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

BIOTECHNOLOGY SYLLABUS

(2022 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 4^{th} 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 4^{th} 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 6^{th} 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
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.

Course outcome : Student will be able to

- Design and plan an experiment
- Execute statistical methods in biological investigations
- Understand and implement IT in learning
- Differentiate the classical and modern aspects of Biotechnology
- Describe the scope and applications of Biotechnology
- List out the Biotechnology institutes and companies in India
- Use safety protocols in biotechnology experiments

Module I
Science, Design and planning of experiment **8 hrs**

Basic concepts of What is Science, Need for scientific research, Importance of reviewing the literature, Hypothesis formulation (Null and alternate hypothesis - definition only), Basis of designing research (sample design and research design), types of data and methods of data collection, Interpretation and report writing.

Module II
Data handling in science and Biostatistics **10 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. Hypothesis testing (Chi square test).

Module III:
Overview of Information of Technology **15 hrs**

Introduction to Computers, Types, Features of modern personal computers and peripherals, Characteristic of hardware and software, overview of operating systems and major application software,. Introduction to use of IT in teaching and learning- educational software- INFLIBNET, NICNET, BRNET; online learning platforms MOOCS, Swayam**,** Internet as a knowledge repository- Google scholar, Science direct.

Application of IT in Medicine, Healthcare, Industry, Crime detection, Publishing, Communication, Resource management and Education. Cyber ethics, Cyber security, cyber-crime,

security privacy issues

Module IV: **15 hrs**

Origin and development of Biotechnology - Introduction and definitions, Historic perspectives, classical concepts of Biotechnology, beginning of modern Biotechnology. Scope of Biotechnology- Commercial potential, Biotechnology in India and its global trends, Major Biotechnology institutes and companies in India.

Application of Biotechnology (Basic idea with only applications needed).

Environmental Biotechnology, Genetic engineering - gene cloning; Medical Biotechnology- Safer and cheaper medicines by Biotechnology; Agricultural Biotechnology - Genetically Modified crops; Food Biotechnology - application of Biotechnology in food processing, Traditional and modern food processing.

Module V

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

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

Suggested Readings

1. An Introduction to Biostatistics: A Manual for studies in Health Sciences., P. Sundar Rao, and J. Richard, Prentice Hall .
2. 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.
3. Biotechnology and Ethics: A Blueprint for the Future, Daniel Callahan President, Hastings Center, Center for Biotechnology, Northwestern University.
4. Biotechnology: Issues, Ethics and Regulations, Tina M. Prow, Communications Specialist, Office of Agricultural Communications and Education.
5. Computers Today, Alexis Leon and Mathews Leon., Leon Vikas.
6. Conceptual Integrated science, Hewitt, Paul G, Suzanne Lyons, ohn A. Suchocki & Jennifer Yeh, Addison-Wesley.2007.
7. Cultural Boundaries of Science, Gieryn, T.F. University of Chicago Press, 1999.
8. Fundamentals of Information Technology, Alexis and Mathew Leon., Leon Vikas
9. Introduction to Genetic Engineering & Biotechnology, Nair, A.J., Infinity Science Press, USA.
10. Introduction to Information Technology, V. Rajaraman., Prentice Hll.
11. Learning Computer Fundamentals., Ramesh Bangia ., Khanna Book Publishers
12. Methods for Teaching Science as Inquiry, Bass, Joel, E and et. al., Allyn & Bacon, 2009 The truth of science, Newton R.G.,
13. Patenting in Biotechnology - Part I, R. Stephen Crespi, Tibtech, Vol. 9, 117-122, 1991.
14. People's Perception of Biotechnology, Renato Schibeci, Ian Barns.
15. Plant Biotechnology: Facts and Public Perception, D. Boulter, Department of Biological Sciences, University of Durham, South Road, Durham DH1 3LE, U.K. (Vol. 40, No.1, pp.1-9, 1995).
16. Public Attitudes to Genetically Engineered Products, Wendy Ross, Katy Marsh, Alexi

Jackson, Jaqui Skoyles, (1998), John Innes Centre, Norwich, U.K.
17. Social issues in Science and Technology: An Encyclopedia, David E. Newton (ABC-CLIO, Santa Barbara), 1999.
18. The Golem: What everyone should know about science, Collins H. and T. Pinch, Cambridge University Press, 1993.

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.

Course outcome: Student will be able to

- Define the diversity of microbial world
- Identify Gram positive and Gram negative bacteria
- Compare the purpose of different growth medias
- Demonstrate the isolation of a pure colony from a mixture of bacterial cultures
- Describe the role of microorganisms in agriculture and biogeochemical cycles.

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

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.

Course outcome: Student will be able to

- Discuss the molecular organization of different levels of protein and the molecular structure of water- hydrogen bonds and physical property of water
- Knowledge of storage, flow of energy and their applications-electrical properties of biological compartments; electrochemical gradients, membrane potential, chemiosmotic hypothesis.
- Application of the law of optics in understanding strategies of light reception in animals, correction of vision faults
- identify and differentiate working principles, instrumentation, and applications of various bio-analytical instruments
- Recall and relate the concepts of radioactivity and its applications
- Reproduce and design an experiment with step-by-step instructions to address a research problem or bio-analytical practical/project

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
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.

Course outcome: Student will be able to

- Understand metabolic diversity among microbes
- Compare aerobic respiration, anerobic respiration and fermentation in bacteria
- Discuss the different methods of bacterial gene transfer
- Describe the various diseases caused by microorganisms

Module I

Introduction to Microbial metabolism **12 Hrs**

Metabolic diversity among microbes-autotrophs and heterotrophs; Nutritional classification of bacteria; Uptake of solutes into bacterial cell

Photosynthesis in bacteria - photosynthetic pigments of bacteria- chlorophyll a and bacterio chlorophyll, carotenoids, phycobiliproteins, leghaemoglobin, mechanism of photosynthesis in bacteria (purple nonsulphur bacteria, green sulphur bacteria) and cyanobacteria.

Respiration in bacteria- aerobic respiration, Glycolysis and tricarboxylic acid cycle, Electron transport and oxidative phosphorylation in Bacteria; Anaerobic respiration- Fermentation- lactic acid and alcohol fermentation.

Module II **12 Hrs**

Bacterial genetics

Transfer of genetic information in bacteria, Bacterial chromosomes- DNA, Plasmids, different types of plasmids- stringent and relaxed; Col plasmids, non-conjugative, mobilizable plasmids, resistance plasmids and transferable drug resistance.

Bacterial Mutation Spontaneous mutation, induced mutations, Isolation of

auxotrophs- replica plating technique; Test for mutagenicity-Ames test; Brief account on repair mechanisms.

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-Lambda phage- bacterial recombination through transduction.

Module III **12 Hrs**

Bacterial Diseases of Humans

Airborne bacterial diseases Streptococcal diseases, Tuberculosis; Foodborne and waterborne bacterial diseases; Foodborne and waterborne intoxications - Botulism; Food borne and waterborne infections - Typhoid fever, Cholera, Shigellosis, *E.coli* Diarrhea; Soil borne bacterial diseases- Anthrax, Tetanus, Leptospirosis.

Viral diseases of Humans - Pneumotropic viral diseases - Influenza, Adenoviral infections, Rhinoviral infections, Dermatoviral diseases - Herpes simplex, chickenpox, Measles, Rubella; Viscerotropic Viral diseases - yellow fever, Dengue fever; Neurotropic viral diseases - Rabies, Polio, H1N1, Nipah.

Practical **18 Hrs**

1. Isolation and identification of *E.coli* from water samples and its identification.
2. Isolation of microorganisms from spoiled food materials.
3. Isolation of starch degrading microorganisms - fungus/bacteria.
4. Examination of microbial flora of the skin.
5. Examination of the microbial flora of mouth.
6. Inhibition of microorganisms by antibacterial agents by disc diffusion 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 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.

9. Microbiology- P. D. Sharma; Rastogi Publications, Meerut
10. Microbiology (7^{th} Ed)- Prescott L. M., Harley, J. P., and Klein D. A. Mc Graw Hill, New York

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
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.

Course outcome: Student will be able to

- understand different types of tissue, organs, and organs systems
- understand classify and identify the diversity of animals.
- identifies his role in nature as a protector, preserver, and promoter of life which he has achieved by learning, observing, and understanding life.
- understand the basis of life processes in the non-chordates and recognize the economically important invertebrate fauna.
- Understand the basis of life processes in the non-chordates and recognize the economically important invertebrate fauna.
- Describe the diversity in form, structure, and habits of vertebrates
- Explain general characteristics and classification of different classes of Vertebrates,their evolutionary importance and adaptations

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.

Course outcome: Student will be able to

- understand different types of tissue, organs, and organs systems
- understand the terminologies and working mechanisms relating to various organ systems in animal physiology- The nervous system, Muscle, skeletal system Reproductive System, and Endocrine System.
- understand the physiology of Digestion, Respiration, Renal physiology, Blood, and the Physiology of the Heart
- analyze how organs system interacts with each other and ultimately control and coordinate the functioning and well-being of the organism
- Apply the knowledge to lead a healthy life

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

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.

Course outcome: Student may be able to

- Memorize the significant historical events in the development of molecular Biology
- Explain the various forms of DNA and understand the applications in different life situations
- Utilize the structure of nucleic acids and genetic code for understanding the central dogma of life
- Understand and differentiate the principle behind DNA replication, transcription, and translation
- Explain the mechanism of gene regulation
- Understand the fundamental concept of the eukaryotic chromosome, its organization, cytoplasmic and chloroplast genome.
- Evaluate the importance of Insertional elements and transposons

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.

Course outcome: Student will be able to

- Define the cells and organs involved in immunity.
- Explain techniques based on antigen antibody interaction
- Interpret the genetic basis of antibody diversity
- Compare various autoimmune diseases and causes

Module I
Introduction to Immunology **7 hrs**

Historical perspective of immunology; haematopoisis; Lineages The Human Immune System: Organs and cells of immune system - structure and functions.

Module II **6 hrs**

Types of immunity - Innate and specific or acquired immunity, Humoral immunity and cell mediated immunity; Brief account on-antigens, Immunogens, haptens, adjuvants.

Module III **6 hrs**
Immunoglobulins

Antibody structure and functions, antigen binding, epitope and paratope, types of antibodies and their structures: isotypes, allotypes and idiotypes.

Module IV **7 hrs**
Measurement of antigen

Antibody-antigen interaction, antigen-antibody reactions, agglutination, ABO blood grouping and Rh incompatibility, immuno-diffusion, immuno-electrophoresis, ELISA-types, RIA; production of monoclonal antibodies using hybridoma technology.

Module V
Immunoglobulin gene **6 hrs**

Genetic basis of antibody diversity-VDJ recombination, Clonal proliferation theory of antibody production.

Immunity to infections of diseases: Brief account on Vaccines and toxoids (Attenuated, Killed, Purified Macro molecules, Peptide Vaccines, Subunit Vaccines , DNA Vaccines, Edible Vaccines).

Module VI **4 hrs**

Autoimmune disease and hypersensitivity: Organ Specific autoimmune diseases - thyroiditis; Myasthenia gravis; Pernicious anemia. Systemic autoimmune disease - Rheumatoid Arthritis, Hypersensitivity disease - Asthma.

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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

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.

Course outcome: Student will be able to

- List out the enzymes and vectors used in rDNA technology
- Execute the steps involved in the construction of recombinant DNA
- Describe the techniques in rDNA technology
- Define the applications of transgenic organisms

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.

Course outcome: Student will be able to

- Demonstrate the preparation of plant tissue culture medium.
- Differentiate various methods in plant tissue culture
- Identify the applications of invitro culture and transgenic plants

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**

Types of *in vitro* cultures

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* cultures

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.

Course outcome: Student may be able to

- List out the major events in the history of animal cell culture
- understand animal cell culture methods, substrate, culture media, preservation, and maintenance of cell lines
- to differentiate viable and nonviable cells and different assays for screening cell viability and cytotoxicity and its applications in various fields
- Describe the various animal cell culture products and their applications
- understand the production of monoclonal antibodies, and bioreactors for large-scale culture of cells
- Knowledge of transgenic animals, *in vitro* fertilization, and embryo transfer. Conceptual understanding of Transplantation
- Evaluate and discuss public and ethical concerns over the use of animal biotechnology

Module I **10 hrs**

Animal Cell Culture

History, animal organ, tissue and cell culture, animal cell culture techniques,

Primary cell cultures and secondary cell cultures, immortalized cell cultures, cell lines, Media – media components and physical parameters,

Instruments and equipments needed for animal cell cultures, uses of animal cell cultures.

Module II **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.

Course outcome: Student may be able to

- Discuss on various databases in biotechnology
- Demonstrate sequence alignment
- Compare the applications of bioinformatics in proteomics and genomics

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.

Course outcome:Students will be able to

- List out the various fermented foods
- Discuss the role of microorganisms in food spoilage
- Implement the various methods of food preservation
- Experiment the quality testing methods of milk.

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.

Course outcome: Student will be able to

- List out the enzymes and vectors used in rDNA technology
- Execute the steps involved in the construction of recombinant DNA
- Describe the techniques in rDNA technology
- Define the applications of transgenic organisms

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

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.

Course outcome: Student may be able to

- List out industrially important microorganisms and their products
- Design a fermentor model
- Explain the steps in upstream and downstream processing
- Relate the beneficial and hazardous effect of microbes in food industry

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 other organic acids (Citric acid), Beverages(beer), solvents (butanol)

Module II **16 hrs**

Fermentation

The biological process of fermentation- various types of fermentation, alcohol fermentation, Bioreactors - types of bioreactors (Airlift bioreactors, continuous stirred tank reactor, tower reactor, batch reactor, upflow anaerobic sludge blanket reactor) /Fermentors, Design and parts of a bioreactor.

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Module III **12 hrs**

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

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-protease and amylase, Immobilization of cells and enzymes- applications

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.

Course outcome: Student may be able to

- Explain the scope of Environmental Biotechnology
- Understand basic ecological concepts, various pollution, its measurements & remediation.
- Assess the quality of the water sample through various parameters - MPN test, dissolved oxygen concentration, biological oxygen demand, chemical oxygen demand.
- Understand the working of the sewage treatment plant
- Evaluate the importance of new waste treatment strategies
- Understanding the various green energy forms and their sources and applications
- Evaluate the measures to reduce environmental pollution
- Understand the importance of the different environmental act

Module I **4 hrs**

Introduction

Importance of Environmental Biotechnology; Pollution - sources of pollution, general characteristics.

Module II **5 hrs**

Water pollution

Organic load in aquatic systems - BOD and COD, microbial quality of water, Laboratory methods for the detection of coliforms in drinks and food; fecal and non-fecal bacteria; Treatment of municipal wastes and hazardous industrial effluents.

Module III **10 hrs**

Non-conventional energy sources

Biomass: utilization of biomass as energy source application of microbes in production of fuels from biomass- biogas and methanogenic bacteria, Steps and process of Biogas production; microbial hydrogen production, the gasohol experiment. Energy production from photosynthetic pigments; vegetable oils as engine fuels, energy crops-jojoba; Bioplastics

Module IV **8 hrs**

Bioremediation and Bioleaching: Microbial degradation of pesticides, herbicides and other toxic chemicals in the environment; Bioaugmentation; phytoremediation, superbug. Bioleaching-Enrichment of ores by microorganisms (bioaccumulation and biomineralisation).Bio-assessment of environmental quality.

Module V **5 hrs**

Solid waste treatment

Solid waste treatment - Composting, vermicomposting; Disposal of sludge- Land filling, lagooning.

Module VI **4 hrs**

Environmental legislation:

Water Act; Forest Act; Environmental Protection act.

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.

Course outcome: Student may be able to

- Discuss on various databases in biotechnology
- Demonstrate sequence alignment
- Explain the concepts of phylogenetic tree construction
- Compare the applications of bioinformatics in proteomics and genomics
- Define the concept of nanobiotechnology and its applications

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.

Course outcome : Student will be able to

- Execute statistical methods in biological investigations
- understand the basic concepts in hypothesis testing- chi square test, student t-test e

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.

Course outcome:Students will be able to

- List out the various fermented foods
- Discuss the role of microorganisms in food spoilage
- Implement the various methods of food preservation
- Experiment the quality testing methods of milk.

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.