MAR IVANIOS COLLEGE (AUTONOMOUS)

(Affiliated to the University of Kerala)

Re-assessed & Re-accredited (Fourth Cycle) with 'A^{+}' Grade by NAAC

CPE (College with Potential for Excellence) Status Conferred by UGC

Mar Ivanios Vidya Nagar, Nalanchira P.O., Thiruvananthapuram - 695 015

CAREER RELATED FIRST DEGREE PROGRAMME (FDP)

Under

CHOICE BASED CREDIT & SEMESTER (CBCS) SYSTEM

Group 2 (a)

BOTANY AND BIOTECHNOLOGY

COURSE STRUCTURE & SYLLABUS

(2019 Admission Onwards)

FIRST DEGREE PROGRAMME (FDP)

PROGRAMME OUTCOMES (POs)

- This first degree programme will impart knowledge of science which is the basic outcome of education.
- This programme will help to develop scientific attitude to make the students open minded, critical and curious.
- The programme is aimed to develop skill in practical work, experiments and laboratory materials and equipments along with the collection and interpretation of scientific data to contribute the science.
- The students are expected to understand scientific terms, concepts, facts, phenomenon and their relationships.
- This programme will help to make the students aware of natural resources and environment.
- This programme will provide practical experience to the students as a part of the course to develop scientific ability to work in the field of research and other fields of their own interest and to make them fit for society.
- The programme is aimed to develop ability for the application of the acquired knowledge to improve agriculture and other related fields to make the country self-reliant and sufficient.
- This programme will help the students to understand and appreciate the role of biology in societal issues, such as the environment and biological resources, biodiversity, ethics and human health and diseases.
- This programme will create enthusiasm to understand more about the beautiful planet Earth and to give awareness to the public the need to protect the planet from all kinds of exploitation.
- The programme is aimed to keep the scientific temper which the student acquired from school level and to develop a research culture.

FDP IN BOTANY AND BIOTECHNOLOGY

B.Sc. BOTANY AND BIOTECHNOLOGY (Career Related)

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- The career related first degree programme with Botany as core subject and Biotechnology as Vocational subject is designed to develop a scientific attitude and an interest towards the modern areas of biotechnology in particular and life science in general.
- The students are expected to acquire knowledge of plant and related subjects so as to understand natural phenomenon, manipulation of nature and environment in the benefit of human beings.
- It is aimed to get an aptitude in Biotechnology without losing the importance of basic science such as Botany.
- It will help the students to become critical and curious in their outlook.
- The courses are designed to impart the essential basics in Botany, Zoology, Biochemistry and Biotechnology.
- 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.
- The students will be enriched with the latest developments in the field of Information technology, Biotechnology, and other related fields of research and development.
- In addition to this, 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.
- The students who complete this programme can undergo higher studies or jobs in the fields of Botany as well as Biotechnology.
- 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.

CAREER RELATED FIRST DEGREE PROGRAMME

BOTANY AND BIOTECHNOLOGY

Summary of Courses

Study Components			No. Courses	Credits / Course		Max. / Total Credits
1	**Languages**					
	1	**English**	**4**	**3**		**12**
	2	**Additional Language**	**2**	**3**		**6**
2	**Foundation Courses**		**2**	**2-3**		**5**
	1	Methodology and Perspective of Biotechnology		3		
	2	Biophysics and Instrumentation		2		
3	**Complementary Courses**		**5**	**2-4**		**14**
	Biochemistry		**5**	**T**	**P**	**14**
	1	Introduction to Biochemistry		3		
	2	General Biochemistry		3		
	3	Physiological Aspects in Biochemistry		4		
	4	Metabolism		2		
	5	Practical Biochemistry I (Practical of 1, 2, 3 & 4)			2	
4	**Core Courses**		**27**	**2-4**		**75**
	Botany		**13**	**T**	**P**	**35**
	1	Angiosperm Anatomy and Reproductive Botany		3		
	2	Environmental Studies		4		
	3	Practical Botany I (Practical of 1 & 2)			2	
	4	Phycology, Mycology, Lichenology and Plant Pathology		2		
	5	Horticulture, Mushroom Cultivation and Marketing		2		
	6	Bryology, Pteridology, Gymnosperms and Paleobotany		3		
	7	Cell Biology, Plant Breeding and Evolutionary Biology		2		
	8	Practical Botany II **(**Practical of 4, 5, 6 & 7)			2	
	9	Angiosperm Morphology and Systematic Botany		4		
	10	Economic Botany, Ethnobotany and Medicinal Botany		2		

	11	Plant Physiology		4		
	12	Genetics		3		
	13	Practical Botany III **(**Practical of 9, 10, 11 & 12)			2	
	Biotechnology (Vocational)		**14**	**T**	**P**	**40**
	1	Microbiology		4		
	2	Microbial Metabolism, Genetics and Diseases		3		
	3	Biotechniques I (Practical of 1 & 2)			2	
	4	Protista and Animal Diversity		4		
	5	Animal Physiology and Anatomy		3		
	6	Molecular Biology		3		
	7	Immunology		2		
	8	Biotechniques II (Practical of 4, 5, 6 & 7)			2	
	9	Recombinant DNA Technology		4		
	10	Plant Biotechnology		3		
	11	Animal Biotechnology		3		
	12	Food and Industrial Biotechnology		3		
	13	Environmental Biotechnology		2		
	14	Biotechniques III (Practical of 9, 10, 11, 12 & 13)			2	
5	**Open Courses of Vocational Subject**		**3**	**2**		**2**
	1	Bioinformatics		2		
	2	Food and Dairy Biotechnology		2		
	3	Genetic Engineering		2		
6	**Elective Courses of Vocational Subject**		**3**	**2**		**2**
	1	Bioinformatics and Nanobiotechnology		2		
	2	Biostatistics		2		
	3	Food and Dairy Biotechnology		2		
7	**Project**		**1**	**4**		**4**
					Total Credits	**120**

T - Theory

P - Practical

CAREER RELATED FDP IN BOTANY AND BIOTECHNOLOGY

SUMMARY OF SEMESTER WISE HOUR DISTRIBUTION

SEMESTER I

Course Code	Course Title	Teaching hrs/week		Total hrs	Total Credits	Duration of Exam	Marks for Evaluation	
		T	P				CE	ESE
AUEN111.4	English	5		90	3	3 hrs	20	80
AUFR111.4 AUHN111.4 AUML111.4	Additional Language	5		90	3	3 hrs	20	80
AUBB121	Methodology and Perspective of Biotechnology	3		54	3	3 hrs	20	80
AUBB131	Introduction to Biochemistry	3	2	90	3	3 hrs	20	80
AUBB141	Angiosperm Anatomy and Reproductive Botany	2	2	72	3	3 hrs	20	80
AUBB151	Microbiology	2	1	54	4	3 hrs	20	80
	Total	25		450	19			

Hour Distribution: BT-3+3, BO-4, CC-5, LC-5+5 = 25

SEMESTER II

Course Code	Course Title	Teaching hrs/week		Total hrs	Total Credits	Duration of Exam	Marks for Evaluation	
		T	P				CE	ESE
AUEN211.4	English	5		90	3	3 hrs	20	80
AUFR211.4 AUHN211.4 AUML211.4	Additional Language	5		90	3	3 hrs	20	80
AUBB221	Biophysics and Instrumentation	2		36	2	3 hrs	20	80
AUBB231	General Biochemistry	3	2	90	3	3 hrs	20	80
AUBB241	Environmental Studies	3	2	90	4	3 hrs	20	80
AUBB24PI	Practical Botany I (Practical of AUBB141 & AUBB241)				2	3 hrs	20	80
AUBB251	Microbial Metabolism, Genetics and Diseases	2	1	54	3	3 hrs	20	80
AUBB25PI	Biotechniques I (Practical of AUBB151 & AUBB251)				2	3 hrs	20	80
	Total	25		450	22			

Hour Distribution: BT-3+2, BO-5, CC-5, LC-5+5 = 25

SEMESTER III

Course Code	Course Title	Teaching hrs/week		Total hrs	Total Credits	Duration of Exam	Marks for Evaluation	
		T	P				CE	ESE
AUEN311.4	English	5		90	3	3 hrs	20	80
AUBB331	Physiological Aspects in Biochemistry	3	2	90	4	3 hrs	20	80
AUBB341	Phycology, Mycology, Lichenology and Plant Pathology	3	1	72	2	3 hrs	20	80
AUBB342	Horticulture, Mushroom Cultivation and Marketing	3	1	72	2	3 hrs	20	80
AUBB351	Protista and Animal Diversity	3	1	72	4	3 hrs	20	80
AUBB352	Animal Physiology and Anatomy	2	1	54	3	3 hrs	20	80
	Total	25		450	18			

Hour Distribution: BT-7, BO-8, CC-5, EN-5 = 25

SEMESTER IV

Course Code	Course Title	Teaching hrs/week		Total hrs	Total Credits	Duration of Exam	Marks for Evaluation	
		T	P				CE	ESE
AUEN411.4	English	5		90	3	3 hrs	20	80
AUBB431	Metabolism	3	2	90	2	3 hrs	20	80
AUBB43PI	Practical Biochemistry I (Practical of AUBB131, AUBB231, AUBB331 & AUBB431)				2	3 hrs	20	80
AUBB441	Bryology, Pteridology, Gymnosperms and Paleobotany	3	1	72	3	3 hrs	20	80
AUBB442	Cell Biology, Plant Breeding and Evolutionary Biology	3	1	72	2	3 hrs	20	80
AUBB44PII	Practical Botany II (Practical of AUBB341, AUBB342, AUBB441 & AUBB442)				2	3 hrs	20	80
AUBB451	Molecular Biology	3	1	72	3	3 hrs	20	80
AUBB452	Immunology	2	1	54	2	3 hrs	20	80
AUBB45PII	Biotechniques II (Practical of AUBB351, AUBB352, AUBB451 & AUBB452)				2	3 hrs	20	80
	Total	25		450	21			

Hour Distribution: BT-7, BO-8, CC-5, EN-5 = 25

SEMESTER V

Course Code	Course Title	Teaching hrs/week		Total hrs	Total Credits	Duration of Exam	Marks for Evaluation	
		T	P				CE	ESE
AUBB541	Angiosperm Morphology and Systematic Botany	4	2	108	4	3 hrs	20	80
AUBB542	Economic Botany, Ethnobotany and Medicinal Botany	4	2	108	2	3 hrs	20	80
AUBB551	Recombinant DNA Technology	3	1	72	4	3 hrs	20	80
AUBB552	Plant Biotechnology	2	1	54	3	3 hrs	20	80
AUBB553	Animal Biotechnology	2	1	54	3	3 hrs	20	80
AUBB581.a AUBB581.b AUBB581.c	Bioinformatics Food and Dairy Biotechnology Genetic Engineering	3		54	2	3 hrs	20	80
	Total	25		450	18			

Hour Distribution: BT-10, OC-3, BO-12 = 25

SEMESTER VI

Course Code	Course Title	Teaching hrs/week		Total hrs	Total Credits	Duration of Exam	Marks for Evaluation	
		T	P				CE	ESE
AUBB641	Plant physiology	4	3	126	4	3 hrs	20	80
AUBB642	Genetics	4	2	108	3	3 hrs	20	80
AUBB64PIII	Practical Botany III (Practical of AUBB541, AUBB542, AUBB641 & AUBB642)				2	3 hrs	20	80
AUBB651	Food and Industrial Biotechnology	3	2	90	3	3 hrs	20	80
AUBB652	Environmental Biotechnology	2	2	72	2	3 hrs	20	80
AUBB65PIII	Biotechniques III (Practical of AUBB551, AUBB552, AUBB553, AUBB651 & AUBB652)				2	3 hrs	20	80
AUBB691.a AUBB691.b AUBB691.c	Bioinformatics and Nanobiotechnology Biostatistics Food and Dairy Biotechnology	2		36	2	3 hrs	20	80
AUBB653	Project on Biotechnology	Tutorial 1		18	4	3 hrs	20	80
	Total	25		450	22			

Hour Distribution: BT-10, EC-2, BO-13 = 25

Total Work Load in Hours

Subjects	Work Load in Hours
Main Core - Botany	900
Vocational core - Biotechnology	900
Complementary - Biochemistry	360
English	360
Second Language	180
Total	**2700**

I. QUESTION PAPER PATTERN

For All Semesters

Question Type	Total number of questions	Number of Questions to be answered	Marks for each questions	Total Marks
Very short answer (One or two sentences)	10	10	1	10
Short answer (Not to exceed one paragraph)	12	8	2	16
Short essay (Not to exceed 120 words)	9	6	4	24
Long essay	4	2	15	30
Total	**35**	**26**	**--**	**80**

II. OPEN / ELECTIVE COURSES

During the programme the students have to undergo one open course and one elective course. The students attached to the Biotechnology department can opt one course from the Biotechnology department as elective course and the other from any one of the other departments as open course. The student has to do the open course during the fifth semester and the elective course during the sixth semester. As a beginning, the department will choose one open course for the fifth semester and one elective course for the sixth semester depending on the faculty and infrastructure available.

(a) Open Courses of Vocational Subject

i) Bioinformatics

ii) Food and Dairy Biotechnology

iii) Genetic Engineering

(b) Elective Courses of Vocational Subject

i) Bioinformatics and Nanobiotechnology

ii) Biostatistics

iii) Food and Dairy Biotechnology

III. CONTINUOUS EVALUATION

Evaluation and Grading

The evaluation of each course shall consist of two parts.

1) Continuous Evaluation (CE)

2) End Semester Evaluation (ESE)

The CE and ESE ratio shall be 1:4 for both courses with or without practical. There shall be a maximum of 80 marks for ESE and maximum of 20 marks for CE.

For all courses (Theory and Practical), grades are given on a 7-point scale based on the total percentage of mark (CE+ESE) as given below.

Criteria for Grading

Percentage of marks	CCPA	Letter Grade
90 and above	9 and above	A+ : Outstanding
80 to < 90	8 to < 9	A : Excellent
70 to < 80	7 to < 8	B : Very Good
60 to < 70	6 to < 7	C : Good
50 to < 60	5 to < 6	D : Satisfactory
40 to < 50	4 to < 5	E : Adequate
Below 40	< 4	F : Failure

IV. TESTS (Max. Marks: 10)

For each course there shall be one class test during a semester. Valued answer scripts shall be made available to the students for perusal within 10 working days from the date of the test.

V. ATTENDANCE (Max. Marks: 5)

The allotment of marks for attendance shall be as follows.

Attendance %	Marks
Attendance of 75%	1 Mark
76% & less than 80%	2 Marks
80% & less than 85%	3 Marks
85% & less than 90%	4 Marks
90% & above	5 Marks

VI. ASSIGNMENTS OR SEMINARS (Max. Marks: 5)

Each student shall be required to do one assignment or one seminar for each course. Valued assignments shall be returned to the students. The seminars shall be organized by the teacher/teachers in charge of CE and the same shall be assessed by a group of teachers including the teacher/ teachers in charge of that course. Assignments/Seminars shall be evaluated on the basis of their quality. The teacher shall define the expected quality of an assignment in terms of structure, content, presentation etc. and inform the same to the students. Due weight shall be given for punctuality in submission. Seminar shall be similarly evaluated in terms of structure, content, presentation, interaction etc.

VII. EVALUATION OF PRACTICAL EXAMINATION

The practical examinations for the core subject shall be conducted by the institution at the end of semesters 2, 4 and 6 with a common time table and questions set by the college. Similarly the practical examination for the complementary course shall be conducted by the college at the end of the 4th semester. The examiners shall be selected from a panel of experts prepared by the Controller of Examination. There shall be two external examiners and one internal examiner who is not in charge of the practical classes of respective batches. The mark sheet duly certified by the head of the institution should be sent to the Controller of Examination of the college before the commencement of the end semester examinations. There shall be continuous evaluation for all the practical courses. The evaluation scheme for the end semester practical examinations shall be as per revised guidelines 2019.

VIII. STUDY TOUR

It is compulsory that every student has to undertake a field work/field tour/study tour of not less than three days under the guidance of teachers of the Department during V or VI semester. They can visit biodiversity rich places or any of the regional or national scientific laboratory/ industry at which any type of scientific research in the areas of physical, chemical, mathematical or biological sciences are carrying out. They can also visit any of the university teaching and research departments. Students are required to interact with scientists/ physicist/ professors/ researchers/ academicians in the institute, where they are visiting and make a comprehensive report on their visit. The interaction can be individually or as a group mode, but the students shall submit their individual reports. The report shall contain the following points.

1. Name of the institute visited:
2. Areas of research work carrying out in the institute:
3. Name of scientists/ physicist/ professors/ researchers/ academicians to whom they interacted:
4. Description of any major work carrying out in the institute (not less than 600 words or 2 pages):
5. Few photographs:
6. Correlation between your knowledge with this research activity:

The tour reports countersigned by Head of the Department must be submitted along with the practical record and field book during the practical examination of AUBB64PIII. If a student fails to undergo the study tour he / she may not be permitted to attend the examination.

IX. PROJECT / DISSERTATION WORK

For each First Degree Programme there shall be a Project/Dissertation work. The Project/Dissertation work can be done either individually or by a group not exceeding eight students. However, Viva-Voce based on the Project/Dissertation work shall be conducted individually. The students are allowed to do project work outside the college only in recognized government institutes or laboratories.

The topics shall either be allotted by the supervising teacher or be selected by the students in consultation with the supervising teacher. The report of the Project/Dissertation shall be submitted to the Department in duplicate before the completion of the sixth semester. There shall be no continuous assessment for Project/Dissertation work. A Board of two Examiners appointed by the Controller of Examination shall evaluate the report of the Project/Dissertation work.

IX.A. GUIDELINES FOR PREPARATION AND SUBMISSION OF PROJECT / DISSERTATION IN FDP IN BOTANY AND BIOTECHNOLOGY

As a part of study the candidate has to do a project work. The project carries 4 credits. The aim of the Project work is to bring out the talents of students and to introduce research methodology. The work may be chosen from any branch of Biotechnology, which may be Experimental. Emphasis should be given for originality of approach.

The project shall be done individually or as a group of maximum eight students. The projects are to be identified during the 4th semester with the help of the supervising teacher. The report of the project (of about 30-40 pages) in duplicate shall be submitted to the department by the end of the 6th semester well before the commencement of the examination. The reports are to be produced before the external examiners appointed by the institution as per guidelines for valuation.

IX.B. EVALUATION OF PROJECT

The evaluation of the project shall be done by two external examiners according to the scheme given below. Each candidate shall be evaluated separately. There shall be a maximum of 15 candidates per session with two sessions per day.

The evaluation of dissertation shall be according to the scheme given below.

Component	Marks
Originality of approach	9
Relevance of the topic	9
Involvement of the candidate	12
Presentation of report	45

There should be a viva voice based on the Project/ Dissertation conducted individually. The various components to be considered in the viva-voce are given below.

Components	Marks
Understanding the objective of the project work	5
Background knowledge of Project &subject	5
Knowledge on the Content	15

The grade for the Project is consolidated by combining the Grades of Dissertation submission and the Project based viva-voce, taking in to account the weights assigned to them as shown below.

Particulars	**Weight**
Dissertation	3
Viva-voce	1

There shall be no continuous evaluation for the project.

SEMESTER I

SEMESTER I
Foundation Course - 1
AUBB121 - Methodology and Perspective of Biotechnology
Credits 3
Contact Hours: 54

***Aim and Objectives*:** The aim is to introduce the modern scientific methods and to familiarize biotechnology and its various areas. The students will be able to understand how science works. Students will learn how to apply IT in Biological science. They will receive a general awareness about biotechnology and its application in various fields.

Module I **12 hrs**

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 and technology

Experimentation in Science **6 hrs**

Design and planning of experiments - hypothesis - Null and alternative hypothesis, Experimentation, Types of experiments, data collection, Observation and types of observations, interpretation and deduction of results, selection of controls, necessity of units and dimensions, Repeatability and replication of experiments, Documentation and Record keeping in research

Module II **16 hrs**

Data Handling in Science and Biostatistics **6 hrs**

Significance of statistical methods in biological investigations; classification and tabulation, graphical and diagrammatic representation, central tendency - Mean, Median, Mode - any one method with simple problems. Standard Deviation, Variance, standard error, Basics of Hypothesis testing (excluding problems).

Overview of Information of Technology **10 hrs**

Features of modern personal computers and peripherals, characteristic of hardware and software, Overview of Operating systems and major application software.

Internet as knowledge repository, Academic Search engines - PUBMED, Google scholar, Science direct, Scopus.

Introduction to the use of IT in teaching and learning - Educational softwares, INFLIBNET, NICNET, BRNET

Module III **6 hrs**

Social Informatics

IT and Society, Cyber ethics, cybercrime, 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.

Module IV **8 hrs**

Origin and Development of Biotechnology

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.

Module V **8 hrs**

Applications of Biotechnology in Various Fields

(Techniques not required - an overview of applications)

Industrial Biotechnology - Major Products through Bioprocess and Fermentation Technology, metabolite production;

Environmental Biotechnology - Biological fuel generation, sewage and Effluent treatment;

Medical Biotechnology - safer and cheaper medicines by biotechnology, Biopharming;

Agriculture and Forest Biotechnology - 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- application of biotechnology in food processing.

Module VI **4 hrs**

Safety and Ethics in Biotechnology

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. 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.
2. Biotechnology and Ethics: A Blueprint for the Future, Daniel Callahan President, Hastings Center, Center for Biotechnology, Northwestern University.
3. Biotechnology: Issues, Ethics and Regulations, Tina M. Prow, Communications Specialist, Office of Agricultural Communications and Education.
4. Computers Today, Alexis Leon and Mathews Leon., Leon Vikas.
5. Conceptual Integrated science, Hewitt, Paul G, Suzanne Lyons, ohn A. Suchocki & ennifer Yeh., Addison-Wesley.2007.
6. Cultural Boundaries of Science, Gieryn, T.F. University of Chicago Press, 1999.
7. Fundamentals of Information Technology, Alexis and Mathew Leon., Leon Vikas
8. Introduction to Genetic Engineering & biotechn9ology, Nair, A.J., Infinity Science Press, USA.

9. Introduction to Information Technology, V.Rajaraman., Prentice Hll.
10. Learning Computer Fundamentals., Ramesh Bangia ., Khanna Book Publishers
11. Methods for Teaching Science as Inquiry, Bass, Joel,E and et. al., Allyn & Bacon, 2009 The truth of science, Newton R.G.,
12. Patenting in Biotechnology - Part I, R. Stephen Crespi, Tibtech, Vol. 9, 117-122, 1991.
13. People's Perception of Biotechnology, Renato Schibeci, Ian Barns.
14. 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).*
15. Public Attitudes to Genetically Engineered Products, Wendy Ross, Katy Marsh, Alexi Jackson, Jaqui Skoyles, (1998), John Innes Centre, Norwich, U.K.
16. Social issues in Science and Technology: An Encyclopedia, David E. Newton (ABC-CLIO, Santa Barbara), 1999.
17. The Golem: What everyone should know about science, Collins H. and T. Pinch,Cabridge University Press, 1993.

SEMESTER I

Complementary Course - 1

AUBB131 - Introduction to Biochemistry

Credits 3

Contact Hours: 90 (Theory 54 + Practical 36)

***Aim and Objectives*:** To give basic awareness about the concepts and physical aspects in biochemistry and to develop analytical skills in students in order to prepare them to use instruments.

Module I **7 hrs**

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 **7 hrs**

Solutions: Meaning of normality, molality, molarity, percentage solution, mole fraction, parts per million, simple numerical problems from the above, fundamental principles of diffusion, osmosis, osmotic pressure, Vant Hoff's laws of osmotic pressure, simple numerical problems, definition of isotonic, hypotonic and hypertonic solutions, biological importance of osmosis, surface tension, viscosity.

Module III **6 hrs**

Colloids: Definition of true solutions, suspensions, colloids and crystalloids, distinction between lyophilic and lyophobic colloids, properties of colloids, biological significance of

colloids, emulsions and emulsifying agents, Donnan membrane equilibrium, Donnan equation and its significance.

Module IV **6 hrs**

Thermodynamics: Laws of conservation of energy - first and second laws and its relevance in biological system, entropy and enthalpy, Gibbs free energy, Bioenergetics - endothermic and exothermic reactions of biological systems. Energy change in biochemical reactions. Sources of heat limits of temperature, heat dissipation and conservation.

Module V **10 hrs**

Colorimetry and Spectrophotometery: Beer-Lambert's law, molar extinction coefficient, colorimeter, spectrophotometer

Centrifugation: Principle of sedimentation technique, principle and procedure and application of differential centrifugation, density gradient centrifugation, ultracentrifugation, rate zonal centrifugation, isopycnic centrifugation.

pH meter: Principle and working.

Module VI **10 hrs**

Chromatography: Principle procedure and application of paper, TLC, ion-exchange, affinity and gel filtration chromatography.

Electrophoresis: Principle, procedure and application of zone electrophoresis - paper electrophoresis, gel electrophoresis (native PAGE, SDS-PAGE)

Module VII **8 hrs**

Bio-organic chemistry: Common functional groups and their significance in biomolecules, -OH, -SH, -CHO, -C=O, -COOH, $-NH_2$, -NH. Intra and Intermolecular interactions in biological system: hydrogen bond, covalent bond, hydrophobic interaction, disulphide bond, peptide bonds, glycosidic bond, phosphodiester linkage, Watson-Crick base pairings, Vander Wall's force. Classification of isomerism with examples.

Practical **36 hrs**

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

General Reactions of Carbohydrates

Qualitative Analysis of Carbohydrates

Carbohydrates - Glucose, Fructose, Galactose, Xylose, Sucrose, Maltose, 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, 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.

Suggested Readings

1. Physical Biochemistry by David Freifelder Publisher: W.H. Freeman & Co Ltd (September 1976)
2. A Biologist's Guide to Principles and Techniques of Practical Biochemistry by BryanL.Williams, Keith Wilson Hodder Education,
3. Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker Cambridge University Press.
4. The Tools of Biochemistry by Cooper, T. G. 1977. Publisher: John Wiley & Sons
5. Biophysical Chemistry Principles & Techniques Handbook (2003) by Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath Publisher: Himalaya Publishing House.
6. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
7. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi.
8. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi.
9. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd.
10. Text Book of Medical Biochemistry by MN Chatterjea and R Shinde, 3rd edition, JAYPEE Publishers, New Delhi.
11. Introduction to Biophysics by Pranab Kumar Banerjee (2008) Publishers: S. Chand & Company ltd ISBN: 81-219-3016-2.
12. Biochemistry: A Students survival Guide by Hiram. F. Gilbert (2002) Publishers: McGraw-Hill

SEMESTER I
Core Course - 1
AUBB141 - Angiosperm Anatomy and Reproductive Botany
Credits 3
Contact Hours: 72 (Theory 36 + Practical 36)

***Aim and objectives*:** 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 **7 hrs**

Angiosperm Anatomy

1. Objectives, methodology and scope of plant anatomy.
2. Microscopy - Simple and Compound
3. Micrometry - Ocular and Stage micrometer
4. Basic techniques – Sectioning (Hand, Microtome), Killing and fixation (FAA and Carnoy's formula), Dehydration (Ethanol, Isopropyl alcohol, Glycerine), Stains (Saffranin, Haematoxylin and Acetocarmine), Staining techniques, Mounting (Canada balsam, DPX)
5. Whole mounts - Cytological methods: Maceration, Smear and Squash preparation
6. 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 **9 hrs**

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

Module III **9 hrs**

1. Primary structure - Root, stem and leaf (Dicot & Monocot).
2. 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.
3. Anomalous secondary growth - *Bignonia*, *Boerhaavia*, *Dracaena*.

Module IV **9 hrs**

Reproductive Botany

1. Introduction to angiosperm embryology.
2. Microsporogenesis - 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 **2 hrs**

Palynology

Pollen structure and morphology, Viability test for pollen grains (Tetrazolium test and Fluorescein diacetate test), Economic importance (pollen allergy) and its importance in taxonomy.

Practical **36 hrs**

Anatomy **30 hrs**

1. Study of microscopes – Different magnification of light microscopes
2. Familiarize stains, fixatives and mounting media
3. General awareness of microtechnique - Maceration, Smear and Squash preparation
4. Demonstration of hand and microtome sectioning
5. Examination of different types of cells - single celled and multicellular systems
6. Measurement of specimens using micrometer (Demonstration only)
7. Non-living inclusions - Cystolith, Raphide, Sphaero-raphide, Aleurone grains
8. Starch grains (Eccentric - Potato, Concentric - Tapioca, Compound - Rice)
9. Simple permanent tissue - Parenchyma, Chlorenchyma, Aerenchyma, Collenchyma and Sclerenchyma
10. Primary structure - Dicot stem: *Hydrocotyle, Eupatorium* or any normal type
11. Monocot stem: Grass, *Asparagus* or any normal type
12. Dicot root: Pea, *Limnanthemum* or any typical dicot root
13. Monocot root: *Colocasia* or any typical monocot root
14. Secondary structure - Stem (Normal type) – *Vernonia* or any normal type
15. Secondary structure - Root (Normal type) - *Tinospora, Carica papaya* or any normal type
16. Secretory tissue: Resin canal, Nectary, Lysigenous and Schizogenous cavities. Laticifers - Articulated and non-articulated
17. Stomatal types (anomocytic, anisocytic, diacytic and paracytic)
18. Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia*
19. Leaf anatomy - Dicot leaf: *Ixora*. Monocot leaf : Grass

Reproductive Botany **3 hrs**

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

Palynology **3 hrs**

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

References

1. Pandey B.P. (2014). Plant Anatomy, Revised Edition, S. Chand and Company Pvt. Ltd., New Delhi.
2. Pandey S.N. and Chadha A. (2015). Plant Anatomy and Embryology, Vikas Publishing House Pvt. Ltd., New Delhi.
3. Pijush Roy (2010). Plant Anatomy, 2nd Edition, New Central Book Agency (P) Ltd., Kolkata.
4. Ashok M. Bendre and Ashok Kumar (2017). A Text Book of Practical Botany II, 7th Edition, Rastogi Publications, Meerut.
5. Pandey B.P. (2013). Modern Practical Botany, Volume II, Revised Edition, S. Chand and Company Pvt. Ltd., New Delhi.

Suggested Readings

1. Esau K. (1965) - Plant Anatomy - Wiley Eastern, New York.
2. Fahn A. (1985) - Plant Anatomy - Pergamon Press, Oxford.
3. Maheswari P. - Embryology of Angiosperms - Vikas Pub:
4. Nair PKK Palynology of Angiosperms
5. Biology - McGraw Hill Co, New York.
6. Prasad and Prasad (1972) Outlines of Botanical Micro technique, Emkay publishers, New Delhi
7. Coutler E. G. (1969) Plant Anatomy - Part I Cells and Tissues - Edward Arnold, London.
8. Vashista .P. C (1984) - Plant Anatomy - Pradeep Publications - Jalandhar

SEMESTER I
Vocational Core Course - 1
AUBB151 - Microbiology
Credits 4
Contact Hours: 54 (Theory 36 + Practical 18)

***Aim and Objectives*:** The course on microbiology is destined to give a thorough and basic understanding in various aspects of classical Microbiology, which forms the basis of any biotechnology application. Students were expected to master the major theoretical and practical expertise from this course.

Module I **6 hrs**

Introduction

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

Module II **7 hrs**

Classification of bacteria - Concept of microbial species, strains, biovars, serovars. Brief introduction to Bergey's manual.
Microbial cell structure - Comparison of Eukaryotic and Prokaryotic cells, Structure of Gram positive and Gram negative bacteria; Motility in bacteria, kinds of flagella and ultra-structure of flagella; Sporulation.

Module III **7 hrs**

Bacterial Nutrition

Culture media - Types and uses, Bacterial growth curve, factors affecting growth of microbes; measurement of growth; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes.
Pure culture Methods: Direct plating, Serial dilution technique, Spread plate, Streak plate, Pour plate; Slant culture and Stab culture, Anaerobic bacterial culture (any two methods).

Module IV **6 hrs**

Agricultural Microbiology

Biological nitrogen fixation, free living and symbiotic nitrogen fixation, Mechanism of Nitrogen fixation; Mycorrhizal associations; Biofertilizers - types and applications; Rhizosphere effect.

Module V **6 hrs**

Environmental Microbiology

Biogeochemical cycles - Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremophiles - Thermophiles, Acidophiles, Halophiles and Alkalophiles; Biotechnological application of extremophiles.

Module VI **4 hrs**

Virology

Viruses, general characteristics, structure of viruses. Bacteriophages - structure of T4 bacteriophage; Lytic and Lysogenic cycles. Viral culture.

Practical **18 hrs**

1. Laboratory safety and good laboratory practices.
2. Principles and application of laboratory instruments - Microscope, Incubator, Autoclave, Centrifuge, LAF, Filtration unit, Shaker, pH meter.
3. Cleaning and sterilization of glassware.
4. Preparation of media - Nutrient Agar and Broth.
5. Inoculation and culturing of Bacteria in Nutrient agar and Nutrient broth.
6. Preparation of agar slant, stab, agar plate.
7. Purification techniques - streak plating method - T streaking, Quadrant, Zig Zag; pour plate, spread plate.
8. Staining of Bacteria - Simple staining, Gram staining and Negative staining.
9. Growth of Bacteria in liquid media: Determination of kinetics of bacterial growth.
10. Microscopic tests for bacterial motility - Hanging drop method.
11. Isolation of bacteria from air open plate method.
12. Enumeration of bacteria in a given soil sample using pour plate method.
13. Microbiological examination of water samples - Standard plate count method

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 (9^{th} Ed) - Prescott L. M., Harley, J. P., and Klein D. A. Mc Graw Hill, New York
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.
9. Microbiology- P D Sharma; Rastogi Publications, Meerut.
10. Holt J. S., Krieg N. R., Sneath, P.H.A. and Williams S. T. 1994. Bergey s' Manual of Determinative bacteriology. (9th ed).Williams & Wilkins, Baltimore.
11. Brock Biology of Microorganisms (15th Edition). Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl. NY : Pearson, [2018]
12. Microbiology: An Introduction, 12th Edition, Gerard J. Tortora, Berdell R. Funke, and Christine L. Case. Pearson, [2016]

SEMESTER II

SEMESTER II
Foundation Course - 2
AUBB221 - Biophysics and Instrumentation
Credits 2
Contact Hours: 36

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

Module I **8 hrs**

Principles of Thermodynamics **4 hrs**

Laws of Thermodynamics entropy and enthalpy, Gibbs free energy, bioenergetics-endothermic and exothermic reactions of biological systems.

Electrical Properties of Biological Compartments **4 hrs**

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

Module II **5 hrs**

Biophysics of Photosynthesis

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.

Module III **6 hrs**

Biophysics of Vision, Muscle Movements and Hearing

Mechanism of vision and correction of vision faults, Mechanism of muscle movements and hearing.

Module IV **4 hrs**

Microscopy

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

Module V **13 hrs**

Bioinstrumentation **7 hrs**

Basic Principles and Working of Instruments – Spectrophotometer (UV and Visible) - Beer Lambert's Law. Brief account of Densitometry, Fluorimetry, Atomic absorption spectroscopy, Mass spectrometry, MALDI-TOF, NMR, X-ray crystallography.

Electrophoresis **3 hrs**

Principle of Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE & SDS PAGE) and Agarose gel electrophoresis, Two dimensional electrophoresis and isoelectrofocussing, immune electrophoresis

Isotopes and Radioisotopes **3 hrs**

Isotopes and radioisotopes, radiations - ionizing radiations,

Application of isotopes and radioisotopes in biological research, radioisotope tracer technique and autoradiography.

Practical

Familiarizing the working of the following instruments

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

SEMESTER II
Complementary Course - 2
AUBB231 - General Biochemistry
Credits 3
Contact Hours: 90 (Theory 54 + Practical 36)

***Aim and Objectives*:** To familiarize the students with the building blocks of living matter, the biomolecules, their structure, components, reactions, their derivatives, biological significance and the basic tests to identify them.

Module I **10 hrs**

Chemistry of 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. Qualitative test for carbohydrates.

Module II **10 hrs**

Chemistry of Lipids: Classification, 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 - structure and function of phosphotidyl choline and phosphotidyl ethanolamine. Sphingolipids - structure and function of cerebrosides and gangliosides. Steroids - structure of cholesterol and ergosterol. Colour reactions of sterols.

Module III **8 hrs**

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

Module IV **8 hrs**

Proteins: Physical properties, solubility, isoelectric point and isoelectric precipitation, elementary study of primary secondary, tertiary and quaternary structure of proteins, colour reactions, precipitation reactions, denaturation, oligopeptides, amino acid analysis of proteins.

Module V **8 hrs**

Chemistry of 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.

Module VI **10 hrs**

Enzymes: Classification and nomenclature, general properties, apoenzyme, holoenzyme, coenzyme, 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, Significance of v_{max} and k_m, 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), Coenzymes.

Practical **36 hrs**

Qualitative Analysis of Lipids

Fatty acids: Stearic acid/ Oleic acid.

Tests - Solubility, Translucent spot tests, Test for Unsaturation

Glycerol

Tests - Acrolein test, Borax fusion test, 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.

Suggested Readings

1. Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson
2. 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.
3. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
4. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga
5. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain (2008) Publishers: S. Chand & Co Ltd.
6. Text Book of Biochemistry, 5th edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi.

7. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
8. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi.
9. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi.

SEMESTER II
Core Course - 2
AUBB241 - Environmental Studies
Credits 4
Contact Hours: 90 (Theory 54 + Practical 36)

***Aim and Objectives*:** 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 **6 hrs**

Natural Resources

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

Module II **14 hrs**

Ecosystems

1. Ecosystems - Concept of an ecosystem- structure and function of an ecosystem.
2. Biotic and abiotic components - Energy flow in an ecosystem.
3. Ecological succession - Definition & types.
4. Food chains - Food web & ecological Pyramids.

5. Introduction - types, characteristic features, structure and functions of the following ecosystems (Brief study only).
   1. Forest ecosystem 2. Grassland ecosystem 3. Desert ecosystem 4. Aquatic ecosystems - Ponds, Streams, Rivers, Oceans, Estuaries.
6. Morphological, anatomical & physiological adaptations of Hydrophytes, Xerophytes, Halophytes, Epiphytes, Parasites.

Module III **14 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 & 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 **12 hrs**

Social Issues and the Environment

1. From unsustainable to sustainable development. Urban problems related to energy. Water conservation, Rain water
2. Harvesting, water shed management. 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 **8 hrs**

Phytogeography

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. Phytogeographical regions of India.

References

1. Misra S.P. and Pandey S.N. (2016). Essential Environmental studies, 4th Edition, Ane Books Pvt. Ltd., New Delhi.
2. Shukla R.S. and Chandel P.S. (2015). A Textbook of Plant Ecology, Revised Edition, S. Chand and Company Pvt. Ltd., New Delhi.
3. Ashok M. Bendre and Ashok Kumar (2017). A Text Book of Practical Botany II, 7th Edition, Rastogi Publications, Meerut.
4. Pandey B.P. (2013). Modern Practical Botany, Volume II, Revised Edition, S. Chand and Company Pvt. Ltd., New Delhi.

Suggested Readings

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

SEMESTER II
Core Course - Practical
AUBB24PI - Practical Botany I
(Practical of AUBB141 & AUBB241)
Credits 2
Contact Hours: 72 (Practical hours of AUBB141 & AUBB241)

Practical of AUBB141 **36 hrs**

Angiosperm Anatomy and Reproductive Botany

Anatomy **30 hrs**

1. Study of microscopes – Different magnification of light microscopes
2. Familiarize stains, fixatives and mounting media
3. General awareness of microtechnique - Maceration, Smear and Squash preparation
4. Demonstration of hand and microtome sectioning
5. Examination of different types of cells - single celled and multicellular systems
6. Measurement of specimens using micrometer (Demonstration only)
7. Non-living inclusions - Cystolith, Raphide, Sphaero-raphide, Aleurone grains
8. Starch grains (Eccentric - Potato, Concentric - Tapioca, Compound - Rice)
9. Simple permanent tissue - Parenchyma, Chlorenchyma, Aerenchyma, Collenchyma and Sclerenchyma
10. Primary structure - Dicot stem: *Hydrocotyle, Eupatorium* or any normal type
11. Monocot stem: Grass, *Asparagus* or any normal type
12. Dicot root: Pea, *Limnanthemum* or any typical dicot root
13. Monocot root: *Colocasia* or any typical monocot root
14. Secondary structure - Stem (Normal type) – *Vernonia* or any normal type
15. Secondary structure - Root (Normal type) - *Tinospora, Carica papaya* or any normal type
16. Secretory tissue: Resin canal, Nectary, Lysigenous and Schizogenous cavities. Laticifers - Articulated and non-articulated
17. Stomatal types (anomocytic, anisocytic, diacytic and paracytic)
18. Anomalous secondary thickening - *Bignonia, Dracaena, Boerhaavia*
19. Leaf anatomy - Dicot leaf: *Ixora*. Monocot leaf : Grass

Reproductive Botany **3 hrs**

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

Palynology **3 hrs**

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

Practical of AUBB241 **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. Phytogeographical regions of India.

SEMESTER II
Vocational Core Course - 2
AUBB251 - Microbial Metabolism, Genetics and Diseases
Credits 3
Contact ours: 54 (Theory 36 + Practical 18)

***Aim and Objectives*:** This course is designed to get an in-depth knowledge in Microbial metabolism, microbial genetics, and microbial diseases. This knowledge is very important as far as Biotechnology is concerned. The students are expected to master all microbial related techniques to pursue studies in biotechnology.

Module I **12 hrs**
Bacterial Metabolism
Introduction
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.
Nutrition in bacteria - Bacterial Growth curve, Measurement of growth, factors affecting growth of bacteria. Photosynthetic and chemosynthetic organisms- purple sulfur bacteria
Anabolism of carbohydrates - Photosynthetic bacteria and cyanobacteria- photosynthetic pigments of bacteria, mechanism of photosynthesis in bacteria, carbon sources
Nitrogen metabolism- Biological nitrogen fixation, symbiotic nitrogen fixation, components involved in the process of nitrogen fixation, Inorganic nitrogen metabolism, assimilation of inorganic nitrogen, Nitrogen cycle.
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.

Module II **12 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 phage - general structure, general multiplication in bacteria - lytic phase and lysogenic phase, bacterial recombination through transduction.

Bacterial recombination and transferable drug resistance.

Module III **12 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, Cholera, *E.coli*, Diarrheas, Brucellosis

Soil borne bacterial diseases - Anthrax, Tetanus, Leptospirosis

Viral diseases of humans - Pneumotropic viral diseases - Influenza, Adenoviral infections, Rhinoviral infections, HINI

Dermatoviral diseases - Herpes simplex, chickenpox, Measles, Rubella

Viscerotropic Viral diseases - yellow fever, Dengu fever

Neurotropic viral diseases - rabies, polio

Systemic disease - Ebola

Practical **18 hrs**

1. Detection of bacterial morphology using methylene blue stain
2. Bacterial spore staining
3. Isolation and identification of *E. coli* from using MPN technique
4. Isolation of microorganisms from spoiled food materials
5. Isolation of starch degrading microorganisms
6. Isolation of *Lactobacillus* from curd and its identification
7. Isolation of yeast from fruit samples and its culturing.
8. Examination of microbial flora of the skin
9. Examination of the microbial flora of mouth.
10. Isolation and examination of Throat and nasopharyngeal cultures
11. Isolation of Plaque-forming bacteriophage from sewage

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

Vocational Core Course - Practical

AUBB25PI - Biotechniques I

(Practical of AUBB151 & AUBB251)

Credits 2

Contact Hours: 36 (Practical hours of AUBB151 & AUBB251)

Practical of AUBB151 **18 hrs**

Microbiology

1. Laboratory safety and good laboratory practices.
2. Principles and application of laboratory instruments - Microscope, Incubator, Autoclave, Centrifuge, LAF, Filtration unit, Shaker, pH meter.
3. Cleaning and sterilization of glassware.
4. Preparation of media - Nutrient Agar and Broth.
5. Inoculation and culturing of Bacteria in Nutrient agar and Nutrient broth.
6. Preparation of agar slant, stab, agar plate.
7. Purification techniques - streak plating method - T streaking, Quadrant, Zig Zag; pour plate, spread plate.
8. Staining of Bacteria - Simple staining, Gram staining and Negative staining.
9. Growth of Bacteria in liquid media: Determination of kinetics of bacterial growth.
10. Microscopic tests for bacterial motility - Hanging drop method.
11. Isolation of bacteria from air open plate method.
12. Enumeration of bacteria in a given soil sample using pour plate method.
13. Microbiological examination of water samples - Standard plate count method

Practical of AUBB251 **18 hrs**

Microbial Metabolism, Genetics and Diseases

1. Detection of bacterial morphology using methylene blue stain
2. Bacterial spore staining
3. Isolation and identification of *E. coli* from using MPN technique
4. Isolation of microorganisms from spoiled food materials
5. Isolation of starch degrading microorganisms
6. Isolation of *Lactobacillus* from curd and its identification
7. Isolation of yeast from fruit samples and its culturing.
8. Examination of microbial flora of the skin
9. Examination of the microbial flora of mouth.
10. Isolation and examination of Throat and nasopharyngeal cultures
11. Isolation of Plaque-forming bacteriophage from sewage

SEMESTER III

SEMESTER III
Complementary Course - 3
AUBB331 - Physiological Aspects in Biochemistry
Credits 4
Contact Hours: 90 (Theory 54 + Practical 36)

***Aim and Objectives*:** The course is intended to introduce the student to the basics of physiological aspects and to familiarize the students with the basics of human nutrition.

Module I **10 hrs**

Biochemistry of Blood: Physical properties and constituents of blood, types of blood cells RBC, WBC, lymphocytes and platelets. Hemoglobin: Structure and function of hemoglobin, types of hemoglobin, abnormal hemoglobin, bile pigments formation, iron metabolism - absorption and transport. Blood clotting: Mechanism of blood clotting (Intrinsic and extrinsic pathway), clotting factors, anticoagulants, bleeding time, clotting time, hemopoesis - blood forming organs, erythropoeisis, leucopoiesis. Blood groups: Classification, chemical basis for blood group specificity.

Module II **10 hrs**

Nutrition: Vitamins: Definition, classification - fat soluble and water soluble, source, chemical nature (without structure) functions of vitamins. Deficiency diseases.
Nutrition: Caloric value, BMR- Carbohydrates, fats and proteins. Minerals: Outline the study of requirements, sources and functions of Ca, P, Mg, Na, K, Cl, I, Cu, Zn, Mn, and Fe.

Module III **7 hrs**

Detoxification: Metabolism of foreign compounds in the liver - oxidation, conjugation, hydrolysis, reduction, examples of each type. Liver function test. Structure of nephron, formation of urine, renal function test, renal threshold, constituents of urine.

Module IV **9 hrs**

Respiration and Acid-Base balance: Respiration: Partial pressure of gases, chemical and physiological events affecting the diffusion of O_2 and CO_2, exchange of CO_2 during respiration, transport of gases in blood, carbonic anhydrase, chloride shift, oxygen dissociation curve, Bohr effect. Acid Base balance: Body water balance, buffers in blood, respiratory acidosis and alkalosis, metabolic acidosis and alkalosis.

Module V **9 hrs**

Clinical Biochemistry: Elementary study of Diabetes - classification, blood glucose levels, GTT, glycosylated Hb. Hypercholesterolemia - serum cholesterol levels, Hemophilia, Arthrosclerosis - characteristics, pathophysiology, risk factors and management, Obesity - characteristics, risk factors, classification based on BMI. Jaundice.

Module VI **9 hrs**

Endocrinology: Organization of endocrine system, classification and functions of adrenalin, nor adrenalin, cortisone, Cortisol, corticosterone, deoxycorticosterone, Estradiol, thyroxine, TSH, ACTH, Gonadotropin, GH, Oxytocin and vasopressin, peptide hormones (Structure not needed).

Practical **36 hrs**

Qualitative Analysis of Amino acids and Proteins

Amino acids (any 4 amino acids)

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

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

Suggested Readings

1. Advanced Text Book on Food and Nutrition, Vol I and II, Dr. MS Swaminathan.2nd edition. The Bangalore Printing and Publishing Co Ltd.
2. Arthur Vander, James Sherman, and Dorothy Luciano Vander et al.: Human Physiology: The Mechanism of Body Function, Eighth Edition © The McGraw-Hill Companies.
3. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi,
4. Hawk's Physiological Chemistry, Bernard L. Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi p 10- 15.
5. Human Physiology (2001) by Andrew Davies, GH Blakeley, Cecil Kidd Publisher: Churchill Livingstone
6. Human Physiology (2001) by Bipin Kumar Publisher: Campus Books International
7. Human Physiology (2001) by KC Sawant Publisher: Dominant Publishers & Distributors
8. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi,
9. Plant Biochemistry by Hans-Walter Heldt Professor Em (3ed 2004) Publisher: Academic
10. Principles Of Biochemistry, 6e (1959) by Abraham White, Philip Handler Publisher: Tata McGraw-hill Publishing Company Limited
11. Textbook of Medical Biochemistry for Medical Students by DM Vasudevan and Sreekumari S. 5th edition, Japee Brothers, Medical Publishers,
12. Textbook of Medical Physiology, 11/e with Student Consult Access (2005) by Arthur C Guyton, John E Hall Publisher:

SEMESTER III
Core Course - 3
AUBB341 - Phycology, Mycology, Lichenology and Plant Pathology
Credits 2
Contact Hours: 72 (Theory 54 + Practical 18)

***Aim and Objectives*:** To impart basic knowledge about lower plants such as algae, fungi, Lichen and the diseases caused by these organisms in plants. This will give an account on the life cycle, habitat, anatomy, classification and its involvement in the life cycle of other members of living world.

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*
3. 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 **18 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 **6 hrs**

Lichenology

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

Module IV **8 hrs**

Plant Pathology

1. Introduction to plant 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 **18 hrs**

Phycolcogy **8 hrs**

1. Make micropreparations 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 **5 hrs**

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

Lichenology **2 hrs**

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

Plant Pathology **3 hrs**

5. Identify the diseases mentioned with respect to causal organism and symptoms.
6. Students should be trained to prepare the fungicide Bordeaux mixture & Tobacco decoction.

References

1. Fritsch F. B 1945, Structure and Reproduction of Algae Vol.I & II. Cambridge University Press.
2. Alexopoulos C.J & MIMS C.V 1988. Introductory Mycology, John Wiley & Sons.
3. Vashishta B.R. 1990, Botany for Degree Students, Fungi, S.Chand & Co.
4. Vasishta B.R 1990, Botany for Degree Students, Algae, S.Chand & Co.

Suggested Readings

1. Alain Durieux 2009, Applied Microbiology, Springer International Edition
2. Chapman V.J & Chapman D.J, The Algae, Macmillan.
3. Dr. G. Gunasekharan - Labortary Manual of Microbiology – New Age Pub:
4. Heritage. L. 2007, Introductory Microbiology, Cambridge University Press India Pvt Ltd
5. Jim Deacon 2007, Fungal Biology, 4th edition, Blackwell Publishing, Ane Books Pvt. Ltd.
6. Kanika Sharma 2009, Manual of Microbiology, Ane Books Pvt. Ltd.
7. Mamatha Rao 2009, Microbes and Non flowering plants, Impact and applications; Ane Books Pvt. Ltd.
8. R .C .Dubey & D .K .Maheswari - A text Book of Microbiology – Chand & Co:
9. Schlegel, 2008 General Microbiology , Cambridge University Press India Pvt Ltd
10. Singh V, Pandey PC and Jam D.K 1998, A Text Book of Botany for Under Graduate Students, Rastogi Publications.
11. Smith G.M 1955, Cryptogamic Botany, Vol.I McGraw Hill.
12. Webster J 1970, Introduction to Fungi, Cambridge University Press.

SEMESTER III

Core Course - 4

AUBB342 - Horticulture, Mushroom Cultivation and Marketing

Credits 2

Contact Hours: 72 (Theory 54 + Practical 18)

***Aim and Objectives*:** This course will give an idea about the application of biological science particularly plant science in business generations and self-employment. This focuses on the horticulture, Mushroom cultivation, its marketing and also in forest depended economy and its impact on society

Module I **12 hrs**

Horticulture

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

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 - Pruning shears, secateurs, spade, trowel, garden rake, hand rake, sprinkers/sprayers, showel and lawn mower
Manures and fertilizers - Farmyard manure, compost, vermicompost and biofertilizers. Chemical fertilizers - NPK, Time and application of manures and fertilizers, Foliar sprays

Module II **14 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
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 III **10 hrs**

Growth regulators in horticulture - Rooting hormones, Growth promoters, Flower induction, Parthenocarpy
Plant protection - Common diseases of fruits and vegetable crops, Weedicides, Fungicides, Pesticides

Module IV **10 hrs**

Mushroom Cultivation and Marketing

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
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 V **8 hrs**

Diseases - Common pests, disease prevention and control measures.
Processing - Blanching, steeping, sun drying, canning, pickling, freeze drying.
Storage - short term and long term storage.
Common Indian mushrooms.
Production level, economic return, Foreign exchange from Mushroom cultivating countries and international trade.

Practical **18 hrs**

Horticulture

Propagation methods- Layering, Budding and grafting

Flower arrangement

Field Study: Visit to a Botanical garden under the guidance of the teacher is encouraged.

Mushroom Cultivation and Marketing

Field Study: Visit to a mushroom cultivating Laboratory, Collection and Identification of Mushrooms

References

1. Bailey L.H 1901, The Standard Cyclopaedia of Horticulture Volume 1, 2 and 3, Macmillan Publications.
2. Harander Singh. 1991. Mushrooms- The Art of Cultivation- Sterling Publishers.
3. Kaul T N 2001. Biology and conservation of mushrooms. Oxford and IBH publishing company N. Delhi
4. Manibhushan Rao K 1991, Text Book of Horticulture, Macmillan Publications

Suggested Readings

1. Anil Kumar Dhiman. 2003. Sacred plants and their medicinal uses. Daya publishing house, New Delhi.
2. Arora J.S 1990, Introductory Ornamental Horticulture, Kalyani 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. Gupta P.K. Elements of Biotechnology.
6. Indian Journal of Mushrooms**.** Published by I.M.G.A. Mushroom Research Laboratory. College Agriculture, Solan
7. Kumar N 1989, lntroduction to Horticulture, Rajalakshmi Publications
8. Pandey B P 1996. A textbook of fungi. Chand and company N Delhi.
9. Sharma P.D. 2004. Ecology and Environment. Rastogi publications, Meerut
10. Shujnrnoto, 1982, The Essentials of Bonsai, David & Charles, Newton

SEMESTER III
Vocational Core Course - 3
AUBB351 - Protista and Animal Diversity
Credits 4
Contact Hours: 72 (Theory 54 + Practical 18)

***Aim and Objectives*:** This course is designed in such a way to get a basic insight into the diversity of animals and its morphological and physiological adaptations suited to their ecosystems.

Module I **2 hrs**

Classification of Organisms: Two kingdom system; Three kingdom system; Four kingdom system; Five kingdom system; Three domain system

Module II **6 hrs**

Kingdom Protista

Taxonomic positions, general features and classification.
Salient features of the following phyla with brief note on the examples cited
Phylum Apicomplexa e.g. *Plasmodium* (Detailed study of life history and pathogenicity)
Phylum Ciliophora e.g. *Paramecium*
Phylum Dinoflagellata e.g. *Noctiluca*
Phylum Parabasalia e.g. *Trichonympha*
Phylum Rhizopoda e.g. *Entamoeba*

Module III **6 hrs**

Kingdom Animalia

Salient features; Levels of organization: cellular, tissue, organ and system
Branches: Mesozoa, Parazoa and Eumetazoa
Branch: Eumetazoa
- Radiata
- Bilateria
  - Protostomia; Acoelomata, Pseudocoelomata and Eucoelomata
  - Deuterostomia

Schizocoela and Enterocoela
Body segmentation, metamerism and pseudometamerism
Salient features of the following phyla; Classification up to classes; External features, adaptations and economic importance of examples cited

Module IV **2 hrs**

Phylum Porifera

Class Calcarea (Calcispongiae) e.g. *Sycon*
Class Hexactinellida (Hydrospongiae)
Class Demospongiae

Module V **2 hrs**

Phylum Cnidaria (**Coelenterata**)

Class Hydrozoa e.g. *Obelia* (mention alternation of generation)
Class Scyphozoa e.g. *Aurelia*
Class Anthozoa e.g. Sea anemone

Module VI **2 hrs**

Phylum Platyhelminthes

Class Turbellaria e.g. *Bipalium*
Class Trematoda e.g. *Fasciola*
Class Cestoda e.g. *Taenia solium*

Module VII **2 hrs**

Phylum Nematoda

Class Secernentea (Phasmida) e.g. *Ascaris*
Class Adenophorea (Aphasmida) e.g. *Trichinella*

Module VIII **2 hrs**

Phylum Annelida

Polychaeta
Class Polychaeta e.g. *Nereis*
Clitellata
Class Oligochaeta e.g. Earthworm
Class Hirudomorpha e.g. *Hirudinaria*

Module IX **3 hrs**

Phylum Mollusca

Class Aplacophora e.g. *Neomenia*
Class Monoplacophora e.g. *Neopilina*
Class Bivalvia (Pelecypoda or Lamellibranchiata) e.g. Pearl oyster
Class Polyplacophora e.g. *Chiton*
Class Gastropoda e.g. *Pila*
Class Cephalopoda e.g. *Sepia*
Class Scaphopoda e.g. *Dentalium*

Module X **1 hr**

Phylum Onychophora

e.g. *Peripatus*

Module XI **10 hrs**

Phylum Arthropoda

Subphylum Trilobitomorpha
Subphylum Chelicerata
Class Merostomata e.g. *Limulus*

Class Arachnida e.g. Scorpion
Class Pycnogonida
Subphylum Mandibulata
Class Crustacea e.g. Prawn (*Penaeus*)
Class Chilopoda e.g. *Scolopendra*
Class Symphyla e.g. *Scutigeralla*
Class Diplopoda e.g. *Spirostreptus*
Class Pauropoda e.g. *Pauropus*
Class Insecta e.g. Cockroach (External characters, mouth parts; digestive system and nervous system)

Pests of:
(1) Paddy: *Leptocorisa acuta* and *Spodoptera mauritia*
(2) Stored food grains: *Sitophilus oryzae* and *Tribolium*

Module XII **4 hrs**

Phylum Echinodermata

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 XIII **4 hrs**

Phylum Chordata

Salient features of the phylum Chordata; Classification up to classes; External features, adaptations of examples cited.

Subphylum Urochordata e.g. *Ascidia*
Subphylum Cephalochordata e.g. *Amphioxus*
Subphylum Vertebrata
Division Agnatha e.g. *Petromyzon*; Gnathostomata (Jawed Vertebrates)
Superclass Pisces e.g. *Scoliodon*
Superclass Tetrapoda

Module XIV **8 hrs**

Class Amphibia
General characters
Order Gymnophiona (Apoda) e.g. *Ichthyophis*
Order Urodela (Caudata) e.g. *Amblystoma* (mention axolotl larva)
Order Anura e.g. *Rana* (morphology only)

Class Reptilia
General characters
e.g. *Calotes*, *Draco*
Non-poisonous snakes e.g. *Ptyas*
Poisonous snakes e.g. *Naja, Viper* and *Bungarus*

Identification of non-poisonous and poisonous snakes

Class Aves (Birds)

General characters
Flightless birds. e.g. Ostrich
Flying birds e.g. Pigeon (morphology and different types of feathers)
Peafowl
Flight adaptations of birds

Class Mammalia

General characters
e.g. *Echidna*, kangaroo, Bat, Whale
Adaptations of aquatic mammals

Practical **18 hrs**

Identification and assigning the systematic position of the following specimens:

1. Protozoa - any 4.
2. Porifera - any
   Study of gemmules.
3. Coelenterata - any 5.
4. Aschelminthes - any 2.
   Ascaris T.S. of male and female.
5. Platyhelminthes - any 4 (adaptations of parasitic forms to be stressed)
6. Annelida - any 4.
7. Minor phyla - any 2.
8. Arthropoda - any 10 (including at least 5 insect pests of paddy/banana plant/stored food grains and 2 beneficial insects).
9. Mollusca - any 8 (including any 2 beneficial and any 2 harmful species).
10. Echinodermata - any 5 (representing one each from five different classes).
11. Prochordates - Ascidia, Branchiostoma (Amphioxus).
12. Pisces - any 8 (including 2 cartilaginous fishes, 2 fishes with accessory respiratory organs, 4 common food fishes).
13. Amphibia - any 3 (representing the orders Apoda, Urodela and Anura).
14. Reptilia - any 5 (including at least one poisonous and one non-poisonous snake of Kerala).
15. Aves - any 3 common birds of Kerala (based on museum specimens or field observations).
16. Mammalia - any 5 (based on museum specimens or field observations).

Note:

Practical examinations shall give emphasis on systematics of animals. Questions on taxonomy may be designed so as to assess the student's knowledge in identification of organisms and assigning the systematic position down to the prescribed taxa. Students may be asked to arrange a miscellaneous group of animals into different taxonomic groups in chart form mentioning the salient features of the groups.

Suggested Readings

1. Ruppert E.E., Fox R and Barnes R.D. (2004) Invertebrate Zoology. Thomson Books/Cole. USA.
2. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol II
3. Jordan, E. L. and Verma, P. S. Invertebrate Zoology. S. Chand and Co.
4. Jordan, E. L. and Verma, P. S. Vertebrate Zoology. S. Chand and Co.
5. Kotpal, R. L. (2002) Modern Text Book of Zoology: Invertebrates. Rastogi Publishers.
6. Kotpal, R. L. (2002) Modern Text Book of Zoology: Vertebrates. Rastogi Publishers.
7. Mayer E. (1980) Principles of Systematic Zoology. Tata McGraw Hill Publishing Co. New Delhi.
8. Vijayakumaran Nair K, J. Jayakumar and P.I. Paul (2007) Protista and Animal Diversity. Academica.
9. Nayar, K. K. et al. General & Applied Entomology TMH
10. Nigam S. (1978) Invertebrate Zoology. S. Nagin and Co.
11. Hickman C.P. and Roberts L.S. (1994) Animal Diversity. Wm. C. Brown, Dubuque, IA
12. Venugopal Rao et al. (2003) Integrated Insect Pest Management. Agro.
13. The New Encyclopedia Britannica, Macropedia, (1998). Encyclopedia Britannica Inc., Chicago.
14. Green N.P.O., et al (2000) Biological Science. Cambridge University Press.
15. Outlines of Zoology- Ekambaranatha Iyer; Chand Publications, New Delhi
16. Brusca R.C. and Brusca G.J. (1990) Invertebrates. Sinauer Associates, Sunderland,MA.
17. Pearse V and Pearse J, Buchsbaum M and Buchsbaum R. (1987) Living Invertebrates Blackwell Scientific Publications, California.
18. Chandler, A.C. and Read. Parasitology.
19. Dhami, P. S. and Dhami, J. K. Invertebrate Zoology. R. Chand and Co.
20. Dhami, P. S. and Dhami, J. K. Vertebrate Zoology. R. Chand and Co.
21. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol I
22. Invertebrate Zoology- Chand publications, New Delhi
23. Manual of Zoology – Ekambaranatha Iyer; Chand Publications, New Delhi
24. Vertebrate Zoology - Chand Publications, New Delhi

SEMESTER III
Vocational Core Course - 4
AUBB352 - Animal Physiology and Anatomy
Credits 3
Contact Hours: 54 (Theory 36 + Practical 18)

***Aim and Objectives*:** This course will give very fundamental and essential information about the anatomy and functioning of the various types of cell, tissues and organs in selected model organisms.

Module I **2 hrs**
Animal cell, tissues, organs and organ systems

Module II **3 hrs**
Nutrition - Feeding mechanisms, digestion - types of digestion, basic mechanisms of digestion, digestive system and its function, Human digestive system

Module III **4 hrs**
Respiratory system - Respiration, types of respiration, cellular respiration - oxidation of glucose, Human respiratory system, pulmonary respiration

Module IV **5 hrs**
Circulatory system - Circulation, types of circulation - open and closed circulation.
Human circulatory system, Human Heart, heart beat; Tissue fluid.
Lymphatic system - comparison of blood and lymph

Module V **5 hrs**
Reproductive system - Reproduction, types of reproduction - asexual, sexual and vegetative reproduction
Human reproductive system - gametogenesis, spermatogenesis, structure of human sperm, Oogenesis, Menstrual cycle, Human embryogenesis

Module VI **5 hrs**
Excretory system - Excretion and its significance, excretory products of body,
Excretory organs of invertebrates, excretory organs of vertebrates,
Nephrons - structure and function, Kidneys - structure and function, Formation of urine, Dialysis

Module VII **4 hrs**
Bioregulatory system - Glands, Hormones, Endocrine glands and feedback mechanism

Module VIII **5 hrs**

Nervous system - Neurons - structure and function, nervous system of invertebrates and vertebrates, Human Nervous system

Module IX **3 hrs**

Skeletal and muscular system - Human skeleton and muscular system

Practical **18 hrs**

Minor Practical

1. Nereis - parapodium.
2. Earthworm - body setae.
3. Earthworm - coelomocytes.
4. Cockroach - mouth parts.
5. Cockroach - salivary glands.
6. Prawn - appendages.
7. Fishes - different types of scales (placoid, ctenoid and cycloid scales).

Major Practical

1. Earthworm - nervous system.
2. Cockroach- alimentary canal.
3. Cockroach - nervous system.
4. Prawn - nervous system.

Suggested Readings

1. Arthur C. Guyton, Textbook of Medical Physiology, W.B.Suanders Co.
2. C.C. Chatterjee, Human Physiology Vol. 1 & 2 -; Medical Allied Agency
3. Chandler, A.C. and Read. Parasitology.
4. Dhami, P. S. and Dhami, J. K. Invertebrate Zoology. R. Chand and Co.
5. Dhami, P. S. and Dhami, J. K. Vertebrate Zoology. R. Chand and Co.
6. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol II
7. Ekambaranatha Ayyar, M. and Ananthakrishnan, T. N. A Manual of Zoology. Vol I
8. HT Yost , Cellular physiology, Prentice Hall
9. John B. West, Physiological Basis of Medical Practice, William & Wilkins
10. Jordan, E. L. and Verma, P. S. Invertebrate Zoology. S. Chand and Co.
11. Jordan, E. L. and Verma, P. S. Vertebrate Zoology. S. Chand and Co.
12. Kotpal, R. L. (2002) Modern Text Book of Zoology: Invertebrates. Rastogi Publishers.
13. Kotpal, R. L. (2002) Modern Text Book of Zoology: Vertebrates. Rastogi Publishers.
14. Mayer E. (1980) Principles of Systematic Zoology. Tata McGraw Hill Publishing Co. New Delhi.
15. Vijayakumaran Nair K, J. Jayakumar and P.I. Paul (2007) Protista and Animal Diversity. Academica.
16. William S Hoar General and Comparative physiology, Prentice Hall

SEMESTER IV

SEMESTER IV
Complementary Course - 4
AUBB431 - Metabolism
Credits 2
Contact Hours: 90 (Theory 54 + Practical 36)

***Aim and Objectives*:** The course aims at providing an overview of energy production by explaining the general principles of cellular energy metabolism and schematizing the different metabolic pathways.

Module I **12 hrs**

Metabolism of carbohydrates: Digestion of carbohydrates and absorption (outline study). Glycolysis - Reactions, fate of pyruvate, regulation of glycolysis, Gluconeogenesis - reaction pathway, reciprocal regulation of gluconeogenesis and glycolysis. Cori cycle. Pentose Phosphate Pathway - reactions, biological significance, regulation of pathway. Glycogen metabolism - glycogenesis, glycogenolysis, control of glycogen metabolism - allosteric and hormonal regulation. (Only pathway outlines without structures).

Module II **12 hrs**

Metabolism of Lipids: Digestion and absorption of lipids (outline study), Composition and function of bile acids, enterohepatic circulation (outline study), Scheme of β-oxidation, ATP yield in β-oxidation (Stearate & Palmitate as examples) and regulation, Basics of ω- and α-oxidation. Ketone body formation.

Cytoplasmic system of fatty acid biosynthesis and regulation of the pathway. Essential fatty acids. Synthesis of Triacylglycerols (outline study). Outline study of biosynthesis of cholesterol and bile acids. Physiological functions of phospholipids (Structure of intermediates of metabolic pathway not required).

Module III **8 hrs**

Metabolism of Amino acids and Proteins: Zymogen activation of proteolytic enzymes of GI tract. Digestion of proteins and absorption of amino acids - role of glutathione cycle. Reactions involved in the metabolism of amino acids - deamination, transamination and decarboxylation coenzymes involved in these reactions. Urea cycle.

Module IV **10 hrs**

Bioenergetics: Redox reactions, redox potential and free energy, mitochondrial electron transport chain, coenzymes and prosthetic groups of respiratory chain enzymes - sites of ATP production, P/O ratio, inhibitors of electron transport chain, oxidative phosphorylation chemiosmotic hypothesis (outlines only), uncouplers of oxidative phosphorylation. Formation of ATP - oxidative and substrate level phosphorylation. High energy compounds with structures (ATP, ADP, Creatine phosphate, 1,3-bisphosphoglycerate, PEP etc.). Role of high energy phosphate groups.

Module V **12 hrs**

Genetic aspects of Metabolism: DNA structure - nucleosomes, 30 nm fibers and radial loops. Prokaryotic DNA replication - DNA polymerases, replication forks, Okazaki fragments and accessory proteins. Brief study of structure and types of RNA and their functions. Prokaryotic transcription process. Genetic code - properties of genetic code. Protein biosynthesis in prokaryotes - synthesis of aminoacyl tRNA, initiation - Shine Dalgarno sequence, elongation aminoacyl tRNA binding, peptide bond formation, translocation followed by termination.

Practical **36 hrs**

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.

Quantitative Analysis of Nucleic Acids

Estimation of DNA by diphenylamine method.
Estimation of RNA by Orcinol method

Demonstration Experiments

Enzyme Assays

- Urease/Trypsin
- Kinetics of Urease/Trypsin (Effect of pH, substrate Concentration, enzyme concentration and temperature)
- Progress curve of Urease/Trypsin
- Digestion of carbohydrates - action of salivary amylase

Suggested Readings

1. Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson Michael M. Cox (Author) , Publisher: W. H. Freeman; 2004
2. 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
3. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
4. Principles Of Biochemistry (1995) by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: McGraw-Hill Book Company – Koga
5. Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson
6. Biochemistry (2008) by Rastogi Publisher: McGraw Hill.
7. Plant Biochemistry by Hans-Walter Heldt Professor Em (3ed 2004) Publisher: Academic.
8. Text Book of Biochemistry, 5th edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi.

SEMESTER IV
Complementary Course - Practical
AUBB43PI - Practical Biochemistry I
(Practical of AUBB131, AUBB231, AUBB331 & AUBB431)
Credits 2
Contact Hours: 144 (Practical hours of AUBB131, AUBB231, AUBB331 & AUBB431)

Practical of AUBB131 **36 hrs**
Introduction to Biochemistry

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

General Reactions of Carbohydrates

Qualitative Analysis of Carbohydrates
Carbohydrates - Glucose, Fructose, Galactose, Xylose, Sucrose, Maltose, 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, 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.

Practical of AUBB231 **36 hrs**
General Biochemistry

Qualitative Analysis of Lipids
Fatty acids: Stearic acid/ Oleic acid.
Tests - Solubility, Translucent spot tests, Test for Unsaturation
Glycerol
Tests - Acrolein test, Borax fusion test, 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.

Practical of AUBB331 **36 hrs**
Physiological Aspects in Biochemistry

Qualitative Analysis of Amino Acids and Proteins
Amino acids (any 4 amino acids)
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
Tests - Solubility, Ninhydrin reaction, Xanthoproteic reaction, Folin's test, Lowry's test, Biuret test, Heat denaturation, TCA precipitation, Alcohol precipitation.

Practical of AUBB431 **36 hrs**
Metabolism

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.

Quantitative Analysis of Nucleic Acids
Estimation of DNA by diphenylamine method.
Estimation of RNA by Orcinol method

Demonstration Experiments
Enzyme Assays
- Urease/Trypsin
- Kinetics of Urease/Trypsin (Effect of pH, substrate Concentration, enzyme concentration and temperature)
- Progress curve of Urease/Trypsin
- Digestion of carbohydrates - action of salivary amylase

Suggested Readings

1. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi ISBN 81-88237-41-8.
2. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.
3. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (Ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5.
4. Hawks Physiological Chemistry, Bernard L.Oser (ed).TATA McGRAW Hill Publishing Company LTD, New Delhi.
5. ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974

SEMESTER IV

Core Course - 5

AUBB441 - Bryology, Pteridology, Gymnosperms and Paleobotany

Credits 3

Contact Hours: 72 (Theory 54 + Practical 18)

***Aim and Objectives*:** Students should be trained in basic botany such as lower plants like Bryophytes, Pteridophytes, Gymnosperms, etc. to get an in-depth knowledge about various plant groups.

Module I **12 hrs**

Bryology

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 **16 hrs**

Pteridology

1. Introduction: General characters, morphological and phylogenetic 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 **8 hrs**

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

Module IV **14 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 **4 hrs**

Paleobotany

1. Objectives of paleobotany. 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 **5 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 V.S., 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 **6 hrs**

1. *Psilotum:* External features stem T.S., synangium T.S.
2. *Lycopodium:* Habit, stem T.S., stobilus 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* - Branch of indefinite growth, spur shoot, T.S. of old stem and needle, R.L.S and T.L.S. of stem, male and female cone, V.S. of male and female cone, ovule V.S.
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 **2 hrs**

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

References

1. Vashishta B.R., Sinha A.K. and Adarsh Kumar (2014). Bryophyta, Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.
2. Vashishta P.C., Sinha A.K. and Anil Kumar (2015). Pteridophyta, Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.
3. Vashishta P.C., Sinha A.K. and Anil Kumar (2016). Gymnosperms, Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.
4. Pandey S.N., Misra S.P. and Trivedi P.S. (2016). A Textbook of Botany, Volume II, 13th Edition, Vikas Publishing House Pvt. Ltd., New Delhi.
5. Pandey B.P. (2011). Modern Practical Botany, Volume I, Revised Edition, S. Chand and Company Pvt. Ltd., New Delhi.
6. Pandey B.P. (2013). Modern Practical Botany, Volume II, Revised Edition, S. Chand and Company Pvt. Ltd., New Delhi.

Suggested Readings

1. Andrews H.N. (1967) - Studies on Palaeobotany – C .J. Felix.
2. Arnold C. A (1947) - Introduction to Palaeobotany - McGraw Hill Co. New Delhi.
3. Chopra RN and P. K. – Biology of Bryophytes - Wiley Eastern Ltd. 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. Parihar N .S. – An introduction to Bryophyta - Central Book Depot. Alahabad
7. Smith G.M. (1955) - Cryptogamic Botany – Vol.II – Mc Graw Hill Co. New Delhi
8. Sporne K. R. (1966) - Morphology of Pteridophytes - Hutchin University Library , London
9. Sporne K. R. (1967) - Morphology of Gymnosperms - Hutchin University Library , London
10. Vashista B. R. (1993) - Pteridophyta - S. Chand and co. New Delhi
11. Vashista B. R. (1993) Gymnosperms - S. Chand and co. New Delhi
12. Vasishta B. R. - Bryophyta - S. Chand and Co. New Delhi

SEMESTER IV
Core Course - 6
AUBB442 - Cell Biology, Plant Breeding and Evolutionary Biology
Credits 2
Contact Hours: 72 (Theory 54 + Practical 18)

***Aim and Objectives*:** This course will provide a basic understanding in cell biology, plant breeding and evolution, which is needed for a student of biology and can supplement in understanding and pursuing studies in Biotechnology.

Module I **30 hrs**

Cell biology

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; heterochromatin 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 **14 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 hybridization, inter generic, inter specific, inter varietal hybridization 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 **10 hrs**

Evolutionary Biology

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. Fixation of specimens for cytological studies
2. Preparation of cytological stains like acetocarmine and safranin
3. Make acetocarmine squash preparation of onion root tip and 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

References

1. De Robertis, E.D.P and Robertis, E.M.P (1991) Cell and molecular biology Scientific American books.
2. Gerald Karp (1985) Cell biology, Mc Graw Hill company.
3. BD Singh (2003) Plant Breeding. Kalyani Publishers
4. Dobzhansky, B (1961) Genetics and origin of species, Columbia university Press New York

Suggested Readings

1. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
2. Allard RW (1960) Principles of Plant Breeding. John willey and Sons. Inc. New York
3. Cohn, N.S. (1964) Elements of Cytology. Brace and World Inc, New Delhi
4. Darnel, J.Lodish, Hand Baltimore, D. (1991) Cell and molecular biology. Lea and Fibiger, Washington.
5. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
6. Lewin, B, (1994) Genes, Oxford University Press, New York.
7. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
8. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
9. Roy S.C. and Kalayan kumar De (1997) Cell biology. New central Boos Calcutta
10. Sandhya mitra,(1998)Elements of molecular biology. Macmillan, India Ltd.

11. Sharma JR (1994) Principles and Practices of Plant Breeding. Tata McGraw-Hill Pub. Co. New Delhi
12. Sharma, A.K and Sharma a (1980) Chromosome technique Theory and practice, Aditya Books, New York
13. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
14. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
15. Twymann, R.M. (1998) Advanced molecular biology Viva books New Delhi.
16. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd

SEMESTER IV

Core Course - Practical

AUBB44PII - Practical Botany II

(Practical of AUBB341, AUBB342, AUBB441 & AUBB442)

Credits 2

Contact Hours: 72 (Practical hours of AUBB341, AUBB342, AUBB441 & AUBB442)

Practical of AUBB341 **18 hrs**

Phycology, Mycology, Lichenology and Plant Pathology

Phycolcogy **8 hrs**

1. Make micropreparations 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 **5 hrs**

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

Lichenology **2 hrs**

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

Plant Pathology **3 hrs**

5. Identify the diseases mentioned with respect to causal organism and symptoms.
6. Students should be trained to prepare the fungicide Bordeaux mixture & Tobacco decoction.

Practical of AUBB342 **18 hrs**

Horticulture, Mushroom Cultivation and Marketing

Horticulture

Propagation methods- Layering, Budding and grafting

Flower arrangement
Field Study: Visit to a Botanical garden under the guidance of the teacher is encouraged.

Mushroom Cultivation and Marketing
Field Study: Visit to a mushroom cultivating Laboratory, Collection and Identification of Mushrooms

Practical of AUBB441 **18 hrs**
Bryology, Pteridology, Gymnosperms and Paleobotany

Bryology **5 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 V.S., 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 **6 hrs**
1. *Psilotum:* External features stem T.S., synangium T.S.
2. *Lycopodium:* Habit, stem T.S., stobilus 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* - Branch of indefinite growth, spur shoot, T.S. of old stem and needle, R.L.S and T.L.S. of stem, male and female cone, V.S. of male and female cone, ovule V.S.
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 **2 hrs**
1. Fossil pteridophytes - *Rhynia* Stem, *Lepidodendron, Lepidocarpon*.
2. Gymnosperm - *Lyginopteris*

Practical of AUBB442 **18 hrs**
Cell Biology, Plant Breeding and Evolutionary Biology

1. Fixation of specimens for cytological studies
2. Preparation of cytological stains like acetocarmine and safranin

3. Make acetocarmine squash preparation of onion root tip and 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

SEMESTER IV
Vocational Core Course - 5
AUBB451 - Molecular Biology
Credits 3
Contact Hours: 72 (Theory 54 + Practical 18)

***Aim and Objectives*:** 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.
RNA silencing

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 **18 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

Suggested Readings

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

SEMESTER IV
Vocational Core Course - 6
AUBB452 - Immunology
Credits 2
Contact Hours: 54 (Theory 36+ Practical 18)

***Aim and Objectives*:** To give a basic training to the students of Biotechnology on immune system, immunology and immunology related techniques. Training in this course will create an interest in immunology and is essential for further studies in Biotechnology.

Module I **3 hrs**
The Human Immune System
Organs and cells of immune system

Module II **6 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 **6 hrs**
Immunoglobulins
Antibody structure in relation to function and antigen binding: types of antibodies and their structures: isotypes, allotypes and idiotypes.

Module IV **7 hrs**
Measurement of Antigen
Antibody - antigen interaction, antigen - antibody reactions, agglutination, immuno-diffusion, immuno-electrophoresis, ELISA, RIA, production of polyclonal and monoclonal antibodies, hybridoma technology.

Module V **6 hrs**
Immunoglobulin Gene
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 **4 hrs**
Autoimmunity and Autoimmune Diseases - Hashimoto's thyroiditis; Myasthenia gravis; Rheumatoid Arthritis, Pernicious anaemia.

Practical **18 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. Basics of Biotechnology- A J Nair; Laxmi Publications, New Delhi
3. Immunology – Joshi, Osama; AgroBotanica, New Delhi
4. Immunology – R A Goldsby, T J Kindt, B A Osborne, Janis Kuby; W H Freeman & Company, New York
5. Instant Notes in Immunology – P M Abbas, A H Lichtman, M W Fanger; Viva Books Pvt.Ltd, New Delhi.
6. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston,USA.
7. Principle Cellular and Molecular Immunology- Jonathan M Austyn 7 Kathryn J Wood; Oxford, New York

SEMESTER IV

Vocational Core Course - Practical

AUBB45PII - Biotechniques II

(Practical of AUBB351, AUBB352, AUBB451 & AUBB452)

Credits 2

Contact Hours: 72 (Practical hours of AUBB351, AUBB352, AUBB451 & AUBB452)

Practical of AUBB351 **18 hrs**

Protista and Animal Diversity

Identification and assigning the systematic position of the following specimens:

1. Protozoa - any 4.
2. Porifera - any
   Study of gemmules.
3. Coelenterata - any 5.
4. Aschelminthes - any 2.
   Ascaris T.S. of male and female.
5. Platyhelminthes - any 4 (adaptations of parasitic forms to be stressed)
6. Annelida - any 4.

7. Minor phyla - any 2.
8. Arthropoda - any 10 (including at least 5 insect pests of paddy/banana plant/stored food grains and 2 beneficial insects).
9. Mollusca - any 8 (including any 2 beneficial and any 2 harmful species).
10. Echinodermata - any 5 (representing one each from five different classes).
11. Prochordates - Ascidia, Branchiostoma (Amphioxus).
12. Pisces - any 8 (including 2 cartilaginous fishes, 2 fishes with accessory respiratory organs, 4 common food fishes).
13. Amphibia - any 3 (representing the orders Apoda, Urodela and Anura).
14. Reptilia - any 5 (includung at least one poisonous and one non-poisonous snake of Kerala).
15. Aves - any 3 common birds of Kerala (based on museum specimens or field observations).
16. Mammalia - any 5 (based on museum specimens or field observations).

Note:

Practical examinations shall give emphasis on systematics of animals. Questions on taxonomy may be designed so as to assess the student's knowledge in identification of organisms and assigning the systematic position down to the prescribed taxa. Students may be asked to arrange a miscellaneous group of animals into different taxonomic groups in chart form mentioning the salient features of the groups.

Practical of AUBB352 **18 hrs**
Animal Physiology and Anatomy

Minor Practical

1. Nereis - parapodium.
2. Earthworm - body setae.
3. Earthworm - coelomocytes.
4. Cockroach - mouth parts.
5. Cockroach - salivary glands.
6. Prawn - appendages.
7. Fishes - different types of scales (placoid, ctenoid and cycloid scales).

Major Practical

1. Earthworm - nervous system.
2. Cockroach- alimentary canal.
3. Cockroach - nervous system.
4. Prawn - nervous system.

Practical of AUBB451 **18 hrs**
Molecular Biology

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

Practical of AUBB452 **18 hrs**
Immunology

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

SEMESTER V
Core Course - 7
AUBB541 - Angiosperm Morphology and Systematic Botany
Credits 4
Contact Hours: 108 (Theory 72 + Practical 36)

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

Module I **12 hrs**

Morphology

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

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 labelled 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.), Field book and Tour report at the time of practical examination.
5. Field trips are to be conducted for three days either as continuous or one day trips.

References

1. Davis, P.11. and Haywood, V.H, 1963. Principles of Angiosperm Taxonomy. Oliver and Royd, London.
2. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-Hill Book Co., New York.
3. Pandey SN and Misra SP, 2008 Taxonomy of Angiospenus; Ane Books Pvt. Ltd.
4. Singh. G. 1999. Plant Systematics: Theory and practice Oxford & IBH Pvt, Ltd. New Delhi.

Suggested Readings

1. Heywood, V.H. and Moore D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
2. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge London.
3. Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York, Ane Books Pvt. Ltd
4. Lawrence. G.H.M. 1951. Taxonomy of Vascular Plants. Macmillan, New York.
5. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New York.
6. Nordenstam. B.., El-Gazaly, G. and Kassas. M. 2000. Plant Systematics for 21st Century
7. Radford. A.E.1986. Fundamentals of Plant Systematics Harper and Row, New York.
8. Sivarajan,V.V. Introduction to the principle of plant taxonomy, Oxford and IBH Publishing Company
9. Stace. C.A. 1989. Plant Taxonomy and Biosystematics. 2nd ed. Edward Arnold,London.
10. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.
11. Woodland. D.E. 1991. Contemporary Plant Systematics. Prentice Hall, NewJersay.

SEMESTER V
Core Course - 8
AUBB542 - Economic Botany, Ethnobotany and Medicinal Botany
Credits 2
Contact Hours: 108 (Theory 72 + Practical 36)

***Aim and Objectives*:** This gives awareness about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and also about the traditional medicines and herbs, and its relevance in modern times.

Module I **30 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.

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 **20 hrs**

Ethnobotany

1. Definition - Importance, scope, categories and significance.
2. Study of various methods to collect Ethnobotanical 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, NMPB, BSI, NBRI in conservation and cultivation of medicinal plants.
2. A general account of the medicinal value of the following plants:
   Rhizome - *Curcuma longa* and *Zingiber officinale*; Bulb - *Allium cepa* and *Allium sativum*; Root - *Acorus calamus, Asparagus racemosus, Catharanthus roseus, Hemidesmus indicus, Rauvolfia serpentina* and *Withania somnifera*; Leaves - *Aloe vera, Andrographis paniculata* and *Centella asiatica*; Bark - *Saraca asoca*; Whole plant - *Adhatoda vasica*, *Bacopa monnieri* and *Phyllanthus amarus*.
3. Production of herbal drugs. Extraction procedure - Adulteration of drugs.

Module IV **7 hrs**

1. Definition and scope of Pharmacognosy - Ancient and modern medicines -Siddha, Ayurveda, Unani, Acupuncture, Homoeopathy and Allopathy.
2. Sources of crude drugs - roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds.

Practical **36 hrs**

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

References

1. Verma V, 2009 Text Book of Economic Botany; Ane Books Pvt. Ltd.
2. K. Jain. Glimpses of Ethnobotany. Oxford and IBH Publishing Company, New Delhi.
3. S.K. Jain, 1987. A Manual of Ethno botany. Scientific Publishers, Jodhpur

Suggested Readings

1. Kapoor LD, 2001 Hand Book of Ayurvedic Medicinal Plants, CRC Press New York,
2. Davis, P.11. and Haywood, V.H, 1963. Principles of Angiosperm Taxonomy,Oliver and Royd, London.
3. T.E Walles. Text book of Pharmacognosy,
4. Rajiv K Sinha. Ethnobotany.

SEMESTER V
Vocational Core Course - 7
AUBB551 - Recombinant DNA Technology
Credits 4
Contact Hours: 72 (Theory 54 + Practical 18)

***Aim and Objectives*:** To give a basic training to the students of Biotechnology on recombinant DNA and related techniques. Training in this course will create an interest in genetic engineering and is essential for further studies in Biotechnology.

Module I **8 hrs**

Introduction to Gene Cloning and Its Applications

Introduction and overview of steps in recombinant DNA - technology Enzymes involved: Restriction endonucleases, DNA ligases, Alkaline phosphatase, Polynucleotide kinase, Terminal transferase, Taq polymerase, Reverse transcriptase. Adapters and linkers.

Module II **15 hrs**

Vectors Definition and properties - Plasmid vectors - pBR322, pUC series; Bacteriophage lambda and M13 based vectors, Phagmids and Cosmid vectors, Shuttle vectors, Yeast Artificial vectors (YACs), Bacterial artificial vectors (BACs).

Module III **15 hrs**

Cloning of Genes

Host cells, Competent cell preparation, Construction of recombinant DNA, screening and selection of transformed cells. DNA libraries preparation and uses of Genomic DNA and cDNA libraries. Gene transfer methods Direct and vector mediated gene transfer.

Module IV **10 hrs**

Techniques in rDNA Technology

Polymerase chain reaction and its types. Molecular marker techniques: RFLP, AFLP, RAPD; DNA Barcoding, Nucleic acid sequencing (Maxam and Gilbert method, Sanger's method). Gene expression analysis Southern hybridization, Immunoblotting, RT-PCR, Northern hybridization and microarrays.

Module V **6 hrs**

Transgenic organisms and its impact in agriculture, Medicine and Environment. Biosafety and ethics in genetic engineering. Human genome project a brief account.

Practical **18 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
8. Competent cell preparation
9. PAGE demonstration
10. Quantification of DNA using diphenyl amine method

Suggested Readings

1. Animal cell culture - John R W Master; Oxford University Press
2. Culture 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 Singh Kalyani Publishers, New Delhi.
8. Microbiology (7th Ed) - Prescott L. M., Harley, J. P., and Klein D. A. Mc Graw Hill, New York

SEMESTER V
Vocational Core Course - 8
AUBB552 - Plant Biotechnology
Credits 3
Contact Hours: 54 (Theory 36 + Practical 18)

***Aim and Objectives*:** This course is designed to impart basic knowledge in the applied aspects of plant biotechnology for the improvement of agriculture and plant based industries. It will give an outline of plant tissue culture cell culture and plant genetic transformation methods, which will help the students to pursue further studies in these aspects.

Module I **6 hrs**

Introduction to Plant Tissue Culture

Brief history of plant tissue culture. Fundamental principles of *in vitro* plant cultures: Basic techniques of plant tissue culture - Plant Tissue Culture Laboratory Organization, Tools and Instruments for Plant Tissue Culture, Sterilization Techniques, Surface sterilization of explants, Components of plant tissue culture media - preparation and its functions, use of plant growth regulators

Module II **8 hrs**

Callus cultures, Micropropagation Methods, Cell Suspension Cultures, Organ culture-root cultures, Meristem Culture, Production of gynogenic (Ovule Culture) and androgenic (Pollen Culture) haploids.

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

Somaclonal variation - isolation of Somaclonal variants and applications of Somaclonal variations

Module III **6 hrs**

Application of *in vitro* Culture

Somatic Embryogenesis and Artificial Seed Production. Plant secondary metabolites production, hairy root cultures, Advantages and disadvantages of *in vitro* methods

Module IV **8 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.

Module V **8 hrs**

Transgenic Plants

Insect Resistant Plant - BT Cotton, Herbicide Resistant Plant - Glyphosate Resistant, Salt Tolerant, Stress Tolerant Crops, FLAVR SAVR Tomato and Golden Rice. Biopharming - production of therapeutic proteins in transgenic plants, edible vaccines.

Practical **18 hrs**

1. Familiarization of instruments and special equipments used in the plant tissue culture experiments
2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS 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. Production of artificial seeds (encapsulation method)

Suggested Readings

1. An Introduction to Plant Tissue Culture M K Razdan; Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
2. Basics of Biotechnology- A. J. Nair; Laxmi Publications, New Delhi.
3. Biotechnology-Fundamentals and Application- S S Purohit and S K Mathur;

Agrobotanica, India.
4. Introduction to Genetic Engineering & Biotechnology- A. J. Nair; Jones & Bartlett Publishers, Boston, USA.
5. Introduction to Plant Biotechnology- H S Chawla; Oxford & IBH publishing Co.Pvt.Ltd., New Delhi.
6. Modern concept of Biotechnology H. D. Kumar; Vikas Publishing House, Pvt. Ltd., New Delhi.
7. Plant biotechnology, Recent Advances P. C. Trivedi; Panima Publishing Corporation, New Delhi.
8. Plant cell, Tissue and Organ Culture - Fundamental Methods, O. L. Gamborg, G. C. Philips; Narosa Publishing House, New Delhi.
9. Role of Biotechnology in Medicinal and aromatic plants - Irfan A Khan and Atiya Khanum; Ukaaz Publications, Hyderabad.

SEMESTER V

Vocational Core Course - 9

AUBB553 - Animal Biotechnology

Credits 3

Contact Hours: 54 (Theory 36 + Practical 18)

***Aim and Objectives*:** To introduce the subject of animal biotechnology and its applications to the students in an attractive and simple manner.

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 **8 hrs**

Application of Animal Cell Cultures

Characterization of cell lines,
Products of animal cell cultures - hormones (insulin, growth hormones), interferon, t-plasminogen activator, factor VIII, factor IX and virus cultivation;
Production of polyclonal and monoclonal antibodies - hybridoma technology

Module III **8 hrs**

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 IV **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 **18 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
5. Evans blue assay of pollen grains or blood cells
6. Demonstration of ELISA technique
7. Protein purification by ion exchange chromatography from serum

Suggested Readings

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

SEMESTER V
Open Course (Vocational) - 1
AUBB581.a - Bioinformatics
Credits 2
Contact Hours: 54

***Aim and Objectives*:** This course is for non-biology or non-biotechnology students, who are interested to know about the methods and application of computers and bioinformatics and its contribution in the various fields of biotechnology.

Module I **18 hrs**

Computers - Types of computers - Characteristic of hardware and software. Bio-chips, computer network sending and receiving e-mail, Internet- browsing – searching biological articles information in internet.

Introduction to bioinformatics - Definition History and evolution of bioinformatics, Impact of bioinformatics in modern biology.

Module II **18 hrs**

Impact of bioinformatics in modern biology, uses of databases in biology - Analysis of proteins and nucleic acid sequences - molecular modelling.

Databases - various types of databases, Biological Databases - Importance of databases in biotechnology, NCBI, Gene bank, PubMed etc.

Module III **9 hrs**

Tools (software) in bioinformatics - Tools for sequence alignments - BLAST and Fasta.

Module IV **9 hrs**

Genomics and proteomics - Definitions, Application of Proteomics and genomics in Biotechnology.

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. Biotechnology V. Kumaresan, Saras publication
5. A text book of biotechnology, R. C. Dubey, S. Chand Publications, New Delhi

SEMESTER V
Open Course (Vocational) - 2
AUBB581.b - Food and Dairy Biotechnology
Credits 2
Contact Hours: 54

***Aim and Objectives*:** This course is for non-biology or non-biotechnology students. Students from other disciplines are also can undergo this course to get basic knowledge in the application of Biotechnology in food processing, food spoilage, food preservation and dairy industry.

Module I **15 hrs**

Concept and scope of food biotechnology - food composition and types of food, fermented foods from wheat and rice flour, meat , fish and egg, vegetables (kimchi, sauerkraut), overview of alcoholic beverages from various fruits and grains - distilled (vodka, rum, whisky, brandy) and undistilled beverages (wine, cider, sake, beer). Microbes of fermented foods - lactic acid bacteria, yeast.

Module II **15 hrs**

Food spoilage

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 **14 hrs**

Food Preservation - methods of food preservation, Physical & Chemical Methods, Osmotic pressure - preserving foods in sugar and salt, chemical preservatives, Radiation as a preservation method.

Module IV **10 hrs**

Microbes in Dairy industry - contamination, spoilage, microbes of milk and dairy products, fermented dairy products, industrial production of cheese, probiotics and nutrition; Milk borne diseases; Milk quality testing - resazurin, methylene blue reduction test.

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.

SEMESTER V
Open Course (Vocational) - 3
AUBB581.c - Genetic Engineering
Credits 2
Contact Hours: 54

***Aim and Objectives*:** This course id for non-biology or non-biotechnology students, who are interested to know about the methods and application of genetic engineering and its contribution in the various fields of biotechnology.

Module I **16 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 **16 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.

Module III **12 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.

Module IV **10 hrs**

PCR - Principle and applications

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

Suggested Readings

1. Animal cell culture- John R W Master; Oxford University Press
2. Culture 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 Singh, Kalyani Publishers, New Delhi

SEMESTER VI

SEMESTER VI
Core Course - 9
AUBB641 - Plant Physiology
Credits 4
Contact Hours: 126 (Theory 72 + Practical 54)

***Aim and Objectives*:** To give basic information on plant physiology and the related biochemical and biophysical aspects to the students of Biotechnology. This course will equip the students to understand the functions of the plant system on biophysical and biochemical approach.

Module I **2 hrs**

Introduction to plant physiology - Physiological processes, their significance other applications

Module II **10 hrs**

Water Relations of Plants

Water Absorption

1. Importance of water to plants- the physical and chemical properties of water
2. Organs of absorption - root and root hairs
3. Membranes - permeable, differentially permeable and impermeable
4. Physical aspects of absorption, imbibition, diffusion and osmosis
5. Plant cell as an osmotic system, osmotic pressure, turgor pressure, wall pressure and diffusion pressure deficit, water potential, osmotic potential, pressure potential, matrix potential, Plasmolysis and its significance
6. Mechanism of absorption of water - active and passive absorption - root pressure

Ascent of Sap

Vital theories

Physical theories - Cohesion - tension theory

Loss of Water from Plants

1. Transpiration- cuticular, lenticular and stomatal mechanism
2. Factors affecting transpiration
3. Significance of transpiration
4. Guttation
5. Water stress and its physiological significance

Module III **6 hrs**

Mineral Nutrition

Gross chemical analysis of plant - Essential and non-essential elements, Criteria of essentiality of elements, Essential elements: major end minor. Role of essential elements, their deficiency diseases.

Culture methods: Solution culture, Sand culture, Hydroponics, Aeroponics, Foliar nutrition, Soil as source of nutrients.

Mechanism of mineral absorption:

(a) Passive absorption - ion exchange - Donnan equilibrium

(b) Active absorption - Carrier concept

Module IV **6 hrs**

Enzymes

1. Structure - coenzymes, cofactor
2. Properties
3. Nomenclature
4. Classification - IUB system
5. Enzyme action
6. Competitive inhibition and non competitive inhibition

Module V **14 hrs**

Photosynthesis

1. Significance and general equation
2. Photosynthetic apparatus and pigment systems - chromatographic techniques for the separation of photosynthetic pigments
3. Raw materials of photosynthesis
4. Mechanism
   a) Light reaction
      i) Radiant energy and its effects on chlorophyll pigments
      ii) Cyclic and non-cyclic photophosphorylation
      iii) Source of oxygen liberated
      iv) Hill reaction
   b) Dark reaction
      i) Trace the path of carbon in photosynthesis
      ii) Calvin cycle
5. C_3 and C_4 plants, CAM plants
6. Photorespiration
7. Factors affecting photosynthesis, Law of limiting factors

Module VI **12 hrs**

Respiration

1. Definition and general equation
2. Significance
3. Respiratory substrates
4. Mechanism - Glycolysis, Kerb's cycle, terminal oxidation
5. Oxidative pentose phosphate pathway
6. Factors affecting respiration
7. Anaerobic respiration - Alcoholic fermentation and lactic acid fermentation
8. Energy relations - aerobic and anaerobic respiration
9. Respiratory quotient and its significance
10. Oxidation of fats

Module VII **8 hrs**

Nitrogen metabolism

1. Source of nitrogen
2. Nitrification, Denitrification and Ammonification
3. Symbiotic nitrogen fixation
4. Rotation of crops
5. Nitrogen Cycle

Module VIII **4 hrs**

Translocation of Solutes

1. Pathway of organic solutes
2. Mechanism of pholem transport
3. Mass flow hypothesis
4. Protoplasm streaming theory

Module IX **6 hrs**

Growth and Development

1. Definition
2. Dormancy and germination of seeds
3. Phases of growth - measurement and factors affecting growth
4. Differentiation, morphogenesis and senescence
5. Growth Hormones - Auxins, Gibberellins, Kinins, Abscissic acid, Ethylene and their practical applications
6. Photoperiodism
7. Vernalization

Module X **4 hrs**

Plant Movements and Stress Physiology

Tropic and nastic movements, Circadian rythm

General account on Stress physiology (brief study)

Practical **54 hrs**

1. Water potential of onion peel, *Rhoeo* peel by plasmolytic method.
2. Separation of plant pigments by paper chromatography.

Demonstration Experiments

1. Thistle funnel experiment
2. Tissue tension
3. Root Pressure
4. Suction force due to transpiration
5. Foliar transpiration by using bell jar
6. Transpiring surface - 4 leaf experiment
7. Potometer - Farmer's and Ganong's
8. Water balance - Relation between transpiration and absorption

9. Evolution of oxygen during photosynthesis
10. Necessity of chlorophyll, CO_2 and light in photosynthesis
11. Measurement of photosynthesis
12. Simple respiroscope
13. R.Q. by Respirometer
14. Anaerobic respiration
15. Fermentation
16. Geotropism and phototropism - Klinostat
17. Hydrotropism
18. Measurement of growth - Arc and Lever Auxanometer

References

1. Salisbury.F.B and Ross.C.W (2006): Plant Physiology 4e, Wadsworth publishing company
2. William G. Hopkins – Introduction to Plant Physiology John Wiley & Sons, New York.
3. Jain .V.K (1996) Fundamentals of Plant Physiology
4. Devlin & Witham – Plant Physiology, C B S publishers.

Suggested Readings

1. Devlin R.M (1979) Plant Physiology
2. Dieter Hess;(1975):Plant physiology
3. Kochhar P. L . & Krishnamoorthy H. N . – Plant Physiology. Atmaram & Sons Delhi, Lucknow.
4. Kumar & Purohit – Plant Physiology - Fundamentals and Applications, Agrobotanical publishers
5. Malic C. P. & Srivastava A. K .– Text book of Plant Physiology Kalyani Publishers New Delhi.
6. Noggle G R & Fritz G J (1991) Introductory Plant physiology, Prentice Hall of India.
7. Pandey S.N. & Sinha B. K. (1986) – Plant physiology, Vikas publishing House- New Delhi.
8. Sundara Rajan S . – College Botany Vol.IV, Himalaya publishing House.

SEMESTER VI
Core Course - 10
AUBB642 - Genetics
Credits 3
Contact Hours: 108 (Theory 72 + Practical 36)

***Aim and Objectives*:** This course is supposed to supplement the basic knowledge in genetics in general and Mendelian genetic in particular. This is essential to study the various branches of biology like molecular biology and gene technology.

Module I **26 hrs**

Classical Genetics

1. Mendelian Genetics - Mendel and his experiments, Mendel's success, Mendelian principles, Mendelian ratios, monohybrid and dihybrid crosses, back cross and test cross
2. Genetics after Mendel - Modified Mendelian ratios; Incomplete dominance - Flower colour in *Mirabilis*; Interaction of genes - Comb pattern in poultry. 9:3:3:1; Epistasis - Recessive. Coat colour in mice. 9:3:4; Dominant epistasis. Fruit colour in summer squash. 12:3:1; Complementary genes. Flower colour 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 colour 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 colour in man, ear size in Maize.

Module II **24 hrs**

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. Eye colour 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 **18 hrs**

Molecular Genetics

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 **4 hrs**

Population Genetics

1. Hardy Weinberg law, Factors affecting equilibrium - Mutation, migration and selection.

Practical **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: 1
   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

References

1. John Ringo (2004) Fundamental Genetics. Cambridge University Press India Pvt. Ltd.
2. Lewin, B, (1994) Genes, Oxford University Press, New York.
3. Gardner,E.J and Snustad,D.P(1984) Principles of Genetics. John Wiley, New York.
4. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd

Suggested Readings

1. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
2. Dobzhansky, B (1961) Genetics and origin of species, Columbia university Press New York
3. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd

4. Gupta P. K. – Genetics (Rastogi publications).
5. Gupta, P. K. Genetics, Rastogi Publications.
6. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
7. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
8. Sharma, A.K and Sharma a (1980) Chromosome technique Theory and practice, Aditya Books, New York
9. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
10. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd

SEMESTER VI

Core Course - Practical

AUBB64PIII - Practical Botany III

(Practical of AUBB541, AUBB542, AUBB641 & AUBB642)

Credits 2

Contact Hours: 162 (Practical hours of AUBB541, AUBB542, AUBB641 & AUBB642)

Practical of AUBB541 **36 hrs**

Angiosperm Morphology and Systematic Botany

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 labelled 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.), Field book and Tour report at the time of practical examination.
5. Field trips are to be conducted for three days either as continuous or one day trips.

Practical of AUBB542 **36 hrs**

Economic Botany, Ethnobotany and Medicinal Botany

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

Practical of AUBB641 **54 hrs**
Plant Physiology

1. Water potential of onion peel, *Rhoeo* peel by plasmolytic method.
2. Separation of plant pigments by paper chromatography.

Demonstration Experiments

1. Thistle funnel experiment
2. Tissue tension
3. Root Pressure
4. Suction force due to transpiration
5. Foliar transpiration by using bell jar
6. Transpiring surface - 4 leaf experiment
7. Potometer - Farmer's and Ganong's
8. Water balance - Relation between transpiration and absorption
9. Evolution of oxygen during photosynthesis
10. Necessity of chlorophyll, CO_2 and light in photosynthesis
11. Measurement of photosynthesis
12. Simple respiroscope
13. R.Q. by Respirometer
14. Anaerobic respiration
15. Fermentation
16. Geotropism and phototropism - Klinostat
17. Hydrotropism
18. Measurement of growth - Arc and Lever Auxanometer

Practical of AUBB642 **36 hrs**
Genetics

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: 1
    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

SEMESTER VI
Vocational Core Course - 10
AUBB651 - Food and Industrial Biotechnology
Credits 3
Contact Hours: 90 (Theory 54 + Practical 36)

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

Module I **8 hrs**

Industrial Microbiology

Microbes in industry - Industrially important microorganisms, screening and isolation, industrially important enzymes and chemicals, Industrial production of enzymes and chemicals, Microbial production of antibiotics (Penicillin), vitamins (B_{12}), amino acids (glutamic acid and lysine) and other organic acids (Citric acid and acetic acid).

Module II **16 hrs**

Fermentation

The biological process of fermentation - various types of fermentation, alcohol fermentation, Respiration vs Fermentation - Important products of fermentation**.** Fermentation as an industry, selection of industrial microorganisms for specific products and reactions,

Laboratory scale biological process - scale up of biological reactions in to bioprocess;

Bioreactors - types of bioreactors / Fermentors, Bioreactors for bacteria and yeast cells, Fermentors for plant cell cultures and animal cell cultures.

Module III **12 hrs**

Upstream Processing

Media for fermentation, media sterilization and media aeration, pH, temperature, batch fermentation, continuous fermentation, chemostatic cultures, fermentation by immobilized cells and enzymes.

Downstream Processing

Downstream processing and product recovery, Different physical and chemical methods for the separation of fermentation products.

Module IV **8 hrs**

Agricultural waste and food industry wastes as the substrate for fermentation, solid state fermentation; production of single cell proteins, microbial production of enzymes;

Module V **10 hrs**

Food Biotechnology **6 hrs**

Microorganism in food spoilage, types of spoilage, canning, microbes in the spoilage of

canned foods, principles of preservation of foods, Hazardous effect of food spoilage, mycotoxins.

Microbial processing Foods - Confectionery, Fermented foods,

Dairy Industry **4 hrs**

Microbes in dairy industry, dairy products; microbial processing of foods - enzymes in food processing

Practical **36 hrs**

1. Preparation of media and sterilization for alcohol fermentation by yeast.
2. Preparation of Ethyl alcohol from glucose by Yeast fermentation - separation of ethanol by distillation (demonstration)
3. Growth Curve of bacteria or yeast cultures in nutrient broth
4. Isolation of microorganisms from spoiled food and identification
5. Isolation of organisms from curd/ milk and fermentation of lactose
6. Demonstration of setting laboratory fermentor - basic features, purpose, procedure and application- Demonstration of running a laboratory fermentor.
7. Enzyme assay - amylase / protease / lipase
8. Demonstration of cell / enzyme immobilization in calcium alginate beads.

Suggested Readings

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.

SEMESTER VI
Vocational Core Course - 11
AUBB652 - Environmental Biotechnology
Credits 2
Contact Hours: 72 (Theory 36 + Practical 36)

***Aim and Objectives*:** 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 and bioprocess technology in the application of biotechnology in protecting the environment from pollution.

Module I **4 hrs**

Introduction

Ecosystem, Biodiversity, Types of ecosystem and biosphere.

Module II **4 hrs**

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

Module III **5 hrs**

Water Pollution

Organic load in aquatic systems, BOD, COD, Suspended solids, Total dissolved solids. Bacteriological analysis of drinking water, presumptive, completed and confirmed test.

Module IV **5 hrs**

Treatment of waste water, primary, secondary, tertiary treatment. Biological treatment of waste water - aerobic and anaerobic methods - suspended growth treatment process, attached growth treatment process.

Module V **5 hrs**

Biological control of pests and insects, Biopesticides - *Bacillus thuringiensis*, bioherbicides, Biofertilizers

Module VI **3 hrs**

Bioremediation - Microbial degradation of pesticides, herbicides and other toxic chemicals in the environment.

Module VII **3 hrs**

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

Module VIII **5 hrs**

Non-Conventional Energy Sources

Biomass - Utilization of biomass as energy source - application of microbes in production of fuels from biomass - biogas, biomethanol, bioethanol, microbial hydrogen production.
Solar energy converter, hopes from photosynthetic pigments, vegetable oils as engine fuels

Module IX **2 hrs**

Bioleaching

Enrichment of ores by microorganisms (bioaccumulation and biomineralisation)

Practical **36 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 VI
Vocational Core Course - Practical
AUBB65PIII - Biotechniques III
(Practical of AUBB551, AUBB552, AUBB553, AUBB651 & AUBB652)
Credits 2
Contact Hours: 126 (Practical hours of AUBB551, AUBB552, AUBB553, AUBB651 & AUBB652)

Practical of AUBB551 **18 hrs**
Recombinant DNA 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
8. Competent cell preparation
9. PAGE demonstration
10. Quantification of DNA using diphenyl amine method

Practical of AUBB552 **18 hrs**
Plant Biotechnology

1. Familiarization of instruments and special equipments used in the plant tissue culture experiments
2. Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS 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. Production of artificial seeds (encapsulation method)

Practical of AUBB553 **18 hrs**
Animal Biotechnology

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
5. Evans blue assay of pollen grains or blood cells

6. Demonstration of ELISA technique
7. Protein purification by ion exchange chromatography from serum

Practical of AUBB651 **36 hrs**
Food and Industrial Biotechnology

1. Preparation of media and sterilization for alcohol fermentation by yeast.
2. Preparation of Ethyl alcohol from glucose by Yeast fermentation - separation of ethanol by distillation (demonstration)
3. Growth Curve of bacteria or yeast cultures in nutrient broth
4. Isolation of microorganisms from spoiled food and identification
5. Isolation of organisms from curd/ milk and fermentation of lactose
6. Demonstration of setting laboratory fermentor - basic features, purpose, procedure and application - Demonstration of running a laboratory fermentor.
7. Enzyme assay - amylase / protease / lipase
8. Demonstration of cell / enzyme immobilization in calcium alginate beads.

Practical of AUBB652 **36 hrs**
Environmental Biotechnology

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.

SEMESTER VI
Elective Course (Vocational) - 1
AUBB691.a - Bioinformatics and Nanobiotechnology

Credits 2
Contact Hours: 36

***Aim and Objectives*:** 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
7. Bioinformatic s- Data bases, tools and algorithms- Bosu O. U and Thukral S. K. Oxford University Press, New Delhi
8. Bioinformatics basics: applications in biological science and medicine - H.H. Rashidi and L.K. Buehler CRC Press, London.
9. Bioinformatics - sequence, structure and databases- Des Higgins and Willie Taylor. Oxford University Press

SEMESTER VI
Elective Course (Vocational) - 2
AUBB691.b - Biostatistics
Credits 2
Contact Hours: 36

***Aim and Objectives*:** This course is for biotechnology students, who are interested to know about the methods and application of statistics and its contribution in the various fields of biotechnology.

Module I **12 hrs**

Introduction **2 hrs**

Biostatistics - definition - statistical methods - basic principles.

Data Handling in Science and Biostatistics **10 hrs**

Documentation of experiments - Nature and types of Data - significance of statistical methods in biological investigations,

Sampling techniques, methods of sampling, collection of data; primary and secondary data, classification and tabulation, graphical and diagrammatic representation.

Module II **10 hrs**

Measures of central tendency - Mean, Mode, Median; Geometric mean - merits & demerits.

Measures of dispersion - Range, Quartile deviation, Mean deviation, Standard deviation, Standard error, Variance.

Distribution patterns - Normal distribution, Binomial distribution - basic concepts.

Module III **14 hrs**

Correlation and Regression - basic concepts

Basic idea of significance test, hypothesis testing - Chi-square test, Student t-test - basic concepts, level of significance, confidence level.

Suggested Readings

1. An Introduction to Biostatistics: A Manual for studies in Health Sciences., P. Sundar Rao, and J. Richard, Prentice Hall.
2. Statistics in Biology, Vol. I Mc Graw hill. New York.Bliss C J K(1967)
3. Statistics for Biologists, Cambridge Univ, Press, Cambridge. Campbell R C (1974)
4. Daniel. Biostatistics (3rd edition) Panima Publishing, Compotation. Daniel (1999)

SEMESTER VI
Elective Course (Vocational) - 3
AUBB691.c - Food and Dairy Biotechnology
Credits 2
Contact Hours: 36

***Aim and Objectives*:** This course is for Biotechnology students. Students can undergo this course to get basic knowledge in the application of Biotechnology in food processing, food spoilage, food preservation and dairy industry.

Module I **8 hrs**

Concept and scope of food biotechnology - food composition and types of food, fermented foods from wheat and rice flour, meat, fish and egg, vegetables (kimchi, sauerkraut), overview of alcoholic beverages from various fruits and grains - distilled (vodka, rum, whisky, brandy) and undistilled beverages (wine, cider, sake, beer). Microbes of fermented foods - lactic acid bacteria, yeast.

Module II **10 hrs**

Food spoilage

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 **8 hrs**

Food Preservation - methods of food preservation, Physical & Chemical Methods, Osmotic pressure - preserving foods in sugar and salt, chemical preservatives, Radiation as a preservation method.

Module IV **10 hrs**

Microbes in Dairy industry - contamination, spoilage, microbes of milk and dairy products, fermented dairy products, industrial production of cheese, probiotics and nutrition; Milk borne diseases. Milk quality testing - resazurin, methylene blue reduction test.

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.

SEMESTER VI
Project Work
AUBB653 - Project on Biotechnology
Credits 4
Tutorial Hours: 18

An independent project or dissertation work has to be carried out by each student during the V or VI semester under a faculty member of the institute within the college or outside the college, and report of the Project/Dissertation 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.