata

Suborder 1. Lacertilia: Calotes, *Hemidactylus*, *Chamaeleon,, Draco*

*S*uborder 2. Ophidia: *Typholops*, *Dryophis*, *Ptyas, Naja, Bungarus, Enhydrina,* Viper

Order 3. Crocodilia: *Crocodylus*, *Alligator*

Subclass 4. Synapsida: *Cynognathus*

Identification of poisonous snakes using identification key.

Module V **4 hours**

Class Aves

General characters

Subclass 1. Archaeornithes: *Archaeopteryx* (brief account and affinities)

Subclass 2. Neornithes

Super order 1. Palaeognathae (=Ratitae)

Examples: *Apteryx* (kiwi), *Struthio* (ostrich), Emu

Super order 2. Neognathae (=Carinatae)

Examples: peafowl, sparrow (*Passer*), Crow, koel, parrot, pigeon, Kite, *penguin*, vulture, owl, hornbill Flight adaptations in birds Migration of birds

Module VI **18 hours**

Class Mammalia

General characters

Homo sapiens – detaied study of anatomy (exclude skull, arteries, veins and nerves)

Subclass 1. Prototheria : platypus (*Ornithorhynchus*), *Tachyglossus* (= *Echidna*)

Subclass 2. Metatheria : opossum (*Didelphis*), kangaroo (*Macropus*)

Subclass 3. Eutheria

Order 1. Pholidota	pangolin (*Manis*)
Order 2. Lagomorpha	rabbit (*Oryctolagus*), hare (*Lepus*)
Order 3. Rodentia	Rat (*Ratus*)
Order 4. Insectivora	hedgehog (*Paraechinus*), *Suncus* (=*Crocidura*)
Order 5. Chiroptera	*Pteropus, Vampyris*

Order 6. Primata	*Macaca, Gorilla, Pongo*, *Hylobates, Homo*
Order 7. Carnivora	seal (*Phoca*), walrus (*Odobenus*), *Panthera(=Leo)* sps, *Canis,* Herpestes
Order 8. Cetacea	*Delphinus* (dolphins), *Balaenoptera* (baleen whale)
Order 9. Artiodactyla	Giraffe, *Hemitragus* (tahr), Camel, Hippopotamus
Order 10. Perissodactyla	*Equus* (horse), *Rhinoceros*
Order 11. Sirenia	*Dugong*
Order 12. Proboscidea	*Elephas maximus indicus* (Indian elephant), *Loxodonta africana* (African savanna elephant), *Loxodonta cyclotis* (African forest elephant) Aquatic mammals and their adaptations

Suggested Readings

- Bhaskaran, K.K. & Biju Kumar, A. *Chordate Zoology*, Manjusha Pub.
- Dhami, P. S. & Dhami, J. K. *Chordate Zoology.* R. Chand & Co
- Ekambaranatha Ayyar, M. & Ananthakrishnan, T. N. *A Manual of Zoology*. *Vol. II Part I & II*
- Jordan, E. L. & Verma, P. S. *Chordate Zoology.* S. Chand & Co, New Delhi
- Kotpal, R. L. *Modern Textbook of Zoology*: *Vertebrates*. Rastogi Pub.
- Thangamani, A. et al. A Textbook of Chordates, SARAS Pub.
- Chaudhury, S.K. *Concise Medical Physiology*, NCBA
- Daniel, J.C. *The Book of Indian Reptiles and Amphibians*. BNHS-OUP
- Guyton and Hall *A Textbook of Medical Physiology*
- Induchoodan. *Keralathile Pakshikal*. Kerala Sahitya Academy, Trichur
- Kardong, K.V. *Vertebrates.*
- McMinn R.M.H. *et al* A Colour Atlas of Human Anatomy, Wolfe
- Parker and Haswell. *A Textbook of Zoology Vol. II*
- Prater, S. H. *The Book of Indian Animals*. BNHS-Oxford
- Salim Ali. *Birds of Kerala*. OUP
- Salim Ali. *The Book of Indian Birds*. BNHS-Oxford
- Sedgwick. *Students Textbook of Zoology, Vol. II*
- Sharma, B.D. *Indian Poisonous Snakes.* Anmol Publications, New Delhi
- Sherwood, L. *Principles of Human Physiology*, Brooks/Cole
- Young, J. Z. *Life of Vertebrates.* Clarendon Press, Oxford

SEMESTER IV

Core Course

BV1441.2 Animal Physiology

Credits: 2 Contact Hours: 36

Module I 4 hours

Nutrition: Types of nutrition; Mechanical and chemical digestion of carbohydrates, proteins and fats; hormonal control of digestion; absorption mechanism; BMR Vitamin deficiency diseases.

Module II 4 hours

Respiration: respiratory pigments and their role; gas transport – oxygen and CO_2 transport; Oxyhaemoglobin curve; Bohr effect; Carbon monoxide poisoning. Physiological effects of smoking

Module III **8 hours**

1. **Circulation:** Body fluids – importance and types; closed and open types of circulatory system; blood – composition and functions; blood groups – ABO and Rh systems, MN, Lewis and Bombay groups; blood clotting – intrinsic and extrinsic mechanisms and their factors; anticoagulants.

2. **Heart:** types of heart – tubular and chambered; neurogenic and myogenic; pace makers and conducting system of human heart; cardiac rhythm; blood pressure; electrocardiogram. Common cardiovascular diseases (hypertension, arteriosclerosis, myocardial infarction)

Module IV **8 hours**

1. **Excretion**: nitrogenous wastes; ammonotelic, ureotelic and uricotelic modes of excretion; structure of human nephron; urine formation in man – detailed account with countercurrent system; normal and abnormal constituents of urine; hormonal regulation of renal function; Dialysis and artificial kidney

2. **Muscle Physiology**: types of muscles; ultrastructure of striated muscle fibre; muscle contraction – theories of contraction; chemistry of contraction; neuromuscular junction; fatigue; muscle twitch; latent and refractory periods; rigor mortis.

Module V **12 hours**

1. **Nerve Physiology**: structure of a typical neuron; types of neurons; myelinated and nonmyelinated nerve fibres; structure and types of synapse; initiation and conduction of nerve impulse; neurotransmitters; synaptic transmission; reflex action and reflex arc; EEG; Nervous disorders - epilepsy, Alzheimer's disease, Parkinson's disease.

2. **Endocrinology:** hormones – definition and types of hormones; mechanism of hormone action-at the levels of cell membrane, organelles and genes; positive and negative feedback regulation; structure and functions of endocrine glands – thyroid, parathyroid, thymus, islets of Langerhans, adrenal, pituitary, hypothalamus, pineal body, gonads and placenta; brief account of prostaglandins Hormonal disorders

Suggested Readings

- Arora, Mohan P. Animal Physiology. Himalaya Publishing House
- Mariakuttikan and Arumugam, N. Animal Physiology. Saras Publication
- Nagabhushanam, R. et al. Textbook of Animal Physiology. Oxford & IBHS
- Rastogi, S.C. Essentials of Animal Physiology. Wiley Eastern Ltd.
- Sebastian, M.M. Animal Physiology. Madonna Books, Kottayam
- Verma, P.S. Tyagi, B.S. and Agarwal, V.K. Animal Physiology. S.Chand & Co.
- Berry, A.K. A Text book of Animal Physiology, Emkay Publications.
- Best and Taylor's Physiological Basis of Medical Practice. West, J.B. (Ed.) B.I. Waverly.
- Chatterjee, C.C. Human Physiology. Medical Allied Agency.
- Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology. Harcour
- Hill, R.W., Wyse, G.A. and Anderson, M. Animal Physiology. Sinauer Associates.
- Hoar, W.S. General and Comparative Animal Physiology. PHI.
- Kay, Jan. Introduction to Animal Physiology. Bios Scientific Publishers.

· Moyes, C.D. and Schulte, P.M. Principles of Animal Physiology. Pearson Education
· Oser, B. Hawk's Physiological Chemistry. TMH.
· Schmidt-Nielsen, K. Animal Physiology Adaptation and Environment. Cambridge Uni. Press.
· Voet, D. and Voet, J.G. Biochemistry. John Wiley & Sons

SEMESTER IV

Core Course

BV 1442.2 Cell Biology

Credits: 2 **Contact Hours: 36**

Module I **2 hours**

1. History and scope of Cell Biology; discovery of cells. Cell theory and its modern version.
2. General classification of cell types: prokaryotes and eukaryotes, PPLOs, bacteria, plant cell and animal cell

Module II **8 hours**

1. Cell membrane – Chemical composition, ultrastructure, Fluid mosaic model, modifications and functions; transmembrane transport, cell signalling and signal transduction.
2. Structure and function of cell organelles – Endoplasmic reticulum: morphology, types, formation and functions. Ribosomes: Types, subunits and functions. Golgi bodies – morphology, types, formation and functions. Lysosomes: morphology, classification, polymorphism and functions. Centrioles: structure and functions. Mitochondria: structure and functions; (mention oxidative phosphorylation and electron transport). Microbodies: Morphology, peroxisomes, glyoxisomes and functions. Cytoskeleton: microtubules, microfilaments and intermediate filaments.
3. Interphase Nucleus – structure and function Nuclear membrane: pores and pore complex; nuclear lamina; Nucleoplasm: nature and importance Nucleolus: structure; nucleolar organizer and functions. Chromatin: Euchromatin and heterochromatin

Module III **8 hours**

1. Chromosomes – Chemical composition; structure of a typical metaphase chromosome; centromeres, telomeres, nucleosome organization'; Classification of chromosomes; Giant chromosomes (polytene and lampbrush chromosomes; endomitosis); chromosome banding pattern.
2. Chromosomal aberrations: Variations in number and structure.

Module IV **9 hours**

1. Cell cycle: G_1, S, G_2 and M phases (mention G_0 and D_0 stages and their significance)
2. Mitosis: description of all stages.
3. Meiosis: description of all stages; synaptonemal complex and significance**.**

Module V **9 hours**

1. Cell differentiation: General characteristics; apoptosis, necrosis.
2. Cancer Cells: characteristics of cancer cells; types of tumour; factors responsible for cancer.

Suggested Readings

- Arumugam N, Cell Biology, SARAS Pub.
- Bhaskaran, K.K. & Biju Kumar, A. Cell Biology, Gnetics and Molecular Biology, Manjusha Pub.
- Gupta, P. K. *Cell and Molecular Biology*, Rastogi Pubs., Meerut.
- Powar, C.B. *Cell Biology.* Himalaya Publishing House.
- Verma, P.S. & Agarwal, V.K. *Cytology*, S. Chand & Co.
- Alberts, B. *et al. Molecular Biology of the Cell.* Garland Science.
- De Robertis, E.D.P. and De Robertis, E.M.F. *Cell and Molecular Biology*, Lippincott Williams and Wilkins
- Karp, Gerald. *Cell and Molecular Biology*. John Wiley and Sons
- Lodish, Harvey *et al. Molecular Cell Biology*. Scientific American Books
- Sadava, D.E. *Cell Biology.* Jones and Barlette Publishers.
- Sharma, A. *Chromosomes*, Oxford & IBH Wolfe, S.L. *Molecular and Cellular Biology*. Wadsworth Pub. Co.

SEMESTER III & IV

Core Course

BV1443.2 Practical Zoology – II

[Practical of BV1341.2, BV1342.2, BV1441.2 & BV1442.2]

Credits: 2 **Contact Hours: Semester III: 36; Semester IV: 36; Total: 72**

Cell Biology

1. Measurement of size of microscopic objects using ocular and stage micrometers
2. Study of different types of cells (prokaryotes and eukaryotes) using slides/models/charts.
3. Study of cytoplasmic organelles and cell inclusions (through permanent slides, models and charts)
4. Study of interphase nucleus in human buccal smear and Barr bodies.
5. Study of mitochondria in insect flight muscles/ human buccal smear.
6. Study of stages of mitosis – squash preparation of onion root tip.
7. Calculation of mitotic index and metaphase index in onion root.

Genetics

1. Study of monohybrid ratio using coloured beads.
2. Study of normal chromosome complement and karyotype of man.
3. Preparation of karyoidiogram from microphotographs
4. Study of abnormal karyotypes and genetic syndromes of man (Down syndrome, Turner's syndrome and Klinefelter's syndrome)
5. Construction of pedigree chart – any two
6. Frequency of genetic traits in humans: blood groups, eye colour, widow's peak (any two traits).

Developmental Biology (charts/models/permanent slides)

1. Study of different types of eggs: frog, chick and man.

2. Frog development: Cleavage, Blastula, Gastrula
3. Chick embryology: Primitive streak stage and 24 hours embryo.

Physiology

1. Paper partition chromatography of amino acids (3 amino acids and a mixture)
2. Blood smear preparation – identification of leucocytes
3. Determination of human blood group – A, B, AB and O, and Rh+ and Rh-
4. Osmotic properties of RBCs – effect of isotonic, hypotonic and hypertonic solutions.
5. Activity of human salivary amylase on starch
6. Detection of Abnormal constituents of urine (glucose and albumin)

SEMESTER V

Core Course

BV1541.2: Systematics, Biodiversity and Animal Behaviour

Credits: 3 **Contact Hours: 54**

Systematics

Module I **8 hours**

1. Introduction: definition of classification, taxonomy and systematics; nomenclature- binomial and trinomial nomenclature; International rules of Zoological nomenclature (brief account).
2. Principles of classification: Procedures and rules of Taxonomy; hierarchy, taxon, phenon, category; concept of species and subspecies.
3. Methods of systematics: numerical taxonomy (phenetics), cladistics (phylogenetic systematics), evolutionary classification and molecular systematics.

Biodiversity

Module II **10 hours**

1. Introduction: definition; global biodiversity, biodiversity of India; levels of biodiversity –species diversity, community and ecosystem diversity and genetic diversity; types of biodiversity – alpha, beta and gamma diversities; species diversity and ecosystem stability; keystone species.
2. Biodiversity hotspots: Global biodiversity hotspots; Indian region (Western Ghats, Sree Lanka, Eastern Himalaya & Indo-Burma)
3. Threats to biodiversity: habitat modification, pollution and poaching; invasive species.
4. Loss of biodiversity and its causes
5. Biodiversity Convention: IUCN categories and Red Data Book.

Animal Behaviour

Module III **8 hours**

1. Introduction: History and scope of animal behaviour, methods used in the study of Ethology

2. Stimulus and Response: Stimulus-response theory; stimulus filtering; fixed action pattern; innate releasing mechanism; sign stimulus and social signals (social releasers).

3. Behaviour patterns, behaviour systems and social behaviour (definitions)

4. Categories of behaviour systems (definition and examples): shelter seeking, agonistic, ingestive, sexual, care giving, care soliciting, eliminative, allelomimetic and investigative behaviour.

Module IV **18 hours**

1. Instinctive behaviour: definition; characteristics of instinctive behaviour; comparison of instinct and learning; adaptive advantage.
2. Learning: types of learning; habituation; reflexes, latent learning, insight learning and imprinting. Physiology of learning.
3. Motivation: goal oriented behaviour and drive; models of motivation (Deutsch's model and Lorenz's psychohydraulic model).

Module V **10 hours**

1. Circadian rhythm: definition; biological clock; chronobiology; role of pineal gland.
2. Hormones and behaviour (brief account).
3. Sociobiology: social groups – merits and demerits; properties of societies;
4. Societies in honey bee and elephants.
5. Pheromones: types of pheromones; chemical nature of pheromones; human pheromones.

Suggested Readings

· Kapoor, V.C. *Theory and Practice of Animal Taxonomy*, Oxford & IBH
· Donald, L.S. *Principles and Techniques of Contemporary Taxonomy*.
· Mayr, E. *Principles of Systematic Zoology*, TMH
· Agrawal, K.C. *Biodiversity*, Agrobios
· Ananthakrishnan T. N. *Animal Biodiversity Patterns and Process*. Scientific Publishers.
· Arora, Mohan P. *Animal Behaviour.* Himalaya Publishing House
· Kumar, Vinod. *Animal Behaviour.* Himalaya Publishing HouseReena Mathur.
· *Animal Behaviour*, Rastogi & Co., Meerut.
· Singh, Harjindra. *Textbook of Animal Behaviour.* Anmol Publishers
· Alcock, J. *Animal Behaviour.* Sinauer Associates.
· Boulenger, E.G. *Animal behaviour*, Atlantic Pub. & Distributors
· Dethier, V.G. and Stellar, E. *Animal Behaviour*
· Dewsbury, D.A. *Comparative Animal Behaviour*. McGraw Hill Book Co.
· Eibl-Eibesfeldt, I. *Ethology*: *The Biology of Behaviour*
· Prakash M. *et al*. *Recent Advances in Animal Behaviour*. 7 Vols., Anmol.
· Manning, A. and Dawkins, M.S. *An Introduction to Animal Behaviour.* Cambridge University Press.
· Ranga, M.M. *Animal Behaviour.* Agrobios
· Scott, John Paul. *Animal Behaviour*.
· Slater, P.J.B. *Essentials of Animal Behaviour.* Cambridge University Press
· Wood Gush, D.G.M. *Elements of Ethology*

SEMESTER V

Core Course

BV 1542.2: Genetics

Credits: 4 **Contact Hours: 90**

Module I — 18 hours

1. Mendelian Genetics: Mendel and his experiments; Mendelian laws of inheritance.
2. Genetic terminology: gene, allele, genotype, phenotype, genome; wild type and mutant type; test cross, back cross and reciprocal cross.
3. Gene interactions: Allelic - incomplete dominance; codominance; lethal genes. Non-allelic - complementary genes; epistasis; co-epistasis, dominant (feather coat) and recessive (coat colour).
4. Polygenic or quantitative inheritance: skin colour in man.
5. Multiple alleles: blood group alleles -ABO system and its inheritance.

Module II — 18 hours

1. Linkage, crossing over and recombination: linked genes, linkage group; complete and incomplete linkage; chromosome theory of linkage; crossing over – mechanism and kinds of crossing over; significance of crossing over; sex linkage; chromosome mapping (brief account).
2. Mutations: Types of mutations: somatic and germinal, spontaneous and induced, autosomal and allosomal, chromosomal and gene mutation; molecular basis of mutation; induction of mutation – physical and chemical mutagens.
3. Extrachromosomal inheritance: maternal effects in Drosophila, mitochondrial DNA and kappa particles in Paramecium.

Module III — 18 hours

1. Sex determination: autosomes and sex chromosomes; Barr bodies and Lyon's hypothesis; Chromosomal basis of sex determination (XX-XY, XX-XO, ZZ-ZW types); Genic balance theory; sex mosaics; environmental control of sex determination; intersex, gynandromorphs.
2. Sex-linked, sex-limited and sex-influenced inheritance.

Module IV — 18 hours

1. Concept of gene: structural and functional concept; genome; split genes; introns and exons; overlapping genes; transposable elements; pseudogenes.
2. Genetics of development: role of gene in development - (very brief accounts of) gene modulation; homeotic genes and Hox genes; transgenics and knockout mutations.

Module V — 18 hours

Human genetics

1. Karyotyping: human chromosome complement; pedigree analysis.
2. Chromosomal anomalies and human disorders – autosomal anomalies- Down's syndrome, Edwards syndrome; Sex chromosome anomalies- Klinefelter's syndrome, Turner's syndrome.
3. Biochemical Genetics- albinism, alkaptonuria, phenyl ketonuria and sickle cell anemia (brief account).

4. Eugenics and Genetic counselling
5. Human Genome Project

Suggested Readings

- Arumugam N, Genetics, SARAS Pub.
- Ahluwalia, K.B. *Genetics*. New Age International (P) Ltd. Publishers
- Gupta, P.K. *Cytogenetics*. Rastogi & Co.
- Verma, P.S. & Agarwal, V.K. *Genetics*, S. Chand & Co.
- Burns, G. W. & Bottino, P. J. *The Science of Genetics*. Maxwell McMillan
- Curt Stein. *Principles of Human Genetics*. Euresia Publishing House
- Gardner, E. J. et al. *Principles of Genetics*. John Wiley & Sons.
- Goodenough, U. *Genetics*. Halt, Reinharts & Winston
- Sarin, C. *Genetics*. TMH
- Sinnott, W.E., Dunn, L.C. and Dobzhansky, T. *Principles of Genetics*

SEMESTER VI

Core Course

BV1641.2: Evolution

Credits: 2 **Contact Hours: 90**

Module I **10 hours**

1. Geological time scale: various eras, periods and epochs with characteristic fauna.
2. Fossils: dating of fossils; significance of fossils.

Module II **8 hours**

Origin of Life: origin of basic biomolecules, proteinoids, coacervates and microspheres; concept of Oparin and Haldane; Experiment of Miller.

Module III **10 hours**

Evidences of organic evolution- morphological, embryological, palaeontological, biochemical, physiological, and biogeographical; living fossils.

Module IV **18 hours**

(a) Early Evolutionary thoughts: Theories and their criticism – Lamarckism, Darwinism, Mutation theory.

(b) Population genetics: gene pool and gene frequencies; Hardy-Weinberg law. Genetic polymorphism and its evolutionary significance. Genetic load and genetic death.

(c) Factors that change gene frequency: Evolutionary forces – natural selection and genetic drift. Other factors – migration, bottleneck effect and founder effect.

Module V **18 hours**

Process of Evolution

(a) Modern synthetic theory: Development; concepts; operation (variations, natural selection, isolation, speciation).

(b) Variations – nature and sources- recombination, chromosomal variations, gene mutations.

(c) Natural selection: significance; types – stabilizing, directional, and disruptive selection.

(d) Isolation: Isolating mechanisms – types and significance

(e) Speciation: types and process

Module VI **8 hours**

Products of Evolution

(a) Evolution of Biosphere (anaerobic and aerobic metabolism, photosynthesis, oxygen build up and its consequences), Origin of Prokaryotes and Eukaryotes, Evolution of eukaryotic organelles (mitochondria and chloroplast)

(b) Evolution of man (brief accounts of Ramapithecus, Australopithecus, Neanderthal man, Cromagnon and Modern man).

Module VII **12 hours**

(a) Tempo of evolution

(1) microevolution, macroevolution, megaevolution, quantum evolution, gradualism, punctuated equilibrium.

(2) Molecular evolution: rates of molecular change; evolutionary clocks.

(b) Patterns of Evolution

Convergent evolution, Divergent evolution (Adaptive radiation), Coevolution, Parallel evolution, Orthogenesis, Orthoselection, Anagenesis, Cladogenesis, and preadaptation Adaptive radiation in Darwin's finches

Module VIII **6 hours**

Populations and Evolution

(a) Mimicry: Batesian and Mullerian mimicry and their significance.

(b) Altruism; kin selection; sexual selection.

Suggested readings

· Arora, Mohan P. *Evolutionary Biology.* Himalaya Publishing House

· Arumugam, N. *Organic Evolution.* Saras Publications.

· Rastogi, V.B. *Organic Evolution.* Kedar Nath Ram Nath

· Darwin, C. *The Origin of Species*, OUP.

· Dobzhansky, T. *Genetics and the Origin of Species,* Columbia Uty. Press.

· Dobzhansky, T. *et al*: *Evolution*, Surjeet Pubn., Delhi.

· Dobzhansky, T. *Evolution, Genetics and Man*. John Wilkey

· Hall, B.K. and Hallgrimson, B. *Strickberger's Evolution.* .

· Kardong, K.V. *An Introduction to Biological Evolution.* McGraw Hill.

· Lull, R.S. *Organic Evolution*. Light Life Publication

· Mayr, E. *Animal Species and Evolulation*. Academic Press

· Marshall, J. *Evolution*. McMillan Publishing Co. Inc. N.Y.

· Moya, A. and Font, E. *Evolution from Molecules to Ecosystem.* OUP

· Savage, J.N. *Evolution Process and Product*. Affiliated East West Press, New Delhi
· Simpson, G.G. *The Major Features of Evolution*. Columbia University Press
· Stebbins, G.L. *Process of Organic Evolution*. Prentice Hall East West Press, New Delhi

SEMESTER V & VI

Core Course

BV1642.2 Practical Zoology III

[Practical of BV1541.2, BV1542.2 & BV1641.2]

Credits: 3 **Contact Hours: Semester V: 36; Semester VI: 36; Total: 72**

1. Preparation of dichotomous key up to Orders/Families for identification of any two groups (insects/ molluscs/ fishes/ snakes)
2. Identification (Generic and specific name) and systematic position of animals belonging to different groups and habitats of the locality (based on slides, specimens, photos or figures). Non-chordates (Coelenterates/Crustaceans/Insects/Molluscs): 10; Chordates (fishes/Snakes /Birds/Mammals):10
3. Study of models/charts/specimens related to any four of the following:
   (a) Homologous organs (limbs of 5 different groups of vertebrates)
   (b) Analogous organs (wings of bird, insect and bat)
   (c) Vestigial organs in humans (any four)
   (d) Connecting links (*Archeopteryx* and *Peripatus*)
   (e) Adaptive radiation in reptiles/mammals/Darwin's finches
   (f) Evolution of man based on three hominid fossils
4. Study of food web (Construction and comment)
5. Estimation of dissolved oxygen in two samples of water.
6. Estimation of dissolved carbon dioxide in two samples of water.
7. Demonstration of primary productivity by light and dark bottles.
8. Determination of pH of different sample solutions using indicator paper or pH meter.
9. Determination of concentration of unknown solutions (nitrates/sulphates) using photocolorimeter/ spectrophotometer
10. Extraction of soil insects by Berle's funnel (Demonstration).
11. Alarm pheromones in insects (Demonstration).

Field study/ Study tour

Field trip and/or Study Tour are a compulsory element of the curriculum. The students are required to visit different ecological habitats and/or places or institutions of biological interest for not less than 5 days. The study is preferably spread over the first, second and third years. They are expected to visit Research Institutes/ Wildlife sanctuaries/ Zoological Museums/ Zoos/ ecosystems/ local areas of biological interest. A detailed report of the field study/study tour specifying the habitats, places and institutions visited, date and time of visit, details of observations made, description of the observed fauna etc. must be submitted by each student for evaluation on the day of practical examination of Semester VI. The Study tour/ Field study report is compulsory for each student appearing for practical examination.

Core Courses of Chemistry

SEMESTER I

Core Course

BV1142 Inorganic Chemistry I

Credit 4 **Contact hours: 126 (Theory 90 + Practical 36)**

Aim and Objective

1. To understand the structure of atomic nucleus, properties of elements in relation to electronic configuration.
2. To learn the principles of chemical analysis. Upon course completion, the student will be able to appreciate how the inner structure of elements dictates the chemical properties of elements, how elements bond together to form compounds. She/He will acquire basic laboratory skills required for chemical analysis and become familiar with data collection, record keeping and data analysis in a chemical laboratory.

Module I

Atomic Structure **21hrs**

Introduction- Wave mechanical concept of the atom - Dual Character of electron-de Broglie equation - matter waves and electromagnetic waves - experimental verification of de Broglie relation - Heisenberg's uncertainty principle - expression and physical significance. Schrodingers wave equation - Charge cloud and probability concepts - orbitals, radial and angular probability distribution curves, shapes of orbitals. Particle in a one- dimensional box. eigen functions and eigen values. Particle in a three dimensional box

Electronic Configuration and Periodicity

Quantum numbers - Pauli's exclusion Principle - Aufbau Principle – Hund's rule - Electronic configuration of atoms - classification of elements into s, p, d, f blocks - atomic radii, ionization enthalpy, electron gain enthalpy and electronegativity- Pauling's scale, Mullikan and Alred - Rochow scale- ionic character - periodicity - horizontal, vertical and diagonal relationships - anomalous behaviour of the first element of a group.

Module II

Analytical Principles - I **21 hrs**.

Qualitative Analysis - Common ion effect - solubility product - principle and procedure of elimination of interfering anions - precipitation of cations.

Quantitative Analysis - Calibration and use of apparatus and weights for titration.

Theory of titration - acid-base, redox, precipitation and complexometric titrations. Theory of indicators - acid-base, redox, adsorption and metallochromic indicators.

Gravimetric Analysis - Mechanism of precipitate formation - Factors affecting solubility of precipitates - coprecipitation and post precipitation - Effect of digestion - washing, drying and ignition of precipitates. Chromatography - classification of methods - Elementary study of adsorption, paper, thin layer, ion exchange and gas chromatographic methods.

Module III

Chemical bonding **21 hrs**

Ionic bond-ionic solids and their structures, Rock salt, Rutile, Zinc blend, Wurtzite, radius ratio effect and coordination number, limitations of Radius ratio rule-lattice energy of ionic compounds- Born-Lande equation, Born-Haber cycle, solvation energy and solubility of ionic solids- covalent character of ionic bond, Fajan's rules

Covalent bond-valence bond theory and its limitations- hybridization, VSEPR theory and its applications- structure of XeF_2, XeF_4, XeF_6, ClF_3, IF_5, IF_7, NH_3,H_3O^+& H_2O

VB theory of H_2 molecule, MO theory, LCAO of H_2 ion, homonuclear diatomic molecules-C_2, B_2, N_2, O_2 and ions like O_2^+- heteronuclear diatomic molecules (HF, NO, and CO) – comparison of VB and MO theories Polarity of Covalent bond- dipole moment- percentage ionic character- dipole moment and molecular structure

Module IV

Chemical Bonding II **21 hrs**

Metallic bonding- free electron theory, VB theory and band theory(Qualitative treatment only)- weak electrical forces – hydrogen bond, inter and intramolecular hydrogen bond, intermolecular interaction – induction forces and dispersion forces such as van der Waals forces, ion –dipole, dipole-dipole, ion-induced dipole, dipole-induced dipole, induced dipoleinduced dipole interactions.

(a) Concepts of Acids and Bases Arrhenius theory, Lowry – Bronsted theory, Lewis theory. Hard and soft acids and bases, the SHAB principle, relative strength of acids and bases, effect of solvent on acid and base strengths

(b) Evaluation of analytical data Significant figures, types of errors. standard deviation, relative standard deviation, Student t test , F test, Q test.

Module V

Nuclear Chemistry **21 hrs**

Natural radioactivity, modes of decay, Geiger –Nuttal rule, artificial transmutation and artificial radioactivity- nuclear stability, n\p ratio, mass defect and binding energy, nuclear fission and nuclear fusion, elementary idea of subatomic particles like neutrino, anti neutrino applications of radioactivity- C^{14} dating, rock dating, neutron activation analysis and isotope as tracers

Module VI

Non Aqueous Solvents **21 hrs**

General properties- classification- self ionization and levelling effect- reaction in non-aqueous solvents- protic and aprotic non aqueous solvents- examples- solutions of metals in liquid ammonia- self ionization of liquid ammonia- liquid SO_2, liquid HF.

Suggested Readings

1) Manas Chanda, "Atomic structure and Chemical Bond including Molecular spectroscopy"
2) E.S. Gilreath "Fundamental concepts of Inorganic Chemistry"
3) Puri, Sharma and Kalia "Inorganic Chemistry"
4) Madan "Inorganic Chemistry".
5) Manku , "Theoretical principles of Inorganic Chemistry" -
6) M. C. Dey and J. Selbin "Theoretical Inorganic Chemistry".
7) F A Cotton and G. Wilkinson "Basic Inroganic Chemistry".
8) A. I. Vogel, "Text book of Qualitative Analysis"
9) A. I. Vogel, "Text book of Quantitative Inorganic Analysis".
10) A. K. Srivasthava and P. C. Jain, "Chemical Analysis".

SEMESTER II

Core Course

BV1243 Inorganic Chemistry – II

Credits: 3 **Contact Hours: 162(Theory 108 + Practical 54)**

Aim and Objective: The course is to impart a basic understanding of the principles of inorganic chemistry as the continuation of the previous course in inorganic chemistry. It will prepare the students to pursue studies in the biochemical and molecular aspects of biology and biotechnology.

Module I

Transition and inner transition elements **32 hours**

(a) Transition elements Electronic configuration and general characteristics - Comparison of 3d, 4d and 5d transition series – Colour, catalytic activities and spectral properties with reference to d^1 to d^{10} systems. Preparation, properties and uses of $K_2Cr_2O_7$, $KMnO_4$ and $TiCl_4$.

(b) Lanthanides and actinides Lanthanides - electronic configuration and general properties – Occurrence and isolation of lanthanides from monazite – Lanthanide contraction – Magnetic properties and complexation behaviour. Actinides – Oxidation states, ionic radii, colour, complex formation in comparison with lanthanides.

Module II

Coordination Chemistry **30 hours**

Nomenclature – EAN rule – Chelates – Stability of complexes – Factors affecting stability of complexes – Isomerism – Structural and stereoisomerism – Geometrical and optical isomerism – Bonding in complexes – V.B. Theory, CFT, M.O.Theory – Effect of crystal field splitting – CFSE – Spectrochemical series - Magnetic properties and colour of metal complexes – Application of coordination compounds in quantitative and qualitative analysis.

Module III

Organometallic Compounds and Bioinorganic Chemistry **25 hours**

(a) Organometallic Compounds Definition – Nomenclature and classification – sigma complex – Pi complex – those containing both sigma and Pi bonds – 18 electron rule – Metal carbonyls – mononuclear and polynuclear (give examples of carbonyls of Fe, Co, Ni) – preparation and properties of carbonyls of iron and nickel – Bonding in organometallic compounds like ferrocene, dibenzene chromium, Ziese's salt – Dinitrogen complexes – Application of organometallic compounds.

(b) Bioinorganic Chemistry Role of metal ions in biological systems – Biochemistry of iron, haemoglobin and myoglobin (elementary idea of the structure and mechanisms of their actions) – Photosynthesis – Sodium-Potassium pump - Biochemistry of magnesium and calcium (brief study only)

Module IV

Compounds of non-transition elements **25 hours**

Manufacture and uses of the following Glass – different types of glasses, Silicates, Zeolites and Silicones. Inorganic Polymers Phosphorus, boron and silicon based polymers – Structure and industrial applications. Borax - boron hydrides, boron nitrides, borazole and carboranes.

Oxides and oxyacids of phosphorus. Oxides and oxyacids of halogens (structure only) – Inter halogen compounds and pseudo halogens – Compounds of noble gases – Uses of noble gases. Refractory carbides, nitrides, salt-like carbides, borides, and silicides

Module V

Instrumental Methods of Analysis **25 hours**

Atomic absorption spectroscopy- flame emission spectroscopy- applications - spectrophotometry- laws of spectrophotometry- applications of spectrophotometry-colorimetry, thermal methods- introduction to TG, DTA and DSC- instrumentations and applications.

Module VI

Chemistry of Nanomaterials **25 hours**

Evolution of Nanoscience – Historical aspects- Preparations containing nano gold in traditional medicine.Lycurgus cup- Faraday's divided metal, Nanosystems in nature. Preparation of nanoparticles: Top-down approaches and Bottom to top approach

Sol–gel synthesis, Colloidal precipitation, Co–precipitation, Combustion technique, Sonochemistry, Hydrothermal technique, High energy ball milling . Carbon nanotubes and fullerenes.

Suggested Readings

1. F. A. Cotton, G. Wilkinson and P. L. Gaus, "Basic Inorganic Chemistry" ; Willey
2. J. D. Lee, "Concise Inorganic Chemistry", ELBS
3. M. C. Day and Selbin,"Theoretical Inorganic Chemistry".
4. J. E. Huheey ,"Inorganic Chemistry- Principles and Structure and Reactivity".
5. H. S.Arniker,"Essentials of Nuclear Chemistry".
6. Sisler,"Non-aqueous Solvents".
7. E. S. Gilreath, " Fundamentals of Inorganic Chemistry" .
8. Willard, Merrit ,"Instrumental Methods of Analysis".
9. Shriver and Atkins,"Inorganic Chemistry" .
10. Bosolo and Johnson ,"Coordination Chemistry".
11. S. F. A. Kettle, "Coordination Chemistry".
12. J. E. Hueey,"Inorganic Chemistry".
13 . T. Pradeep, "Nano, The Essentials", Mc Graw- Hill Education.

SEMESTER II

Core Course

BV1244 Practical Chemistry-I

(Practical of BV1142 & BV1243)

Credits: 2 **Contact hours: Practical Hours of the above courses**

Aima and objective: This the practical course based on the practical components contained in the theory of the respective courses- BV1142 & BV1243. It will give a working knowledge on the analysis of inorganic compounds.

1. Volumetry

(a) Acidimetry and alkalimetry: Preparation of carbonate free sodium hydroxide. Use of constant boiling hydrochloric acid Titrations using (1) Strong acid – strong base (2) Strong base – weak acid (3) Strong acid – weak base, determination of Na_2CO_3 and $NaHCO_3$ in a mixture by indicator method and NH_3 in an ammonium salt by direct and indirect methods.

(b) Permanganometry: The following determinations are to be done using standardised permanganate solution (1) Ferrous iron (2) Oxalic acid (3)Mohr's salt (4) Hydrogen peroxide (5) Calcium (6) Nitrte and (7) MnO_2 in pyrolusite.

(c) Dichrometry: Determination of Ferrous iron using internal and external indicators and Ferric iron after reduction with $SnCl_2$

(d) Cerimetry: Standardisation of ceric ammonium sulphate with Mohr's salt. Determination of oxalic acid using ceric ammonium sulphate.

(e) Iodometry\Iodimetry: Standardisation of thiosulphate using KIO_3, electrolytic copper and potassium dichromate. Determination of a copper salt.

(f) Precipitation titration: Determination of chloride in neutral medium.

(g) Complexometry (using EDTA): Standardisation of EDTA solution with $ZnSO_4$ – determination of Zn, Mg, Ni and Ca – determination of permanent and temporary hardness of water.

(h). Colorimetry (Using photo electric colorimeter): Determination of Iron using thiocynate and ammonia using Nessler's reagent.

Suggested Readings

1. F. A. Cotton, G. Wilkinson and P. L. Gaus, "Basic Inorganic Chemistry" ; Willey
2. J. D. Lee, "Concise Inorganic Chemistry", ELBS
3. M. C. Day and Selbin,"Theoretical Inorganic Chemistry".
4. J. E. Huheey ,"Inorganic Chemistry- Principles and Structure and Reactivity".
5. H. S.Arniker,"Essentials of Nuclear Chemistry".
6. Sisler,"Non-aqueous Solvents".
7. E. S. Gilreath, " Fundamentals of Inorganic Chemistry" .
8. Willard, Merrit ,"Instrumental Methods of Analysis".
9. Shriver and Atkins,"Inorganic Chemistry" .
10. Bosolo and Johnson ,"Coordination Chemistry".
11. S. F. A. Kettle, "Coordination Chemistry".
12. J. E. Hueey,"Inorganic Chemistry".
13. T. Pradeep, "Nano, The Essentials", Mc Graw- Hill Education

SEMESTER III

Core Course

BV1343 Physical Chemistry I

Credits: 3 **Contact hours: 180 (Theory126 + Practical 54)**

Aim and objective of the Course: The **syllabus** deals with the different states of matter, Thermodynamics and group theory. It familiarizes the student with the important topics like defects in crystals and point groups of molecules like water.

Students become aware ofthe different states ofmatter, liquid crystals, basics of group theory and thermodynamic properties like entropy, enthalpy and free energy.

Module I

Gaseous stateand solid state 36 hrs

Ideal gas equation, Behaviour of real gases, Deviation from ideal behaviour, Compressibility factor, Boyle temperature - van der Waal's equation of state – derivation and importance, Virial equation of state, Collision frequency, Collision number, Collision diameter and mean free path.

Types of molecular velocities and their inter relations, Maxwell Boltzmann distribution of molecular velocities, Statement of equation and explanation (No derivation), Effect of temperature on most probable velocity, Derivation of root mean square, most probable and average velocities from the equation.

Critical phenomena: Isotherms of CO_2, continuity of states, Critical constants and their experimental determination, relation between critical constants and van der Waals constants.

Solid state Isotropy and anisotropy, Space lattice and unit cell, Elements of symmetry of crystals, Bravais lattices, Crystal systems, Laws of crystallography, Miller indices, Representation of lattice planes of cubic crystals, Determination of Avogadro number from crystallographic data, X-ray diffraction studies of crystals, Bragg's equation – derivation and applications, Rotating crystal and powder method, Structure of NaCl and KCl Imperfections in crystals, point defects – Schottky and Frenkel defects, Non-stoichiometric defects.

Module II

Liquid state and Dilute solutions 36 hrs

Properties of liquids: Surface tension and its measurement by capillary rise and stalagmometer method, factors affecting Surface tension, Viscosity, Poisuelle's equation, Determination of viscosity by Ostwald's viscometer, Refractive index and its determination by Abbe refractometer.

Dilute solutions: Molarity, Molality, Normality and Mole fraction. Colligative properties, relative lowering of vapour pressure Thermodynamic derivation of "$T_b = K_b \times m$ and "$T_f = K_f \times m$, Osmotic pressure, van't Hoff equation and molecular mass, Isotonic solutions, Determination of molecular mass of solutes by Beckmann's method, Rast's method and cooling curve method. Abnormal molecular mass, van't Hoff factor, Determination of degree of dissociation and association.

Module III

Thermodynamics I 36 hrs

Basic concepts- system, surroundings, types of systems. Extensive and intensive properties, macroscopic properties. State functions and path functions. Types of Processes, Zeroth law of thermodynamics

Definition of internal energy and enthalpy. Heat capacities at constant volume (Cv) and at constant pressure (Cp), relationship between Cp and Cv. Mathematical statement of first law. Reversible process and maximum work. Calculation of work, heat, internal energy change and enthalpy change for the expansion of an ideal gas under reversible isothermal and adiabatic condition.

The Joule-Thomson effect – derivation of the expression for Joule-Thomson coefficient. Sign and magnitude of Joule-Thomson coefficient, inversion temperature.

Thermochemistry – standard states. Enthalpies of formation, combustion and neutralization. Integral and differential enthalpies of solution. Hess's law and its applications. Kirchoff's equation

Need for IInd law. Different statements of IInd law, Thermodynamic scale of temperature. Carnot cycle and its efficiency, Carnot theorem.

Concept of entropy- Definition and physical significance. Entropy as a function of volume and temperature, Entropy as a function of pressure and temperature. Entropy as a criteria of spontaneity and equilibrium.

Gibbs and Helmholtz free energies and their significances- criteria of equilibrium and spontaneity. Gibbs-Helmholtz equation, dependence of Gibbs free energy change on temperature, volume and pressure. Maxwell's relations

Partial molar quantities- Chemical potential-Gibbs-Duhem equation. Concept of fugacity, determination of fugacity by graphical method.

Module IV

Chemical Kinetics **36 hrs**

Order of reaction, Derivation of integrated rate equation of zero, first, second and third order reactions, nth order reaction, determination of order of reactions:- Graphical and analytical methods using integrated rate equations, Fractional life- method, Differential rate equation method, Isolation method. Types of complex reactions:- (a) opposing reactions (b) consecutive reactions (c) parallel reactions (d) chain reactions (explanation and examples only).

Influence of temperature on rate of reaction: Arrhenius equation, Determination of Arrhenius parameter, Energy of activation and its significance. Collision theory, Derivation of the rate equation for a second order reaction based on collision theory, collision theory of unimolecular reactions, Lindemann mechanism, steady state approximation, Theory of absolute reaction rate. Photochemistry**:** Grothus-Draper, Beer- Lambert and Stark- Einstein laws, Quantum yield, Reason for very low and very high quantum yields, Rate equation for decomposition of hydrogen iodide, Qualitative treatment of H_2-Cl_2 reaction and H_2-Br_2 reaction,Fluorescence and phosphorescence, chemiluminescence and photosensitization, Explanation and examples

Module V

Group theory & Liquid crystals **10 hrs**

Group theory: Elements of symmetry – Proper and improper axis of symmetry, plane of symmetry, centre of symmetry and identity element. Combination of symmetry elements, Point groups, C_{2V}, C_{3V} and D_{3h}, Group multiplication table of C_{2V}, Determination of point groups of simple molecules like H_2O, NH_3 and BF_3.

Liquid crystals: Types of liquid crystals – smectic, nematic and cholesteric, Swarm theory of liquid crystals, uses of liquid crystals.

Module VI

Phase Equilibria 26 hrs

Phase Equilibria:-Terminology, the phase rule, thermodynamic derivation of phase rule and its application to (a) water system (b) sulphur system (c) solid-liquid equilibria involving simple eutectic system such as Pb-Ag system, KI-water system, freezing mixtures, thermal analysis and desilverisation of lead (d) solid-liquid equilibria involving compound formation with congruent and incongruent melting points:- $FeC1_3$-H_2O system and Na_2SO_4-H_2O system (e) solid–gas system- decomposition of $CaCO_3$, dehydration of $CuSO_4.5H_2O$, deliquescence and efflorescence.

Chemical and Ionic equilibria

Equilibrium constant and free energy, Thermodynamic derivation of law of mass action, relation between Kp,Kc and Kx, Reaction isotherm, Temperature dependence of equilibrium constant , Pressure dependence of equilibrium constant, Clausius-clapeyron equations and its applications.

Ionic equilibrium : Ionic product of water, Effects of solvents on ionic strength, levelling effect, Pk_a and Pk_b values, solubility product and common ion effect and their applications, pH and its determination by indicator methods, buffer action, Henderson's equation , hydrolysis of salts of all types, degree of hydrolysis and hydrolytic constant, determination of degree of hydrolysis, relation between hydrolytic constant and ionic product of water.

(At least 100 problems are to be worked out from all units together. 30% of the questions for Examination shall contain problems.)

Suggested Readings

1. P W Atkins, "Physical Chemistry", Oxford University Press
2. R J Silby and R A Alberty, "Physical Chemistry", John Wiley & Sons
3. G W Castllan, "Physical Chemistry", Narosa Publishing House
4. F Daniels and R A Alberty, "Physical Chemistry", Wiley Eastern
5. E A Moelwyn Hughes, " Physical Chemistry", Pergamon Press
6. Puri, Sharma and Pathania, "Principles of Physical Chemistry", Millennium Edition, Vishal Publishing Co
7. R. Stephen Berry, Stuart A .Rice, John Ross, "Physical Chemistry",2nd edition, Oxford".
8. Gurdeep Raj, "Advanced Physical Chemistry", Goel Publishing House
9. S Glasstone, "Thermodynamics for Chemists", Affiliated East West Publishers
10. L V Azaroff, " Introduction to Solids", McGraw Hill
11. N B Hannay, " Solid State Chemistry", Prentice Hall
12. Anthony R West, " Solid State Chemistry and its Applications", Wiley Eastern
13. V Ramakrishnan and M S Gopinathan, "Group Theory in Chemistry", Vishal Publishing Co.

SEMESTER IV

Core Course

BV1444 Physical Chemistry II

Credits: 3 **Contact hours: 180 (Theory126 + Practical 54)**

Aim and Objective: The aim of the course is to make the students aware of quantum mechanics, statistical thermodynamics, spectroscopic and non-spectroscopic methods of studying molecules and adsorption phenomena.

The introduce the basics of the developing fields such as spectroscopy, quantum mechanics and statistical thermodynamics**.**

Module I

Binary liquid systems & catalysis 36 hrs

Liquid-Liquid system**:-** Completely miscible, ideal and non-ideal mixtures, Raoult's law, vapour pressure-composition and temperature-composition curves, fractional distillation, deviation from Raoult's law, Azeotropic mixtures, partially miscible liquid system, critical solution temperature, Conjugate layers, example for upper, lower and upper cum lower CST, Theory of steam distillation, distribution law, its thermodynamic derivation, limitations of distribution law, application of distribution law to the study of association and dissociation of molecules, solvent extraction.

Catalysis:- Theories of catalysis, Intermediate compound formation theory, steady state method, Enzyme catalysis, Michaelis-Menten law.

Colloids and Adsorption

Colloidal state: Types of solutions – true, colloid and suspensions, Purification of colloids – ultra filtration and electrodialysis, Kinetic, optical and electrical properties of colloids. Ultra microscope, Electrical double layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule. Gels: Elastic and non-elastic gels, Imbibition and syneresis, Micelles and critical micelle concentration, sedimentation and streaming potential, Application of colloids – Cottrell precipitator, purification of water and delta formation.

Adsorption: Physical and chemical adsorption, Freundlich adsorption isotherm, Derivation of Langmuir adsorption isotherm, Statement and explanation of BET and Gibbs isotherms, determination of surface area of adsorbents by Langmuir equation. Applications of adsorption.

Module II

Electro motive force 36 hrs

Electrochemical cells(brief explanation) Reference electrodes-standard hydrogen electrode, calomel electrode, Types of electrodes-Metallic electrodes, anion reversible electrodes and redox electrodes, Electrode reactions and cell reactions, Derivation of Nernst equation for electrode potential and cell potential, Gibb's Helmholtz equation and EMF of a cell, calculation of "G, "H and "S from EMF data.

Concentration cells with and without transference, electrode and electrolyte concentration cells, derivation of equation for the EMF of concentration cells with and without transference, Liquid Junction Potential, Fuel cells :- Hydrogen-Oxygen fuel cell, Hydrocarbon – Oxygen fuel cell.

Redox electrodes and redox systems, formal redox potential, principle of redox indicators, over voltage and polarization.

Applications of potential measurement:- Determination of ionic product of water, hydrolysis constant and solubility product, pH value using quinhydrone and glass electrode, potentiometric titrations of acid-base and redox reaction.

Electrical conductance

Inter ionic attraction theory, Debye-Huckel-Onsager equation (Qualitative treatment only) activity and activity co-efficient of electrolytes, Kohlrausch's law and its applications , wein effect, Debye-Falkenhagen effect, Walden's rule.

Ionic mobilities:- Transference number and its determination by Hittorff's and moving boundary methods, abnormal transference numbers, Applications of conductivity measurements:- Determination of degree of dissociation of weak electrolytes, degree of hydrolysis, solubility of sparingly soluble salts, conductometric titrations involving strong acid- strong base, strong acid-weak base, weak acid- strong base, weak acid-weak base and precipitation.

Module III

Thermodynamics III & Statistical thermodynamics **36 hrs**

Nernst heat theorem, proof and its consequences. Statement of IIIrd law-Plank's statement, Lewis Randall statement. Concept of perfect crystal, evaluation of absolute entropies of solid, liquid and gas. Exception to IIIrd law with reference to examples- CO, NO, N_2O and H_2O

Phase space, system, assembly and ensemble-types of ensembles and uses. Thermodynamic probability, Boltzmann distribution law (no derivation). Partition function, entropy and probability. Thermodynamic functions in terms of partition functions - internal energy, enthalpy, pressure, work function and free energy function.

Module IV

Quantum mechanics **36 hrs**

Radiation phenomena- blackbody radiation, photoelectric effect, Compton effect and atomic spectra. Planck's quantum theory and explanation of the radiation phenomena.

Schrodinger wave equation – significance of Ø, well behaved functions, Concept of operators and some operators of interest (properties of operators not required), Postulates of quantum mechanics

Application of quantum mechanics to simple systems- particle in 1 D box, normalization of wave function, Particle in 3 D box. Concept of degeneracy. Application to hydrogen atom (no derivation) Schrodinger wave equation in Cartesian and spherical polar co-ordinates, Quantum numbers.

Module V

Spectroscopy **36 hrs**

Regions of electromagnetic spectrum. Different units of energy (erg, joule, calorie, cm^{-1}, Hz, 0 A and eV) and their inter conversions. Interaction of radiations with matter. Various types of molecular spectra. Born-Oppenheimer approximation.

Rotational spectroscopy: microwave spectra of diatomic molecules, energy expression, selection rule, rotational energy levels, determination of bond length, effect of isotopic substitution.

Vibrational spectroscopy: Harmonic oscillator. IR spectra of diatomic molecules. Energy expression. Selection rules, frequency of separation, calculation of force constant, anharmonic oscillators. Morse equation. Fundamental and overtone transitions, combination bands, degree of freedom of polyatomic molecules.

Raman spectroscopy: Stoke's and antistoke's lines and their intensity difference, rotational Raman spectrum. Selection rule. Frequency of separation, vibrational Raman spectrum, Mutual exclusion principle.

Electronic spectroscopy: Franck-Condon principle. Singlet and triplet states dissociation and pre-dissociation. Electronic spectra and diatomic molecules. Dissociation energy, electronic spectra of polyatomic molecules (qualitative idea only).

NMR spectroscopy: Principle of NMR, nuclear spin. Interaction of nuclear spin with external magnet. Precession. Relaxation, Chemical shift. Low resolution spectra. Delta and tau scales. Spin-spin coupling and high resolution spectra.

Electron spin resonance spectroscopy: principle. Types of substances with unpaired electrons, interaction of electron magnet with external magnet. Energy level splitting. Lande splitting factor, presentation of ESR spectrum. The normal and derivative spectra. Hyperfine splitting. Simple examples like methyl and benzene radicals.

Surface properties: Examination of surfaces using ESCA, Auger, Scanning Tunneling Microscopy (STM) and Scanning Electron Microscopy (SEM).

At least 100 problems are to be worked out from all units together. 30% of the questions for Examination shall contain problems.

Suggested readings

1. P W Atkins, "Physical Chemistry", Oxford University Press
2. R J Silby and R A Alberty, "Physical Chemistry", John Wiley & Sons
3. G W Castllan, "Physical Chemistry", Narosa Publishing House
4. Puri, Sharma and Pathania, 'Principles of Physical Chemistry', Millennium Edition, Vishal Publishing Co.
5. Gurdeep Raj, "Advanced Physical Chemistry", Goel Publishing House.
6. S Glasstone, "Thermodynamics for Chemists", Affiliated East West Publishers
7. M C Guptha, "Elements of Statistical Thermodynamics", New Age International (P) Ltd.
8. L K Nash, "Elements of Statistical Thermodynamics", Addison Wesley
9. A W Adamson, "The Physics and Chemistry of Surfaces", Interscience
10. N K Adam, " The Physics and Chemistry of Surfaces", Oxford University Press
11. M W Hanna, "Quantum Mechanics in Chemistry", Benjamin
12. I N Levine, "Quantum Chemistry", Prentice Hall
13. C N Banwell, "Fundamentals of Molecular Spectroscopy", Tata McGraw Hill
14. Manas Chanda, "Atomic structure and Chemical bonding in Molecular Spectroscopy", Tata McGraw Hill
15. 15.Physical Chemistry, R. Stephen Berry, Stuart A Rice $ John Rose 2nd Edn , Oxford.

SEMESTER IV

Core Course

BV 1445 Practical Chemistry II

(Practical of BV1343 & BV1444)

Credits: 2 **Contact hours: 108 (Practical hours of BV1343 & BV1444)**

Practicals of Physical Chemistry

The following experiments are to be practiced by the students Determination of

1. Partition coefficient of iodine between CCl_4 and H_2O
2. Transition temperature of a salt hydrate. Molar mass of a solute using transition point depression of a salt hydrate.
3. Molar mass of a solute. Depression in freezing point of a solid solvent by cooling curve method.
4. Critical solution temperature of phenol – water system.
5. Viscosity of binary mixtures and then concentration of an unknown mixture.
6. Surface tension of binary mixtures and then concentration of an unknown mixture.
7. Refractive index of KCl solutions of different concentrations and then concentration of an unknown solution.
8. Conductometric titration of NaOH Vs HCl.
9. Potentiometric titration of Fe^{2+} vs $Cr_2O_7^{2"}$
10. Potentiometric titration of $KMnO_4$ Vs KI
11. Determination of water equivalent of a calorimeter and heat of neutralisation of strong acid – strong base.
12. Kinetics of hydrolysis of an ester
13. Influence of KCl impurity on miscibility temperature of phenol – water system and then the determination of concentration of a given KCl solution

SEMESTER V

Core Course

BV1543 Organic Chemistry I

Credits: 4

Contact hours: 180 (Theory 108 + Practical 72)

Aim and Objective : The syllabus includes hybridization, mechanism of reactions, aromaticity and the chemistry of aliphatic and aromatic substituted compounds.

It learns the behaviour of aliphatic and aromatic compounds like aromatic aldehydes, ketones and halides. By studying this topics the students get an idea of the mechanism of reactions of organic compounds and hybridization.

Module I

Hybridisation and various types of reagents **36 hrs**

Hybridisation – sp^3, sp^2 and sp, structure and shapes of simple organic molecules, bond lengths, bond angles and bond energy, Electron displacement effects – inductive effect, electromeric effect, hyperconjugation, resonance, steric effect. Homolytic and heterolytic fission.

Types of organic reactions, energy considerations. Reaction intermediates – carbocations, carbanions, free radicals, carbenes, benzynes. Methods of determination of reaction mechanism – product analysis, intermediates, isotope effect, kinetic and stereochemical studies.

Reaction mechanisms

Mechanism of addition of hydrogen, electrophilic and free radical addition, Markownikoff's rule and kharasch effect. Mechanism of nucleophilic and electrophilic addition reactions, Nucleophilic and electrophilic substitution reactions, elimination reactions – E1, E2, S_N1, S_N2 and S_Ni reactions and mechanisms. Study of reactions of hydroboration, epoxidation, ozonolysis, hydration, cis-hydroxylation.

Module II

Arenes & Aromaticity **36 hrs**

Nomenclature of benzene derivatives, Aromaticity, Huckel's rule, Non- benzenoid aromatic compounds – 5 membered and 7 membered ring compounds- structure of benzene.

Mechanism of aromatic electrophilic substitution in benzene– halogenation, nitration, sulphonation, Friedel-Crafts alkylation, acylation. Energy profile diagram. Orienting effect of substituents like –OH, $-NH_2$, $-NO_2$, $-CH_3$ and halogens. Nucleophilic aromatic substitution. Elimination-addition mechanism, reactivity and orientation- aromatic electrophilic substitution in naphthalene- Friedel- Crafts alkylation and nitration.

Substituted Arenes, Alkyl halides & Aryl halides Methods of formation of alkyl benzenes, alkynyl benzenes, and biphenyl. Preparation and properties of aryl halides.

Alkyl halides: Nomenclature and classes of alkyl halides, preparation and properties, Synthetic uses of vinyl chloride, chloroform, carbon tetrachloride, trichloroethylene, chloroprene, Freon12, DDT, BHC.

Module III

Alcohols & Phenols **36 hrs**

General methods of preparation and properties of alcohols. Methods to distinguish primary, secondary and tertiary alcohols. ascent and descent in alcohol series. Oxidation of alcohols with acidified $KMnO_4$, $K_2Cr_2O_7$. Jones reagent and PCC (Pyridinium Chloro Chromate). Polyhydric alcohols: - Preparation and properties of ethylene glycol and glycerol, their industrial importance.

Phenols: - Preparation and properties of phenols. Acidity of phenols and its comparison with alcohols and acids. Effect of substituents on acid strength of Phenols. Industrial Importance of methanol, ethanol – Absolute alcohol methylated spirit, power alcohol, allyl alcohol, benzyl alcohol, picric acid, quinol and nitro phenols.

Aldehydes and Ketones

Aldehydes and Ketones: - General methods of preparation and properties of aldehydes and ketones (both aliphatic and aromatic). Reduction with $LiAlH_4$, Sodium borohydride, Aluminium Iso Propoxide Wolf-Kishner reduction, Clemmenson reduction. Test to distinguish aldehydes and ketones. Condensation reactions

and its Mechanisms – Aldol condensation, mixed and crossed aldol condensation and benzoin condensation. Preparation and uses of crotonaldehyde, mesityl oxides, cinnamaldehyde, salicylaldehyde, vanillin, naphthaquinone and anthraquinone.

Ethers, Carboxylic acids and their derivatives **18 Hrs**

Ethers: -Preparation and properties. Zeisel method of estimation of alkyl group. Brief Study of epoxides and crown ethers. Carboxylic acids and their derivatives: - Preparation and properties of aliphatic and aromatic carbojxylic acids. Ascent and descent series in aliphatic carboxylic acids. Effect of substituents on acidity of aliphatic and aromatic carboxylic acids. Preparation, properties and uses of anthranilic acid, cinnamic acid, lactic acid, salicylic acid, adipic acid, acid anhydrides, amides, esters, coumarin, malic acid, tartaric acid and citric acid.

Module V

Stereochemistry of Organic Compounds. **27 hrs.**

Optical isomerism: elements of symmetry, chirality, steriogenic centre, enantiomers, chiral and achiral molecules with two stereogenic centres, dia stereo isomers, meso compounds, resolution, inversion and racemization reaction. Aymmetric synthesis, absolute configuration, sequence rule, D-L, R-S systems of nomenclature. Optical activity of compounds having no chiral carbon (Allenes and Biphenyls).

Geometrical isomerism: E - Z systems of nomenclature. Geometric isomerism in maleic and fumaric acid and butadiene.

Conformational isomerism: Configurational analysis of ethane, n – butane and cyclohexane. Newmann projection formula and Sawhorse formula.

Module VI

Carbohydrates **27 Hrs**

Classification and Nomenclature of monosaccharides. Configuration of monosaccharides. Preparation, properties and structural elucidation of glucose, fructose and sucrose. Anomers, epimers and mutarotation. Mechanisms of Epimerization and Mutarotation. Ascent and descent series in aldoses and ketoses. Conversion of aldoses to ketoses and ketoses to aldoses. Conversion of glucose to mannose.

Polysaccharides: - Starch and Cellulose - Preparation, properties and structure of starch and cellulose (structural elucidation not expected). Industrial application of cellulose.

Suggested readings

1. I L Finar, "Organic Chemistry - Vol. I", Longman
2. M K Jain, "Principles of Organic Chemistry",
3. Morrison & Boyd, "Organic Chemistry", Prentice Hall
4. Peter Sykes, "A Guide book to Mechanisms in Organic Chemistry", Longman
5. Jerry March, "Advanced Organic Chemistry", Wiley
6. Bahl & Bahl, "Advanced Organic Chemistry"
7. Tewari & Mahrotra, "A text book of Organic Chemistry"
8. P L Soni, "Organic Chemistry"
9. Rein hard Bruckner, "Advanced Organic Chemistry Reaction Mechanisms"
10. Arun Parikh, Hansa Parikh, Khyati Parikh, "Name Reactions in Organic Synthesis".

SEMESTER VI

Core Course

BV1643 Organic Chemistry II

Credits: 3

Contact hours: 180 (Theory 126 + Practical 54)

Aim and Objective of the Course : The syllabus deals with organic compounds like ethers, acids, carbohydrates, aminoacids, proteins, nucleic acids, oils, fats, detergents, vitamins, terpenes, alkaloids, hormones and enzymes and their properties and the stereochemistry of organic compounds.

The students will get an interesting idea about the stereochemistry of organic compounds and the preparation and properties of organic compound

Module I

Amino acids, Proteins and Nucleic acids **36 hrs.**

Amino acids: - Classification, structure and stereochemistry of amino acids, essential and non essential amino acids, zwitter ion, isoelectric point, General methods of preparation and reactions of á - amino acids.

Peptides: structure and synthesis (Carbo benzoxy method, Sheehan method only).

Proteins: - Structure of proteins, denaturation and colour reactions.

Nucleic acids:- Classification and structure of DNA and RNA. Replication of DNA, Genetic Codes.

Module II

Oils, Fats, Detergents, Alkaloids and Terpenes **18 hrs.**

Oils and Fats: - *Occurrence and extraction. Common fatty acids, soap, saponification value, iodine value, acid value, synthetic detergents and detergent action, alkyl and aryl sulphonates.* **Alkaloids:** - Extraction and structural elucidation of conine, nicotineand importance of quinine, morphine and codeine.

Terpenes: - Essential oils, isolation of citral and geraniol (No structural elucidation) Isoprene and special isoprene rule.

Module III

Vitamins, Hormones, Enzymes and Synthetic Reagents **36 hrs.**

Vitamins: - Classification and important sources, physiological action and deficiency symptoms of vitamin A, B_1, B_2, and B_{12}. C, D, E and K.

Hormones: - Introduction, steroid and sex hormones – examples and functions (Structure not expected).

Enzymes: - General nature and classification, specificity of enzymes.Synthetic reagents: -

Acetoaceticester-synthesis and tuatomerism-syntheic application of Acetoaceticester, Synthesis and synthetic application of Diethylmalonate. Grignard reagents, organic zinc reagents, Reformatsky reaction.

Module IV

Organic Synthesis, Rearrangements, Synthetic Polymers and Dyes **36 Hrs**

Study of reactions and mechanisms of Meerwin-Pondorf- Verley reductions, Gattermann-Koch reaction, Gattermann aldehyde synthesis, Claisen condensation, Knoevenangal reaction, Perkin reaction, Cannizaro reaction, Reimer- Tiemann reaction, Sandmeyer reaction & Wittig reaction,

Mechanism of Pinacol-Pinacolone rearrangement, Claisen rearrangement, Fries rearrangement, Benzidine rearrangement and Beckmann rearrangement.

Polymers- Types of polymerization- addition, condensation and coordination polymerization. **Zieglar –Natta catalyst**. Synthesis and applications of urea – formaldehyde resins, Bakelite, polythene, PVC, PMMA, Nylon-6,6. Natural and synthetic resins. Buna-N , Buna-S, Neoprene, Polystyrene.

Biodegradable polymers- two examples- starch and cellulose. Number average molecular weight and weight average molecular weight of polymers. Composites (refer any two)

Dyes- Theory of colour and constitution, classification of dyes, synthesis of methyl orange, congo red, malachite green, crystal violet, phenolphthalein, fluorescein, alizarin and indigo

ModuleV

Organic Sulphur and Nitrogen compounds **18 Hrs**

Aromatic sulfur compounds –Preparation and applications of benzene sulphonic acids, toluene sulphonic acid, benzene sulphonyl chloride, sulphanilic acid , sulphanilamide and sulpha drugs- sulphapyridine, sulphathiazole, sulphadiazine, sulphaguanidine and sulphaacetamide.

Organic Nitrogen Compounds- Nitro compounds- preparation of nitroalkanes and nitroarenes, tautomerism, reduction of nitrobenzene in acid , base and neutral medium. General methods of preparation and reactions of aliphatic and aromatic amines, classification of amines, separation of mixture of amines, methods to distinguish primary, secondary and tertiary amines, basicity of amines, effect of substituents , quarternary ammonium compounds- Hofmann elimination. Diazonium and diazo compounds- preparation, structure and their synthetic importance.

Module VI

Organic Spectroscopy **36 Hrs**

UV-Visible Spectroscopy- absorption, types of electronic transitions, effect of conjugation, concept of chromophore, auxochrome, bathochrome, hypochromic shifts, hyperchromic and hypochromic effects. UV-Visible spectra of enes. Calculation of ëmax.

IR Spectroscopy- molecular vibrations, factors influencing vibrational frequencies, inductve effect and hydrogen bonding. Finger print region and interpretation of IR spectra of simple organic molecules such as phenol, acetone, acetanilide, benzaldehyde.

NMR spectroscopy- Proton NMR- shielding and deshielding effect, chemical shift, factors influencing chemical shift, spin-spin splitting, coupling constant, interpretation of PMR spectrum of simple molecules like ethylbromide, pure ethanol and impure ethanol(acidic impurities), acetaldehyde and toluene. Basic knowledge of C^{13} NMR

Mass spectrometry- Theory of mass spectrum, base peak and molecular ion peak, types of fragmentation, Mclafferty rearrangement, isotopic effect. Applications- determination of molecular mass.

Suggested Readings

1. Morrison & Boyd,"Organic Chemistry". :
2. F. Carey, Mc Graw Hill,"Organic Chemistry". :
3. I.L. Finar, "Organic Chemistry", Vol I & II Longmann.
4. L.G. Wade, "Organic Chemistry".
5. 5.P.Y. Bruice,"Organic Chemistry".

6. Stanley, H. Pine, Mc Graw Hill,"Organic Chemistry".
7. Jerry March,"Advanced Organic Chemistry".
8. S.M. Mukherji and S.P. Singh, " Reaction Mechanism in Organic Chemistry" Mac Millan.
9. Rein hard Bruckner ,"Advanced Organic Chemistry Reaction Mechanism".
10. Bahl & Bahl," Advanced Organic Chemistry".
11. Tewari, Mehrotra," A text book of Organic Chemistry".
12. M.K. Jain ,"Principles of Organic Chemistry".
13. Fieser & Fieser," Advanced Organic Chemistry".
14. D. Nasipuri, "Stereo Chemistry of Organic compounds" .
15. Arun Parikh, Hansa Parikh, Khyati Parikh ,"Name Reactions in Organic Synthesis".

SEMESTER VI

Core Course

BV1644Practical Chemistry-III

(Practical of BV1543 & BV1643)

Credits: 3 **Contact hours: 108 (Practical Hours of BV1543 & BV1643)**

1. Gravimetry

The following determinations are to be done using silica crucible (1) Ba as $BaSO_4$ (2) Sulphate as $BaSO_4$ (3) Iron as Fe_2O_3 (4) Calcium as $CaCO_3$ (5) Aluminium as Al_2O_3 and Magnesium as

$Mg_2P_2O_7$.

The following determinations are to be done using sintered crucible

(1) Magnesium as oxinate (2) Nickel using dimethyl glyoxime (3) Copper as copper thiocyanate and (4) Silver as silver chloride

II. Organic Chemistry Practicals

1. Tests for elements : Nitrogen, halogens and sulphur
2. Determination of physical constants
3. Studies of the reactions of common functional groups using known organic compounds.
4. Qualitative analysis with a view to characterization of the functional groups. The following compounds may be given for the analysis : chlorobenzene, benzyl chloride, phenol, o – m – p – cresols, naphthols, resorcinol, benzaldehyde, acetophenone, benzophenone, benzoic, phthalic, cinnamic and salicylic acids, ethyl benzoate, methyl salicylate, benzamide, urea, aniline, o, m, p – toluidines, dimethylaniline, nitrobenzene, o – nitro toluene p – nitro toluene, m – dinitrobenzene, naphthalene, anthracene, glucose and sucrose.
5. Organic preparations involving halogenation, nitration, oxidation, reduction, acetylation benzoylation, hydrolysis and diazotisation.

III. Chromatography

a. Paper chromatographic separation of mixture of nitroanilines, amino acids and sugars.
b. Separation of a mixture of dyes by column chromatography.

IV. Organic estimation

c. Molar mass determination of an acid and base by titration method

d. Determination of the phenol/aniline by bromate – bromide mixture.

Suggested Readings

1. A.I.Vogel, "A text book of Qualitative Analysis including semi micro methods" Longmans.

2. V.V.Ramanujam, "Semi micro Qualitative Analysis"

3. E.S.Gilreath "Qualitative Analysis using semi micro method" Mc Graw Hill

4. A.I.Vogel, "A text book of Qualitative Inorganic Analysis" Longmass

5. A.I.Vogel, "Elementary Practical Organic Chemistry" Longmass

6. Day and Raman, "Laboratory Mannual of Organic Chemistry". Viswanathan

7. Mann and Saunders, "Practical Chemistry"

8. A.Findlay, "Practical Physical Chemistry"

9. R.C.Das and E.Behara, "Experimental Physical Chemistry", Tata Mc Graw Hill

10. N.K.,Vishnoi, "Advanced practical organic chemistry" Vikas publishing house, New Delhi.

Core Courses of Biotechnology

SEMESTER I

Core Course

BV1143 Biochemistry & Metabolism

Credits: 4 **Contact hours: 126 (Theory 54 + Practical 108)**

Aim and Objective: The course will impart a basic understanding about the concept of the biochemical basis of phenomenon life and metabolic reaction of cells that are essential for the sustenance of life. It specially focuses on the development of analytical skills in biochemistry by giving more importance to the laboratory experiments of biochemistry.

Module I

Structural features of water molecule, dissociation of water, ionic product of water, acids and bases, concepts of pH, pOH, theoretical calculations of pH and pOH, dissociation of weak acids , buffers buffer action and buffer capacity, buffers in biological system, Henderson – Hasselbalch equation, titration curve of weak acids, simple numerical problems involving application of this equation.

Module II

Solutions: Expression of concentration- normality, molality, molarity, percentage solution, mole fraction, parts per million, Problems related to concentrations.

Colloids: Definition of true solution, suspension, colloids and crystalloids, lyophilic and lyophobic colloids, Properties of colloids, biological significance of colloids, emulsions and emulsifying agents,

Diffusion, osmosis, osmotic pressure, Vant Hoff's laws of osmotic pressure, definition of isotonic, hypotonic and hypertonic solutions, biological importance of osmosis, surface tension, viscosity.

Module III

Carbohydrates : Classification, optical isomerism, D and L series, epimers, aldoses and ketoses, structural relationships of aldoses, ring structure of monosaccharides, anomers, mutarotation, chemical reactions of glucose and fructose, glycosides, deoxy sugars, amino sugars, sugar alcohols and sugar acids, O- acyl O-methyl derivatives of monosaccharides, ozazone, disaccharides, structure and important properties of sucrose, maltose, isomaltose, lactose and cellobiose, Trisaccharide (examples only), structure and important properties of polysaccharides- starch, glycogen, cellulose, and chitin.

Metabolism of carbohydrates: Carbohydrate digesting enzymes- alpha amylase, breakdown of starch and cellulose, Glycolysis, Citric acid cycle, electrontransport system and oxidative phosphorylation, Energy balace of cellular oxidation of glucose.

Biosynthesis of carbohydrate- photosynthesis- photochemical reaction, dark reaction, alternate pathways of glucose synthesis, glycogen synthesis. Qualitative test for various trypes of carbohydrates.

Module IV

Lipids: Classification of lipids, chemical composition of tryglycerides, fatty acids, structure and properties , reactions of fatty acids, triglycerides- general structure and properties, acid number, Saponification number and iodine number fats, glycerol, Acrolein test, **Phospholipids,** derivatives of phospholipids- glycerophosphates, sphingosine phosphate, nonphosphorylated sphingolipids,- cerebrosides, gangliosides, sulphatides, (structure only) Steroids- structural features, sterols, structure of cholesterol and ergosterol . Colour reactions of sterols.

Biosynthesis and breakdown of lipids- scheme of â-oxidation (stearate and palmitate as examples) and regulation, Basics of ù amd á- oxidation, Ketone body formation, Fatty acid biosynthesis and regulation, essential fatty acids, outline of the synthesis of triglycerides.

Module V

Amino acids and proteins: Classification of amino acids, amino acids occurring in proteins, optical activity, UV absorption, Zwitterions, chemical reactions of amino acids, proteins, biological significance, classification – fibrous proteins, globular proteins, conjugated proteins, hydrolysis of proteins and separation of amino acids.

Proteins: Physical properties, solubility, isoelectric point and isoelectric precipitation,

Protein structure: study of primary secondary, tertiary and quaternary structure of proteins, colour reactions, precipitation reactions, denaturation, oligopeptides, amino acid analysis of proteins, hemoglobin- functions and components of plasma proteins.

Module VI

Enzymes: Classification and nomenclature, units of enzyme activity, progress curve, effect of enzyme concentration, substrate concentration, temperature and pH on reaction velocity of enzyme catalyzed reactions. Michaelis- Menten constant, enzyme affinity, Michaelis- Menten equation (Derivation not expected),Enzyme specificity, different types , enzyme activation , enzyme inhibition- competitive and non-competitive , Line weaver – Burk plot, application of LB plot, allosteric regulation (Brief study) purification of enzymes, criteria of purity, coenzymes.

Module VII

Nucleic acids: Base compositions, structure of purines and pyrimidines, ribose and deoxy ribose, nucleoside structure , nucleotides- nomenclature, structure of polynucleotide – DNA,RNA primary structure and inter nucleotide linkage Watson and Crick double helix model of DNA, different types of RNA.

Practical

Familairization and Practice of the following techniques and concepts

1. Weighing in Chemical balance
2. Preparation of solutions
3. percentage, molar & normal solutions, dilution from stock solution etc.
4. Demonstration of dialysis
5. Demonstration of PAGE
6. Demonstration of Paper Chromatography
7. Demonstration of Thin Layer Chromatography
8. Colorimetry and Spectrophotometry techniques
9. Verification of Beer Lambert's law
10. Verification of molar extinction coefficient of any known compound

Carbohydrates

Qualitative analysis of Carbohydrates.

Carbohydrates-Glucose, Fructose, Galactose, Xylose, Sucrose, Maltose, Lactose, Starch & Dextrin

Tests- Molisch's test, Anthrone test, Fehling's test, Benedict's test, Picric acid test, Barfoed's test, Bial's test, Seliwanoff's test, Foulger's test, Phloroglucinol test, Mucic acid test, Iodine test, Hydrolysis of Sucrose and Starch, Osazone test.

Quantitative Analysis of carbohydrates Estimation of glucose by Nelson-Somogyi method Estimation of reducing sugar by anthrone method.

Estimation of pentose by Orcinol method.

Estimation of ketose by Roe-Papedopaulose method.

Lipids

Qualitative analysis of Lipids

Fatty acids: Stearic acid, Oleic acid. Tests- Solubility, Translucent spot tests, Test for Unsaturation

Glycerol

Tests- Acrolein, Solubility.

Triglycerides

Tests-Solubility, Saponification, Translucent spot test

Cholesterol

Tests- Solubility, Salkowski reaction, Liebermann-Burchard reaction

Quantitative Analysis of Lipids

Estimation of Cholesterol by Carr-Drecktor method.

Estimation of Cholesterol by Zak's method.

Determination of Acid Value.

Determination of Saponification value.

Determination of Iodine number of oil

Amino acids and Proteins

Qualitative analysis of Amino acids and Proteins

Amino acids- (Tyrosine, Glycine, Tryptophan, Histidine, Arginine, Cysteine, Cystine, Proline, Methionine) (single components only need be given)

Tests- Solubility, Ninhydrin reaction, Xanthoproteic reaction, Millons test, Morners test, Glyoxalic acid test, Ehrlich's test, Nitroprusside test, Lead acetate, Test for Methionine, Aldehyde test, Sakaguchi reaction, Isatin test

Proteins-Ovalbumin and Casein *Tests*-Solubility, Ninhydrin reaction, Xanthoproteic reaction, Folin's test, Lowry's test, Biuret test, Heat denaturation, TCA precipitation, Metal precipitation, Alcohol precipitation.

Quantitative Analysis of Amino acids and Proteins Estimation of Tyrosine by Folin-Lowry method.

Estimation of Protein by Biuret method.

Estimation of Protein by Folin-Lowry method.

Estimation of Protein by Bradford's method.

Nucleic Acids

Quantitative Analysis of Nucleic Acids

Estimation of DNA by diphenylamine method.

Estimation of RNA by Orcinol method

Enzyme Assays

Assay of any two of the following enzymes

Salivary amylase/ acid phosphatase/lysozyme

Kinetics of salivary amylase / acid phosphatase (Effect of pH, substrate Concentration, enzyme concentration and temperature)

Progress curve of salivary amylase / acid phosphatase

Suggested Readings

1. Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson David L. Nelson (Author)
2. Michael M. Cox Publisher: W. H. Freeman; Fourth Edition (April 23, 2004)
3. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi .
4. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi,
5. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (Ed), Kalyani Publishers, Ludhiana.
6. Hawks Physiological Chemistry, Bernard L.Oser (ed).TATA McGRAW Hill Publishing Company LTD, New Delhi.
7. ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.
8. Text Book of Biochemistry, 5th edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi
9. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974
10. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
11. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd
12. Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker Cambridge University Press
13. A Biologist's Guide to Principles and Techniques of Practical Biochemistry by BryanL.Williams, Keith Wilson Hodder Education.

SEMESTER II

Core Course

BV1245 Microbiology

Credits- 2 **Contact hours-126 (Theory 72 + Practical 54)**

Module I

Introduction **10 hrs**

Scope and history of microbiology: Pasteur's experiments, concept of sterilization, methods of sterilization -dry heat, wet heat or steam, radiation, chemical and filtration.

Classification of microorganisms: bacteria, virus, fungi, protozoa, mycoplasma, concept of microbial species, strains; microbial cell surfaces, gram positive and gram negative bacteria, classification of bacteria, Motility in bacteria, kinds of flagella, nutritional classification of bacteria.

Viruses:

Viruses, phage culture, Bacteriophage, DNA and RNA phages, T4 phage, Lytic and lysogenic cycles, Host cell adsorption and penetration, synthesis phage nucleic acid.

Module II **18 hrs**

Bacterial Metabolism

Bacterial cell structure and Growth- Eukaryotic cells and prokaryotic cells, Glycocalyx, bacterial cell membranes, bacterial cell wall, cytoplasm, spores, organs of locomotion, chemotaxis in bacteria, ribosomes in bacteria, bacterial nucleus and chromosomes, bacterial nucleoid. Bacterial Growth curve, Measurement of growth, factors affecting growth of bacteria.

Nutrition in bacteria-classification based on nutrition- autotrophic and heterotrophic organisms, Photosynthetic and chemosynthetic organisms- purple sulfur bacteria, Saprophytes and parasites-pathogenic parasites. Culture media – requirements of bacterial culture media, types and uses, Bacterial growth curve,

Energy production in bacteria- Energy and ATP, aerobic respiration, Glycolysis and tricarboxylic acid cycle, Electron transport and oxidative phosphorylation in Bacteria, catabolism of other carbohydrates.

Anaerobic respiration- Fermentation, alcohol fermentation by yeasts and bacteria, lactic acid fermentation, Methnogenic bacteria, Acetobacter and acetic acid fermentation. Application of bacterial metabolism in industry and agriculture

Isolation of pure culture: Spread plate, streak plate, pour plate etc., synthetic media, simple and complex media. Isolation of anaerobs and its culture techniques, slant culture and stab culture.

Module III **15 hrs**

Bacterial genetics

Bacterial chromosome-

Transfer of genetic information in bacteria, Bacterial chromosomes- DNA, Plasmids, different types of plasmids- non-conjugative, mobilizable plasmids, resistance plasmids **Bacterial Mutation** – Spontaneous mutation, induced mutations, Repair mechanisms, Transposable genetic elements in bacteria, overlapping genes.

Bacterial recombination:

Conjugation- Fertility factors, F+ and F- cells, F pili, High frequency recombination Transformation- Griffith's effect, evidence of DNA as genetic material, Transduction- general characteristics of bacteriophages, Lambda pahage-general structure, general multiplication in bacteria- lytic phase and lysogenic phase, bacterial recombination through transduction.

Phages and plasmids as vectors for genetic engineering, Bacterial recombination and transferable drug resistance

Genetic homogeneity

Spontaneous and induced variations in microbes, Isolation of auxotrophs- replica plating technique and analysis of mutations in biochemical pathways, Microbial assays for vitamins and antibiotics, and other chemotherapeutic agents.

Module IV

Microbes in extreme environments **7 hrs**

Thermophiles and alkalophiles, pathogenic microorganisms- bacteria, fungi, viruses, protozoans and mycoplasma, defense mechanism against microorganisms, symbiosis and antibiosis among microbial population, nitrogen fixing bacteria in agriculture and forestry, photosynthetic bacteria, Role of bacteria in carbon, nitrogen, sulphur and phosphorous cycle in nature.

Module V

Industrial microbes and their uses **7 hrs**

Production of food (dairy and SCP) and drugs (antibiotics such as penicillin & streptomycin), products of fermentation, Strain improvement by enrichment mutation and recombinant DNA technique, production of heterologous proteins of interest in microorganisms.

Module VI **15 hrs**

Microbial Diseases of Humans

Airborne bacterial diseases – streptococcal; diseases, tuberculosis, Pneumococcal Pneumonia, *Klebsiella* Pneumonia,

Foodborne and waterborne bacterial diseases- Foodborne and waterborne intoxications- Botulism, Staphylococcal food poisoning;

Foodborne and waterborne infections- Typhoid fever, salmonellosis, Cholera, Shigellosis, *E.coli* Diarrheas, Brucellosis

Soilborne bacterial diseases- Anthrax, Tetanus, Leptospirosis,

Viral diseases of Humans- Pneumotropic viral diseases-Influenza, Adenoviral infections, Rhinoviral infections,

Dermatoviral diseases- Herpes simplex, chickenpox, Measles, Rubella,

Viscerotropic Viral diseases- yellow fecer, Dengu fever,

Neurotropic viral diseases- rabies, Polio

Control of microorganisms

Physical agents, chemical agents, antibiotics and other therapeutic agents

Experiments for Microbiology Practical **54 hrs**

1. Use of Microscope
2. Sterilization and aseptic techniques-preparation and sterilization of glassware and solutions
3. Media Preparation- Preparation of Luria-Bertani medium and Nutrient agar and sterilization (Broth and plates)
4. Isolation and identification of E.coli from water samples and its identifications.
5. Screening of enterobacteria from water samples and its identification
6. Examination of microbial flora of the available soil and water samples,
7. Isolation of bacteria from soil, water and air-a) Pour plate method, b) Streak plate method for isolation and colony purification.
8. Isolation of microorganisms from spoiled food materials
9. Microbiological examination of various types of waters including commercial and ordinary drinking water
10. Staining of bacteria- Gram staining, Acid fast staining, Negative staining
11. Microscopic tests for bacterial motility
12. Identification of bacterial and fungal cultures microscopically
13. Antibiotics sensitivity tests
14. Serial dilution of bacterial cultures and plating to find out population density of microbes in a given sample
15. Growth of Bacteria in liquid media: Determination of kinetics of bacterial growth
16. Isolation of starch degrading microorganisms- fungus and bacteria and the assay of the enzymes.
17. Fermentation techniques- Determination of substrate utilization with respect to growth kinetics
18. Isolation of lactobacillus from curd and its identification 19.Isolation of yeast from fruit samples and its culturing.
20. Examination of microbial flora of the skin
21. Examination of the microbial flora of mouth.
22. Environmental distribution of microorganisms
23. Gram staining of bacteria
24. Methylen blue stain
25. bacterial spore staining
26. Isolation and examination of Throat and nasopharyngeal cultures
27. Inhibition and destruction of microorganisms by antibacterial chemicals.
28. Production of exoenzymes by bacteria- isolation of alpha amylase producing bacteria and its culturing for the production of alpha amylase 29.Plaque-forming Bacteriophage

Suggested Readings

1. A Textbook of Microbiology – P. Chakraborthy, New central Book agency Pvt. Ltd, calcutta
2. Modern concept of Microbiology – D D Kumar, S Kumar; Vikas Publishing House Pvt. Ltd. New Delhi
3. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
4. Introduction to Microbiology- J Heritage, E G V Evans, R A Killington; Cambridge University Press.

5. Microbiology – L M Prescott, Brown Publishers, Australia
6. Principles of Biotechnology – A. J. Nair Laxmi Publications New Delhi
7. Advances in Microbiology – J P Tewari, T N Lakhanpal, I Singh, R Gupta and B P Chanola; A P H Publishing Corporation, New Delhi.
8. Microbiology: Principles and Explorations – Jacquelyn G. Black. Prentice Hall, New Jersey.

SEMESTER II

Core Course

BV1246 Biotechniques- I

(Practical of BV1143 BV1245)

Credit 2 **Contact hours: Practical hours of BV1143 & BV1245**

Aim and Objective: This course is the practicals of the course BV1143 and 1245, which gives hands on training on the analytical techniques and experiments of Biochemistry and Microbiology which are the core components of Biotechnology experiments

Experiments for Biochemistry and Metabolism (BV1143) **72 hrs**

Familairization and Practice of the following techniques and concepts

1. Weighing in Chemical balance
2. Preparation of solutions- percentage, molar & normal solutions, dilution from stock solution etc.
3. Demonstration of dialysis
4. Demonstration of PAGE
5. Demonstration of Paper Chromatography
6. Demonstration of Thin Layer Chromatography
7. Colorimetry and Spectrophotometry techniques
8. Verification of Beer Lambert's law
9. Verification of molar extinction coefficient of any known compound

Carbohydrates

Qualitative analysis of Carbohydrates.

Carbohydrates-Glucose, Fructose, Galactose, Xylose, Sucrose, Maltose, Lactose, Starch & Dextrin

Tests- Molisch's test, Anthrone test, Fehling's test, Benedict's test, Picric acid test, Barfoed's test, Bial's test, Seliwanoff's test, Foulger's test, Phloroglucinol test, Mucic acid test, Iodine test, Hydrolysis of Sucrose and Starch, Osazone test.

Quantitative Analysis of carbohydrates

Estimation of glucose by Nelson-Somogyi method

Estimation of reducing sugar by anthrone method.

Estimation of pentose by Orcinol method.

Estimation of ketose by Roe-Papedopaulose method.

Lipids

Qualitative analysis of Lipids

Fatty acids: Stearic acid, Oleic acid.

Tests- Solubility, Translucent spot tests, Test for Unsaturation

Glycerol

Tests- Acrolein, Solubility.

Triglycerides

Tests-Solubility, Saponification, Translucent spot test **Cholesterol**

Tests- Solubility, Salkowski reaction, Liebermann-Burchard reaction

Quantitative Analysis of Lipids

Estimation of Cholesterol by Carr-Drecktor method.

Estimation of Cholesterol by Zak's method.

Determination of Acid Value.

Determination of Saponification value.

Determination of Iodine number of oil

Amino acids and Proteins

Qualitative analysis of Amino acids and Proteins

Amino acids- (Tyrosine, Glycine, Tryptophan, Histidine, Arginine, Cysteine, Cystine, Proline, Methionine) (single components only need be given)

Tests- Solubility, Ninhydrin reaction, Xanthoproteic reaction, Millons test, Morners test, Glyoxalic acid test, Ehrlich's test, Nitroprusside test, Lead acetate, Test for Methionine,

Aldehyde test, Sakaguchi reaction, Isatin test

Proteins-Ovalbumin and Casein

Tests-Solubility, Ninhydrin reaction, Xanthoproteic reaction, Folin's test, Lowry's test, Biuret test, Heat denaturation, TCA precipitation, Metal precipitation, Alcohol precipitation.

Quantitative Analysis of Amino acids and Proteins Estimation of Tyrosine by Folin-Lowry method.

Estimation of Protein by Biuret method.

Estimation of Protein by Folin-Lowry method.

Estimation of Protein by Bradford's method.

Nucleic Acids

Quantitative Analysis of Nucleic Acids

Estimation of DNA by diphenylamine method.

Estimation of RNA by Orcinol method

Enzyme Assays

Assay of any two of the following enzymes

Salivary amylase/ acid phosphatase/lysozyme

Kinetics of salivary amylase / acid phosphatase (Effect of pH, substrate Concentration, enzyme concentration and temperature) Progress curve of salivary amylase / acid phosphatase

Experiments for Microbiology (BV1245*)* 54 hrs

1. Isolation of lactic acid bacteria from curd.
2. Lactic acid fermentation using lactose as substrate.
3. Isolation of yeast from fruit samples.
4. Isolation of starch degrading microorganisms- fungus and bacteria and the assay of the enzymes.
5. Production of alpha amylase by *Aspergillus niger*.
6. Fermentation techniques- Determination of substrate utilization with respect to growth kinetics
7. Isolation and identification of E.coli from water samples and its identifications.
8. Environmental distribution of microorganisms -Examination of microbial flora of the available soil and water samples,
9. Isolation of microorganisms from spoiled food materials
10. Isolation of lactobacillus from curd and its identification
11. Examination of microbial flora of the skin
12. Examination of the microbial flora of mouth.
13. Isolation and examination of Throat and nasopharyngeal cultures.
14. Inhibition and destruction of microorganisms by antibacterial chemicals.
15. Production of exoenzymes by bacteria- isolation of alpha amylase producing bacteria and its culturing for the production of alpha amylase 16.Plaque-forming Bacteriophage

SEMESTER III

Core Course

BV1344 Food and Industrial Biotechnology

Credits: 4 **Contact Hours: 90 (T 54 + P 36)**

Aim and Objective: The students will be introduced to the industrial application of Food Biotechnology and Bioprocess technology through this course. Students should be trained to understand commercial importance of biotechnology through its industrial aspects.

Module I **6 hrs**

Concepts and development-Microbes in industry- Industrially important microorganisms, screening and isolation; Important industrial fermentation products

Module II **8 hrs**

Fermentation

The biological process of fermentation- various types of fermentation, alcohol fermentation, scale up of biological reactions in to bioprocess; Bioreactors-types of bioreactors / Fermentors, parts of a bioreactor.

Module III **10 hrs**

Upstream Processing: Media for fermentation, characteristics of ideal production media, media sterilization, aeration, pH, temperature; batch fermentation, continuous fermentation, chemostatic cultures

Down stream processing: Down stream processing and product recovery, Different physical and chemical methods for the separation of fermentation products

Module IV **10 hrs**

Agricultural waste and food industry wastes as the substrate for fermentation, solid state fermentation; production of single cell proteins, microbial production of enzymes- protease and amylase; Immobilization of cells and enzymes-applications

Module V **6 hrs**

Microbial production of antibiotics-Penicillin, vitamins- B_{12}, amino acids- Glutamic acid; Organic acid- Citric acid; Beverages- beer; solvents- butanol

Module VI **14 hrs**

Food Biotechnology

Microorganism in food spoilage, types of spoilage, microbes in the spoilage of canned foods, meat, fish Hazardous effect of food spoilage- food poisoning, mycotoxins; food borne diseases and intoxications

Food preservation- principles of preservation of foods, methods of food preservation: Dairy Biotechnology-Microbes in dairy industry, contamination, spoilage, dairy products, Pasteurization, Industrial process of cheese making, milk borne diseases.

Practicals

Experiments for Industrial Biotechnology Practical **36 hrs**

1. Isolation of yeast from fruit samples and its culturing.
2. Preparation of media for alcohol fermentation by yeast.
3. Preparation of Ethyl alcohol from glucose by Yeast fermentation
4. Separation and quantification of ethanol by distillation (demonstration)
5. Production of wine (Demonstration)
6. Isolation of microorganisms from spoiled food and identification
7. Isolation of organisms from curd/ milk and fermentation of lactose
8. Demonstration of setting laboratory fermentor- basic features, purpose, procedure

Suggested Reading

1. Modern Concept of Biotechnology- H D Kumar; Vikas Publishing House Pvt. Ltd., New Delhi.
2. Food Processing – Biotechnolgical Applications- S S Marwaha & J K Arora, Asiatech Publishers Inc., New Delhi
3. Food Microbiology- M R Adamas & M O Moss; Panima Publishing Corporation, New Delhi.
4. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston, USA.
5. Industrial Microbiology – A H Patel, Panima Publishing House New Delhi.
6. Fermentation technology- Whittaker,
7. Fundamentals of Microbiology, Jones & Bartlett Publishers, Boston, USA.
8. Microbiology (7th Ed)- Prescott L. M., Harley, J. P., and Klein D. A. Mc Graw Hill, New York

SEMESTER III

Core Course

BV1345 Molecular Biology

Credits 4 **Total contact hours 90 (T 54 + P 36)**

Aim and Objective: Molecular biology is basis of modern biology and biotechnology. This course imparts a very essential foundation for the proper understanding of life at molecular level, which is essential for further studies related to genetic engineering, immunology and other modern applied aspects of biology.

Module I **8 hrs**

Introduction History and significant discoveries in molecular biology, Molecular basis of life, Experiments demonstrating DNA as the genetic material, Structure of DNA, replication of DNA – both prokaryotic and eukaryotic, enzymes of DNA replication

Module II **8 hrs**

Genes

Structure of prokaryotic gene: operon, organization of operon, prokaryotic mRNA and its translation, polysomes.

Eukaryotic genes: structure of a gene, reading frame, and regulatory sequences, promoters and enhancers

Module III **12 hrs**

Gene expression:

Transcription- transcription products, types of RNA-mRNA, tRNA, rRNA and small nuclear RNA (snRNA); Eukaryotic transcription, post-transcriptional modification of mRNA, Translation- translation of prokaryotic and eukaryotic mRNA, different stages of protein synthesis, Genetic code: properties of genetic code, codon assignment, start codon and termination codons

Module IV **12 hrs**

Gene regulation: prokaryotic gene regulation, regulation of operon, (lac, his **and trp operon**), catabolic repression; Regulation of eukaryotic gene expression, level of control of gene expression, transcriptional factors, regulation of RNA processing, mRNA translation, mRNA degradation and protein degradation control, post translational modification of proteins.

Module V **8 hrs**

Eukaryotic chromosomes- molecular organization, nucleosomes, Insertional elements and transposons, different types of transposons

Module VI **6 hrs**

Cytoplasmic genome – mitochondrial DNA-structure and important genes chloroplast DNA – structure, important genes and its expression

Practical **36 hrs**

Experiments for Molecular biology

1. Instruments and equipments used in molecular biology and rDNA techniques.

2. Preparation of solutions and buffers for DNA isolation
3. Isolation of Genomic DNA from a suitable source- bacteria, plant or animal tissue
4. Examination of the purity of DNA by agarose gel electrophoresis.
5. Quantification of DNA by UV-spectrophotometer
6. Isolation and purification of plasmid DNA
7. Agarose gel analysis of plasmid DNA
8. Restriction digestion of plasmid DNA
9. Restriction analysis of ë phage DNA

Suggested Readings

1. Molecular Biology of the gene – Watson, Baker, Bell Gann, Lewinw, Losick; Pearson Education Pvt.Ltd, New Delhi
2. Introduction to Molecular biology- P. Paolella; Mc Graw Hill, New York
3. PCR 3 - Practical Approach – C. Simon Hearington & John J O'Leary; Oxford, New York
4. Essential molecular Biology- A practical Approach, T A Brown; Oxford, New York
5. Basic Biotechnology- A. J. Nair, Laxmi Publications, New Delhi
6. Molecular cell biology H S Bhamrah; Anmol Publications Pvt. Ltd., New Delhi.
7. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
8. Gene VIII- Benjamin Lewin; Offord University Press.
9. Applied Molecular genetics – R L Miesfeld; Wiley.Liss , New Delhi.
10. Principles of Gene manipulation- R.W.Old & S.B. Primrose; Blackwell Scientific Publications

SEMESTER IV

Core Course

BV 1446 Recombinant DNA Technology

Credits-2 **Contact hours 90 (Theory 54+ Practical 36)**

Module I **10 hrs**

Introduction to gene cloning and its applications, Tools of recombinant DNA technology- Restriction endonucleases, classification and general characteristics of endonucleases; Other enzymes used in the recombinant DNA technique- DNA ligase, alkaline phosphatase;

Module II **15 hrs**

Vectors, the vehicle for cloning: special features needed for a vector, Various types of cloning vectors- plasmid cloning vectors- pBR322, Expression vectors, the pUC series, Bacteriophage cloning vectors - phage$_{ë}$ cloning vectors, M13 based vectors, Phagmids and Cosmid vectors,

Artificaial Chromosomes:

Yeast Artificial vectors (YACs), Bacterial artificial Vectors (BACs), Application for YAC and BAC,- genome sequencing Shuttle vectors for animals and plants, mammalian vectors;

Gene Therapy- Vectors for gene therapy.

Module III **14 hrs**

Construction of recombinant DNA, host cells, competent cells, bacterial transformation, screening methods of transformed cells, DNA libraries: genomic libraries and cDNA libraries. Application of genomic libraries and cDNA libraries. Various methods of genetic transformation in eukaryotes- Direct gene transfer and vector mediated gene transfer. Screening methods of transformed cells and organisms.

Module IV **15 hrs**

Molecular hybridization techniques for genome analysis Genome analysis: RFLP, AFLP, RAPD, Southern hybridization

PCR: Principle and applications

Nucleic acid sequencing: Principle and applications, Genome sequencing methods, Human genome project– a brief account.

Gene expression analysis – Northern hybridization and microarrays.

Transgenic organisms and its impact in agriculture, Medicine and Environment Biosafety and Ethics in Genetic Engineering

Practical **36 Hrs**

Experiments for Practical of rDNA Technology

1. Preparation of the reagents for rDNA experiments
2. Purification of Plasmid from bacterial Cultures.
3. Electrophoresis and evaluation of plasmid DNA-pUC 18 / pBR 322
4. Estimation of plasmid DNA by UV-VIS spectrophotometer
5. Restriction Digestion of pUC 18 and analysis by agarose gel electrophoresis
6. Transformation of *E. coli* with pUC 18 and selection of ampicillin resistant clones
7. Extraction and purification of Genomic DNA

Suggested Readings

1. Animal cell culture- John R W Master; Oxford University Press
2. Cuture of animal cells – A manual of basic technique, R Ian Freshney; Wiley- Liss Publication, New York.
3. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
4. Introduction to Biotechnology & Genetic Engineering, Jones & Bartlett Publishers, Boston.
5. Modern concept of Biotechnology- H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
6. Introduction to Genetic Engineering & Biotechnology- Nair, A. J., Jones & Bartlett Publishers, Boston,USA.
7. Biotechnology – B D SinghKalyani Publishers, New Delhi

SEMESTER IV

Core Course

BV1447 Immunology

Credits-2 **Contact hours 90 (T 54+ P 36)**

Aim and Objective: To give a basic training to the students of Biotechnology on immune system, immunology and immunology related techniques.

Module I **8 hrs**

The Human Immune System: Organs and cells of immune system

Module II **8 hrs**

Historical perspective of immunology: Immune system and immunity, innate and specific or acquired immunity, Immune system- organs, tissues and cells involved in immunity, Humoral immunity and cell mediated immunity, antigens, antibodies, immunogens, haptens.

Module III **10 hrs**

Immunoglobulins:

Antibody structure in relation to function and antigen binding: types of antibodies and their structures: isotypes, allotypes and idiotypes.

Module IV **10 hrs**

Measurment of antigen

Antibody-antigen interaction, antigen-antibody reactions, agglutination, immuno-diffusion, immuno-electrophoresis, ELISA, RIE, production of polyclonal and monoclonal antibodies, hybridoma technology,

Module V

Immunoglobulin gene **8 hrs**

Genetic basis of antibody diversity; effect of T cell functions Immunity to infections of diseases: vaccines - attenuated and recombinant vaccines, vaccination.

Module VI **4 hrs**

Antibodies in targeting therapeutic agents- therapeutic antibodies

Module VII **6 hrs**

Autoimmunity and autoimmune diseases: Hashimoto's thyroiditis; Myasthenia gravis; Rheumatoid Arthritis, Pernicious anemia, Asthma.

Experiments for Immunology Practical **36 hrs**

1. Immune cells –observation by staining and cell counting
2. Separation of immune cells from lymphoid organs of lab animals / blood.
3. Blood grouping –Determination of blood groups
4. Agglutination tests and immunological precipitation
5. Neutralization and complement fixation reaction

6. Demonstration of Radio immunoassay and ELISA
7. Demonstration of Immuno-electrophoresis

Suggested Readings

1. An Introduction to Immunology – C V Rao, Narosa Publishing House, New Delhi
2. Instant Notes in Immunology – P M Abbas, A H Lichtman, M W Fanger; Viva Books Pvt.Ltd, New Delhi.
3. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
4. Immunology – Joshi, Osama; AgroBotanica, New Delhi
5. Immunology – R A Goldsby, T J Kindt, B A Osborne, Janis Kuby; W H Freeman & Company, New York
6. Basics of Biotechnology- A J Nair; Laxmi Publications, New Delhi
7. Principle Cellular and Molecular Immunology- Jonathan M Austyn 7 Kathryn J Wood; Oxford, New York

SEMESTER IV

CoreCourse

BV1448 Biotechniques II

(Practical of BV1344, BV1345, BV1446, BV1447)

Credits: 2 **Contact hours: 144 (Practical Hours of the above courses)**

Practical

Experiments for Industrial Biotechnology Practical (BV1344) **36 hrs**

1. Isolation of microorganism for the production of alpha amylase
2. Culturing of Aspergillus niger and students should familiarize the industrial products from this fungus
3. Isolation of yeast from natura sources- grapesw and other types of fruits
4. Isolation of lactic acid producing bacteria fron curd and production of lactic acid
5. Preparation of media and sterilization for alcohol fermentation by yeast.
6. Preparation of Ethyl alcohol from glucose by Yeast fermentation- separation of ethanol by distillation (demonstration)
7. Growth Curve of bacteria or yeast cultures in nutrient broth
8. Isolation of microorganisms from spoiled food and identification
9. Isolation of organisms from curd / milk and fermentation of lactose
10. Demonstration of setting laboratory fermentor- basic features, purpose, procedure and application- Demonstration of running a laboratory fermentor.

Experiments for Molecular biology Practical (BV1345) **36 Hrs**

1. Instruments and equipments used in molecular biology and rDNA techniques.
2. Isolation of Genomic DNA
3. Examination of the purity of DNA by agarose gel electrophoresis.

4. Quantification of DNA by UV-spectrophotometer
5. Isolation and purification of plasmid DNA
6. Agarose gel analysis of plasmid DNA
7. Restriction digestion of plasmid DNA

Experiments for Practical of rDNA Technology (BV1446) **36 Hrs**

1. Preparation of the reagents for rDNA experiments
2. Purification of Plasmid from bacterial Cultures.
3. Electrophoresis and evaluation of plasmid DNA-pUC 18 / pBR 322
4. Estimation of plasmid DNA by UV-VIS spectrophotometer
5. Restriction Digestion of pUC 18 and analysis by agarose gel electrophoresis
6. Transformation of E. coli with pUC 18 and selection of ampicillin resistant clones
7. Extraction and purification of Genomic DNA

Experiments for Immunology Practical BV1447) **36 hrs**

1. Immune cells –observation by staining and cell counting
2. Separation of immune cells from lymphoid organs of lab animals / blood.
3. Blood grouping –Determination of blood groups
4. Agglutination tests and immunological precipitation
5. Neutralization and complement fixation reaction
6. Demonstration of Radio immunoassay and ELISA
7. Demonstration of Immuno-electrophoresis

SEMESTER V

Core Course

BV1544 Environmental Biotechnology

Credits: 3 **Contact hours 54 (Theory 36 + Practical 18)**

Aim and Objective: This course is one of the core courses under vocational subject biotechnology. It is concerned with the application of biotechnology in keeping the environment clean and healthy. Various techniques are described and will be benifited by the students in their higher studies in biotechnology.

Module I **5 hrs**

Introduction Ecosystem, Biodiversity, Types of ecosystem and biosphere;

Module II **5 hrs**

Pollution: sources of pollution, general characteristics of domestic wastes, community wastes, agricultural wastes, effect of solid waste in the environment

Module III **6 hrs**

Water pollution: Organic load in aquatic systems, BOD and COD, microbial quality of water, drinks and food Use of biotechnology in the treatment of municipal wastes and hazardous industrial effluents

Module IV **8 hrs**

Bioremediation: Microbial degradation of pesticides, herbicides and other toxic chemicals in the environment, Biological control of pests and insects, Biopesticides- *Bacillus thuringiensis*, bioherbicides; Application of biotechnology in the production of biofertilizers and nitrogen fixation – nitrogen fixing microorganisms, mycorrhiza

Module V **4 hrs**

Renewable and non renewable energy resources: conventional fuels and their environmental impacts (fire word, animal oils, coal, petroleum)

Module VI **5 hrs**

Non-conventional energy sources

Biomass: utilization of biomass as energy source– application of microbes in production of fuels from biomass-biogas and methanogenic bacteria, microbial hydrogen production, production of methanol, ethanol and other types of chemicals from biomass and agricultural wastes, the gasohol experiment

Solar energy converter, hopes from photosynthetic pigments, vegetable oils as engine fuels, energy crops-jojoba; Possibility of plant based petroleum industry and cellulose degradation for combustible fuels

Module VII **3 hrs**

Bioleaching

Enrichment of ores by microorganisms (bioaccumulation and biomineralisation); Bio-assessment of environmental quality

Practical

Experiments for Environmental Biotechnology **18 hrs**

1. Microbiological assessment of drinking water- water from well, river, water supply department and packaged drinking water
2. Isolation of microbes from the environment- from air, soil, floor of the lab, from water.
3. Assessment of organic load in aquatic systems and factory effluent- Determination of BOD and COD.
4. Biogas production by methanogenic bacteria or by mixed culture.
5. Isolation of nitrogen fixing bacteria from leguminous plants
6. Determination of NP and K in biofertilizers

Suggested readings

1. Environmental Biotechnology - Alan Scragg; Longman, England
2. Biotechnology fundamentals and applications – Purohit & Mathur; Agrobotanica, India
3. Biotechnology – B D Singh; Kalyani Publishers, New Delhi
4. Biological waste water treatment 2nd Edition- Grady C P L
5. Biological Conservation – Spellergerg I F
6. Environmental issues and Options – Mishra C.
7. Biodiversity- Status and Prospects- Pramod tandon etal Narosa Publishing House, New Delhi
8. Ecology 2nd Edn, Subrahmanyam N S, Sambamurty V.S.S; Narosa Publishing House.

SEMESTER V

Core Course

BV 1545 Plant Biotechnology &

Animal Biotechnology

Credits 4 **Contact hours 90 (Theory 72+Practical 18)**

Aim: This course is designed to impart basic knowledge in the applied aspects of plant biotechnology and animal biotechnology for the improvement of agriculture and plant based and animal based industries. It gives an ibtroduction about the various technques of animal cell culture, cloning and tissue culture of plants and animals.

Module I **10 hrs**

Fundamental principles of *in vitro* plant cultures: use of plant growth regulators, composition of tissue culture media- media components and its functions.

Sterilization Methods - Steam sterilization, Dry sterilization, Filter sterilization, surface sterilization of explants **Types of *in vitro* cultures** Callus cultures, cell suspension cultures, organ cultures- root cultures, hairy root cultures, embryo cultures, anther culture;

Module II **10 hrs**

Application of in vitro cultures:embryogenesis and organogenesis a brief understanding, clonal multiplication and micropropagation- meristem culture, axillary bud and shoot tip culture, anther and pollen culture- production of haploids and its uses; Plant secondary metabolites production through cell, tissue and organs cultures, Advantages and disadvantages of *in vitro* methods

Module III **10 hrs**

Somaclonal variation

Possible reasons of Somaclonal variations, applications of Somaclonal variations in agriculture and Horticulture, merits and demerits of Somaclonal variation

Protoplast culture

Protoplast- isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells.

Module VI **12 hrs**

Genetic engineering of plants: Methods of gene transfer in plants –Physical, chemical and biological methods *Agrobacterium tumefaciens*, tumor formation in plants by *A. tumefaciens*, application of *A. tumefaciens* in plant genetic engineering, Virus mediated gene transfer in plants.

Transgenic plants

Transgenic crops, Impact of transgenic plants in agriculture and Horticulture, Non Agricultural applications of transgenic plants- Biopharming- production of therapeutic proteins in transgenic plants, edible vaccines, disease resistant, salt tolerant, pest resistant and stress tolerant crop and medicinal plants; Metabolic engineering of plants for enhanced and controlled production of plant products.

Animal Biotechnology

Module I **10 hrs**

Animal cell culture : History, animal organ, tissue and cell culture, animal cell culture techniques, Primary cell cultures and secondary cell cultures, immortalized cell cultures, cell lines, Media – media components and physical parameters, Instruments and equipments needed for animal cell cultures, uses of animal cell cultures.

Module II **10 hrs**

Application of Animal Cell Cultures Characterization of cell lines, Products of animal cell cultures- hormones (insulin, growth hormones), interferon, t-plasminogen activator, factorVIII, Factor IX and virus cultivation; Expression of cloned proteins in animal cells, production of vaccines in animal cells, production of polyclonal and monoclonal antibodies-hybridoma technology

Scale up of animal cell cultures: Special bioreactors for large-scale cultivation of animal cells, anchor depended cells and suspension cultures, Roller bottles and spinner flasks

Module III **10 hrs**

Stem cell technology: Stem cell culture and its clinical uses, types of stem cells; gene therapy and tissue grafting; Growth factors promoting proliferation of animal cell cultures Preservation and maintenance of animal cell cultures- cryopreservation and transport of animal cell cultures; Transgenic animals and its practical uses, Bioethics in animal cell culture, stem cell technology and transgenic animals

Practical **10 Hrs**

Experiments for Plant Biotechnology Practical

1. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media.
2. Preparation of M S Media
3. Surface sterilization of plant materials for inoculation (implantation in the medium)
4. Development of callus cultures and its sub-culturing
5. Organogenesis- shoot regeneration, root regeneration, somatic embryogenesis
6. Micropropagation of potato/tomato/ - Demonstration
7. Familiarization of instruments and special equipments used in the plant tissue culture experiments- Laminar Airflow chamber,
8. Protoplast isolation and culturing – Demonstration

Experiments for Practicals in Animal Biotechnology **8 hrs**

1. Familiarization of methods, equipments and techniques of animal cell culture
2. Isolation of lymphocytes from blood
3. Cell viability assay by die exclusion method and cell counting
4. MTT assay of cells Evans blue assay of pollen grains or blood cells
5. Demonstration of ELISA technique
6. Protein purification by ion exchange chromatography from serum

Suggested readings

1. Plant biotechnology, Recent Advances- P C Trivedi; Panima Publishing Corporation, New Delhi.
2. Introduction to Plant Biotechnology- H S Chawla; Oxford & IBH publishing Co.Pvt.Ltd., New Delhi.

3. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.

4. An Introduction to Plant Tissue Culture – M K Raxdan; Oxfird & IBH Publishing Co.Pvt. Ltd., New Delhi

5. Role of Biotechnology in Medicinal and aromatic plants- Irfan A Khan and Atiya Khanum ; Ukaaz Publications, Hyderabad.

6. Plant vell, Tissue and Organ Culture- Fundamental Methods, O L Gamborg, G C Philips; Narosa Publishing House, New Delhi.

7. Biotechnology-Fundamentals and Application- S S Purohit and S K Mathur; Agrobotanica, India.

8. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.

9. Modern concept of Biotechnology- H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.

9. Animal cell culture- John R W Master; Oxford University Press

10. Culture of animal cells – A manual of basic technique, R Ian Freshney; Wiley- Liss Publication, New York.

SEMESTER VI

Core Course

BV1651 Biotechniques III

(Practical of BV1544 and BV1545)

Credit: 2 **Contact hours: 126 (90+ Practical hours of the above courses)**

Experiments for Plant Biotechnology Practical (BV1545) **40 hrs**

1. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media.
2. Preparation of M S Media
3. Surface sterilization of plant materials for inoculation (implantation in the medium)
4. Development of callus cultures and its sub-culturing
5. Organogenesis- shoot regeneration, root regeneration, somatic embryogenesis
6. Micropropagation of potato/tomato/ - Demonstration
7. Familiarization of instruments and special equipments used in the plant tissue culture experiments- Laminar Airflow chamber,
8. Protoplast isolation and culturing – Demonstration

Experiments for Practical in Animal Biotechnology **30 hrs**

1. Familiarization of methods, equipments and techniques of animal cell culture
2. Isolation of lymphocytes from blood

3. Cell viability assay by die exclusion method and cell counting
4. MTT assay of cells Evans blue assay of pollen grains or blood cells
5. Demonstration of ELISA technique
6. Protein purification by ion exchange chromatography from serum

Experiments for Environmental Biotechnology (BV1544) 20 hrs

1. Microbiological assessment of drinking water- water from well, river, water supply department and packaged drinking water
2. Isolation of microbes from the environment- from air, soil, floor of the lab, from water.
3. Assessment of organic load in aquatic systems and factory effluent- Determination of BOD and COD.
4. Biogas production by methanogenic bacteria or by mixed culture.
5. Isolation of nitrogen fixing bacteria from leguminous plants
6. Determination of NP and K in biofertilizers

Open Courses and

Elective Courses

CHOICE OF OPEN COURSE

The students have the freedom to opt any one of the open courses during the fifth semester from other departments.

Open Course of Biotechnology shall be offered only to students from other B. Sc. Programmes (Non-Biotechnology students). One course shall be offered from the following choices:

1. BV 1551. Bioinformatics
2. BV1552 Food & Dairy Biotechnology
3. BV 1553 Genetic Engineering
4. BV 1554 Basics of Environmental Biotechnology

Elective Courses of Biotechnology

(One course to be selected from the following**)**

1. BV1661 – Bioinformatics & Nanobiotechnology
2. BV1662- Food & Dairy Biotechnology
3. BV 1663- Genetic Engineering

SEMESTER V

Open course for students of other Departments

BV1551 Bioinformatics

Credits: 2 **Contact hours: 54**

Aim and Objective: To introduce the subject of bioinformatics to the students of biology. Students should be familiarized to the importance of the bioinformatics, databases, genomics and proteomics, tools and software of bioinformatics at the elementary levels.

Module I

Bioinformatics- definition History and evolution of bioinformatics, Impact of bioinformatics in modern biology, Databases- various types of databases, Biological Databases- Importance of databases in biotechnology, NCBI, Gene bank, PubMed. Etc.

Module II

Internet resources for Biotechnology, a short introduction to genome analysis, genome sequencing projects, genome similarity, Tools (software) in Bioinformatics. Tools for sequence alignments- BLAST and Fasta.

Module III

Genomics and Proteomics-Definitions, Application of Proteomics and genomics in Biotecnology.

Practicals in Bioinformatics

1. Use of Computers in Biological science- Data base creation, Data base retrieval – Online use of Computational tools.
2. Identification of a given sequence as DNA, RNA or Proteins
3. To analyze the sequence of a given DNA and find out sequence composition
4. To find out the number of times a sequence is repeated in a given DNA sequence 5.To find out the complementary sequence of a given nucleotide sequence

Suggested Readings

1. Introduction to Bioinformatics – V. Kothekar, Druv Publication
2. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston, USA.
3. Bioinformatics- Genomics and Post-genomics, Frederich Dardel & Francois Kepes; John Wiley & Sons.

SEMESTER V

Open / Elective course

BV1552/ BV1649 Food & Diary Biotechnology

Credit 2 **Contact hours: 54 (Open course) / 36 (Elective)**

Module I

Microbes of food and fermented food- Curd, wheat and rice flour, Meat and fish, Poultry and eggs, Breads and bakery products, Grains

M icrobiological contamination of foods- indicator organisms, cultural techniques, direct methods, immunological methods etc.

Module II

Food spoilage

Module Microbes involved in food spoilage- Spoilage of Canned foods Meat and dairy products. Conditions of food spoilage- pH, physical structure, chemical composition, oxygen and temperature Chemistry of food spoilage-microbial toxins and food poisoning Food borne diseases and its prevention

Module III

Food Preservation- methods of food preservation, Physical & Chemical Methods, Osmotic pressure – preserving foods in sugar and salt, chemical preservatives, Radiation as a preservation methods

Module IV

Microbes of Dairy industry- Dairy products Microbes in fermented food production Industrial production of antibiotics (penicillin & streptomycin) and organic acids (acetic acid & Citric acids) Microorganisms as food – fermented food, microalgae- Single cell protein, Edible amshrooms.

Suggested Readings

1. Food Microbiology- MR Adams and Moss
2. Food Processing- Biotechnological applications Marwah &Arora
3. Food Microbiology-William C Frazer
4. Industrial microbiology -LE Casida

Open course for students from other Departments/ Elective Course for Biotechnology students

BV 1553 / BV 1650 Genetic Engineering

Credit 2 **Contact hours: 54 (open Course) / 36 (Elective Course)**

Module I

Introduction to gene cloning and its applications, **Tools of recombinant DNA technology**- Restriction endonucleases, classification and general characteristics of endonucleases; Other enzymes used in the recombinant DNA technique- DNA ligase, alkaline phosphatase;

Module II

Vectors, the vehicle for cloning: special features needed for a vector, Various types of cloning vectors- plasmid cloning vectors- pBR322, Expression vectors, the pUC series, Bacteriophage cloning vectors - phage $_{ë}$ cloning vectors, M13 based vectors, Phagmids and Cosmid vectors,

Module III

Construction of recombinant DNA, host cells, competent cells, bacterial transformation, screening methods of transformed cells, DNA libraries: genomic libraries and cDNA libraries. Application of genomic libraries and cDNA libraries. Various methods of genetic transformation in eukaryotes- Direct gene transfer and vector mediated gene transfer. Screening methods of transformed cells and organisms.

Module IV

Molecular hybridization techniques for genome analysis Genome analysis: RFLP, AFLP, RAPD, Southern hybridization PCR: Principle and applications Nucleic acid sequencing: Principle and applications, Genome sequencing methods, Human genome project– a brief account.

Suggested Reading

· Animal cell culture- John R W Master; Oxford University Press
· Cuture of animal cells – A manual of basic technique, R Ian Freshney; Wiley- Liss Publication, New York.
· Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
· Introduction to Biotechnology & Genetic Engineering, Jones & Bartlett Publishers, Boston.
· Modern concept of Biotechnology- H D Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
· Introduction to Genetic Engineering & Biotechnology- Nair, A. J., Jones & Bartlett Publishers, Boston,USA.
· Biotechnology – B D SinghKalyani Publishers, New Delhi

Open course for students from other Departments

BV 1554. Basics of Environmental Biotechnology

Credits: 2 **Contact hours 54**

Aim and Objective: This course is aimed to bring an enthusiasm on environmental protection and it should give the contribution of biotechnology techniques to keep the environment clean and healthy. As well it should highlight the economic aspects in the application of biotechnology in protecting the environment from pollution.

Module I **15 hrs**

Introduction Environment Basic concepts- Atmosphere, hydrosphere, lithosphere, biosphere Scope and Importance of Environmental Biotechnology; Pollution- sources of pollution, general characteristics; Environmental legislation-water Act; Forest Act; Environmental Protection act.

Module II **15 hrs**

Water pollution: Organic load in aquatic systems - BOD and COD, microbial quality of water, Laboratory methods for the detection of coliforms in drinks and food; fecal and non-fecal bacteria; Treatment of municipal wastes and hazardous industrial effluents.

Module III **12 hrs**

Non-conventional energy sources: Biomass: utilization of biomass as energy source– application of microbes in production of fuels from biomass- biogas and methanogenic bacteria, Steps and process of Biogas production; vegetable oils as engine fuels, energy crops-jojoba; Bioplastics

Module IV **12 hrs**

Bioremediation: herbicides and other toxic chemicals in the environment; Biodegradation, phytoremediation, superbug; Biopesticides- *Bacillus thuringiensis*, bioherbicides; Solid waste treatment-Composting, vermicomposting; Disposal of sludge- Land filling, lagooning

Suggested readings

1. Environmental Biotechnology - Alan Scragg; Longman, England
2. Biotechnology fundamentals and applications – Purohit & Mathur; Agrobotanica, India
3. Biotechnology – B D Singh; Kalyani Publishers, New Delhi
4. Biological waste water treatment 2nd Edition- Grady C P L
5. Biological Conservation – Spellergerg I F
6. Environmental issues and Options – Mishra C.
7. Biodiversity- Status and Prospects- Pramod tandon etal Narosa Publishing House, New Delhi
8. Ecology 2nd Edn, Subrahmanyam N S, Sambamurty V.S.S; Narosa Publishing House.
9. Biotechnology –U. Sathyanarayana; Biotechnology – U. Sathyanarayana Books and Allied (P) Ltd, Kolkata
10. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
11. Microbiology (7th Ed) Prescott L. M., Harley, J. P., and Klein D. A. Mc Graw Hill, New York

Elective course for Biotechnology students

BV 1648 Bioinformatics and Nanobiotechnology

Credit 2 **Contact hours: 36**

Aim and Objective: This course is for biotechnology students, who are interested to know about the methods and application of bioinformatics and modern Nanobiomolecules and their contribution in the various fields of biotechnology and healthcare.

Module I **8 hrs**

Bioinformatics- definition , scope, limitations History and evolution of bioinformatics, Impact of bioinformatics in modern biology and research. Databases- various types of databases, Biological Databases- Importance of databases in biotechnology, NCBI, Gene bank, PubMed.

Module II **6 hrs**

Sequence alignment- Pair wise sequence alignment-sequence homology vs similarity; similarity and identity. Database similarity searching- BLAST, FASTA format; Multiple sequence alignment, scoring function, CLUSTAL W

Module III **6 hrs**

Phylogenetic tree construction- distance based methods and character based methods, PHYLIP

Module IV **6 hrs**

Proteomics – technology of protein expression analysis, 2D PAGE, MS, Protein identification through database search, protein data bank Functional Genomics- Sequence based approaches, Microarray based approaches Applications of proteomics and genomics

Module V **10 hrs**

Nanobiotechnology -Introduction to nanoworld, classification of nano materials, application of nano crystals, DNA chip, nano biosensors –DNA sensors; Quantum dots; Drug delivery systems and techniques-prosthesis and implants-diagnosis and screening; Applications of Nanobiotechnology in medicine and health.

Suggested Readings

1. Introduction to Bioinformatics – V. Kothekar, Druv Publication
2. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston, USA.
3. Bioinformatics- Genomics and Post-genomics, Frederich Dardel & Francois Kepes; John Wiley & Sons.
4. A text book of Biotechnology, R. C. Dubey, S. Chand Publications, New Delhi
5. Essential Bioinformatics- Jin Xiong, Cambridge University Press, UK.
6. Nanobiotechnology: Concepts, Applications and Perspectives-C.M. Niemeyer and C.A. Mirkin, Wiley, US

BV1652 Project Work / Dissertation

An independent project or dissertation work related to Biotechnology has to be carried out by each student during the VI semester under a faculty member of the college, with in the college or an external Institute/ Department / University duly certified by the Head of the Department and supervising teacher, has to be submitted for evaluation at the time of examination in VI semester.

Elective Courses of Botany

SEMESTER VI

Elective Course of Core subject

BV16421.1 Horticulture

Credits: 2 **Contact Hours: 54**

Module I **10 hrs**

Introduction: Divisions of horticulture, Importance and scope of horticulture. Principles of garden making, Types of pots and containers Potting mixture and potting media – soil, sand, peat, sphagnum moss, vermiculite Soil types, Soil preparation, Irrigation methods, Hydroponics

Module II **12 hrs**

Propagation methods- Cuttings , Layering – Air layering, Ground layering (Tip, Trench and Compound) Budding – T- budding, Grafting – Approach grafting, Bridge grafting, whip and tongue grafting. , Garden tools and implements

Manures and fertilizers- Farmyard manure, compost, vermicompost and biofertilizers. Chemical fertilizers – NPK., Time and application of manures and fertilizers. Foliar sprays

Module III **12 hrs**

Components of Garden- Lawns and landscaping, Trees, shrubs and shrubberies, climbers and creepers, Flower beds and borders, ornamental hedges, edges, Drives, roads, walks and paths, Carpet beds, topiary, trophy, rockery, Conservatory or green houses Indoor garden, Roof garden, Bonsai

Module IV **8 hrs**

Flower Arrangement- Containers and requirements for flower arrangements, Free style, Shallow and Mass arrangement, Japanese – Ikebana, Bouquet and garland making, Dry flower arrangement

Harvesting- Methods, Storage, Marketing of Fruits, vegetables and flowers, Preservation and processing of fruits and vegetables

Module V **12 hrs**

Growth regulators in horticulture- Rooting hormones, Growth promoters, Flower induction, Parthenocarpy

Plant protection- Common diseases of fruits and vegetable crops, Weedicides, Fungicides, Pesticides

Field Study: Visit to a Botanical garden under the guidance of the teacher is encouraged.

Suggested Readings

1. Arora J.S 1990, Introductory Ornamental Horticulture, Kalyani Publications
2. Bailey L.H 1901, The Standard Cyclopaedia of Horticulture Volume 1,2 and 3, Macmillan Publications.
3. Bose T.K and Mukerjee D 1987, Gardening in India, Oxford Book House
4. Chauhan V.S, Vegetable Production in India, RamPrasad & Sons
5. Kumar N 1989, lntroduction to Horticulture, Rajalakshmi Publications
6. Manibhushan Rao K 1991, Text Book of Horticulture, Macmillan Publications
7. Shujnrnoto, 1982, The Essentials of Bonsai, David & Charles, Newton

SEMESTER VI Elective Course

BV1643.1 Mushroom Cultivation and Marketing

Credits: 2 **Contact hours: 54**

Module I **10 hrs**

History and introduction: Edible mushrooms and Poisonous mushrooms. Systematic position, morphology, distribution, structure and life cycle of *Agaricus* and *Pleurotus.* Nutritional value, medicinal value and advantages- types- milky, straw, button and poisonous mushrooms

Module II

Nutritional value, medicinal value and advantages- types- milky, straw, button and poisonous mushrooms

Module III **22 hrs**

Cultivation: Paddy straw mushroom – substrate, spawn making. Methods – bed method, polythene bag method, field cultivation. Oyster mushroom cultivation –Substrate, spawning, pre-treatment of substrate. Maintenance of mushroom. Cultivation of white button mushroom – Spawn, composting, spawning, harvesting.

Module IV **12 hrs**

- Diseases- Common pests, disease prevention and control measures.
- Processing - Blanching, steeping, sun drying, canning, pickling, freeze drying.
- Storage – short term and long tem storage.

Module V **10 hrs**

- Common Indian mushrooms.
- Production level, economic return, Foreign exchange from Mushroom cultivating countries and international trade.

Field Study: Visit to a mushroom cultivating Laboratory

Suggested readings

1. Pandey B P 1996. A textbook of fungi. Chand and company N Delhi.
2. Kaul T N 2001. Biology and conservation of mushrooms. Oxford and IBH publishing company N.Delhi
3. Gupta P.K. Elements of Biotechnology.
4. Harander Singh. 1991. Mushrooms- The Art of Cultivation- Sterling Publishers.
5. Indian Journal of Mushrooms. Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan

SEMESTER VI

Elective Course

BV1644.1 Forestry

Credits: 2 **Contact hours: 54**

Module I **10 hrs**

General introduction to forests- Natural and Man made; Tropical, temperate, evergreen semievergreen, deciduous; Monoculture, multipurpose, social and industrial, Forest and gene conservation.

Module II **12 hrs**

Silviculture- concept and scope of study of natural and artificial regeneration of forests. Clear felling, uniform shelter, wood selection, coppice and conservation systems. Silviculture of some of the economically important species in India such as *Azadirachtaindica, Tectona grandis, Eucalyptus,*Mahagoni *Dalbergia sisso* and *Santalum album*, jack wood, Rubber.

Wood: Homogenous and heterogenous- spring and autumn wood- Porous and non porous wood- Heart and sap wood.

Relevance of wood anatomical studies in Kerala- Identification of wood- preparation of key and their uses

Module III **10 hrs**

Social and agro forestry. Selection of species and role of multipurpose trees. Food, fodder and energy. Social forest- Avenue plantation. Sacred plants- definition, importance of sacred trees like *Ficus religiosa, Emblica officinalis, Aegle marmelous*.

Module IV **10 hrs**

Seed orchards, seed dormancy- Types of dormancy, physical and chemical methods to overcome seed dormancy. Forest laws- necessity, General principles, Indian forest act 1927 and their amendment.

Module V **12 hrs**

Forest resources and utilization. Forest products- timber, pulp wood, secondary timbers, non timber forest products (NTFPs).

Definition and scope (brief outline) of the following Gums, resins, fibers, oil seeds, nuts, rubber, canes and bamboos, medicinal plants, charcoal. Lac collection and marketing.

Field Study

1. Identification of wood using key: Teak, Jack wood, Mahogany, Rubber, Azadirachta, Eucalyptus.
2. Visit to a plywood factory to have knowledge of wood based industry.

Suggested readings

1. Arora J.S 1990, Introductory Ornamental Horticulture, Kalyani Publications
2. Bailey L.H 1901, The Standard Cyclopaedia of Horticulture Volume 1,2 and 3, Macmillan Publications.
3. Bose T.K and Mukerjee D 1987, Gardening in India, Oxford Book House
4. Chauhan V.S, Vegetable Production in India, RamPrasad & Sons

5. Kumar N 1989, lntroduction to Horticulture, Rajalakshmi Publications

6. Manibhushan Rao K 1991, Text Book of Horticulture, Macmillan Publications 7.Shujnrnoto, 1982, The Essentials of Bonsai, David & Charles, Newton

8. Pandey B P 1996. A textbook of fungi. Chand and company N Delhi.

9. Kaul T N 2001. Biology and conservation of mushrooms. Oxford and IBH publishing company N.Delhi

10. Gupta P.K. Elements of Biotechnology.

11. Harander Singh. 1991. Mushrooms- The Art of Cultivation- Sterling Publishers.

12. Indian Journal of Mushrooms**.** Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan

13. Sagreiya, K.P. 1994. Forests and Forestry (Revised by S.S. Negi). National book trust. New Delhi.

14. Tribhawan Mehta, 1981. A handbook of forest utilization. Periodical Expert Book Agency, New Delhi.

15. Kollmann and Cote 1988. Wood science and Technology. Vol.I & II Springer verlag.

16. Sharma P.D. 2004. Ecology and Environment. Rastogi publications, Meerut

17. Singh M.P. and Vinita Vishwakarma. 1997. Forest environment nd Biodiversity. Daya publishing house, New Delhi.

18. Tiwari K.M. 1983. Social forestry in India.

19. Anil Kumar Dhiman. 2003. Sacred plants and their medicinal uses. Daya publishing house, New Delhi.

20. B.S. Chundawat and S.K.Gautham. 1996. Text book of Agroforestry. Oxford and IBH Publishing house, New Delhi.

21. A Hand book of Kerala Timbers- KFRI, Trichur.

Elective Courses in Zoology

One of the three Elective courses is to be opted from those listed in the Syllabus of BSc Zoology Programme.

UNIVERSITY OF KERALA

Career-related First Degree program Under
Choice Based Credit and Semester (CBCS) System

Group 2 (b)
BIOTECHNOLOGY

Botany/ Zoology, Chemistry &
Biotechnology

Course structure and Syllabus

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