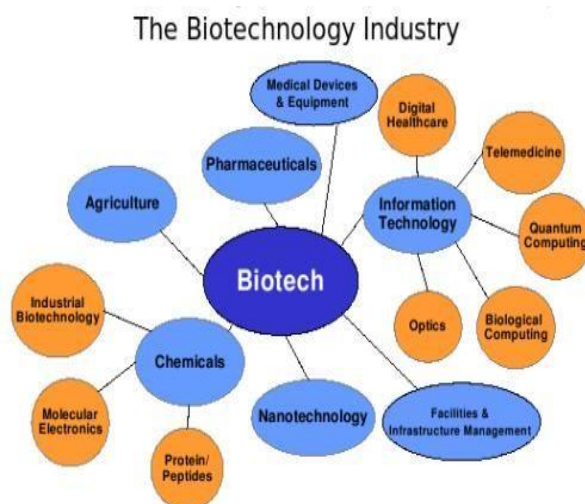


PERIYAR UNIVERSITY

Periyar Palkalai Nagar

Salem – 636 011

Degree of Bachelor of Science
OUTCOME BASED EDUCATION



Syllabus for **B.Sc. BIOTECHNOLOGY** (SEMESTER PATTERN)

(For Candidates admitted in the Colleges affiliated to Periyar University
from 2021-2022 onwards)

OBE PATTERN REGULATIONS
(From 2021 – 2022 Onwards)

Scheme of Examination and Course Structure (semester wise)

PERIYAR UNIVERSITY,SALEM – 11

BACHELOR OF SCIENCE

BRANCH – BIOTECHNOLOGY

OBE PATTERN REGULATIONS

(The revised syllabus shall be effective from the academic year 2021-2022 onwards)

1. Objectives

Biotechnology is the research-oriented science including a fusion of biology and technology. This study includes a large variety of subjects including Biochemistry, Genetics, Microbiology, Biochemistry, Immunology and Engineering. It is associated with other subjects such as Health and Medicine, Bio-statistics, Cell Biology, Seed Technology, Plant Biotechnology etc. Biotechnology features the use of living cells and bacteria in the industrial process. Biotechnology can be applied in developing various vaccines, medicines and diagnostics, improving energy production and conservation and increasing productivity.

The objectives of the course are

- To impart the knowledge about the theoretical development of Biotechnology.
- To elucidate the use of various Biological Science concepts which are required for the development of Biotechnology.
- To emphasize the scope of using biotechnology tools in various disciplines.
- To equip the students with effective applications of various biotechnology tools for solving many real life problems.
- To provide a platform for pursuing higher studies such as Post-graduate and Doctorate degrees

Learning Outcomes

On successful completion of the B. Sc. Biotechnology program,

- The students should be able to demonstrate proficiency in basic science and fundamental biotechnological tools
- The graduates could understand the working principles of advanced biological sciences
- The graduates acquire employability skills in the field of Pharmaceutical, food and agricultural industries
- The graduates get motivated towards deep learning, higher studies and research in life sciences
- The graduates develop health and environment awareness towards social Responsibility.

OBE PATTERN REGULATIONS

(From 2021 – 2022 Onwards)

PERIYAR UNIVERSITY, SALEM – 11.

DEFINITION

Programme : “Programme” means a course of study leading to the award of a degree in a discipline.

Course : “Course” refers to a subject offered under the degree programme spread over the complete Programme of study a sunder.

Part I : means “Tamil/other languages” offered under the programme.

Part II : means “English” language offered under the programme.

Part III: :means “Allied subjects” offered as allied, which is interdisciplinary in nature but related to the programme.

Part III : means “Elective subjects” related to the core subjects of the programme concerned.

PART IV

i) “Tamil” means basic orientation in Tamil language for those students who have not studied Tamil upto 12 standard.

ii) “Advanced Tamil” means, the subject is meant for students who have studied Tamil language upto 12th standard and chosen other languages in college but would like to advance their Tamil language skills.

iii) “Non-Major Electives” means option is being given to students who do not come under the above two categories (i & ii).

iv) Skill based subject means the courses offered under the programme related to Advanced Skill acquisition for industrial application for which a separate Diploma will be awarded along with the Degree.

v) “Foundation Course” means courses offered as

Value Education - Manavalakkalai yoga (1st year)

Environmental Studies (1st year)

Part V

“Extension Activities” means all those activities which form part of NSS/NCC/Sports/YRC and other co and extracurricular activities.

A detailed explanation of the above with relevant credits are given under “Scheme of Examination along with Distribution of Marks and Credits”

Duration: Means the stipulated years of study to complete a programme as prescribed by the University time to time. Currently for the undergraduate programme the duration of study is THREE years. These regulations apply to the regular course of study in approved institutions of the University.

Credits: Means the weightage given to each course of study (subjects) attributed by the experts of the Board of Studies concerned.

Credit System: Means, the course of study under this pattern, where weightage of credits are spread over to different semesters during the period of study and the Cumulative Grade Point Average will be awarded based on the credits earned by the students. The following are the total credit points:

For Undergraduate Programme (Three years) : 140

4. AIM AND SCOPE OF THE COURSE:

- ❖ The topics included in different units of different papers would enable the students to develop technical skills in technology and applied branches.
- ❖ Skill based subjects like Bioinstrumentation, Developmental Biology, Nanobiotechnology and Bioinformatics and Proteomics and Genomics have been included in order to provide opportunities in employment and research in Government and Private Organizations.
- ❖ There is also scope for self employment for the students.
- ❖ Practicals included in the syllabus will improve the skills of the students in Plant tissue culture, Animal tissue culture, Molecular biology, Immunology, Genetic engineering, Bioprocess technology, Enzymology and Laboratory techniques.

i) Eligibility for Admission

A candidate who has passed Higher Secondary Examination in any one of the biological sciences (Botany/Zoology, Biology). (Academic/Vocational stream-Agri, Home Science, Poultry) under higher secondary board of examination, Tamil Nadu or as per norms set by the Government of Tamil Nadu or an examination accepted as equivalent thereto by the Syndicate.

ii) Duration of the Course

The course for the degree of Bachelor of Science shall consist of three academic years divided into six semesters. Each semester consists of 90 working days.

5. PASSING MINIMUM

The candidate shall be declared to have passed the examination if the candidate secures not less than 30 marks out of 75 marks in the University Examination (UE) in each theory paper and 10 marks (out of 25) in the Continuous Internal Assessment (CIA) in each theory paper.

For the Practical paper, a minimum of 24 marks (out of 60) in the University Examination (UE) and 16 marks (out of 40) in the Continuous Internal Assessment (CIA) is required to pass the examination.

The CIA of each practical paper includes evaluation of record. However submission of record for the University Practical Examination is mandatory.

Examinations	Maximum Marks			Passing Minimum		
	CIA	UE	Total	CIA	UE	Total
Theory Paper	25	75	100	10	30	40
Practical Paper	40	60	100	16	24	40

6. CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who secure not less than 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in the First Class.

All other successful candidates shall be declared to have passed in the Second Class.

Candidates who obtained 75% of the marks in the aggregate shall be deemed to have passed the examination in First Class with Distinction provided they pass all the examinations prescribed for the course at the first appearance.

Candidates who pass all the examinations prescribed for the course in the first instance and within a period of three academic years from the year of admission to the course only are eligible for University Ranking.

1. **Passing Minimum** is 40% of the **ESE** and also 40% of the minimum of the paper/course.
2. **Minimum Credits to be Earned:**

For THREE year Programme: Best 140 Credits

Part I and II : Languages

Part III : Major, Elective, Allied

Part IV : Soft Skills

Part V : Extension Activities

6. Marks and Grades:

The following table gives the marks, grade points, letter grades and classification to indicate the performance of the candidate.

**Conversion of Marks to Grade Points and Letter Grade
(Performance in a Course/Paper)**

RANGE OF MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90 –100	9.0 - 10.0	O	Outstanding
80–89	8.0 - 8.9	D+	Excellent
75–79	7.5 - 7.9	D	Distinction
70–74	7.0 - 7.4	A+	Very Good
60–69	6.0 - 6.9	A	Good
50–59	5.0 - 5.9	B	Average
40–49	4.0 - 4.9	C	Satisfactory
00–39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

CALCULATION OF GPA AND CGPA

For a Semester :

$$\text{GPA} = \frac{\text{Sum of the Multiplication of Grade Points by the Credits of the Courses}}{\text{Sum of the Credits of the Courses in a Semester}}$$

$$\text{Grade Point Average (GPA)} = \frac{\sum_i C_i G_i}{\sum_i C_i}$$

For the entire Programme:

CGPA

$$= \frac{\text{Sum of the Multiplication of Grade Points by the Credits of the Entire Programme}}{\text{Sum of the Credits of the Courses of the Entire Programme}}$$

C_i = Credits earned for course 'i' in any semester

G_i = Grade Point obtained for course 'i' in any semester.

n refers to the semester in which such courses were credited

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5-10.0	O+	First Class With Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class With Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
4.5 and above but below 5.0	C+	Third Class
4.0 and above but below 4.5	C	
0.0 and above but below 4.0	U	Re-appear

*The candidates who have passed in the first appearance and within the prescribed Semester of the UG Programme (Major, Allied and Elective Courses Alone) are eligible

8 . MAXIMUM DURATION FOR THE COMPLETION OF THE UG PROGRAMME

The maximum duration for completion of the UG Programme will not exceed twelve semesters.

9. COMMENCEMENT OF THIS REGULATION

The OBE regulations shall take effect from the academic year 2021 – 2022 (i.e.) for the students who are admitted in the first year of the course during the academic year 2021 – 2022 and thereafter.

10 . TRANSITARY PROVISION

Candidates who were admitted to the UG course of study prior to 2021-2022 will be permitted to appear for the examination under those regulations for a period of three years (i.e.) up to and inclusive of the examinations of April/May 2024. Thereafter they will be permitted to appear for the examination based on the regulations then in force.

QUESTION PAPER PATTERN AND EVALUTION FOR ALL COURSES

11.1 Distribution of Marks for Theory Examinations:

EXAMINATIONS	MARKS
CIA (Continuous Internal Assessment)	25 Marks
UE (University Examinations)	75 Marks
TOTAL	100 Marks

11.2 Evaluation of Continuous Internal Assessment (CIA):

S.NO	INTERNAL ASSESSMENT	DISTRIBUTION OF MARKS
1	Test	15 Marks
2	Assignments	5 Marks
3	Attendance	5 Marks
TOTAL		25 Marks

11.3.Question Paper Pattern for Core /Allied/Elective/SBEC Papers (Theory):

Time: Three hours	Maximum Marks: 75
Part - A (15 x 1 = 15) Answer ALL questions (Three Questions from Each Unit)	
Part - B (2 x 5 = 10) Answer any TWO questions (One Question from Each Unit)	
Part - C (5 x 10 = 50) Answer ALL questions (One Question from Each Unit with Internal Choice)	

11.4 Distribution of Marks for Core and Allied I Practical:

EXAMINATIONS	MARKS
CIA (Continuous Internal Assessment) Including Practical Record	40 Marks
UE (University Examinations)	60 Marks
TOTAL	100 Marks

11.5. Evaluation of Continuous Internal Assessment (CIA) for Core and Allied Practical:

S.NO	INTERNAL ASSESSMENT	DISTRIBUTION OF MARKS
1	Record	25 Marks
2	Test	10 Marks
3	Attendance	5 Marks
TOTAL		40 Marks

		Value added courses/ Job oriented Certificate courses	Optional
		UGC-SWAYAM online /MOOC's, NPTEL courses	Optional

Note : Subject code to be cross verified especially for allied Biostatistics and Computer Science Course

12. SCHEME OF EXAMINATIONS

The scheme of examination for different semesters shall be as follows :

Course structure under OBE (semester – wise details)

B.Sc., Biotechnology

(for the students admitted from the academic year 2021-2022 onwards)

Course structure under OBE (Semester-wise Details)
Biotechnology
(For the students admitted from the Academic year 2021-2022 onwards)

PART	PAPER CODE	COURSE	TITLE OF THE PAPER	HOURS	CREDIT	MARKS		TOTAL
						CI A	U E	
SEMESTER – I								
I	21UFTA01	Language I	Tamil – I	6	3	25	75	100
II	21UFEN01	Language II	English – I	6	3	25	75	100
IV	21UPEL01		Professional English I	6	4	25	75	100
III	21UBT01	Core Theory – I	Cell Biology	5	4	25	75	100
	21UBCA01	Allied I: Theory - I	Biochemistry -I	5	4	25	75	100
	21UBCAP01	Allied Practical – I	Lab in Biochemistry - I*	3	-	-	-	-
	21UBTP01	Core Practical – I	Lab in Cell biology	3	3	40	60	100
IV	21UVE01	Common	Value Education (Yoga)	2	2	100	75	100
NO. OF COURESES – 7			TOTAL	36	23	-	-	700
* Examination at the End of Second Semester								
SEMESTER – II								
I	21UFTA02	Language	Tamil – II	5	3	25	75	100
II	21UFEN02	Language	English – II	5	3	25	75	100
	21UPEL02		Professional English II	6	4	25	75	100
III	21UBT02	Core Theory – II	Genetics	5	4	25	75	100
	21UBCA02	Allied I: Theory - II	Biochemistry - II	5	4	25	75	100
	21UBTP02	Core Practical – II	Lab in Genetics	3	3	40	60	100
	21UCAP01	Allied practical- I	Lab in Biochemistry	3	3	40	60	100
IV	21UES01	Common	Environmental Studies	2	2	25	75	100
IV	21UBTS01	SBEC – I	Bioinstrumentation	2	2	40	60	100
NO. OF COURESES – 9			TOTAL	30	24	-	-	900
SEMESTER – III								
I	21UFTA03	Language	Tamil – III	5	3	25	75	100
II	21UFEN03	Language	English – III	5	3	25	75	100
III	21UBT03	Core Theory – III	General Microbiology	5	4	25	75	100
	21USTA05	Allied II: Theory - III	Biostatistics	5	4	25	75	100
	21UBTP03	CORE PRACTICAL – III	Lab in Microbiology	3	3	25	75	100
		Allied Practical	Computer Practical *	3	-	-	-	-

IV	21UBTS02	SBEC- II	Developmental Biology	2	2	25	75	100
	NMEC – I			2	2	25	75	100
NO. OF COURESES – 7			TOTAL	30	21	-	-	700
* Examination at the End of Fourth Semester								
SEMESTER – IV								
I	21UFTA04	Language	Tamil – IV	5	3	25	75	100
II	21UFEN04	Language	English – IV	5	3	25	75	100
III	21UBT04	Core Theory – IV	Molecular Biology	6	4	25	75	100
		Allied II: Theory - IV	E-Commerce Techniques	6	4	25	75	100
	21UBTP04	Core Practical – IV	Lab in Molecular Biology	3	3	40	60	100
		Allied Practical IV	HTML Programming	3	3	40	60	100
	NMEC – II			2	2	25	75	100
	Internship Programme	Clinical Lab, Sericulture Farm, Effluent Treatment Plant, Sugarcane Industry, Fruit and Beverage Industries, Aavin Diary, Horticulture Research Station, Soil Testing Organic Farming, Medical Coding, TNAU , Veterinary University, Plant Tissue Lab, Molecular Biology Lab, Medical Lab Technology, Bio Fertilizer Unit, Mushroom Production Unit..						
NO. OF COURESES – 7			TOTAL	30	22	-	-	700
SEMESTER – V								
III	21UBT05	Core Theory – V	Plant Biotechnology	6	4	25	75	100
	21UBT06	Core Theory – VI	Immunology and Immunotechnology	5	4	25	75	100
	21UBT07	Core Theory – VII	Genetic Engineering	6	5	25	75	100
		Elective - I		5	4	25	75	100
	21UBTP05	Core Practical – V	Lab in Plant biotechnology	3	4	40	60	100
	21UBTP06	Core Practical - VI	Lab in Genetic Engineering and Immunology	3	4	40	60	100
IV	21UBTS03	SBEC – III	Nano Biotechnology and Bioinformatics	2	2	25	75	100
NO. OF COURESES – 7			TOTAL	30	27	-	-	700
SEMESTER – VI								
III	21UBT08	Core Theory – VIII	Animal Biotechnology	6	5	25	75	100
	21UBT09	Core Theory – IX	Proteomics and	6	4	25	75	100

			Genomics					
	21UBT10	Core Theory X	Bioprocess and Enzyme technology	5	4	25	75	100
		Elective – II		5	4	25	75	100
	21UBTP07	Core Practical – VII	Lab in Animal Biotechnology	3	4	25	75	100
	21UBTP08	Core Practical – VIII	Lab in Bioprocess Technology and enzymology	3	4-	25	75	100
IV	21UBTS04	SBEC – IV	Pharmaceutical Biotechnology	2	2	25	75	100
V	21UEX01	Common	Extension Activities	-	-	-	-	-
NO. OF COURESES – 8			TOTAL	30	27	-	-	700
TOTAL NO. OF COURESES - 42			GRAND TOTAL	180	148	-	-	4400
UE – University Examination					CIA – Continuous Internal Assessment			
SBEC – Skill Based Elective Course					NMEC – Non Major Elective Course			

ELECTIVE SUBJECTS

Sem	Part	Subject Code	Subject
V	III	21UBTE01	MEDICAL BIOTECHNOLOGY
		21UBTE02	ENZYME AND ENZYME TECHNOLOGY
VI	III	21UBTE03	FOOD BIOTECHNOLOGY
		21UBTE04	ENTERPREUNERSHIP IN BIOTECHNOLOGY

SKILL BASED ELECTIVE COURSES SUBJECTS

SEM	PART	SUB CODE	COURSE	Hrs.		CRE	MARKS		
				Lect.	LAB		DIT	CIA	EA
SEMESTER – IV									
IV	II		Bioinstrumentation	2	-	2	25	75	100
	III		Developmental Biology	2	-	2	25	75	100
	V		Nanobiotechnology and Bioinformatics	2	-	2	25	75	100
	VI		Pharmaceutical biotechnology	2	-	2	25	75	100

ALLIED PAPERS I YEAR									
III	I		Biochemistry I	6	-	4	25	75	100
	II		Biochemistry II	5	-	4	25	75	100
ALLIED PAPERS II YEAR									
III	III		Biostatistics	5	-	4	25	75	100
	IV		Computer Applications in Biology	6	-	4	25	75	100

NON MAJOR ELECTIVE COURSE SUBJECTS

Sem	Part	Subject Code	Subject
III	PART IV	21UBTN01	Concept of biotechnology
IV	PART IV	21UBTN02	Biotechnology for human welfare

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FIRST SEMESTER

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	I
CORE THEORY	I
PAPER CODE	21UBT01
TITLE OF THE PAPER	Cell Biology
HOURS/WEEK	5
NO. OF CREDITS	4

Learning Objectives

- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
 - Students will understand how these cellular components are used to generate and utilize energy in cells
 - Students will understand the cellular components underlying mitotic cell division
- On successful completion of the subject the student should have understood the Structural features, Organelles and the cellular mechanisms

Course Outcome

On the successful completion of the course, student will be able to

Design the model of a cell.

Differentiate the structure of prokaryotic and eukaryotic cell.

Explain the organization of Genes and chromosomes, chromosome morphology and its aberrations

Compare and contrast the events of cell cycle and its regulation

Explain the communications of cells with other cells and to the environment.

To know the cell organelles and locate its parts along with functions

UNIT I

Cell as a basic unit, Cell theory, Cell size and Shape, Prokaryotic and Eukaryotic organization, Structural comparison of microbial , plant and animal cells.

UNIT II

Cell wall and Membrane : Plasma membrane-Model of plasma membrane, fluidity of membranes, membrane proteins and their functions; Transport across the membrane- Selective permeability of membranes; Cell adhesion; Cell junction.

UNIT III

Structure and functions of cell organelle; Mitochondria, chloroplast, Endoplasmic reticulum, Golgi

Complex, Lysosomes, Ribosomes, Peroxisomes, Glyoxisomes, Vacuoles, centrioles, cytosols, Microtubules and Microfilaments.

UNIT IV

Cell cycle and Cell Signalling: Cell division, Cell cycle, Mitosis, Meiosis, Cell signaling, G-protein receptors, Cell membrane traffic, Cellular senescence and Apoptosis.

UNIT V

Specialised cells, Motile cells (Amoeboid, Ciliary, Flagellar Movements, Nerve cells and Nerve impulse conduction, Muscle cells and Muscle contraction, Plant cells (Parenchyma cells, Xylem and Phloem Cells)

REFERENCE BOOKS:

1. **De Robertis.**, Cell Biology, Blaze Publishers and Distributors Pvt .Ltd., New Delhi
2. **Gerald Karp.**, Cell and Molecular Biology Concepts and Experiments-4TH Edition
3. **Wilson & Marrison.**, Cytology, Reinform Publications.
4. **Ajoy Paul.**, 2011. Text Book of Cell and Molecular Biology-Books and Allied (P)Ltd, Kolkata, 3rd Edition.
5. **Aminul Islam .**, 2011, Text Book of Cell Biology-Books and Allied(P)Ltd, Kolkata. 1ST Edition.
6. **Sharp.**, Fundamentals of Cytology-McGraw Hill Company.
7. **Pijushroy .**, 2010, Plant Anatomy, New Central Book Agency, Put Lit., New Delhi.
8. **P.S.Verma & V.K.Agarwal.**, (2016-Reprint)-Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S.Chand Publishing Company Pvt Ltd, New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://study.com/academy/lesson/symbiotic-relationships-mutualism-commensalism-amensalism.html>

<https://www.khanacademy.org/science/biology/ecology/intro-to-ecosystems/a/energy-flow-primary-productivity>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	I
CORE PRACTICAL I	I
PAPER CODE	21UBTP01
TITLE OF THE PAPER	Lab In Cell Biology
HOURS/WEEK	3
NO. OF CREDITS	3

LEARNING OBJECTIVES :

The main objectives of this course are to:

- To introduce an fundamentals of cell biology techniques
- To teach students the basic techniques and instrument principles in biotechnology
- To give hands on cell biology experiments

COURSE OUTCOME

Be aware of the laboratory rules and regulations.

Understand On the successful completion of the course, student will be able to:
the importance, evolution and diversity of cells and preparation of slides
Learns to visualize the cells by employing different types of microscopes

1. Microscopes and its parts.
2. Micrometry - Stage and Ocular Micrometer.
3. Cell Counting – Haemocytometer.
4. Mounting epithelium and observing living animal and plant cells using vital staining.
5. Mitosis in Onion root tip squash.
6. Meiosis in grasshopper testis / flower buds.
7. Preparation of Permanent Slides – Muscle cells.

8. Observation of Permanent Slides - Cardiac muscle, Sperm cell.
9. Staining of macromolecules – Carbohydrates and Lipids.
10. Microtomy (Demo).

WEB LINKS

[https://www.bjcancer.org/Sites OldFiles/ Library/UserFiles/pdf/Cell Biology Laboratory Manual.pdf](https://www.bjcancer.org/Sites%20OldFiles/Library/UserFiles/pdf/Cell%20Biology%20Laboratory%20Manual.pdf)

<https://sjce.ac.in/wp-content/uploads/2018/04/Cell-Biology-Genetics-Laboratory-Manual-17-18.pdf>

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SECOND SEMESTER

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	II
CORE Theory	II
PAPER CODE	21UBT02
TITLE OF THE PAPER	Genetics
HOURS/WEEK	5
NO. OF CREDITS	4

LEARNING OBJECTIVES

The main objectives of this course are to:

Understand on Historical introduction to Genetics and genetic materials

Understanding the concept and principles of genetics exchanges and

Its expression in host and to provide an idea about gene regulations and its control

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

Obtain acquaintance on historical overview of microbial genetics and genetic Materials

Comprehend the concept of replication of genetic materials

Understand about regulation of gene expression and mutation

Demonstrate the genetic exchange mechanism in microorganisms

Gain knowledge on Mutation

Grasp the Basic of genetics and their role

UNIT I

History of Classical and Modern Genetics, Concept and organization of genetic material in bacteria ,Plant and Animal, structure ,types, forms and functions of DNA and RNA. Genetic model organisms and significance (*E. Coli*, *Arabidopsis thaliana*, *Coenorhabditis elegans*).

UNIT II

Mendelian inheritance, Non-Mendelian inheritance, Linkage, Crossing over, Chromosomal theory of inheritance, Sex linked and Sex limited inheritance. Natural gene transfer methods in bacteria.

UNIT III

Fine structure of genes, Genetic code, Structural and numerical alterations of chromosome deletion, Inversion, Duplication, Translocation. Mutations - (Spontaneous and Induced), mutagens Biochemical basis of mutation.

UNIT IV

Ploidy –Euploidy and Aneuploidy, Inborn Genetic disorders, Inherited single gene disorders.

UNIT V

Cytogenetics, Human Karyotyping, Banding techniques, Human Genetic diseases, Gene therapy, Pedigree analysis.

REFERENCE BOOKS

1. **Robertis et al.,1995** 8th edition.cell and molecular biology-Waverly publication.
2. **E.J.Gardener,M.J.Simmonsand D.P.Snustad**, Principles of genetics-John Wiley&sons publications.
3. **Strickberger,M.W.,1997.**4th Edition. Genetics-Printice hall
4. **Alberts .,2002.**Molecular biology of the cell-Garland publications,4th edition.
5. **Ajoy Paul., 2011.** Text Book of Genetics -Books and Allied (P)Ltd, Kolkata,3rd Edition

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://www.khanacademy.org/science/biology/classical-genetics/chromosomal-basis-of-genetics/a/linkage-mapping>

<https://study.com/academy/lesson/genetic-structure-of-human-populations-definition-lesson-quiz.html>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	II
SBEC – 1	I
PAPER CODE	21UBTS01
TITLE OF THE PAPER	Bioinstrumentation
HOURS/WEEK	2
NO. OF CREDITS	2

LEARNING OBJECTIVES

The main objectives of this course :

- The student should have understood the analytical techniques in the field of Biotechnology
- To make the students to understand the basic principles of Bioanalytical instruments

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

Demonstrate the basics of instrumentation by analysis

Exemplify the structure of atoms and molecules by using the principles of Spectroscopy

Evaluate by Separating and Purifying the components

understand the need and applications of imaging techniques

categorize the working principle and applications of fluorescence and radiation based techniques

UNIT-I

Beer Lambert's law - Colorimeter and its applications. Spectrophotometer-Principle and its applications- Types of Spectrophotometer- UV, visible, Infrared Spectrophotometer.

UNIT-II

Principle and working of pH meter. Electrophoresis - Principle and its applications - Types of electrophoresis- Agarose Gel, SDS-PAGE and isoelectric focusing.

UNIT-III

Imaging techniques -EEG, ECG, CT SCAN, MRI SCAN, X-RAY, EMG, NMR, PET.

UNIT-IV

Centrifuge - Principle and its applications - Types of Centrifuge, Chromatography - Principle and its applications, Types- Paper, TLC, Column, Affinity and Ion-exchange.

UNIT –V

Biosensors- Principle and its applications- Electrochemical, Thermometric, Potentiometric- Optical, Piezo-electric and Amperometric Biosensors. GM Counter, Scintillation Counter, Autoradiography, Flow Cytometry. Working principle of Autoclave, Incubator and Hot air oven.

REFERENCES:

1. Chromatography: Concepts and Contrasts- 1988. **James Miller**, John Wiley and Sons, Inc
2. **H.V. Volkones.**, General Biophysics, Vol I&II
3. **Upadhyay.**, Biophysical Chemistry-, Himalaya Publication, Edition III
4. **S.Mahesh.**, 2003 Biophysics New Age International Private Ltd.
5. **Ghatak, K.L.**, 2003. Techniques and Methods In Biology. PHI Learning Private Ltd. New Delhi
6. **Zubay.G.L.**, 1993. Biochemistry, 4th Edi. WmC. Brown Publishers.

RELATED ONLINE COURSE [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://www.google.com/search?client=firefox-b-d&q=Spectroscopy>

<https://study.com/academy/lesson/medical-imaging-techniques-types-uses.html>

<https://www.erswhitebook.org/chapters/principles-of-respiratory-investigation/imaging-techniques>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	II
CORE PRACTICAL - II	II
PAPER CODE	21UBTP02
TITLE OF THE PAPER	LAB IN GENETICS
HOURS/WEEK	3
NO. OF CREDITS	3

LEARNING OBJECTIVES

The main objectives of this course are to:

- To teach students the concept of Mitosis and visualize the sex chromatin under the microscope.
- To give hands on experience in quantification of important biological constituents of cell.

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

Successfully quantify the important biological constituents of cell.

Analyze the sex chromatin present in different cells.

Examine and evaluate the stages of Mitosis

Could able to separate and interpret the mixture of components

1. Mendel's law of genetics - Mono and Dihybrid crosses (Demo).
2. Rearing morphology of *Drosophila* (Mutant eye identification).
3. Observation of Genetic model organisms (*Arabidopsis thaliana* and *Coenorhabditis elegans*)- Permanent slides.
4. Isolation of spontaneous mutant cells.
5. Isolation of petite mutant yeast cell.
6. Identification of Barr body (Buccal epithelium smear).
7. Preparation of polytene chromosomes (*Chironomus* larvae salivary gland)- squash preparation.

8. Staining of DNA and RNA – Methyl green pyronin

WEB LINKS

www.slideshare.net/TapeshwarYadav1/clinical

www.niddk.nih.gov/research-funding/at-niddk/labs.

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THIRD SEMESTER

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	III
CORE THEORY	III
PAPER CODE	21UBTP02
TITLE OF THE PAPER	GENERAL MICROBIOLOGY
HOURS/WEEK	5
NO. OF CREDITS	4

LEARNING OBJECTIVES

The main objectives of this course are:

1. To appreciate the efforts of the Scientists for the development of Microbiology and Microscopes.
2. To equip the students with the real knowledge of working with different types of Microbes. To understand the variety of microorganisms and to analyze their true potential

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

Remember and recall the historical events which paved the development of different types of microscopes.

Understand and differentiate the different types of microbes.

Analyze the media composition and grow the desired microbe.

Apply the knowledge to enumerate the microorganisms from natural environment.

Evaluate the success of understanding the viruses

UNIT I

Definition and Scope of Microbiology. History and Recent Developments, Contribution of Leeuwenhoek, Louis Pasteur, Robert Koch, Elie Metchnikoff, Edward Jenner and Alexander Flemming. Spontaneous and Biogenesis of Microbiology.

UNIT II

Microscopy-Light Microscopy, Bright field, Dark field, Phase contrast, Differential Interference contrast microscopy, Fluorescence and Electron microscopy. Stain and Staining techniques-Simple, Differential (Gram and Acid fast) and Special Staining (Endospore ,Capsular).

UNIT III

Ultracellular structure of prokaryotic cell structure and functions, Bacterial cell wall and its composition, Flagella, Pili and Capsule. Structure and functions of Cyanobacteria.

UNIT IV

Sterilization-Physical and Chemical methods, Culture media and its types, Microbial growth – Growth curve, Measurement and factors affecting growth, Pure culture techniques, Anaerobic culture, Preservation of Cultures.

UNIT V

Antimicrobial Chemotherapy- Antibiotics and Types-Mode of Action-Determining the level of Antimicrobial activity. Antimicrobial Agents.

REFERENCE BOOKS

1. **Dubey, RC and Maheswari DK (2005).** A Test book of microbiology. Chand & Company Ltd., New Delhi
2. **Sundara Rajan S (2003).** Collage Microbiology. Volume 172. Revised Edition, Varadhana Publication, Bangalore.
- 3 **Pelczar Tr. MJ, Chan ECS & Kreig NR (2006).** Microbiology. 5th Edition, Tata Mc Graw-Hill Companies Ltd.
4. **Prescott LM, JP Harely and DA Klien (2005)** Microbiology. 6th International Edition Mc Graw Hill Companies Ltd.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://www.microscopeworld.com/p-3658-types-of-microscopes.aspx>

<https://micro.magnet.fsu.edu/cells/bacteriacell.html>

<https://www.biotopics.co.uk/microbes/tech1.html>

<https://courses.lumenlearning.com/microbiology/chapter/introduction-to-microbial-biochemistry/>

<https://en.wikipedia.org/wiki/Pathogen>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	For B.Sc. Bio-technology and Bio-Chemistry
SEMESTER	III
ALLIED THEORY III	ALLIED - III
PAPER CODE	21USTA05
TITLE OF THE PAPER	BIO–STATISTICS
HOURS/WEEK	5
CREDIT	4

Learning Objectives:

- To introduce the applications of statistics in Bio-Technology, Bio-Chemistry and Microbiology.

Course Outcomes:

The students will be able to:

- Understand and apply the statistical methods like measures of location, dispersion and the relationship between two variables in bio-statistics.
- Understand large and small samples in laboratory study to apply it in real life problems.

UNIT – I Collection and Presentation of Statistical Data

Biostatistics – Definition – Types of data – Primary and secondary data – Methods of Collection of data – Sources of data in life science – Limitations and Uses of Statistics – Classification and Tabulation of data – Diagrammatic and Graphical representation of data.

UNIT – II Measures of Central Tendency

Definitions – Mean – Median – Mode – Geometric mean – Harmonic mean – Characteristics of a good average – Merits and demerits.

UNIT – III Measures of Dispersion

Range – Quartile deviation – Mean deviation and their co-efficients – Standard deviation – Co-efficient of variation – Merits and demerits.

UNIT – IV Correlation and Regression

Definitions – Types and Methods of Correlation –Karl Pearson's coefficient of correlation – Spearman's Rank correlation coefficient – Regression: Simple regression equations (two variables) – Simple Problems.

UNIT – V Test of Significance

Sampling distribution - Standard error – Test of Hypothesis: Simple hypothesis, Null hypothesis and Alternative Hypothesis – Test of significance: Large sample tests based on Mean, Differences of Means, Proportion and Difference of Proportions - Small sample test based on Mean, Difference of Means, Paired 't' test - F-test - Chi-square test.

Books for Reference:

1. Gupta S. P. (2001), Statistical Methods, Sultan Chand & Sons, New Delhi.
2. Pillai R. S. N. And Bagavathi. V. (2005), Statistics, S. Chand & Company Ltd., New Delhi.
3. P.S.S. Sundar Rao, J. Richard (2012). Introduction to Bio-Statistics and Research methods, Prentice Hall of India Pvt Ltd, New Delhi.
4. Gurumani. N (2005), An introduction to Bio-Statistics, 2nd Revised Edition, MJP Publishers.
5. Daniel. W. W, (1987), Bio-Statistics, John Wiley and Sons, New York.
6. Beth Dawson, Robert G Trapp (2004), Basic and Clinical Biostatistics, McGraw Hill, New Delhi.
7. Zar J, Bio Statistical Analysis, Prentice Hall, India.
8. Bernard Rosner, Fundamentals of Biostatistics, (8th edition), Cengage Learning, USA.
9. Rossi R. J (2010), Applied Biostatistics for Health Science, John Wiley, New York.
10. Rao C. R, Advanced Statistical Methods in Biometric Research, John Wiley, New York.

Web links:

- <https://faculty.franklin.uga.edu/dhall/sites/faculty.franklin.uga.edu.dhall/files/lec1.pdf>
- <https://www.tutorialspoint.com/statistics/>
- <http://www.stat.yale.edu/Courses/1997-98/101/sigtest.htm>
- <http://biostat.jhsph.edu/~jleek/teaching/2011/754/lecture1.pdf>
- <http://homepage.divms.uiowa.edu/~dzimmer/applied-multivariate/lecturenotesold.pdf>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	III
SBEC – II	II
PAPER CODE	21UBTS02
TITLE OF THE PAPER	DEVELOPMENTAL BIOLOGY
HOURS/WEEK	2
NO. OF CREDITS	2

LEARNING OBJECTIVES:

To understand sequential changes from single cell organization to organ level of organization in the development of multicellular organisms.

- Students will understand the role of developmental genetics in defining biological processes.
- Students will appreciate that recent advances in molecular biology are due to our ever increasing depth of understanding of basic biological processes.
- Students will solve a variety of problems using creative thinking skills and analytical skills in the lab

COURSE OUTCOME:

On completion of the course, the student should be able to:

- use main developmental biology concepts
- explain the molecular mechanisms that underlie animal and plant development
- explain underlying developmental biology processes of sperm and egg.
- review scientific literature in the subject developmental biology critically
- plan and carry out laboratory sessions as well as interpret results to examine the importance of specific genes in developmental biology processes.
- understands the students about sequential changes from single cell organization to organ level in the development of multicellular organisms.

UNIT I

Spermatogenesis and Oogenesis in mammals, Menstrual cycle, Monitoring of estrus cycle, Sperm banking. Hormones involved in reproduction.

UNIT II

Activation of sperm and egg- interaction of sperm and egg- Sequence of events in sperm entry- Egg surface changes. Post- fertilization changes. Embryo development.

UNIT III

Cell cleavage- pattern of cleavage- Chemical changes -Distribution of cytoplasmic substances in the egg- Metamorphosis (Insects and amphibians)- Hormone control of metamorphosis.

UNIT IV

Development of Microsporangium and Megasporangium, Pollination, Embryo- Embryo sac development and double fertilization in plants, seed formation and germination. Out line of experimental embryology.

UNIT V

Organization of shoot and root apical meristem, and development.

Leaf development and Phyllotaxy.

REFERENCES:

1. **Gilbert, Scott's.** 10th edition (2014). Developmental biology .Sinauer Association, Inc., Publishers.
2. **Chattopadhyay.S.** 2016. An Introduction to developmental Biology, Books are allied (P) Ltd, Kolkata. First Edition.
3. **Bruce M Carlson,** Patten's Foundation of Embryology,. Tata McGraw Hill Co.
4. **Balinsky,B.I.,** 1981. 5th edition. An Introduction to embryology , W.B. Saunders Co., Philadephia.
5. **Verma, P.S., Agarwal, V.K., and Tyagi.,** 1995. Chordate embryology, S. Chand & Co., New Delhi.
6. **Berril, N.T., Karp, G.,** 1998. Development. Tata McGraw Hill Co., New York.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://www.mooc-list.com/course/developmental-biology-saylororg>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	III
NMEC -1	I
PAPER CODE	21UBTN01
TITLE OF THE PAPER	CONCEPT OF BIOTECHNOLOGY
HOURS/WEEK	2
NO. OF CREDITS	2

LEARNING OUTCOMES

To provide students with an introduction to genetics, molecular biology, tools and applications of biotechnology.

To provide a strong foundation essential for subjects in the later years of the Biotechnology.

COURSE OUTCOMES

Students who successfully complete this unit will be able to:

1. Describe the fundamental biochemical processes of cells such as ion/molecule uptake, energy transfers, metabolism and the immune system
2. Describe the fundamentals of cell division and genetics, including the role of DNA as genetic material
3. Describe the basic principles and techniques used for the study and manipulation of DNA
4. Appreciate the application of biotechnology in diverse areas such as health and medicine, agriculture and/or the environment
5. Conduct and/or observe a variety of laboratory exercises where some of the above theoretical knowledge is applied to practical situations
6. Demonstrate the ability to work safely and communicate effectively.

UNIT I

Scope of Biotechnology. History of Biotechnology: Conventional and Modern Biotechnology – Biotech industries. Biotechnology Tree. Strategies of gene cloning.

UNIT II

Tools used in gene cloning – Restriction endonucleases – Types – Features. Ligases – Linkers, adaptors and homopolymer tails. Modifying enzymes.

UNIT III

Vectors – Properties of good Vector .Constructed plasmids- pBR322. Cosmid vectors, Animal vectors- SV40. Plant vectors- Ti derivatives.

UNIT IV

Introduction of genes – Vector mode – transformation and transfection. Vector less mode – Biolistics, Electroporation, Microinjection.

UNIT V

Selection of recombinants. Marker techniques- PCR, RFLP, RAPD and blotting techniques

REFERENCES:

1. **Principles of Gene Manipulation Old & Primrose**, (1989), 3rd edition
 2. **Biotechnology**, Satyanarayana. U, (2008), Books and Allied (p) Ltd
 3. **Biotechnology and Genomics**, Gupta P.K: (2004) Rastogi publication.
 4. **Gene cloning and DNA analysis** Brown, T.A (1996),. Blackwell science, Osney Mead, Oxford.
 5. **A text book of Biotechnology**, Dubey, R. C. (2007), S.Chand & Company Ltd. New Delhi.
 6. **Biotechnology**, Singh, B. D (2004). Kalyani Publishers, New Delhi
- Note: This paper is offered for other major students.

WEB LINKS

<https://www.mooc-list.com/tags/biotechnology>

https://onlinecourses.swayam2.ac.in/cec20_bt07/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	III
CORE PRACTICAL - III	III
PAPER CODE	21UBTP03
TITLE OF THE PAPER	LAB IN MICROBIOLOGY
HOURS/WEEK	3
NO. OF CREDITS	3

LEARNING OBJECTIVES

The main objectives of this course are to:

To introduce an fundamentals of cell biology and microbiology techniques

To teach students the basic techniques and instrument principles in biotechnology

To give hands on microbiology and cell biology experiments

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

Be aware of the laboratory rules and regulations

Understand the importance, evolution and diversity of cells and preparation of Buffers

Learns to visualize the cells by employing different types of microscopes

Bring in the concepts of microbial culturing techniques

Analysis of phenotypic characterization of known and unknown microbes and basic instruments

1. Media Preparation (Solid & Liquid, Semi Solid) and Sterilization.
2. Isolation & Enumeration of Microorganism from water and Soil.
3. Types of culture method Streak plate, Pour plate, Stab & Slant preparation.
4. Measurement of Growth rate of bacteria - Turbidometric method.
5. Staining Techniques–Gram’s staining, Spore Staining, Lacto phenol Cotton Blue Staining.
6. Hanging drop technique (Motility Test).
7. Characterization of microorganisms -IMVIC tests.
8. Microscopic slide preparation –Fungi & Bacteria.

9. Antibiotic sensitivity Test - Kirby Bauer method

REFERENCE BOOKS

Benson HJ. Microbiological applications: a laboratory manual in general microbiology. WCB/McGraw-Hill; 1998

Cullimore DR. Practical manual of groundwater microbiology. CRC Press; 2007 Dec 17

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://www.azolifesciences.com/article/What-is-a-pH-Meter-and-How-Does-it-Work.aspx>

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FOURTH SEMESTER

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER	IV
CORE THEORY-IV	IV
PAPER CODE	21UBT04
TITLE OF THE PAPER	MOLECULAR BIOLOGY
HOURS/WEEK	6
NO. OF CREDITS	4

LEARNING OUTCOME:

Upon successful completion of the Molecular & Cellular Biology undergraduate curriculum, students will be able to:

of Transcription and processing of transcripts, RNA editing.

1. **Molecular Events of understand and appreciate the diversity of life as it evolved over time by processes of mutation, selection and genetic change.**
2. **explain that the growth, development, and behavior of organisms are activated through the expression of genetic information in context.**
3. **Summarize that biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of physics.**
4. **execute quantitative analysis to interpret biological data.**
5. **construct and utilize predictive models to study and describe complex biological systems.**
6. **apply concepts from other sciences in order to interpret biological phenomena.**
7. **communicate biological concepts and understanding to members of a diverse scientific community as well as to the general public.**

COURSE OUTCOMES

Learning structural levels of nucleic acids- DNA and RNA and genome organization in prokaryotes and eukaryotes

Understanding the concept of Gene and the gene architecture.

`Overview of the central dogma of life and various molecular events Learning molecular events in the DNA replication and role of different enzymes

Molecular Events Translation leading to protein synthesis and Post translational modification.

Understanding the regulation of gene expression in prokaryotes using operon concept and Eukaryotes.

UNIT I

Central dogma: DNA as a genetic material. Modern concept of gene organization. DNA replication in prokaryotes and Eukaryotes, Enzymes and proteins involved in replication. DNA repair mechanisms –Light and Dark.

UNIT II

Transcription & transcriptional control: (Prokaryotes and eukaryotes), Initiation, elongation, termination, promoter sequences, TATA box, Hogness box, CAAT box, Enhancers, upstream activating sequences. Post transcriptional modifications, splicing.

UNIT III

Translation: Prokaryotic and eukaryotic translation, Initiation, elongation and termination, Co and post translational modifications of proteins. Import into nucleus, mitochondria and chloroplast. Genetic code: Codon, Anti-codon,

UNIT IV

Control of gene expression at transcription and translation level: regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, Regulation of gene expression-Operon concepts (*lac&trp*). Recombination – Homologous and Non – homologous recombination.

UNIT V

Biology & Genetics of cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes (P53 and PRB genes), virus-induced cancer, metastasis, interaction of cancer cells with normal cells. Protein Microarray.

REFERENCES:

1. **T.A. Brown.**, Molecular Biology, Labfax, Bioscientific publishers Ltd, Oxford.
2. **J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steltz & A.N. Weiner.** Molecular Biology of gene (4th edition) The Benjamin/Cummings publications C Inc. California.
3. Principles of Gene Manipulation – By **R.W. Old & S.B. Primrose**, Blackwell publication.

WEB LINKS (MOOC,SWAYAM,NPTL)

<https://www.mooc-list.com/tags/molecular-biology>

https://onlinecourses.swayam2.ac.in/cec20_ma13/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER IV	IV
NMEC-2	II
PAPER CODE	21UBTN02
TITLE OF THE PAPER	BIOTECHNOLOGY FOR HUMAN WELFARE
HOURS/WEEK	2
NO. OF CREDITS	2

LEARNING OBJECTIVES

The goal of biotechnology is to produce, drugs , vaccine, transgenic and plants by using living organisms such as bacterial cells, yeast, mammalian cells, etc.,

The course is designed to give an idea about the role of biotechnology in relation to Human Welfare i.e Sericulture. Aquaculture. Vermiculture, Mushroom technology

Biofertilizers. Biopesticides. Biorepellants, Pest control and management. Biomass (SCP). Bioplastics. Bioweapons

COURSE OUTCOMES

Students who successfully complete this unit will be able to:

Describe the basic principles and techniques used for the study and manipulation of DNA

Appreciate the application of biotechnology in diverse areas such as health and medicine, agriculture and/or the environment

Conduct and/or observe a variety of laboratory exercises where some of the above theoretical knowledge is applied to practical situations

Demonstrate the ability to work safely and communicate effectively.

UNIT I

Sericulture. Aquaculture. Vermiculture, Mushroom technology.

UNIT II

Biofertilizers. Biopesticides. Biorepellants, Pest control and management. Biomass (SCP). Bioplastics. Bioweapons.

UNIT III

Bio dyes, Bio fuels , - Biodiesel & Biogas. Bioindicators. Biodegradation- Role of GMO's.

UNIT IV

Production of Penicillin, Recombinant Vaccines (HBV). Recombinant Insulin. Plantibodies. Vaccines in animal cells, Gene therapy.

UNIT V

Transgenic animal and their applications – Mice, Sheep and Fish. Transgenic plants and their applications – BT Cotton, Flavr – Savr tomato and Golden rice.

REFERENCE

1. **Animal Biotechnology**, M.M. Ranga, (2000), Agrobios (INDIA),
2. **Introduction to Plant Biotechnology** Chawla, (2003) (2nd edn) Oxford and IBH publishers.
3. **Biotechnology**, Satyanarayana. U, (2008) Books and allied (p) Ltd.
4. **Industrial Microbiology** – A.H. Patel, MacMillan Publishers , 2005
5. **A text book of Biotechnology** , R.C. Dubey , (2001), Rajendra Printer. New Delhi.
6. **Environmental Biotechnology**. A.K. Chatterji. Third edition. PHI Learning Pvt Ltd. New Delhi.

Web link : (MOOC,SWAYAM,NPTEL)

<https://www.mooc-list.com/tags/biotechnology>

https://onlinecourses.swayam2.ac.in/cec20_bt07/preview

https://onlinecourses.swayam2.ac.in/cec21_bt03/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER IV	IV
CORE PRACTICAL – IV	IV
PAPER CODE	21UBTP04
TITLE OF THE PAPER	LAB IN MOLECULAR BIOLOGY
HOURS/WEEK	3
NO. OF CREDITS	3

LEARNING OBJECTIVES

The main objectives of this course are to :

To teach the students concept of isolation of DNA from living organism

To give hands on experience in isolation and separation of Protein, RNA and DNA.

COURSE OUTCOMES

AT the end of this course the students able to

- To acquire knowledge about basic molecular biology tools
- To develop the skills in isolating and identifying the challenges in molecular biology related tools
- To develop the skill for implementing new project plants

1.Isolation of genomic DNA from bacteria.

2.Separation of DNA by AGE.

3.Estimation of DNA (DPA method).

4.Isolation and purification of protein (Dialysis) - Demo

5.Estimation of Protein (Lowry's method).

6.Separation of protein by SDS PAGE.

7.Estimation of RNA (Orcinol method).

8.Bacterial transformation.

10.Isolation of antibiotic resistant mutant

RELATED WEB LINKS

[https://www.researchgate.net/publication/320508474 Molecular Biology Laboratory manual](https://www.researchgate.net/publication/320508474_Molecular_Biology_Laboratory_manual)

<http://www-personal.umd.umich.edu/~poelkers/OelkersMolbiolmanualUMD2016.pdf>

[https://vulms.vu.edu.pk/Courses/BIO203/Downloads/Manual BIO203 Methods%20in%20Molecular%20Biology.pdf](https://vulms.vu.edu.pk/Courses/BIO203/Downloads/Manual_BIO203_Methods%20in%20Molecular%20Biology.pdf)

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FIFTH SEMESTER

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER V	V
CORE THEORY	V
PAPER CODE	21UBT05
TITLE OF THE PAPER	PLANT BIOTECHNOLOGY
HOURS/WEEK	6
NO. OF CREDITS	5

LEARNING OBJECTIVES:

- To understand various *in Vitro* culture techniques of Plants
- To learn gene transferring mechanisms in Plants
- Impart knowledge on basics of plant tissue culture and its requirements
- Acquire knowledge about the gene transfer techniques and applications
- Understand the genetic engineering and gene modification in agriculture
- Gain insight about valuable secondary metabolites, its production and purification
- Highlight the applications of plant biotechnology in the modern era

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

- Understand scientific and technical skills on plants study
- Acquire knowledge on limitations and challenges in plant cell tissue culture.
- Know the applications of Plant Biotechnology
- Learn the preservative methods of cells
- Evaluate and discuss public and ethical concerns over the use of plant Biotechnology

UNIT - I PLA

Plant tissue culture:

Tissues culture media - Composition and its preparation. Plant Tissue Culture applications - Micropropagation, Callus culture, somatic embryogenesis, suspension culture, embryo culture, haploid culture, protoplast culture and fusion, Somoclonal variation, artificial seeds, hardening.

UNIT - II

Gene transfer:

Plant transformation technology- Ti and Ri plasmids, binary & co- integrated vector systems; viral vectors and their applications; 35S and other promoters; genetic markers- reporter genes- virulence genes- Cloning Strategies - Gene transfer methods in plants- Direct DNA transfer methods, Agrobacterium mediated nuclear transformation.

UNIT - III

Plant Genetic Engineering:

Applications of Plant Genetic Engineering – crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Genetic modification in Agriculture - transgenic plants, genetically modified foods, ecological impact of transgenic plants.

UNIT - IV

Secondary metabolites:

Secondary metabolic pathways in plants. Industrial phytochemical products from plants - Alkaloids, Biodegradable Plastics, Therapeutic proteins, antibodies, plant vaccines, herbal drugs, bioethanol and biodiesel.

UNIT - V

Plant biotechnological application:

Extraction & purification of phyto-chemicals. phytoremediation; Green house and green home technology. Molecular pharming; Applications for producing fine chemicals, drugs, and alternative fuels, herbicide and pest resistant plants, ethical issues relating to plant breeding.

TEXT BOOKS:

1. Chawla, H. S. 2013. Introduction to Plant Biotechnology. 3rd edition. Oxford & IBH publishing company.
2. Razdan, M. K. 2002. Introduction to Plant tissue culture. 2nd edition. Oxford & IBH publishing company.

REFERENCE BOOKS:

1. Grierson, D. and Covey, S.V. 1988. Plant Molecular Biology. 2nd edition. Blackie Publishers.
2. Bhojwan, S. S. 1996. Plant tissue culture - Theory and Practice. 1st edition. Elsevier Publishers

WEB LINKS

https://onlinecourses.swayam2.ac.in/cec21_bt03/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER IV	V
CORE THEORY VI	VI
PAPER CODE	21UBTP06
TITLE OF THE PAPER	IMMUNOLOGY AND IMMUNOTECHNOLOGY
HOURS/WEEK	6
NO. OF CREDITS	4

LEARNING OBJECTIVES

The main objectives of this course are to:

- This course presents the basic defense mechanism of animals
- To make the student to understand the concept immunology
- On successful completion of the subject the student should have understood:
Immunity, Antigen, Antibody, Cells of immune system and their function and regulations

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

- Design a model of Immunoglobulin/ Antibodies
- Describe which cell types and organs present in the immune response
- Illustrate various mechanisms that regulate immune responses and maintain Tolerance
- Exemplify the adverse effect of immune system including Allergy, hypersensitivity and autoimmunity
- Apply basic techniques for identifying antigen antibody interactions
- Explain the stages of transplantation responses

UNIT I

History of the immune system, Innate and Acquired immunity. Haematopoiesis. Cells and organs of the immune system.

UNIT II

Nature & biology of Antigen & super antigens. Haptens, Mitogens, Adjuvants. Humoral response – B cell activation and proliferation. Cell mediated immunity – T cell receptors and its **activation**.

UNIT III

Immunoglobulins – Structure and functions. Antigen – Antibody reactions – Agglutination, precipitation, RIA, ELISA, FACS and Immunopanning. Hybridoma technology & CCA. Organization and expression of immunoglobulin genes. Antibody Engineering & Finger Printing.

UNIT IV

Cytokines: Types and function, Complement- Properties and activation pathways, Classical, Lectin & Alternative pathway. Major Histocompatibility Complex. Immunological tolerance. Immunity to infectious agents (intra cellular parasites, helminthes viruses).

UNIT V

Transplantation immunology. Hypersensitivity and its types. Autoimmunity, Immune senescence, Cancer immunology, Vaccines. Immunotherapeutics. Immuno enhancing technology.

REFERENCES:

1. Kubey, J. 1993. Immunology Freeman and company.
2. Janeway, C.A., Immuno-biology Paul Travers 1994.
3. Seemi Farhat Basir., Text Book of Immunology by. First edition. PHI Learning Pvt Ltd, New Delhi.
4. Madhavee Latha, P., A Text Book of Immunology, First Edition. S.Chand & Company Ltd, New Delhi.
5. Ajoy Paul.. Textbook of Immunology
6. Rajasekara pandian M and Senthil kumar B., 2007. Immunology and Immunotechnology. (2007), Panima publishing corporation , New Delhi.

WEB LINKS

https://onlinecourses.swayam2.ac.in/cec20_bt05/preview

https://onlinecourses.nptel.ac.in/noc20_bt43/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER V	V
CORE THEORY VII	VII
PAPER CODE	21UBT07
TITLE OF THE PAPER	GENETIC ENGINEERING
HOURS/WEEK	5
NO. OF CREDITS	4

COURSE OBJECTIVE

The main objectives of this course are to:

1. To gain knowledge about the importance of gene manipulation and gene transfer technologies
2. To learn the concept of vectors and expression systems and methods of selection

To understand and describe the concept of Hybridization technique

COURSE OUTCOME

On the successful completion of the course, student will be able to:

Acquaint with the vocabulary involved in molecular cloning strategies and techniques used to probe DNA for specific genes of interest

Apprehend with the tools and techniques in rDNA technology and types of Vectors

Relate the role of restriction and modifying enzymes in recombinant DNA Technology

Explore the techniques involved in construction of genomic DNA library and cDNA library

Design the protocols for analyzing gene transfer methods and to explore knowledge on hybridization based markers

UNIT-I

History, scope and recent developments in Genetic Engineering; guidelines; Molecular tools in genetic engineering- Restriction enzymes: Endo & Exonucleases, Ligase. Modifying enzymes- DNA & RNA polymerase, reverse transcriptase, terminal transferase; nucleases (DNases, RNases, S1) T4 polynucleotide kinase, Alkaline Phosphatase and ligase (E.coli & T4).

UNIT-II

Ligation (cohesive & blunt end ligation) – linkers & adaptors. Cloning vectors: plasmid - definition, properties and types. pUC19 & pBR322- phage vectors (λ & M13), Cosmid vectors, Shuttle and expression vectors; YAC (*S.cerevisiae* as a model)& BAC (*E.coli*).

UNIT-III

Screening and selection of recombinants; Gene transfer methods, PCR - Principle, Types and applications.

UNIT-IV

Hybridization techniques: Probes (radio active & non radio active), detection. PCR - Principle, Types and applications; Labeling of DNA- Nick translation, Random priming method & labelling by primer extension. Construction of genomic & c DNA libraries. Gene expression in bacteria, yeast, insects, plant & mammalian cells

UNIT-V

Chromosomes engineering, targetted gene replacement, gene editing, & silencing. Site directed mutagenesis.

References:

1. Primrose, S.B. and Twyman, R.M., 2006. Principles of Gene Manipulation and Genomics - 7th Edition. Blackwell Publishing Company.
2. Dubey. R.C. A Text Book of Biotechnology. S. Chand & Co Ltd, New Delhi.
3. Brown T.A., 2008. Genomes. 3rd Edition. New York: Garland Publishing Co. New York: Garland Science.
4. Tvan R.S., 1997. Recombinant gene expression protocols. Human Press Inc., Tokowa
5. Satyanarayana. U, 2008. Biotechnology, Books and Allied (p) Ltd

WEB LINK : (MOOC,SWAYAM,NPTEL)

<https://www.mooc-list.com/tags/genetic-engineering>

https://onlinecourses.nptel.ac.in/noc19_bt15/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER -V	V
SBEC-III	III
PAPER CODE	21UBTS03
TITLE OF THE PAPER	NANOBIOTECHNOLOGY AND BIOINFORMATICS
HOURS/WEEK	2
NO. OF CREDITS	2

LEARNING OBJECTIVES

- To learn the application of nano biotechnology in biological system
- To help the students to understand about nano material and nano medicines
- To understand about application of bioinformatics

COURSE OUTCOME

The student will develop a fundamental knowledge of **nanomaterials**.

The student will demonstrate a basic understanding of the length scale that defines nano for metal and semiconductor materials.

The student will demonstrate an understanding of the challenges on safe **nanotechnology**

A student will develop a fundamental knowledge of DNA databank , protein data bank and sequence alignment tool

UNIT I:

Nanobiology – concepts, definitions, prospects; nanoparticles – size, shape, properties. Bionanoparticles – nanostarch, nano composites – dendrimers.. Types of biomaterials. Biodegradable polymers.

UNIT II:

Methods of nanobiotechnology – Analysis of bimolecular nanostructures by Atomic Force Microscopy, Scanning Probe Electron Microscopy. Nanofabrication - lithography. Drug nanoparticles -structure and preparation ,Liposomes, Cubosomes and hexosomes. Lipid based nanoparticles-liquid nano dispersion, solid liquid nanoparticles

UNIT III:

Nanotubes, Nanorods, Nanofibers and Fullerenes for nanoscale drug . Bio nanoelectronics. Applications of nanobiotechnology in medicine, drug designing and cancer treatment. Medical, social and ethical considerations of nanobiotechnology.

UNIT IV:

Bioinformatics - definition, introduction, history and scope. Databanks – Gen Bank, PDB. Literature DataBanks – PubMed. Biological databases including both proteins and nucleic

acids – sequence – EMBL, DDBJ. Structural databases – CATH, SCOP. Specialized database – genome data base, EST.

UNIT V:

Sequence Alignment based on Matrices (BLOSUM and PAM), tools for sequence alignment – BLAST, FASTA. Clustal W. Phylogenetic analysis– WPGMA, UPGMA methods.

WEB LINKS : (MOOC,SWAYAM,NPTEL)

<https://www.mooc-list.com/tags/nanotechnology>

https://onlinecourses.nptel.ac.in/noc19_bt28/preview

https://onlinecourses.swayam2.ac.in/cec21_bt04/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER V	V
CORE PRACTICAL – V	V
PAPER CODE	21UBTP05
TITLE OF THE PAPER	LAB IN PLANT BIOTECHNOLOGY
HOURS/WEEK	3
NO. OF CREDITS	4

LEARNING OBJECTIVE

The main objectives of this course are to:

- To teach students the latest techniques and principles in Plant Tissue Culture
- To give hands on experience in Plant Tissue Culture technique

COURSE OUTCOME

Understanding the concepts and principles of **Plant tissue culture**.

Learning the techniques of sterilization and monitoring method of sterilization.

Learning different pathways of **plant** regeneration under in vitro conditions - organogenesis and somatic embryogenesis.

Techniques of establishing **cell** suspension **culture**.

1. **Plant Tissue Culture Media Preparation.**
2. **Explant Preparation.**
3. **Establishment and maintenance of callus culture.**
4. **Establishment and maintenance of suspension culture.**
5. **Isolation of protoplasts using enzymatic method and viability checking**
6. **Synthetic seeds (Entrapment method).**
7. **Isolation of genomic DNA from plant.**
8. **Isolation of Chloroplast from Plant cell.**
9. **Kitchen garden Preparation and Green House Visit (Demo).**
10. **Qualitative analysis of Phytochemicals from Crude Plant Extracts.**

WEB LINKS

<https://www.grin.com/document/265322>

<https://www.springer.com/gp/book/9783642817861>

For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER V	V
CORE PRACTICAL – VI	VI
PAPER CODE	21UBTP06
TITLE OF THE PAPER	LAB IN GENETIC ENGINEERING AND IMMUNOLOGY
HOURS/WEEK	3
NO. OF CREDITS	4

LEARNING OBJECTIVES

The main objectives of this course are to:

- To teach students the latest techniques and principles in Immunology and genetic engineering

To give hands on experience in immunological techniques and genetic engineering

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

- Understand the practical skills in Immunology
Acquire skills in genetic engineering
- Examining and analyzing the results involved in immune techniques and genetic engineering
- Developing and applying the recent technology involved in diagnostic techniques of immunology and genetic engineering

IMMUNOLOGY

1. Preparation of plasma and serum.
2. Blood cell analysis – total count, differential count.
3. Agglutination tests:
 - a. ABO Blood grouping.
 - b. WIDAL test.
 - c. ASO test.
 - d. Pregnancy test.
 - e. RPR test.

4. Precipitations:

- a. Radial immunodiffusion.
- b. Double immnodiffusion.
- c. Counter Current immune electrophoresis.

5. DOT-ELISA

II GENETIC ENGINEERING

- 6. Isolation of plasmid DNA and size analysis.
- 7. Restriction digestion.
- 8. Ligation.
- 9. Transformations of recombinants in *E. coli* (Preparation of competent cells).
- 10. PCR amplification (demo).

WEB LINKS

<https://www.springer.com/gp/book/9783030646851>

<https://www.barnesandnoble.com/w/laboratory-manual-for-genetic-engineering-s-john-vennison/1123134555>

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SIXTH SEMESTER

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
CORE THEORY VIII	VIII
PAPER CODE	21UBT08
TITLE OF THE PAPER	ANIMAL BIOTECHNOLOGY
HOURS/WEEK	6
NO. OF CREDITS	5

LEARNING OBJECTIVES

To provide a basic understanding of animal biotechnology and its applications.

COURSE OUTCOMES

In the successful completion of the course, students will be able to:

To develop an understanding on basic pattern of animal cell culture and controlling characters

Acquire knowledge on handling animal cell culture and their applications

Understand the gene transfer technology ,transgenic animal and stem cell technology

Emphasize techniques on fertilization in animals and its development

Highlight the applications of animal biotechnology in various fields

UNIT -I

Animal cell culture media and reagents

Animal cell culture basics- Preparation of culture media- Role of carbon dioxide, serum and growth factors in cell culture, Types of cell culture media, Ingredients, Physiochemical properties, Antibiotics, growth supplements, Fetal bovine serum; Serum free media. Conditioned media, other cell culture reagents, Preparation and sterilization of cell culture media and other reagents.

UNIT-II

Animal cell culture

Principles of sterile techniques and cell propagation; Primary cell culture, secondary cell culture, continuous cell lines, suspension cultures - Chemically defined and serum free media for cell culture Contamination and eradication, cryopreservation of animal cells - Tissue engineering and organotypic culture, Cytotoxicity and viability assays.

UNIT-III

Gene transfer technology

Gene transfer in cells; physical, chemical and biological methods. Production of native and recombinant proteins in animal cell. Hybridoma technology and its applications- gene targeting, silencing and knock-out. Gene transfer technology in animals. Production of transgenic animals.

UNIT-IV

Fertilization in animals

Fertilization in animals: Blastulation, gastrulation, early embryonic development - fate map. Conventional methods of improvement of animal live stock: artificial insemination, in vitro fertilization, embryo culture, embryo sexing, splitting and cloning. Stem cell technology.

UNIT-V

Biotechnological application

Biotechnology of silk worm - commercial production of silk, Baculovirus in Biocontrol, Integrated pest management. Manipulation of Growth hormone - somatotrophic hormone- Thyroid hormone; Manipulation of lactation –Lactogenesis- galactopoiesis - Manipulation of wool growth.

TEXT BOOKS:

1. Freshney.R.I, "Culture of Animal cells: A manual of basic technique", Fifth edition, Wiley Publishers, 2010.
2. Ramadass.P, "Animal Biotechnology: Recent concepts and Developments", MJP Publications, India, 2008.

REFERENCE BOOKS:

1. Rastogi,V. 2001. Developmental Biology. 1st edition. Kedarnath Ramnath Publishers.
2. Leach.C.K, In vitro cultivation of Animal cell, Butterworth and Heinemann Ltd., 1994.

WEB LINKS

https://onlinecourses.nptel.ac.in/noc20_me04/preview

<https://www.blinkcourse.com/Animal-Physiology-p-8983>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
CORE THEORY -IX	IX
PAPER CODE	21UBT09
TITLE OF THE PAPER	PROTEOMICS AND GENOMICS
HOURS/WEEK	6
NO. OF CREDITS	4

LEARNING OBJECTIVES

To provide better knowledge of molecular profiling of genes and proteins for its analysis.

COURSE OUTCOMES

In this **course**, **students** will develop the molecular skills, knowledge about the handling of instruments for different applications.

UNIT I

Studying the Genome: Genetic Mapping-Markers for Genetic Mapping; RFLP, SSLP - VNTR's, STR's, SNP's; Physical Mapping - In situ hybridization, Sequence Tagged Sites Mapping.

UNIT II

Determination of nucleotide sequence: Chemical degradation method, Sanger's dideoxynucleotide synthetic method. Direct DNA sequencing using PCR, Sequencing by conventional shotgun method, Whole genome shot gun method.

UNIT III

ORF scanning – Codon bias, Exon-Intron boundaries - Exon trapping, Gene location – Southern and Northern blotting hybridization, Zoo blotting. Studying a transcriptome – Microarray or chip analysis.

UNIT IV

Proteomics - ID–SDS-PAGE, 2D-PAGE. Detection and quantitation of proteins in gels. Protein staining techniques. Affinity purification of proteins.

UNIT V

Basics of Mass Spectroscopy- MALDI-TOF and ESI and their applications in proteomics. Tandem MS/MS spectrometry.

REFERENCES:

1. **Ajoy Paul.**, 2011. Text Book of Genetics- from Genes to Genomes- Books and Allied (P) Ltd, Kolkata. Third Edition,.
2. **Keith Wilson and John Walker**, 2010. Principles and techniques of practical biochemistry-, Cambridge University Press, 7th edition. 39
3. **U.Sathayanarayana**, Biotechnology, Books and allied (p) ltd., India, 2008.
4. **Hubert Rehn**, 2006 Protein Biochemistry and Proteomics –, Academic press.
5. **Liebler, Humana W.**, 2002. Introduction to proteomics: Tools for new Biology CBS pub.

WEB LINKS <https://nptel.ac.in/courses/102/103/102103017/>

<https://www.coursera.org/courses?query=genomics&page=1>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
CORE THEORY -X	X
PAPER CODE	21UBT10
TITLE OF THE PAPER	BIOPROCESS AND ENZYME TECHNOLOGY
HOURS/WEEK	5
NO. OF CREDITS	4

LEARNING OBJECTIVES

The main objectives of this course are to:

1. Understood the applications of Microbes
2. Know about Fermentation, Microbial products, amino acids solvents, vitamins and antibiotics.
3. Understood the applications of azospirillum, bio pesticides

COURSE OUTCOMES

On successful completion of the course, student will be able to:

Narrate the scope and economics of Microbial Biotechnology

Understand the need of microbial products for the mankind

Examine the learned techniques in production of industrially important products

Think about the innovativeness in the production of new beneficial metabolites

UNIT I

Historical developments in Fermentation. Screening of industrially important microbes. Strain improvement. Inoculum development. Media formulation, Sterilization, Types of fermentation. Enzymes & cell immobilization techniques. Preservation of microbes.

UNIT II

Stoichiometry of cell growth and kinetics. Batch and continuous culture. Immobilization of Cells & Enzymes. Bioreactor- Design, parts and their function. Types of bioreactors- CSTR, Air lift, Bubble column, Packed bed, Tower. Overview of Down stream processing – Extra & Intra cellular products.

UNIT III

Monitoring and control of process variables (Temperature, pH and DO, mass transfer, heat transfer & O₂ transfer mechanism). Computational control of fermentors.

UNIT IV

Biofertilizers – Azola, Azospirillum, Rhizobium, VAM. Biopesticides, Production of microbial products: Enzymes- Amylase, Organic acid- Citric acid, Amino acid- Glutamic acid, Antibiotics- Penicillin, Solvent- Ethanol, Vitamins- Riboflavin and SCP. Mushroom technology,

Vermitechnology, Petro corps. Quorum sensing in bioprocess. Biodyes.

UNIT V

Industrial Enzymes: Thermophilic enzymes, Lipases, Proteolytic enzymes in meat, leather & detergent industries, Enzymes in Fermentation process, cellulose & metal degrading enzymes. Enzyme Engineering- Designer enzymes.

REFERENCES:

1. **Alexandar N. Glazer & Hiroshi Nikaido** Microbial Biotechnology (Fundamental of Applied Microbiology)
2. **El – Mans, E.M.T., and Bryce, C.F.A.** 2002. Fermentation Microbiology and Biotechnology. Taylor & Francis group.
3. **A. H. Patel**, 2005. Industrial Microbiology –MacMillan Publishers.
4. **Satyanarayana. U**, 2008. Biotechnology, , Books and Allied (p) Ltd
P. Ponmurugan, Nithya Ramasubramanian and Fredimoses. 2012. Experimental Procedures in Bioprocess technology and Down stream processing. Anjana Book House, Chennai

WEB LINKS

<https://www.classcentral.com/course/swayam-principles-of-downstream-techniques-in-bioprocess-3967>

<https://www.classcentral.com/course/swayam-industrial-biotechnology-14122>

https://onlinecourses.nptel.ac.in/noc19_bt31/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
SBEC – IV	IV
PAPER CODE	21UBTS04
TITLE OF THE PAPER	PHARMACUETICAL BIOTECHNOLOGY
HOURS/WEEK	2
NO. OF CREDITS	2

LEARNING OUTCOME

The main objectives of this course are to:

- To make the student to understand the concept therapy.
- This Pharmacology is the study of inherited variation in drug response.

To understand the basic steps in the drug research, toxicological, pre-clinical and clinical studies

COURSE OUTCOME

On the successful completion of the course, student will be able to:

Compare and contrast the specific pharmacology of the major classes of drugs, important distinctions among members of each class

Understand the medicinal and pharmaceutical importance of drug compounds

Analyze the fundamental principles of pharmacokinetics and pharmacodynamics.

UNIT I:

History & principle of pharmacology. Drug names & classification systems. General principle of drug action

– Pharmacokinetics, Pharmacodynamics. Measurement of drug action.

UNIT II:

Chemotherapeutic drugs – Protein Synthesis Inhibitors, Anti-Inflammatory, Antibacterial, Antifungal, Antiviral, Anthelmintic, Anticancer Drugs.

UNIT III:

Production of biological – Human insulin, HGH, Erythropoietins, IFN, TNF, IL, Clotting factor VIII.

Synthetic therapy: Synthetic DNA, therapeutic ribozymes, synthetic drugs.

UNIT IV:

Prenatal diagnosis: Invasive Techniques- Amniocentesis, Fetoscopy, Chronic Villi sampling (CVS), Non Invasive Techniques – Ultra Sonography. Diagnosis using protein & enzymes

markers, DNA/RNA based diagnostics.

UNIT V:

Tissue Engineering: Skin, Liver, Pancreas. Recombinant vaccines, Cell adhesion based therapy: Integrins, Inflammation.

REFERENCE

1. **S.S. Purohit, Kaknani, Saleja** Pharmaceutical Biotechnology.
2. **Mary J. Myuk, Richard A. Hoarey, Pamala Lippinwitt Williams** Pharmacology edition.
3. **H.P. Rang, M.M. Pale, J.M. Moore**, Churchill Livingston. Pharmacology.
4. **Page, Curtis, Sulter, Walker**, Halfman Integrated pharmacology. Mosby Publishing Co.
5. **N. Murugesh**, A concise Text Book of Pharmacology. Sixth edition. Sathya Publishers, Madurai.
R.C. Dubey, A Text Book of Biotechnology. S. Chand & Co Ltd, New Delhi

WEB LINKS

<https://www.coursera.org/courses?query=pharmaceutical&page=1>

https://onlinecourses.swayam2.ac.in/cec20_lb05/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
CORE PRACTICAL – VII	VII
PAPER CODE	21UBTP07
TITLE OF THE PAPER	LAB IN ANIMAL BIOTECHNOLOGY
HOURS/WEEK	3
NO. OF CREDITS	4

LEARNING OBJECTIVES

At the end of this course the student is expected to

Study the culture techniques of the animal cell culture

To ensure the students to understand about the production of transgenic products and their therapeutic applications

COURSE OUTCOMES

on the successful completion of the course, students will be able to

understand the practical skills in animal biotechnology

acquires skills in animal tissue culture

examining and analyzing the results involved in animal tissue culture technique

1. Preparation of animal cell culture media.
2. Preparation & sterilization of balanced salt solution and DBSS.
3. Disaggregation of tissues – trypsinization.
4. Culture of chick embryo fibroblast (monolayer).
5. Single cell suspension culture.
6. Viability test and cell counting.
7. Inoculation of virus and observation- Demo.
8. Applications of Co2 incubator & inverted microscope.
9. Isolation of genetic DNA from animal tissue.
10. Application of membrane filter – Demo

WEB LINKS

<https://www.mooc-list.com/course/cell-culture-basics-canvasnet>

<https://nptel.ac.in/courses/102/104/102104059/>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
CORE PRACTICAL – VIII	VIII
PAPER CODE	21UBTP08
TITLE OF THE PAPER	LAB IN BIOPROCESS TECHNOLOGY AND ENZYMOLOGY
HOURS/WEEK	3
NO. OF CREDITS	4

LEARNING OBJECTIVES

The main objectives of the course is to facilitate:
 The Students to gain sound technical knowledge and hands on practical skills in various aspects of bioprocess Biotechnology and enzymology

COURSE OUTCOMES

On the successful completion of the course, student will be able to:
 Acquire an overview about the fundamentals of Bioprocess Technology and enzymology tools and their application in industry, agriculture and milk production

1. Isolation of industrially important enzymes in microorganism (amylase and protease).
2. Isolation of Antibiotic Producing Microorganism.
3. Production & Estimation of Biomass (SCP), Dry weight & Wet weight methods.
4. Production of wine and estimation of Alcohol.
5. Immobilization of yeast cells & Enzymes.
6. Production & Estimation of citric acid.
7. Isolation of *Rhizobia* from Root Nodules.
8. Determination of TDT & TDP.
9. Assay of Amylase and Protease enzyme.

10. Qualitative analysis of milk.

11. Mushroom Cultivation (Demo).

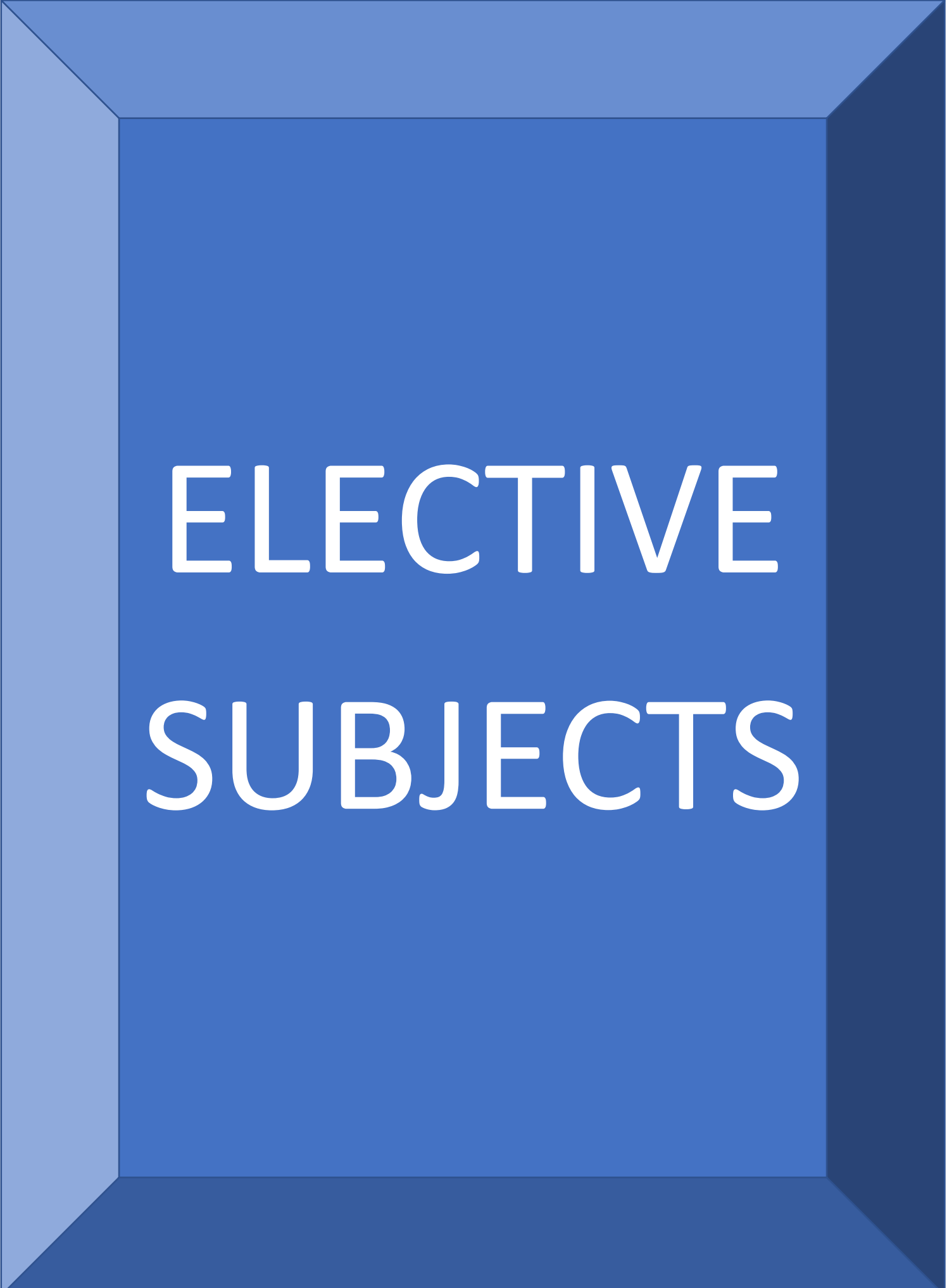
12. Vermicompost Production (Demo).

WEB LINKS

https://onlinecourses.nptel.ac.in/noc19_bt31/preview

<https://www.classcentral.com/course/swayam-industrial-biotechnology-14122>

<https://www.classcentral.com/course/swayam-principles-of-downstream-techniques-in-bioprocess-3967>

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ELECTIVE SUBJECTS

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER V	V
ELECTIVE SUBJECT	PART III
PAPER CODE	21UBTE01
TITLE OF THE PAPER	MEDICAL BIOTECHNOLOGY
HOURS/WEEK	5
NO. OF CREDITS	4

LEARNING OUTCOME

- Understanding of advantages and hazards of microbial world. Advanced knowledge for growth and control micro organisms for wealth production.
- To give students a solid foundation in biology and chemistry.
- To develop analytical and critical thinking skills in biological phenomena through scientific methods

COURSE OUTCOMES

On the successful completion of the course, student will be able to:

Understand the role of biotechnology in healthcare
 describe the pharming for human proteins and nutraceuticals
 analyze the diagnosis and prediction of disorders.
 Evaluate the recent developments in medical biotechnology

UNIT I

Tools of Medical Biotechnology – Biotechnological revolutions- Genomics, combinatorial chemistry, insight into basic biology-Areas of application, Diagnosis and prediction of disorders, Limits and approaches

UNIT II

Principle : ELISA ,western blotting immunofluorescence ,flow cytometry
 Assays : Proliferation assay (lymphocyte,MTT), Cell cytotoxicity,apoptosis

UNIT III

Role of biotechnology in healthcare. Worldwide market and work in medical biotechnology.Vaccine Production-New developments. Biosensors in clinical diagnosis, chiral technology,monoclonal antibodies for immunotherapy.

UNIT IV

Prenatal diagnosis - Invasive techniques and Non-invasive techniques – Diagnosis of pathogenic microbes: Classical and modern methods- Diagnosis using protein and enzyme markers, DNA/RNA based diagnosis - Molecular markers - Microarray technology - genomic and cDNA arrays.

UNT V

Recent developments in medical biotechnology –Pharming for human proteins and nutraceuticals. Tissue engineering and therapeutic cloning, Application of nanotechnology in biomedical sciences- Green anaosubstances, gene delivery, drug delivery. Nanotechnology in replacing defective cells.

REFERENCE BOOKS

Fundamentals of medical biotechnology by Aparna Rajagopalan, Ukaaz publications.

Medical biotechnology by S.N.Jogdand, Himalaya publications

Medical Microbiology- Mackie and Mc Cartney

Jogdand, S. N. Medical Biotechnology, Himalaya Publishing house, Mumbai, 2005.

Click, B. R. and Pasternak. Molecular Biotechnology: Principle and applications of recombinant DNA. ASM Press, 2010

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://www.toppr.com/guides/biology/biotechnology-principles-and-process/tools-of-biotechnology/>

<https://www.slideshare.net/aiswaryababunaishu/applications-of-medical-biotechnology>

<https://byjus.com/biology/application-biotechnology-medicine/>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER V	V
ELECTIVE SUBJECT	PART III
PAPER CODE	21UBTE02
TITLE OF THE PAPER	ENZYME AND ENZYMETECHNOLOGY
HOURS/WEEK	5
NO. OF CREDITS	4

COURSE SCOPE & OBJECTIVES:

- This course provides the theory and knowledge relevant to the enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics.
- Students will also be introduced to the theory as well as applications of enzyme technology in food, medical, and household industries.
- This course serves to provide an awareness of the current and possible future applications of enzyme technologies.

Course Outcomes:

Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms

Discuss various applications of enzymes that can benefit human life

Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.

Unit I- Introduction to Enzymes

General introduction and historic background- General Terminology, Nomenclature and Classification of Enzymes. Enzyme units-Katal and IU. Enzyme activity. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes. Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways. Classification of coenzymes. Isozymes, Abzymes, Synzyme

Unit II- Enzyme Catalysis and Inhibition

Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Serine proteases-Chymotrypsin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens). Reversible Inhibition- Competitive, Non Competitive, Uncompetitive. Irreversible Inhibition- Suicide inhibition. Examples and Mechanism of various Inhibitions like Penicillin, & Iodoacetamide.

Unit III - Enzyme Kinetics

Factors affecting the enzyme activity- Concentration, pH and temperature. Michealis-Menten Equation, K_m , V_{max} , L.B Plot, Turnover number, K_{cat} . Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes.

Unit IV- Enzyme Organisation

Organisation of enzymes in the cell. Enzymes in the cell, localization, compartmentation of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and nonlysosomal pathways, examples.

Unit V Industrial and Clinical uses of Enzymes (Applied Enzymology)

Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, cellulose degrading enzymes, Metal degrading enzymes.

Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflammatory agents, streptokinase, asparaginase, Isoenzymes like CK and LDH. Immobilization of enzymes, Biosensors. Enzyme Engineering and site directed mutagenesis, Designer enzymes.

TEXT BOOKS:

1. Fundamentals of Enzymology : Nicholas Price & Lewis Stevens
2. Enzymes : Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer
3. Biochemistry text books by Stryer, Voet and Lehninger (Relevant Chapters)
4. Proteins by Gary Walsh

WEB LINKS

https://onlinecourses.swayam2.ac.in/cec20_bt20/preview
<https://nptel.ac.in/courses/102/102/102102033/>
<https://www.mooc-list.com/tags/enzymes>

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
ELECTIVE SUBJECT	PART III
PAPER CODE	21UBTE03
TITLE OF THE PAPER	FOOD BIOTECHNOLOGY
HOURS/WEEK	5
NO. OF CREDITS	4

LEARNING OBJECTIVES

The main objectives of the course is to

Make the students to understand the concept of food colors, food flavoring agents, food sweeteners.

Acquire a basic understanding about the food engineering operations

COURSE OUTCOME

On successful completion of the course, student will be able to:

Narrate the scope and economics of Food Biotechnology

Understand the need of edible vaccine products for the mankind

Examine the learned techniques in production of Genetically modified food.

Think about the innovativeness in the production of new beneficial food flavoring agents.

UNIT I :

Microorganisms associated with food - bacteria, fungi & yeast. Enzymes in food preparation. Food contaminations. Food preservation. Food carcinogens & mutagen (N – nitrosamines, Acrylamide & their mode of action)

UNIT II

Food borne diseases. Food Allergens. Antioxidants. Food colors (natural & artificial food colourants). Food flavoring agents. Properties & function of Emulsifiers & Stabilizers in food. Food Sweeteners – Saccharine, Acesulfane, Aspartame & Sucrolose).

UNIT III:

General principle, plant design, construction, functionality of building, Plant layout. Pest proofing / fumigation methods. Water supply to food processing unit.

UNIT IV:

Food engineering operations: Characteristics of food raw materials, preparative operations in food industry, cleaning of food raw materials, sorting of foods, grading of foods. Sensory evaluation of food quality, quality factors for consumer

safety. FSSAI, HACCP FDA.

UNIT V:

Cleaning and sanitation of process plants. Classification & Characterization of waste from food industry. Treatment methods for solid & liquid waste.

Genetically Modified Food – Bovine somatotropin, alpha lactalbumin & lactoferrin in milk, Edible vaccine (Cholera vaccine –potatoes & Hepatitis B vaccine - maize).

REFERENCES:

1. **B.Siva** 2011.Food Processing & Preservation –PHI Learning Pvt Ltd.
2. **D.G. Rao**, 2010. Fundamentals of Food Engineering –PHI Learning Pvt Ltd.
3. **Narang**, Food Microbiology
4. **Michael P. Doyle, Larry. R.** Food Microbiology – Fundamentals & Frontiers
5. **Frazier**, Food Microbiology
6. **Yiu Hui & G. Khachatourians**, Food Biotechnology
7. **ibek, Laramie & Bhunia**, Fundamentals of Food Microbiology, CRC Press.

RELATED ONLINE COURSE

<https://www.mooc-list.com/tags/food-technology>

https://onlinecourses.swayam2.ac.in/cec19_ag01/preview

(For the candidates admitted from the Academic year 2021 –2022 onwards)	
COURSE	B.Sc. Biotechnology
SEMESTER VI	VI
ELECTIVE SUBJECT	PART III
PAPER CODE	21UBTE03
TITLE OF THE PAPER	ENTREPREURSHIP IN BIOTECHNOLOGY
HOURS/WEEK	5
NO. OF CREDITS	4

COURSE SCOPE & OBJECTIVES:

Students will be able to compost in a limited space and describe the decomposing process. The interested students will get the knowledge of Apiculture and Aquaculture. Students will get the employment and they can generate employments, They will also turn towards organic farming. It will help to maintain the environment pollution free and will get the knowledge of biodiversity.

Course Outcome:

Entrepreneurship minors will be able to

1. Sell themselves and their ideas.
2. Find problems worth solving.
3. Create values,

Unit I - Apiculture

Importance and history of apiculture. Different species of honey bees. Morphology, anatomy, colony organization and life cycle. Beekeeping equipment. Social behaviour. Queen rearing. Handling of bee colonies and manipulation for honey production.

Unit II – Aquaculture

Introduction – Importance of Inland fisheries principles and aim of fish culture Qualities of culturable fishes. Types of fish culture – mono culture – composite culture – paddy cum fish culture. Fresh water Prawn culture – Preparation of farm – Reproduction – Seed collection and Transport.

Unit III – Vermicomposting

Vermicomposting : Introduction and Scope. Types of Earthworm and Classification Epigeic, Endogeic, Diageic. Life history of Earthworms (Earthworm Species *Eisenia foetida*). Pests and diseases of Earthworms. Different Methods of Vermicomposting: Small and large scale Bed method, Pit method. Physico- chemical analysis of vermicompost: Nutrient content of vermicompost and their role in agriculture.

Unit IV – Biofertilizers

Biofertilizers – Introduction, biofertilizers using nitrogen fixing microbes & phosphate solubilization. Cultivation, mass production and inoculation of Rhizobium, Azotobacter, Azospirillum, Azolla and cyanobacteria, Carrier-based inoculants, methods of application,

Unit V – Biopesticides

Biopesticides – Bacillus thuringiensis, B. sphaericus, B. popilliae, Psuedomonas syringae. Biocontrol- Microbial control of plant pathogens- Trichoderma. Biological Control – Use of Baculovirus & NPV virus in biological control.

References:

K. Shanmugam. 1992. Fishery Biology and Aquaculture, LEO Pathippagam. Chennai.
The Textbook of Vermicompost, Vermiwash and Biopesticides : Keshav singh and et al Publisher: Biotech Books.
Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.
Bio-fertilizers in Agriculture and Forestry, 1995, by N.S. Subba Rao.
Honey Bee Biology and Beekeeping, Revised Edition. Wicwas Press, Kalamazoo.
Pradip V Jabde, 1993.
Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture, Agricultural Pests and their Controls. Discovery Publishing House, New Delhi. Eva Crane, 1999.

WEB LINKS

<https://www.mitconbiopharma.com/training/bio-tech-training/certificate-course-in-biofertilizers-biopesticides-production/>

<https://www.wireless.education/study/basics-of-fertilizers-science-online-course-by-udemy/>

<https://www.coursera.org/lecture/solid-waste-management/3-10-vermicomposting-of-biowaste-FlljL>

<https://www.openlearning.com/courses/aquaculture-sta2473-/>

MODEL QUESTION PAPERS

(For the candidates admitted from 2021–2022 onwards)

Third Semester

FOUNDATION ENGLISH – III

Time : Three hours

Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions

1. Dr. Kalam take an active interest in the field of Science and —————
(a) Social (b) Arts
(c) Technology (d) Politics
2. The Prince ordered to erect his _____ public places and in Churches.
(a) Palace (b) Building
(c) Statue (d) Tower
3. The story 'Last Leaf' was set in ————— village.
(a) Greenwich
(b) Hertfordshire
(c) Greenworth
(d) Brownwich
4. Robert Burns was a _____ Poet.
(a) English (b) Scottish
(c) French (d) Canadian
5. The poem "La Belle Sans Merci" is a —————
(a) lyric (b) ballad
(c) epic (d) sonnet
6. The poem "The Unknown Citizen" is a/an _____ on the life of Modern man.
(a) satire (b) comedy
(c) ballad (d) epic
7. _____ says that he will marry Mrs. John Shorrocks.
(a) Ben (b) Slater
(c) Abel (d) George
8. The play, 'Underfire' takes place on _____
(a) 30th May 1824 (b) 13th May 1824

(c) 30th May 1842 (d) 31st May 1842

9. The ————— of Police does not want the Queen to drive out.
- (a) Commissioner
(b) Inspector
(c) Sub-Inspector
(d) Chief Inspector
10. Choose the correct Adjective: How ————— eggs are in the basket?
- (a) much (b) many
(c) kilo (d) more
11. Choose the correct Preposition: She threw him out _____ the house.
- (a) of (b) off
(c) on (d) above
12. Change the following into the indirect speech: Ravi said, "We can't play here."
- (a) Ravi said that they could not play there,
(b) Ravi told that they could not play there.
(c) Ravi told that they could play there
(d) Ravi said that they can play there
13. Choose the appropriate question: It is only three hundred
- (a) How much is this shirt?
(b) What colour is this shirt?
(c) Is this shirt beautiful?
(d) Do you like this shirt?
14. Choose the appropriate tag question: Pooja is a singer
- (a) Isn't she? (b) Is she?
(c) Does she? (d) Doesn't she?
15. In a group discussion never _____ when others speak.
- (a) listen (b) intervene
(c) be patient (d) take notes PART B

— (2 × 5 = 10 marks)

Answer any TWO questions, out of Five

16. Sketch the character of Sue in the story "Last Leaf"?
17. What is the central idea of the poem "La Belle Dame Sans Merci"?

18. Why does Prince Albert feel afraid?
19. Write a paragraph on the proverb "All That glitters is not gold".
20. Explain the term "Group Discussion". PART C — (5 ×

10 = 50 marks)

Answer ALL questions.

21. (a) Describe how Kalam appeal for creating a harmonious India.

Or

- (b) Narrate the story of "The wicked Prince" in your own words.

22. (a) Write a critical appreciation of the poem "A Red, Red Rose" by Robert Burns.

Or

- (b) Explain the main message of Long Fellow's "The Psalms of Life:'

23. (a) Bring out the irony of the title and sketch the moral values of "The Dear Departed".

Or

- (b) Write a critical appreciation of the play "Under Fire".

24. (a) Rewrite the following sentences placing adjectives in their right positions:

- (i) The weather is today fine.
- (ii) I met a Canadian tall writer
- (iii) Wonderful lotus is a flower
- (iv) Gold is a metal costly
- (v) My Uncle is a teacher brilliant.

Or

- (b) Draft a notice displayed at the entrance of a park, giving details about the visiting hours, cost of admission tickets to adults and children etc.

25. (a) Frame the appropriate questions for the following sentences:

- (i) They study in Government Arts College.
- (ii) My name is Raju.
- (iii) She writes quickly
- (iv) He visited Chennai, yesterday
- (v) Raja is my best friend.

Or

- (b) Discuss the topic, "Environmental Pollutions".

(For the candidates admitted from 2021–2022 onwards)

GENERAL MICROBIOLOGY

Time : Three hours

Maximum : 75 marks PART

A — ($15 \times 1 = 15$ marks)

Answer ALL the questions.

1. According to Pasteur statements which one of the following is true
 - (a) Living organisms discriminate between stereoisomers
 - (b) Fermentation is a aerobic process
 - (c) Living organisms doesn't discriminate between stereoisomers
 - (d) Both a and b
2. "I found floating thern earthly particles, some green streaks, spirally wound serpent-wise, and orderly arranged, the whole circumstance of each of these streaks was about the thickness of a hair on one's head"..... These words are of
 - (a) Pasteur
 - (b) A. Jenner
 - (b) Leeuwenhoek
 - (d) Koch
3. Bacterial transformations were discovered by
 - (a) Ederberg and Tatum
 - (b) Beadle and Tatum
 - (c) Griffith
 - (d) Jenner
4. Resolving power of a microscope is a function of
 - (a) Wavelength of light used
 - (b) Numerical aperture of lens system
 - (c) Refractive index
 - (d) Wavelength of light used and numerical aperture of lens system
5. In fluorescence microscopy, which of the following performs the function of removing all light except the blue light?
 - (a) Exciter filter
 - (b) Barrier filter
 - (c) Dichroic mirror
 - (d) Mercury arc lamp
6. In Phase contrast microscopy, the rate at which light enters through objects is
 - (a) Constant
 - (b) Inversely proportional to their refractive indices
 - (c) Directly proportional to their refractive indices
 - (d) Exponentially related to their refractive indices

7. Teichoic acid present in Gram-positive bacteria can bind to which ion?
- (a) Fe ions (b) Phosphorus ions
(c) Mg ions (d) Sulphur ions
8. Bacteria having clusters of flagella at both poles of cells are known as?
- (a) Lophotrichous (b) Peritrichous
(c) Amphitrichous (d) Monotrichous
9. Poly-beta-hydroxybutyrate(PHB) present in aerobic bacteria can serve as?
- (a) a reserve carbon and energy source
(b) a reserve source of phosphate
(c) acceptor of oxygen
(d) provides buoyancy
10. Which of the following is the nutritional characterization of *Escherichia coli*?
- (a) Chemotrophic
(b) Organotrophic
(c) Autotrophic
(d) Chemotrophic, Organotrophic, Heterotrophic
11. Which of the following instrument is used for sterilizing the media after it has been prepared?
- (a) Autoclave
(b) Laminar Air Flow Chamber
(c) Inoculum Needle
Incubator
12. Which of the following method can be used to determine the number of bacteria quantitatively?
- (a) Streak-plate
(b) Spread-plate
(c) Pour plate
(d) Pour-plate and spread plate
13. Which of the following chemotherapeutic agent is extensively used because of their antibacterial effectiveness in a wide range of bacterial infections?
- (a) arsphenamine
(b) sulfanilamide
(c) sulfonamide
(d) sulfadiazine
14. Which of the following antibiotics not involved in the inhibition of specific enzyme systems?
- (a) Penicillin
(b) Tetracycline
(c) Sulphonamides
(d) Chloramphenicol

15. Interference mechanism of ciprofloxacin and norfloxacin is due to their action on
- (a) Cell wall synthesis
 - (b) Cell membrane synthesis
 - (c) DNA Function
 - (d) Protein Synthesis

PART B — ($2 \times 5 = 10$ marks)

Answer any Two questions.

- 16. Describe the experiment of Louis Pasteur for fermentation?
- 17. Explain differential staining.
- 18. Flagella is locomotory organ for bacteria. Explain
- 19. What are the methods of preservation of culture?
- 20. Bring out the general characteristics of Antimicrobial drug?

PART C — ($5 \times 10 = 50$ marks)

Answer ALL questions.

21. (a) Give a detailed account on contribution of Leewenhock and Louis Pasteur for microbiology

Or

(b) Explain in detail about biogenesis of microbiology

22. (a) Compare and Contrast the characteristics of bright field and Dark field microscopy

Or

(b) Illustrate with neat diagram, explain the working principles and application of fluorescent microscopy.

23. (a) Describe with labelled diagram in words the fluid mosaic model for cell membrane.

Or

(b) Explain in detail about the structure and flagella movement in prokaryotic cell.

24. (a) Discuss the way in which micro-organism are classified based on their requirement for energy and electron.

Or

(b) Explain how environmental factors affecting bacterial growth.

25. (a) Give a detail account on mechanism of action of antimicrobial drug as cell wall synthesis inhibitor with two examples

Or

(b) Comment on Antibiotic sensitive test

(For the candidates admitted from 2021–2022 onwards)

Third Semester

Biotechnology

SBEC – DEVELOPMENT BIOLOGY

Time : Three hours

Maximum : 75 marks PART A

— (15 × 1 = 15 marks)

Answer ALL questions.

1. What happens during spermatogenesis
 - (a) Mitosis
 - (b) Meiosis
 - (c) Mitosis and Meiosis
 - (d) None of the above
2. Middle piece of mammalian sperm contains
 - (a) Centriole
 - (b) Mitochondria
 - (c) Nucleus and mitochondria
 - (d) Centriole and mitochondria
3. Cessation of menstrual cycle is called as
 - (a) Ovulation
 - (b) Menopause
 - (c) Parturition
 - (d) Menarche
4. Which of the term best suits for milk production
 - (a) Lactation
 - (b) Parturition
 - (c) Mensuration
 - (d) Ovulation
5. Fertilization of sperm and ovum takes place in
 - (a) Ampulla of oviduct
 - (b) Isthmus of oviduct
 - (c) Fimbriae of oviductd
 - (d) Uterus
6. In the absence of acrosome the sperm cannot
 - (a) Penetrate into egg
 - (b) Get energy
 - (c) Get food
 - (d) Swim
7. The types of cleavage found in insects is
 - (a) Holoblastic
 - (b) Discoidal
 - (c) Superficial
 - (d) Meroblastic

8. How many cleavages are completed in the 16-celled stage of an egg?
- (a) 12 (b) 8
(c) 4 (d) 3
9. The fertilized egg divides by the process of
- (a) Oogenesis (b) Cleavage
(c) Regeneration (d) Invagination
10. Male gametophyte of angiosperms is shed as _____ celled pollen grain
- (a) Four
(b) Three
(c) Microspore mother cell
(d) Anther
11. Female gametophyte of angiosperm is represented by
- (a) Ovule
(b) Megaspore mother cell
(c) Embryo sac
(d) Nucleus
12. Embryo sac occurs in
- (a) Embryo (b) Axis part of embryo
(c) Ovule (d) Endosperm
13. Lateral roots originated in
- (a) Cortex (b) Endodermal cells
(c) Pericycle (d) Cork Cambium
14. The apical meristem of roots is found in
- (a) Taproots (b) Radicals
(c) Adventitious roots (d) All the roots
15. Intercalary Meristem results in
- (a) Primary growth
(b) Secondary growth
(c) Apical growth
(d) None of these

PART B — ($2 \times 5 = 10$ marks) Answer any

TWO questions out of Five.

16. Give an account on sperm banking with its importance.
17. Enlist the main characteristic features of egg and sperm.
18. Discuss briefly about cleavage and its patterns.
19. List out the advantage and disadvantage of cross pollination.
20. Write a note on Phyllotaxy and its types.

PART C — ($5 \times 10 = 50$ marks) Answer

ALL questions.

21. (a) Discuss in detail about spermatogenesis in mammals.

Or

- (b) Write an elaborate essay on Oogenesis in mammals.

22. (a) Narrate an essay on post fertilization events.

Or

- (b) Discuss in detail about the activation of sperm and egg in mammals.

23. (a) Write an account on distribution of cytoplasmic substances in the egg.

Or

- (b) Write an essay on the hormonal control of metamorphosis.

24. (a) Distinguish mega sporangium and microsporangium.

Or

- (b) Outline the concepts of experimental biology

25. (a) Explain the shoot apical meristem.

Or

- (b) Write an elaborate account on leaf development.

(For the candidates admitted from 2021–2022 onwards)

Second Semester

Allied II – BIOCHEMISTRY – II

(Common for Biotechnology / Microbiology)

Time : Three hours

Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions.

1. Which one of the following will turn red litmus blue?
 - (a) Vinegar
 - (b) Baking soda solution
 - (c) Lemon juice
 - (d) Soft drinks
2. A buffer solution comprises which of the following?
 - (a) A weak acid in solution
 - (b) A strong acid in solution
 - (c) A weak base in solution
 - (d) A weak acid and its conjugate base in solution
3. Point out the odd man out in accordance with the Henderson-Hasselbalch equation
 - (a) $\text{pH} = \text{pK}_a + \log \{[\text{conjugate base}]/[\text{Acid}]\}$
 - (b) $\text{pOH} = \text{pK}_b + \log \{[\text{conjugate acid}]/[\text{Base}]\}$
 - (c) $\text{pH} = \text{pK}_a - \log \{[\text{conjugate acid}]/[\text{Base}]\}$
 - (d) $\text{pOH} = \text{pK}_b - \log \{[\text{conjugate base}]/[\text{Base}]\}$
4. How many total molecules of ATP are synthesized from ADP via glycolysis of a single molecule of glucose?
 - (a) 4
 - (b) 38
 - (c) 36
 - (d) 5
5. How many molecules of acetyl CoA, an acetyl group attached to 'coenzyme A', are produced from a single molecule of glucose for participation in the Krebs cycle?
 - (a) 1
 - (b) 2
 - (c) 3
 - (d) 4
6. Name the pathway for glucose synthesis by non-carbohydrate precursors?
 - (a) Glycogenesis
 - (b) Glycolysis
 - (c) Gluconeogenesis
 - (d) Glycogenolysis
7. Which of the following statements about transamination reactions is correct?
 - (a) Transamination reactions involve ATP hydrolysis
 - (b) Transamination reactions are irreversible
 - (c) Transamination reactions require NAD^+ or NADP^+

- (d) Transamination reactions require pyridoxal- 5' - phosphate
8. Which of the following statements about the urea cycle is correct?
- Argininosuccinate is lysed to urea and ornithine in the urea cycle
 - Carbamoyl phosphate supplies both of the nitrogen atoms of urea in the urea cycle.
 - The formation of urea from the urea cycle yields energy.
 - Arginine is hydrolysed to urea and ornithine in the urea cycle
9. Which of the following would yield the most energy per gram when oxidized?
- Starch
 - Glycogen
 - Protein
 - Fat
10. Law of thermodynamics which states that energy can neither be created nor be destroyed is
- The second law of thermodynamics
 - Third law of thermodynamics
 - First law of thermodynamics
 - Zero-order kinetics
11. Which of the following factor is not responsible for the actual change in free energy (ΔG)?
- Temperature
 - Pressure
 - The initial concentration of reactant and products
 - pH
12. What is the standard free energy change of ATP?
- Small and negative
 - Large and positive
 - Large and negative
 - Small and positive
13. The primary role of the parathyroid gland is
- To regulate serum calcium levels
 - To regulate metabolic homeostasis
 - To send a hormonal signal to other endocrine system
 - To receive hormonal signal from hypothalamus
14. Which of the following is not a G-protein coupled receptor?
- Glycine receptor
 - Adrenergic receptor
 - Glutamate receptor
 - Muscarinic receptor
15. Which out of the following is not involved in signal transduction by β - adrenergic receptor pathway?
- GTP
 - ATP
 - cAMP
 - cGMP

PART B — (2 × 5 = 10 marks) Answer any
TWO questions out of Five

16. Give an account on basic concepts of acidity
17. What is the role of TCA cycle?

18. Discuss on carboxylation reaction with example
19. List out the inhibitors of ETC.
20. Discuss on the role of cAMP in endocrine system.

PART C — (5 × 10 = 50 marks)

Answer ALL the questions.

21. (a) Derivate the Henderson -Hasselbalch equation.
Or
(b) Explain the principle and procedure of affinity chromatography
22. (a) Recall the steps involved in glycolysis.
Or
(b) Discuss on gluconeogenesis.
23. (a) Explain the reaction of urea cycle.
Or
(b) Distinguish between beta and omega oxidation.
24. (a) Give an over view of electron transport chain with sequence of reaction.
Or
(b) Illustrate on uncouplers of oxidative phosphorylation.
25. (a) Classify the hormones
Or
(b) Highlight the synergistic and antagonistic effect of hormone interactions.

(For the candidates admitted from 2021–2022 onwards)

B.A./B.Sc./B.Com./B.B.A. DEGREE EXAMINATION,

First Semester FOUNDATION

ENGLISH - I

Time : Three hours

Maximum : 75 marks SECTION

A — (15 marks)

I. Answer the following multiple choice questions :

(15 × 1 = 15)

1. How do the guests greet each other at a wedding at 11.00 am?
(a) Good morning (b) Good afternoon
(c) Good evening (d) Good night
2. Sameer is meeting his friend Ram's friend, Joseph, at the post-office. How will he introduce himself?
(a) Hi! I'm Ram's friend
(b) Hello! I'm Sameer
(c) Excuse me. May I introduce myself. I am Ram's friend Sameer
(d) Hello, how do you do?
3. You are late for a function. Your friend Radha has been waiting for the past one hour. What will you say when you meet her?
(a) Sorry, Radha for making you wait so long
(b) Are you waiting?
(c) Sorry, Radha
(d) My friend Radha is waiting
4. What is your favourite subject?
(a) I learn English
(b) I am studying English
(c) English is my favourite subject
(d) I should learn English
5. What is the capital of Kerala?
(a) Cochin (b) Palakkad
(c) Alapuzha (d) Trivandrum
6. Choose the correct meaning of the following underlined expression.
Multiplication of human beings resulted in conflict among themselves.
(a) loving (b) fighting
(c) sharing (d) caring
7. The village people ———— goats and birds to Goddess Kali.
(a) Cooked (b) Caged
(c) Sacrificed (d) Welcomed
8. Fill in the blanks to form correct word : fl__h
(a) a, s (b) e, i
(c) a, i (d) a, e

9. The Giant had a ————— garden.
 (a) lovely (b) ugly
 (c) tiny (d) majestic
10. Give the meaning of the underlined word:
 ‘My precious child, I love you and will never leave you’.
 (a) unworthy
 (b) valuable
 (c) cheap
 (d) popular
11. Rearrange the letter to form a proper word:
 (a) Sagrifice (b) Sacrifice
 (c) Sakrifise (d) Sacrifize
12. Tom was sent to bring the —————.
 (a) ladder (b) hammer
 (c) drill (d) picture
13. Sweets with excess ghee and sugar can be
 _____.
 (a) satisfying
 (b) nauseating
 (c) satiating
 (d) fulfilling
14. Squirming means —————.
 (a) rolling
 (b) keeping straight
 (c) twisting
 (d) curving
15. The picture was hanged in the —————.
 (a) morning
 (b) afternoon
 (c) evening
 (d) midnight

SECTION — B

II) Answer any TWO of the following questions.

(2 × 5 = 10 marks)

16. Fill in the blanks with suitable response:

Prakash : Can you please tell me the
 room in which Mr. Rajan is?

Receptionist : _____

Prakash : _____

Receptionist : The visiting hours are 5 to
7 pm. Now it is 8 O'clock

Prakash : I'm sorry. _____

Receptionist : _____ I can't.
That's against the rules.

Prakash : _____

17. Say whether the following statements are true or false.

- (a) Some tiny animals called human beings a menace. (true/false)
- (b) All the natural resources multiplied. (true/false)
- (c) The branches of trees are its limbs that spread out. (true/false)
- (d) Parkesine was invented by British chemist Alexander Parkes. (true/false)
- (e) The word 'plastic' comes from Italy. (true/false)
- (f) The Giant's garden had peach trees. (true/false)
- (g) Everyone is not a precious child of God. (true/false)
- (h) There are nine Cardinal notes. (true/false)
- (i) Aunt Maria said she would not allow the children to stand around. (true/false)
- (j) The tail of the elephant was like a snake. (true/false)

18. Annotate the following.

- (a) When you saw only set of footprints, It was then
that I carried you.
- (b) Will human ego sacrifice the world. To satiate its lust
for pompous homes?

19. Fill in the blanks with suitable preposition:

- (a) Plastics have made life easier ————— us.
- (b) A nation that has no history ————— its own has nothing
in this world.
- (c) India has given ————— the world the story telling
tradition.
- (d) Kalidasa's 'Shakuntala' has been translated
————— many languages.
- (e) 'Sindhu' ————— Sanskrit means river.
- (f) Indica was written —————
Megasthenes.
- (g) The Aryans who came ————— Bharat called the river
Sindu.

- (h) How long have you been ————— the army?
- (i) Don't sit ————— that chair, it is broken.
- (j) A passenger train usually stops ————— every small station.

20. Match the words in Column A with their meaning in Column B.

S. No.	Column A	Column B
1	bawl	excited
2	seize	weapon
3	deny	shout
4	spear	refuse
5	eager	pull
6	drill	enough
7	sufficient	machine for making holes
8	immense	wake up
9	excel	great or very big
10	awake	perform very well

SECTION — C (50 marks)

21. (a) Read the following passage and answer the questions that follow : (5 × 10 = 50)

India's epics – the Ramayan and the Mahabharata – are ranked among the best in the world. Kalidasa's 'Shakuntala' has been translated in many European languages. India has given to the world the story telling

tradition and it was only from old Sanskrit tales that the Aesop's fables, the Arabian Nights and even the story of Cinderella and the Jack and the Bean Stalks were derived.

- (i) What are the two great epics of India?
- (ii) Who wrote Shakuntala?
- (iii) What are the stories that were derived from the old Sanskrit tales?
- (iv) What are the fairy tales mentioned in the passage?
- (v) What was the book translated in many European languages?

Or

- (b) Answer about your daily activities:
 - (i) What is your favourite subject?
 - (ii) When do you get up every day?
 - (iii) What do you have for breakfast?
 - (iv) When do you break for lunch?
 - (v) How many friends do you have?
 - (vi) When does your college-work start?
 - (vii) How often do you go to movies? (viii) What's your

favourite programme?

(ix) Do you have a 'smart' phone?

When do you go to bed?

1. (a) How was the selfish Giant transformed to a kind Giant?

Or

- (b) How did plastics make life much easier?

2. (a) Give reasons to say that the poem "Footprints in the Sand" is inspirational and heart-warming.

Or

- (b) Attempt an essay on the greatness of India.

3. (a) How and why is the earth becoming an 'orb that's bald'?

Or

- (b) What do you learn from the story "Uncle Podger Hangs a Picture"?

4. (a) Write a letter to the District collector about your ideas of planting and protecting trees in rural areas.

Or

- (b) Write a letter to your friend suggesting Swami Vivekananda's speeches for his reading.

(For the candidates admitted from 2021–2022 onwards)

B.Sc. DEGREE EXAMINATION,

First Semester

Biotechnology

Core I – CELL BIOLOGY

Time : Three hours

Maximum : 75 marks PART A

— (15 × 1 = 15 marks)

Answer ALL questions.

1. The quantosomes was discovered by
(a) Francis Crick (b) Part and Pon
(c) Watson and Crick (d) Jacques Monod
2. Eukaryotic cells containing
(a) True nucleus (b) Definite nucleus
(c) Nucleoid (d) Mesosome
3. Cell divide and produce
(a) Gogi body (b) Mesosome
(c) Daughter cells (d) Single chromosome
4. Plasmodesmata is found in _____
(a) Cell wall (b) Cytoplasm
(c) Nucleus (d) Cell membrane
5. Outermost thin living protective layer of animal cell is _____
—.
(a) Plasma membrane (b) Cell wall
(c) Cell barrier (d) Cell layer
6. Interconnections of adjacent cells through their plasma membrane are called

(a) Cell junctonsons (b) Microvilli
(c) Belt desmosomes (d) Hemi desmosomes
8. Who discovered ribosome?
(a) Jacques Monod (b) Part and Pon
(c) Palade (d) Francis crick
9. The chromosome contains two identical' spinally coiled filaments are called as
(a) (a) Chromatid (b) Centrosome
(c) Centromere (d) Chromonemata
10. The period between two successive cell divisions is called _____
—.
(a) Duplication (b) Growth phase
(c) Cell cycle (d) Inter phase
11. Lysosomes are of called as
a) chromosome b) centrosome
c) mitochondria d) suicidal bag

12 The stage of mitosis during which the nucleolus disintegrates and chromosomes appear is known as _____.

- (a) Prophase
- (b) Metaphase
- (c) Inter phase
- (d) Anaphase

13 Two homologous chromosomes pairing is called

- a) Stem cell
- (b) Synapsis
- (c) Syngamy
- (d) Spindle

b) The programmed cell death is called

- a. Apomixis
- (b) Apoptosis
- (c) Autophagy
- (d) Autolysis

c) Cilia and flagella cellular appendages not found in

- a. Bacteria
- (b) Virus
- (c) Higher plants
- (d) Higher animals

d) Which of the following is not a part of neuron?

- a. Nucleus
- (b) Dendrite
- (c) Synaptic cleft
- (d) Lobe

PART B — ($2 \times 5 = 10$ marks) Answer any TWO questions out of Five.

e) Write a note on prokaryotic cell.

f) Describe about the composition of bacterial cell wall.

g) Explain the structure and function of nucleus.

h) Explain about the cell division.

i) Explain the flagellar movements.

PART C — ($5 \times 10 = 50$ marks) Answer ALL questions either (a) or (b).

j) (a) Explain the Biogenesis theory of origin of life.

Or

(b) Enumerate the Eukaryotic cell organization.

k) (a) Describe the fluid mosaic model of plasma membrane.

Or

(b) Give in detail account of Cell adhesion.

l) (a) Explain about the functions of lysosome.

Or

(b) Write down the structure and functions of mitochondria.

m) (a) Explain about the karyokinesis and mitosis.

Or

(b) Describe about the G-protein receptors.

n) (a) Explain about the Amoeboid movements.

Or

- (b) Describe the Nerve impulse conduction.

(For the candidates admitted from 2021–2022 onwards) B.Sc. .

First Semester

Biochemistry

Allied I – Biochemistry – I (Common for

Biotechnology/Microbiology)

Time : Three hours

Maximum : 75 marks

PART A — (15 × 1 = 15 marks)

Answer ALL questions.

1. Maltose is a disaccharide consist of _____.
 - (a) Glucose and fructose
 - (b) Glucose and galactose
 - (c) Glucose and glucose
 - (d) Glucose and mannose

2. The following polysaccharide is composed of β - glycosidic bonds.
 - (a) Cellulose
 - (b) Starch
 - (c) Glycogen
 - (d) Dextrin

3. Which of the following is a non-reducing sugar?
 - (a) Glucose
 - (b) Lactose
 - (c) Sucrose
 - (d) Maltose

4. Which of the following is a non-essential amino acid?
 - (a) Serine
 - (b) Threonine
 - (c) Lysine
 - (d) Histidine

5. In which amino acid imidazole group, an aromatic ring found?
 - (a) Lysine
 - (b) Arginine
 - (c) Histidine
 - (d) Cysteine

6. Which bond stabilizes the secondary structure of a protein?
 - (a) Covalent bond
 - (b) Hydrophobic bond
 - (c) Hydrogen bond
 - (d) Vanderwall's forces

7. Which of the following is produced with the combination of apoenzyme and coenzyme?
 - (a) Enzyme-substrate complex
 - (b) Enzyme-product cpx
 - (c) Prosthetic group
 - (d) Holo enzyme

Zymogen is a _____.

- (a) Enzyme modulator
 - (b) Vitamin
 - (c) Hormone
 - (d) Enzyme precursor
9. Lock and key theory of enzyme action was proposed by _____.
(a) Koshland (b) Fischer
(c) Kuhne (d) Arrhenius
10. Find out the nucleotide present only in RNA
(a) Adenine (b) Thymine
(c) Cytosine (d) Uracil
11. The width of a double helix is _____. (a) 30 Å
(b) 34 Å
(c) 24 Å (d) 20 Å
12. The nitrogenous base present in lectin is _____.
(a) Serine
(b) Choline
(c) Inositol
(d) Ethanolamine
13. Calcium deficiency in the body occurs in the absence of _____.
(a) Vit D (b) Vit C
(c) Vit A (d) Vit B
14. The deficiency of Vitamin B₁ results in a condition called _____.
(a) Scurvy (b) Cheliosis
(c) Beriberi (d) Pellagra
15. The RDA of Vit A for an adult is _____. (a) 1000 Iu
(b) 3000 Iu
(c) 5000 Iu (d) 8000 Iu

PART B — (2 × 5 = 10 marks) Answer any
TWO questions out of Five.

16. Explain the structure and importance of disaccharides.
17. Write notes on the bonds involved in protein structure.
18. Outline the classification of enzymes with examples.
19. Differentiate saturated fatty acids from unsaturated fatty acids.
20. Highlight the source, RDA, function and deficiency disorder of Vit C.

PART C — ($5 \times 10 = 50$ marks) Answer

ALL questions.

21. (a) Describe the structure and significance of homopolysaccharides.

Or

- (b) Discuss the structure and functions of mucopolysaccharides.

22. (a) Explain the classification of aminoacids based on their side chains.

Or

- (b) Outline the structural levels of organization of proteins.

23. (a) Write notes on

(i) MM equation

(ii) LB plot

Or

- (b) Describe briefly on coenzymes and cofactors with suitable examples.