DWARAKA DOSS GOVERDHAN DOSS VAISHNAV COLLEGE

(Autonomous)

"College with Potential for Excellence"

(Linguistic Minority Institution),

"Gokulbagh" 833, Periyar E.V.R. Salai,
Arumbakkam, Chennai – 106

Syllabus

For

B.Sc., Biotechnology (2021-2022)

CHOICE BASED CREDIT SYSTEM

OUTCOME BASED EDUCATION (OBE)

PROGRAMME CODE: 012

UNDER GRADUATE – DEPARTMENT OF BIOTECHNOLOGY

(Applicable for students admitted for the academic year 2021-22)

Department of Biotechnology

ACADEMIC YEAR 2021–2022

CHOICE BASED CREDIT SYSTEM

I–VI Semesters

SCHEME AND SYLLABUS

OUTCOME BASED EDUCATION (OBE)

DWARAKA DOSS GOVERDHAN DOSS VAISHNAV COLLEGE

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(Linguistic Minority Institution),
"Gokulbagh" 833, Periyar E.V.R. Salai,
Arumbakkam, Chennai – 10611

VISION

To impart value based quality academia; to empower students with wisdom and to charge them with rich Indian traditions and culture; to invoke the self, to broaden the same towards nation building, harmony and Universal brotherhood.

MISSION

To ensure sustained progress and development in imparting quality education, to pioneer new avenues of teaching and research and to emerge as an institution with potential for excellence.

DEPARTMENT OF BIOTECHNOLOGY

VISION

Our vision is to produce competent Biotechnologists with profound expertise, providing a sustainable competitive edge to the present society with their entrepreneurial skills.

MISSION

M1	To impart highly innovative and technical knowledge in the field of biotechnology.
M2	To create opportunities for multi-disciplinary education, training and research in biotechnology.
M3	To expand the scope of Industry -Academia interaction towards commercialization of bio products.

PROGRAM EDUCATION OBJECTIVES (PEOs)

PEO1	To facilitate the students to apply the concepts of Biotechnology, Bioanalytics, computational methods, and other related disciplines of science and technology for pursuing higher education and flourishing careers in industry.
PEO2	To inculcate deeper knowledge in practical skills enabling them to work with multidisciplinary projects.
PEO3	To enhance students learning abilities, entrepreneurial skills, ethical values for a successful professional career.
PEO4	To ensure students apply ethical principles to deal with universal and common issues for sustainable development.
PEO5	To emerge as problem solvers using their critical and creative thinking to address global environmental issues.

PEO TO MISSION STATEMENT MAPPING

MISSION STATEMENTS	PEO1	PEO2	PEO3	PEO4	PEO5
M1	2	3	2	2	2
M2	2	2	3	2	2
M3	2	2	3	2	3

CORRELATION: 3- STRONG 2- MEDIUM 1- LOW

PROGRAM OUTCOMES (PO) IN RELATION TO GRADUATE ATTRIBUTES

At the completion of the B.Sc. Biotechnology program, the students of our Department will be able to:

S.NO	PROGRAMME OUTCOMES
PO1	To participate in various types of employment, development activities and public discourses particularly in response to the needs of the community one serves.
PO2	To understand the need and have the competencies to support local, regional and national development.
PO3	To develop critical and analytical thinking.
PO4	To develop conceptual understanding, problem solving and application of skills.
PO5	To provoke entrepreneurship among the students along with strong ethics and communication skills.
PO6	To develop a questioning mind in diverse environments for better outcomes.
PO7	To engage in lifelong learning and enduring proficient progress.

Mapping of POs TO PEOs

PEO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
PEO 1	3	3	2	2	3	2	3
PEO 2	2	2	3	3	2	2	3
PEO 3	3	2	2	2	3	2	2
PEO 4	2	3	2	2	3	3	2
PEO 5	2	2	3	3	2	3	3

PROGRAM SPECIFIC OUTCOMES

PSO1: Acquire basic knowledge in English and language grammar, communication skills, writing skills and creative writing skills.

PSO2: Comprehensive the core concepts and various ideas, analyze, execute and contribute in the field of biotechnology and other related industries.

PSO3: Possess the basic and essential knowledge on various aspects of biotechnology to successfully pursue their higher studies.

PSO4: Obtain prerequisite skills and have the ability to start pursue their employment, entrepreneurship and research activities.

PSO5: Realize and share the importance of professional integrity, ethical and environmental issues related to the field biotechnology.

DWARAKA DOSS GOVERDHAN DOSS VAISHNAV COLLEGE (Autonomous)

DEPARTMENT OF BIOTECHNOLOGY

(CHOICE BASED CREDIT SYSTEM)

B.Sc., BIOTECHNOLOGY

ELIGIBILITY FOR ADMISSION

- Students who have completed 10+2 pattern with Biology as one of the main subject along with other subjects such as Botany, Zoology, Biochemistry, Microbiology, Nursing, Nutrition and Dietetics, Home science, Siddha, Agricultural science and Veterinary science are eligible to apply for B.Sc. Biotechnology.

DURATION OF THE COURSE

- The duration of the course is three years (six semesters). Each academic year shall be divided into two semesters. The odd semesters shall consist of the period from June to November and the even semester from December to April. There shall be not less than 91 working days for each semester.

B.Sc. BIOTECHNOLOGY CURRICULUM

This is a full-time course comprising of three years (Six Semesters). The department offers instructions in wide areas of Biotechnology such as Cell Biology, Microbiology, Molecular Biology, Chemistry in Everyday Life, Bioinstrumentation, Biochemistry, Genetic Engineering, Biostatistics, Bioinformatics, Bioprocess Technology, Food Biotechnology, Marine Biotechnology, Agricultural Biotechnology, Stem cell Biology Animal Biotechnology, Plant Biotechnology, Environmental Biotechnology, Entrepreneurship, Biosafety, Bioethics and Intellectual property rights, Biofertilizer, Medical Biotechnology and Public Health and Hygiene. The program comprises 11 core papers, 4 allied papers, 3 elective papers, 2 Non-major elective papers, 9 practical courses, skill based elective courses and Environmental studies. The curriculum offered by the department meets the requirement of various national / international research institutes and industries.

ATTENDANCE & EVALUATION

- A candidate who has less than 75% attendance shall not be permitted to write the end-semester examination in the course in which the shortfall exists.

- Evaluation will be done by continuous internal assessment throughout the course. Each semester will have minimum two CIA tests, followed by Generic skills towards the end of the semester. End-semester examination will be conducted at the end of each semester.
- A candidate has to secure a minimum of 50 percent of marks (inclusive Two CIA Tests marks, generic skills & End- Semester examination mark) in each paper.
- A candidate should have passed in soft skills, Value education papers and extension activity for successful completion of the course.

END SEMESTER EXAMINATION

- There shall be one End-semester examination of 3 hours duration carrying 100 marks in each paper covering the entire syllabus prescribed for the course. The End semester examination is normally a written examination for theory and laboratory-based for practical papers. End-semester Practical examinations will be held at the end of even semesters.
- Each theory paper carries 100 marks, 50 marks for end semester examination and 50 marks for continuous internal assessment. Similarly, for practical examinations, each paper carries 100 marks, 50 for external evaluation and 50 marks for the continuous internal assessment.
- The subjects included in Part IV paper carries 100 marks, 50 marks for end semester examination and 50 marks for continuous internal assessment.

Total Number of papers

Subjects	Papers
Language	4
English	4
Core	11
Elective	3
Allied	4
Core practicals (1 - 6)	6
Allied practicals	4
Soft skill	4
Non major elective	2
Value education	1
Environmental studies	1
Extension activity	-

COURSE OUTCOME

- Graduates will gain and apply knowledge of biotechnological concepts to solve problems related to life science fields.
- Graduates will be able to identify, analyse and understand problems in science and finding valid conclusions.
- Usage of appropriate tools & techniques for biotechnological manipulation with the knowledge gained, while keeping in mind safety factor for environment and society.
- Graduates will be able to design, perform experiments, analyse and interpret data for investigating complex problems
- Graduates will be able to justify societal, health, safety & legal issues and understand his responsibilities in biotechnological practices.
- Graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.
- Graduates will be enlightened on the ethical issues in Biotechnology

ELIGIBILITY FOR THE AWARD OF DEGREE

A Candidate shall be eligible for the award of the degree only if she/he has undergone the prescribed course of study in the college for a period of not less than three academic years and passed the examinations of all the Six Semesters prescribed earning a minimum of **140 credits** as per the distribution given in Regulations for Part I, II, III, IV & V and also fulfilled such other conditions as have been prescribed thereof.

Note: Autonomous Colleges Continue to follow the existing credits distribution Scheme and to have flexibility of distribution of credits in Part III & IV.

CREDIT DISTRIBUTION

S. No.	Semester	Credits
1	I	23
2	II	23
3	III	21
4	IV	23
5	V	26
6	VI	26
Total no of credits		**142**

Subjects	Papers	Credits	Total credits
Language	4	3	12
English	4	3	12
Core theory	11	4	44
Elective	3	5	15
Allied theory	4	3	12
Core practicals	6	3	18
Allied practicals	4	2	8
Soft skill	4	3	12
Non major elective	2	2	4
Value education		2	2
Environmental studies	1	2	2
Extension activity		1	1
Total no of credits			**142**

Question paper Pattern-Theory Maximum marks (100)

Section - A	Answer all the 10 Questions (10 x 2= 20 marks)
Section – B	Answer the 5 Questions in either/or pattern choice (5 x 7 = 35 marks)
Section - C	Answer all the Questions [Q. NO: 16 is compulsory] (3 × 15 = 45 marks)

SCHEME ON EXAMINATIONS

As per the University Regulation the following split up of marks for Theory, practical and project are to be followed.

(i) SPLIT UP FOR INTERNAL AND EXTERNAL MARKS FOR THEORY AND PRACTICAL PAPER:

Sl. No.	Paper	Internal	External	Total
1.	Theory	50	50	100
2.	Practical	50	50	100

(ii) SPLIT UP FOR INTERNAL ASSESSMENT MARKS (50) FOR

THEORY: CIE- Continuous Internal Evaluation (50 Marks)

Bloom's Category	**Tests**	**Attendance**	**Generic skills**
Marks (out of 50)	**30**	**5**	**15**
Remember	3		
Understand	3		
Apply	6		
Analyze	9		
Evaluate	9		
Create			15

ESE- Semester End Examination (100 Marks; weightage 50%)

Bloom's Category	**Weightage %**
Remember	10
Understand	10
Apply	14
Analyze	22
Evaluate	29
Create	15

DEPARTMENT OF BIOTECHNOLOGY

SCHEME OF I SEMESTER BSc PROGRAM

Sl. NO	Course Category	Course Code	Course	Hour Distribution				Overall Credits	Total Contact Hours/Week	Marks		
				L	T	P	S			CIA	ESE	Total
1	Part I		Language/ Tamil Paper 1	4	0	0	0	3	4	50	50	100
2	Part II		English Paper 1	4	0	0	0	3	4	50	50	100
3	Part III		**CorePaper1**: Cell biology	6	0	0	0	4	6	50	50	100
4	Part III		**Allied Paper 1:** Microbiology	6	0	0	0	3	6	50	50	100
5	Part III		**Core**: **Practical I: *** Cell biology	0	0	3	0	3	3	50	50	100
6	Part III		**Allied**: **Practical I*** Microbiology	0	0	3	0	2	3	50	50	100
7	Part IV		**1.a.** Those who have not studied Tamil upto XII std and taken a non- tamil language under Part – I shall take Tamil comprising of two courses (level will be at 6^{th}std). **b.** Those who have studied Tamil upto XII std and taken a non- Tamil language under Part- I shall take Advanced Tamil comprising of two courses. **c.** Others who do not come under a+b can choose non-major elective comprising of two courses. **Nonmajor elective 1-** Biotechnology for society	2	0	0	0	2	2	50	50	100
8	Part IV		**2. Skill based subject (Elective)** Soft skill I	2	0	0	0	3	2	50	50	100
Total								**23**	**30**	**400**	**400**	**800**

Part I &II subjects (UG) to be mentioned as Ability enhancement compulsory skills

* Practical Examinations will be conducted in even semester only

SCHEME OF II SEMESTER BSc PROGRAM

Sl. NO	Course category	Course Code	Course	Hour Distribution				Overall Credits	Total Contact Hours/Week	Marks		
				L	T	P	S			CIE	SEE	Total
1	Part I		Language/ Tamil Paper 2	4	0	0	0	3	4	50	50	100
2	Part II		English Paper 2	4	0	0	0	3	4	50	50	100
3	Part III		**Core Paper**: 2 Molecular Biology	6	0	0	0	4	6	50	50	100
4	Part III		**Allied Paper**: 2 Chemistry in Everyday Life	6	0	0	0	3	6	50	50	100
5	Part III		**Core Practical II:** Molecular Biology*****	0	0	3	0	3	3	50	50	100
6	Part III		**Allied Practical II:** Chemistry in Everyday Life*****	0	0	3	0	2	3	50	50	100
7	Part IV		**1. a.** Those who have not studied Tamil upto XII std and taken a non- tamil language under Part – I shall take Tamil comprising of two courses (level will be at 6^{th}std). **b.** Those who have studied Tamil upto XII std and taken a non-Tamil language under Part- I shall take Advanced Tamil comprising of two courses. **c.** Others who do not come under a+b can choose non- major elective comprising of two courses. **Non Major Elective 2** – Food Science	2	0	0	0	2	2	50	50	100
	Part IV		**2. Skill based subject (Elective)** Soft skill II	2	0	0	0	3	2	50	50	100
Total								**23**	**30**	**400**	**400**	**800**

Part I &II subjects (UG) to be mentioned as Ability enhancement compulsory skills

*****Practical Examinations will be conducted in even semester only

SCHEME OF III SEMESTER BSc PROGRAM

Sl. NO	Course category	Course Code	Course	Hour Distribution				Over all Credits	Total Contact Hours /Week	Marks		
				L	T	P	S			CIE	SEE	Total
1	Part I		Language/ Tamil Paper 3	4	0	0	0	3	4	50	50	100
2	Part II		English Paper 3	4	0	0	0	3	4	50	50	100
3	Part III		**Core Paper3: Skill Enhancement Course** Bioinstrumentation	6	0	0	0	4	6	50	50	100
4	Part III		**Allied Paper** 3 : Biochemistry	6	0	0	0	3	6	50	50	100
5	Part III		**Core Practical III**: Bioinstrumentation*	0	0	3	0	3	3	50	50	100
6	Part III		**Allied Practical III**: Biochemistry*	0	0	3	0	2	3	50	50	100
7	Part IV		**Skill based subject:** Soft skill III	2	0	0	0	3	2	50	50	100
8	Part IV		Environmental studies	2	0	0	0	-	2	Examination will be held on IV semester		
		Total						21	**30**	**350**	**350**	**700**

Part I &II subjects (UG) to be mentioned as Ability enhancement compulsory skills

*****Practical Examinations will be conducted in even semester only

SCHEME OF IV SEMESTER BSc PROGRAM

Sl. NO	Course category	Course Code	Course	Credit Distribution				Overall Credits	Total Contact Hours/Week	Marks		
				L	T	P	S			CIE	SEE	Total
1	Part I		Language/ Tamil Paper 4	6	0	0	0	3	4	50	50	100
2	Part II		English Paper 4	4	0	0	0	3	4	50	50	100
3	Part III		**Core Paper** 4: **Skill Enhancement Course** Genetic Engineering	6	0	0	0	4	6	50	50	100
4	Part III		**Allied paper** 4: Fundamentals of Computers and Biostatistics	6	0	0	0	3	6	50	50	100
5	Part III		**Core Practical IV**: Genetic Engineering*****	0	0	3	0	3	3	50	50	100
6	Part III		**Allied practical IV**: Fundamentals of Computers and Biostatistics*****	0	0	3	0	2	3	50	50	100
7	Part IV		**Skill based elective:** Soft skill IV	2	0	0	0	3	2	50	50	100
8	Part IV	Environmental studies		2	0	0	0	2	2	50	50	100
		Total						**23**	**30**	**400**	**400**	**800**

Part I &II subjects (UG) to be mentioned as Ability enhancement compulsory skills

*****Practical Examinations will be conducted in even semester only

SCHEME OF V SEMESTER BSc PROGRAM

Sl. NO	Course category	Course Code	Course	Credit Distribution				Overall Credits	Total Contact Hours/Week	Marks		
				L	T	P	S			CIE	SEE	Total
1	Part III		**Core Paper 5:** Immunology	5	0	0	0	4	5	50	50	100
2	Part III		**Core Paper 6:** Bioinformatics	5	0	0	0	3	5	50	50	100
3	Part III		**Core Paper7:** Bioprocess Technology	5	0	0	0	4	5	50	50	100
4	Part III		**Core Paper8: Skill Enhancement Course :** Food Biotechnology	5	0	0	0	4	5	50	50	100
5	Part III		**Elective paper: 1A** Marine Biotechnology or **Elective paper: 1B** Agricultural Biotechnology or **Elective paper: 1C** Basics of Stem cell Biology	4	0	3	0	5	4	50	50	100
6	Part III		**Core Practical V**: Immunology, Bioinformatics, Bioprocess Technology &Food Biotechnology*	0	0	5	0	3	5	50	50	100
8	Part IV		Value Education	0	0	0	0	2	1	50	50	100
Total								**26**	**30**	**350**	**350**	**700**

Elective papers should to be chosen by the candidate.

***Practical Examinations will be conducted in even semester only

SCHEME OF VI SEMESTER BSc PROGRAM

Sl. NO	Course category	Course Code	Course	Credit Distribution				Overall Credits	Total Contact Hours /Week	Marks		
				L	T	P	S			CIE	SEE	Total
1	Part III		**Core Paper9:** Animal Biotechnology	5	0	0	0	4	5	50	50	100
2	Part III		**Core Paper10: Skill Enhancement Course** Plant Biotechnology	5	0	0	0	4	5	50	50	100
3	Part III		**Core Paper11**: Environmental Biotechnology	5	0	0	0	3	5	50	50	100
4	Part III		**Elective paper:2A** Entrepreneurship, Biosafety, Bioethics and Intellectual property rights or **Elective paper:2B** Biofertilizer or **Elective paper:2C** Medical Biotechnology	4	0	0	0	5	4	50	50	100
5	Part III		**Open Elective paper:3** Public Health and Hygiene	5	0	0	0	5	5	50	50	100
6	Part III		**Core Practical VI**: Animal Biotechnology, Plant Biotechnology& Environmental Biotechnology*	0	0	6	0	3	6	50	50	100
7	Part-V		**Extension Activity**	-	-	-	-	1	-	-	-	-
Total								**26**	**30**	**300**	**300**	**600**

Elective papers should to be chosen by the candidate.

***Practical Examinations will be conducted in even semester only

FIRST SEMESTER

Course Title: Core Paper 1: Cell Biology

Course Code :	**Credits : 04**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to acquaint knowledge on cell and cell biology, molecular mechanisms involved and an eye opener for advanced studies.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	To have an insight of Cell as the fundamental unit of life and to compare the complexity of Eukaryotic cell with the primitive prokaryotic cell, with the identification of specific role of organelles that attribute to the co-ordinated function of cell.
CO2	To analyze the structure and functions of plasma membrane and the various mechanisms that regulates the transport process across cell membranes.
CO3	To selectively categorize the cytoskeletal backbone, cell motility organs and to describe the cell cycle and cell death.
CO4	To predict the response of cells to intra and extracellular environment by studying about the intracellular signaling pathways.
CO5	To specifically examine life processes at the cellular level, such as protein secretion, targeting and protein degradation.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	3	2	2	2	2	1	3	2	2
CO 2	2	2	2	3	2	2	2	2	1	3	2	2
CO 3	2	2	2	3	2	2	1	2	2	3	2	2
CO 4	2	2	2	3	2	2	1	2	1	3	1	2
CO 5	2	2	2	3	2	2	2	2	2	3	1	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Cell theory: Cell as the Unit of Life. General characteristics and difference between prokaryotic and eukaryotic cells. Prokaryotic and Eukaryotic cell structure-Plant and animal cell and their characteristics; cell organelles-structure and functions of mitochondria, chloroplast, endoplasmic reticulum, golgi apparatus, ribosomes, lysosomes, peroxisomes, nucleus and molecular organization of chromatin.	18	CO1
2	Membrane and transport- structure and functions of Cell Membrane, Cell membrane permeability, molecular organization of cell membrane. Transport across cell membrane – passive transport, active transport, ATP pumps- sodium and potassium pump, Ca^{2+} ATPase, co-transport – symport and antiport, Endocytosis and Exocytosis.	18	CO2
3	Cytoskeleton- structure and functions, cell motility- cilia and flagella, cellular interactions, cell adhesion molecules, cell division: mitosis and meiosis, cell cycle and its regulation, Programmed cell death.	18	CO3
4	Cell signaling- receptors in cell signaling, autocrine, paracrine and endocrine signaling, signal amplification. cAMP, IP_3, cGMP and G-proteins role in signal transduction, calcium influx and its role in cell signaling.	18	CO4
5	Protein secretion and sorting- secretory pathway, translocation of secretory proteins across the ER membrane, protein folding- chaperones in protein folding and assembly, modification and degradation of proteins.	18	CO5

TEXT BOOKS:

1. C.B. Powar (2010).*Cell Biology* (3rd Edition), Himalaya publisher, ISBN: 978-93-5024-669-6
2. Dr. P.S. Verma and Dr. V.K. Agarwal. (2016). *Cell biology (cytology, biomolecules and molecular biology)*, S. Chand Publishing, ISBN:9789385676147
3. Lodish*et al*., (2000). *Molecular Cell Biology*, (Fourth Edition), W.H. Freeman & Co, ISBN-10: 0-7167-3136-3

REFERENCE BOOKS:

1. De Robertis, E.D.P. and De Robertis, E.M.F., (1980), *Cell and Molecular Biology* (7th Edition) Saunders College/Holt, Rinehart and Winson, Philadelphia,. ISBN-13 : 978-0030567490;
2. Gerald Karp.(2004*), Cell and Molecular Biology*, 4th ed. John Wiley and sons,. ISBN: 978-1-118-88614-4
3. Bruce Alberts., Lewis.J., Johnson A.J., Raff. L.M. (2002), *Molecular Biology of the Cell*: Garland Publishers,. ISBN-10: 0-8153-3218-1ISBN-10: 0-8153-4072-9
4. Cooper M.G and Hausman E.R (2018). *The Cell: A Molecular approach* (7th Ed.) USA: Oxford University Press, ISBN: 9781605357461

Course Title: Allied Paper1: Microbiology

Course Code :	**Credits : 03**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to acquire the basic knowledge on fundamentals of Microbiology, sterilization; culture techniques, different types of Microscopy and different types of microorganism and its application

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Outline the evolution of microbiology and characterize microorganisms.
CO2	Categorize the methods of sterilization and identify the significance of culture media in the growth of different microbes.
CO3	Discover different staining procedures and microscopic techniques used to visualize microbial cells.
CO4	Distinguish between normal flora and pathogens.
CO5	Define and describe the role of microbes in food intoxications and soil fertility

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	2	1	2	2	2	2	3	1	1
CO 2	2	2	2	2	2	2	2	2	2	3	2	1
CO 3	1	2	2	3	2	2	2	2	3	2	2	2
CO 4	1	2	2	3	1	2	2	2	2	2	2	2
CO 5	2	2	2	3	2	2	2	2	3	2	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Introduction and history of microbiology:** *Evolution of microbiology- Theory of biogenesis*- Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Paul Ehrlich and Fleming. Anatomy of prokaryotic and eukaryotic cells. General characteristics used in classification- five kingdom, six kingdom and eight kingdom systems.	18	CO1
2	**Basic microbiological techniques:** Sterilization and disinfection- Principles-Physical methods- dry heat-moist heat- radiation- filtration (membrane & HEPA), Chemical methods-liquids/gas –mode of action. Types of microbiological media- enrichment, selective and differential media. Growth and nutrition- Nutritional requirements- autotrophs, heterotrophs-Microbial growth curve- kinetics of growth- Measurement of microbial growth and enumeration of cells: Pure culture methods: Serial dilution, pour plate, spread plate, streak plate.	18	CO2
3	**Staining and Microscopy:** Definition of auxochrome, chromophore and dye. Staining techniques- Smear preparation- Simple staining, Gram staining and Endospore staining. Microscopy- Principles and applications- Light, Bright field and dark field, Fluorescence, SEM and TEM.	18	CO3
4	**Normal flora and Pathogenic microbes:** Normal flora of human body- Pathogenic attributes of bacteria-Virulence factors. Pathogenic bacteria: Staphylococcus, Streptococcus. Viruses: Pox, rabies. Fungal diseases: Aspergillosis, Blastomycosis. Parasitic infections: Leishmaniasis, Giardiasis.	18	CO4
5	Food-borne intoxications-Botulism, Staphylococcal &Enterococcal food poisoning -Soil microbes and fertility of soil-Distribution of different types of soil microorganisms-Factors influencing microbial population: Moisture, air, temperature, pH & nutrients. Beneficial interactions: symbiosis, commensalism, proto-cooperation. Harmful interactions- amensalism, competition, parasitism.	18	CO5

TEXT BOOKS:

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002), *Microbiology- Concepts and Applications,(* 5th Edition), *Tata McGraw-Hill, New Delhi,*. ISBN 13: 9780074623206
2. Ananthanarayan, R. and Paniker, (2013) *Text book of Microbiology*, (9th edition), Orient Longman Pvt Ltd., Universities Press, Hyderabad, India,. ISBN 81 250 2808 0
3. Ingraham, J.L., and Ingraham, C.A., (2000), *Introduction to Microbiology* (2nd edition), Brooks/Cole, Thomson Learning, USA,. ISBN-13 : 978-0534552244

REFERENCE BOOKS:

1. Park Talaro and Barry Chess, A. (2017), *Foundations in Microbiology*, (10th edition). *McGraw-Hill Education, New York,* ISBN13: 9781259705212
2. Cappuccino, J.G., and Sherman, N., (2013) Microbiology- A Laboratory manual, (10th edition) *Pearson Benjamin Cummings, US,*. ISBN 13: 9780805376463
3. Prescott, Joanne Willey, Kathleen Sandman and Dorothy Wood (2020), (11th edition), *New York: McGraw-Hill,*. ISBN13: 9781260211887

Course Title: Core Practical – I: Cell Biology

Course Code : 1912207	**Credits : 03**
L: T: P: S : 0:0:3:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to apply the techniques involved in cell biology for studying the different types of blood cells and learn cell fractionation

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Enumerate the different types of blood cells using appropriate techniques.
CO2	Analyze the stages of mitotic and meiotic cell divisions.
CO3	Utilize the techniques involved in cell biology for preservation of specimen.
CO4	Explain the working of different types of microscopes.
CO5	Demonstrate the working principle of cell fractionation.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	1	2	2	3	1	2	2	3	3	1
CO 2	2	2	2	2	2	3	2	2	2	3	2	1
CO 3	3	2	2	2	1	2	1	2	3	2	3	2
CO 4	3	2	2	2	1	3	2	2	3	3	3	1
CO 5	2	2	2	2	1	3	2	2	3	2	2	1

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	1. Introduction to microscopy 2. Epithelial cell preparation from onion peel and buccal cavity. 3. Measuring size of cells using micrometry. 4. Differential leukocyte Count	15	CO1 CO4
2	5. Enumeration of RBC by haemocytometer 6. Enumeration of WBC by haemocytometer	15	CO1 CO2 CO4
3	7. Enumeration of prokaryotic cell 8. Mitosis preparation from onion root tip	15	CO3 CO4
4	9. Meiosis – from grasshopper testis/ Flower buds 10. Permanent slide preparation- stem section, 11. Cell fractionation (nucleus, mitochondria- Demonstration).	15	CO4 CO5

REFERENCE BOOKS:

1. K.V. Chaitanya, (2013), *Cell and molecular biology*: Lab manual, PHI publishers,. ISBN 978-81-203-800-4

Course Title: Allied Practical – I: Microbiology

Course Code :	**Credits : 02**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to apply the techniques involved in identification, characterization and differentiation of microbial cells.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Establish basic skills associated with microbiology and biotechnology
CO2	Gain basic knowledge on various pure culture techniques for the isolation of microorganisms from various samples
CO3	Distinguish between various methods of sterilization
CO4	Characterize and differentiate various types of bacteria using different staining techniques.
CO5	Learn how to measure the size of the different types of microorganism using micrometry method.
CO6	Microscopically analyze the morphological features of fungal organisms using lactophenol cotton blue staining.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	3	3	2	3	2	2	3	3	2
CO 2	2	2	2	2	2	2	3	2	2	3	2	2
CO 3	2	2	2	3	2	2	2	2	3	2	2	2
CO 4	2	2	2	2	3	2	3	2	3	2	2	2
CO 5	2	2	3	3	2	2	2	2	2	2	3	2
CO 6	2	2	2	2	2	3	2	2	2	2	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	1. Sterilization techniques 2. Preparation of microbiological media.	9	CO1 CO2 CO3
2	3. Pure culture techniques a) Pour plate technique b) Spread plate technique c) Streak plate technique 4. Demonstration of microbial contamination on culture plates.	9	CO4
3	5. Determination of the size of microbes using Micrometry 6. Wet mount preparation: Hay infusion broth	9	CO4 CO5
4	7. Morphological characterization of microbes a) Simple staining b) Gram staining c) Capsule staining d) Spore staining. e) Hanging drop technique 8. Biochemical tests for identification of bacteria a) Catalase test b) Oxidase test c) Indole test d) Methyl red and VogesProskauer test e) Citrate utilization test	9	CO1 CO4
5	9. Morphological identification of Fungi using lactophenol cotton blue staining.	9	CO6

REFERENCE BOOKS:

1. Brown A. and Smith H. (2015), *Benson's Microbiological Applications: Laboratory Manual in General Microbiology*, (13th Edition), McGraw-Hill Companies, ISBN13: 9780073402413

Course Title: Non Major Elective 1: Biotechnology For Society

Course Code : 1912103	**Credits : 02**
L:T:P:S : 2:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to gain knowledge about the biotechnological products and their implications in the society

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Identify the importance of biotechnology in different agricultural practices.
CO2	Appreciate the role played by microorganisms in the development of food supplements, biological fertilizers and pesticides.
CO3	Gain knowledge about the application of biotechnology in transforming environmental pollutants and learn the detrimental effects of biological weapons.
CO4	Summarize the basics of antibiotics and outline the production of penicillin.
CO5	Know the significance and uses of transgenic plants.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	3	2	2	3	2	2	2	3	2	3	2
CO 2	2	2	2	3	3	2	2	2	3	2	3	2
CO 3	2	2	2	3	2	2	2	2	2	2	2	3
CO 4	2	2	2	3	2	2	2	2	2	2	1	2
CO 5	2	2	2	2	2	2	2	2	2	2	2	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Introduction to Biotechnology- Role of biotechnology in sericulture- Rearing of silkworms- Importance and applications- Role of biotechnology in apiculture- Bee hive hierarchy- Bee keeping process- Products obtained- Mushroomfarming stages- Cultivation of paddy straw mushroom- Importance of mushroom cultivation.	6	CO1
2	Biofertilizer- Definition- Mass production of *Rhizobium*-Advantages and disadvantages- Biopesticides- Definition- Microbial biopesticides- *Bacillus thuringiensis*- Single cell protein- Introduction- history- production of *Spirulina*SCP- Applications- Advantages & disadvantages.	6	CO2
3	Biodegradation- Definition- Process-role of microorganisms in biodegradation - biodegradable plastics-advantages- Bioweapons- introduction- history- potential agents- delivery methods- harmful effects.	6	CO3
4	Antibiotics- Definition- Introduction and history of antibiotics- sources- classification- spectrum- - production of penicillin- definition of antibiotic resistance.	6	CO4
5	Transgenic plants – Definition of transgene and transgenesis - BT Cotton, Flavr-Savr tomato and Golden rice- history – importance, applications, advantages and disadvantages.	6	CO5

TEXT BOOKS:

1. Sathyanarayana, U., Chakrapani, U., (2008). *Biotechnology*, First edition, Books and allied (P) Ltd, Kolkata.
2. A.K. Chatterji, (2011).*Introduction to Environmental Biotechnology*, Third edition, PHI Learning Pvt Ltd. New Delhi. ISBN-978-81-203-4298-9
3. R.C. Dubey, (2014*). A text book of Biotechnology*, *S.Chand& Company, New Delhi.* ISBN 9788121926089

REFERENCE BOOKS:

1. H. Patel, (2011).*Industrial Microbiology*,(2nd edition), MacMillan Publishers
2. Thakur, I.S., (2019).*Environmental Biotechnology- Basic principles and applications- (*2nd edition)- Dreamtech Press, ISBN 978-93-89307-55-9

SECOND SEMESTER

Course Title: Core Paper: 2: Molecular Biology

Course Code :	**Credits : 04**
L:T:P:S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to gain knowledge on the concept of central dogma of molecular biology that is essential for cellular mechanism.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Explain the fundamental properties, structure and processes of nucleic acids
CO2	Discuss the molecular mechanism of Replication in prokaryotes
CO3	Elucidate the transcription mechanism in prokaryotes
CO4	Explain the process of Initiation, elongation and termination, and post translational modifications of proteins
CO5	Elaborate the regulation of gene expression using Operon concept

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	1	2	2	3	2	2	2	2	3	3	2	2
CO 2	1	2	2	2	2	2	2	2	3	3	2	2
CO 3	1	2	3	2	2	2	2	2	2	3	3	2
CO 4	1	2	3	3	2	2	2	2	2	2	2	2
CO 5	1	2	2	2	2	3	2	2	2	3	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Molecular Biology: Introduction to molecular aspects of life:** DNA as the genetic material –Griffith's experiment, Hershey–Chase experiment; Nucleic acids: Structure, function and properties of DNA (A, B and Z), their characteristics. Different types of RNA (mRNA, tRNA and rRNA) their structure and function.	18	CO1
2	**DNA Replication:** Enzymology of replication (DNA polymerase I, pol II and III, helicases, topoisomerases, single strand binding proteins, DNA melting proteins, primase. Proof of semiconservative replication, Replication origins, initiation, elongation, and termination. Rolling circle replication of DNA; Inhibitorsof DNA Replication.	18	CO2
3	**Transcription:** Transcription in prokaryotes: Enzymatic Synthesis of RNA, Basic features of RNA synthesis, E.coli RNA polymerase, Classes of RNA molecules, Transcription mechanism in prokaryotes- Promoter, initiation, elongation, proof reading and Rho dependent and Rho independent termination; Inhibitors of Transcription.	18	CO3
4	**Genetic code and Protein synthesis:** Genetic code: Features of genetic code, the adaptor hypothesis, attachment of amino acids to tRNA. Codon-anticodon interaction - the wobble hypothesis. Translation: Prokaryotic and eukaryotic translation, Initiation, elongation and termination, Co and post translational modifications of proteins; Inhibitors of Translation.	18	CO4
5	**Gene Expression and regulation:**Control of gene expression at transcription and translation level: Negative and positive control of the the Lac operon,The Arabinose operon, The Tryptophan operon, Relative positions of Promoters andOperators, Feedback Inhibition	18	CO5

TEXT BOOKS:

1. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, HiddePloegh, Angelika Amon, Kelsey C. Martin, (2016). *Molecular Cell Biology* (8th Ed.). US: W. H. Freeman
2. DeRobertis, EDP and E.M.F Robertis (2017).*Cell and molecular biology*, US:Lippincott Williams & Wilkins.
3. Veer BalaRastogi. (2016).*Principles of Molecular Biology*. (2nd Ed.)Medtech publisher. ISBN-13 9789384007478

REFERENCE BOOKS:

1. George M. Malacinski and David Freifelder (2015). "*Essentials of molecular biology*", (4th ed.) Boston: Jones and Bartlett Publishers.
2. Geoffrey M. Cooper and Robert E. Hausman (2018) .*The cell molecular approach*, (8th Ed.)UK: Oxford University Press, ISBN: 9781605357461

Course Title: Allied Paper 2– Chemistry in Everyday Life

Course Code :	**Credits : 03**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to develop cognitive scientific approach on forms of matter to explore scientifically relevant frontiers.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Demonstrate the preparation of the chemical solutions such as normal, molar and molal solutions.
CO2	Distinguish the components of air and water and gain insights on air and water pollution.
CO3	Classify and identify the food flavorants and food preservatives used in food production
CO4	Discuss on the chemicals such as fertilizers and pesticides in agriculture.
CO5	Identify the chemicals used in medicines for the treatment of ailments.
CO6	Analyze and appraise the chemicals used in everyday life and gain insights on green chemistry.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	3	1	2	2	2	2	3	2	2
CO 2	2	3	2	2	1	2	2	2	2	3	1	2
CO 3	3	3	2	2	2	2	2	2	2	3	2	2
CO 4	1	2	3	2	3	3	2	2	2	3	1	2
CO 5	1	3	2	2	2	2	2	2	2	3	2	2
CO 6	2	2	3	2	2	2	2	2	2	3	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Solutions**: Definition, Solute, solvent. Types of solutions – Saturated solution, unsaturated solution, supersaturated solution, aqueous solution, Non-aqueous solution, dilute solution and concentrated solution. **Preparation of Chemical solutions:** Normal solution, Molar solution, Molal solution and Percent solution. Simple dilution (Dilution factor method) and Serial dilution. Buffer: Definition, action of buffer, Types and preparation of buffer solutions. **Fundamental particles of Atom**-Definition and classification;. Periodic Table. Radio isotopes – Applications in medicine and industry.	18	CO1
2	**Components of air** – Water vapour, Oxygen, Nitrogen, Carbon dioxide , Smoke and dust particles. Green house gases and its impact on earth. Air pollution. **Components of water** – Hydrogen & Oxygen. Types: Soft water and hard water. Temporary and permanent hardness. Softening of hard water. Structure of Liquid water and ice. Water at high temperature and pressure. Physical and chemical properties of water. Water pollution. Purification of water for domestic use.	18	CO2
3	**Food additives** – Artificial sweetners- Saccharin ,Cyclomate and aspartate. Food flavorants – Natural, Nature-identical and Artificial flavouring substances. Use of esters, aldehyde and heterocyclic compounds as food flavourants. Food preservatives – Sodium benzoate and antioxidants(BHT and BHA). **Chemicals in food production** – Natural sources, Urea, NPK and super phosphate. Food poison – Natural poison and pesticides (DDT and BHC).	18	CO3
4	**Chemicals in medicines**- Antacids- Sodium bicarbonate, and Milk. Tranquilizers – Nor-adrenaline and Barbituric acid. Analgesic – Narcotic (Morphine and Codeine), Non narcotic (Aspirin), Antipyretics- Paracetamolandanalgin; Antiseptic- Bethional and Iodoform. (Physiological significance only); Anti oxidants in food- Anthocyanin and carotenoids. Adulterants in food.	18	CO4 . CO5
5	**Chemicals in cleansing agents** – Soaps , Types of soaps – Toilet soaps, Floating soaps, Transparent soaps, Medicated soaps, Laundry soaps and Detergents – Anionic detergent and cationic detergent. **Chemicals in Cosmetics** – Emulsifier, Preservatives, Thickeners, Emollient, Glimmer and Shiners. -Creams, Perfumes, Talcum powder, Deodorants. **Chemicals in tooth paste** –Fluoride, antibacterial agent, Desensitizing agent, anti-tarter agent, Sodium bicarbonate, Enzymes and Xylitol. **Green chemistry** – Principles and applications.	18	CO6

TEXT BOOKS:

1. Kirpal Singh, Chemistry in Daily life (2012), PHI publisher, ISBN 978-81-203-4617-8
2. David Ball.W. (2011), Introductory Chemistry, Saylor Foundation, ISBN 13: 9781453311073

REFERENCE BOOKS:

1. Shardendu Kislaya,(2011) *Chemistry in everyday life* , Discovery Publishing house, ISBN 13: 9788183567558
2. David Ball W, John HillW, Rhonda Scott.J(2011), *The Basics of General , Organic and Biological Chemistry*. Saylor Foundation, ISBN 13: 9781453311097.

Course Title: Core Practical: II Molecular biology

Course Code :	**Credits : 03**
L:T:P:S :0:0:3:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to estimate the concentration of biomolecules from various biological samples

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Make use of the conventional and advanced methods in isolating and purifying nucleic acid from various organisms.
CO2	Estimate the concentration of nucleic acid from various biological samples
CO3	Estimate the concentration of protein from various biological samples
CO4	Evaluate the quality of nucleic acids by gel electrophoresis
CO5	Evaluate the quality of nucleic acids by denaturing in formaldehyde gel electrophoresis

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	3	3	1	3	3	2	2	3	3	2
CO 2	1	2	3	3	3	1	1	2	3	3	3	2
CO 3	1	2	3	3	3	2	2	2	3	3	3	2
CO 4	1	2	3	3	3	2	2	2	3	3	3	2
CO 5	1	2	3	3	3	2	2	2	3	3	3	2

Sl. No	Contents of Module	Hrs	Cos
1.	1. Isolation and purification of genomic DNA from bacteria 2. Isolation and purification of genomic DNA from plant 3. Isolation and purification of Plasmids 4. Isolation and purification of RNA	15	CO1
2.	5. Determination of Tm of DNA by UV – Vis spectroscopy 6. Estimation of DNA by Diphenylamine method 7. Estimation of RNA by orcinol method	15	CO2 CO3
3.	8. Agarose gel electrophoresis of purified DNA 9. RNA electrophoresis in formaldehyde gel electrophoresis 10. Gel documentation	15	CO4 CO5

REFERENCE BOOKS:

1. Heather Miller D. Scott Witherow Sue Carson (2011), *Molecular Biology Techniques*, (3rd Edition), ISBN: 9780123855442.
2. Gerald Karp, Janet Iwasa and Wallace Marshall (2016), *Cell and Molecular biology – concepts and experiments*, (8^{th} edition), Wiley, ISBN: 978-1-118-88614-4.

Course Title: Allied practical II– Chemistry in Everyday Life

Course Code :	**Credits : 02**
L:T:P:S :0:0:3:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to prepare chemical solutions, estimate the amount of chemicals present in unknown solutions and evaluate the hardness of water.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Gain insights on the safe handling of laboratory glass wares and laboratory practices
CO2	Prepare of the chemical solutions such as normal, molar and molal solutions.
CO3	Prepare buffer solutions with determined pH
CO4	Estimate the amount of chemicals present in unknown solutions and test the hardness of water.
CO5	Outline the preparation of soaps

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	2	1	2	2	2	3	2	2	2
CO 2	2	2	3	3	2	2	2	2	3	2	2	2
CO 3	2	2	3	3	1	2	2	2	3	2	3	2
CO 4	2	2	2	2	3	2	2	2	3	2	3	2
CO 5	2	2	2	3	2	2	2	2	3	2	3	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	1. Safe handling of laboratory glasswares 2. Handling of pipettes and pipetting of chemical solutions	12	CO1
2	3. Preparation of solutions based on normality, molarity, and percent solutions. 4. Preparation of buffer solutions with determined pH – Acetate buffer and phosphate buffer	12	CO2
3	5. Estimation of sodium hydroxide using standard sodium carbonate 6. Estimate of Hydrochloric acid using Oxalic acid 7. Estimation of Ferrous sulphate using Ferrous ammonium sulphate 8. Estimation of Oxalic acid using standard Mohr's salt	12	CO3
4	9. Estimation of hardness of water. 10. Detection of adulterant in food 11. Extraction of antioxidants in food	12	CO4
5	12. Preparation of soap	12	CO5

TEXT BOOKS:

1. Gupta R.K, Manchanda R.P, Rajesh Kumar, R, *Lab manual Chemistry*, Saraswathi Book house, ISBN 9788173355509
2. Sintayehu L. Kitaw(2015), *Practical Analytical Chemistry, Lab Manual*, LAP LAMBERT Academic Publishing, ISBN-13 : 978-3659290459

REFERENCE BOOKS:

1. Paul Kelter, Michael Mosher, Andrew Scott, James Almy, (2007), *Chemistry Laboratory Manual: The Practical Science*, Houghton Mifflin, ISBN-13 : 978-0618000920.
2. Callie Schieffer, Mick Sakamoto, Michael Finnegan, Scot Whereland Ryan Rice (2012), *General Chemistry Laboratory Manual Star*; Revised Edition, ISBN-13 : 978-0898633634.

Course Title: Non Major Elective 2: Food Science

Course Code :	**Credits : 02**
L:T:P:S : 2:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students will be able to understand the basics concepts of food and its nutritive values and solve food science problem

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Study the energy components of food.
CO2	Classify foods and learn the ill effects associated with the consumption of unhealthy foods.
CO3	Learn the process and the importance of food preservation.
CO4	Understand the basic principles of food packaging.
CO5	Identify the signs of spoilage and determine the role of microbes in spoilage of foods.
CO6	Develop basic knowledge on adulterants in food and the related food standards and specifications.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	3	2	2	3	2	2	2	3	2	3	2
CO 2	3	2	2	2	2	3	3	2	2	2	2	2
CO 3	2	2	2	3	3	2	2	2	2	2	3	2
CO 4	2	2	3	2	3	2	2	2	3	2	3	2
CO 5	2	2	3	2	2	2	2	2	2	2	2	2
CO 6	3	2	2	2	3	3	2	2	2	3	3	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Introduction to food-definition of food science- food as a primary energy source- nutrients- carbohydrates- fats-proteins-vitamins- minerals-water- fiber- functions of food -influences on food choices -difference between junk food and fast food.	**6**	**CO1 CO2**
2	Food preservation- definition- food types- perishable- non- perishable-principles of food preservation- methods- sun drying- pasteurization-canning- dehydration- freezing- chemicals- radiation.	**6**	**CO3**
3	Food packaging- definition- need of packaging- functions of packaging-packaging materials- paper-paperboard-glass-plastic-metals-aseptic packaging-vacuum packaging-MAP- Biodegradable-active-edible packaging.	**6**	**CO4**
4	Food spoilage- definition- food spoilage by microorganisms-different types of spoilage bacteria- spoilage by fungi and yeast-effect of spoilage on various food products.	**6**	**CO5**
5	Food adulteration- Introduction to food adulteration- definition-adulterants in foods-types of adulteration- quantitative, qualitative and informative- common adulteration tests-The Prevention of Food Adulteration Act.	**6**	**CO6**

TEXT BOOKS:

1. Srilakshmi B. (2015)., *Food Science,* sixth edition, New Age International Pvt. Ltd., ISBN 13: 9788122438093.
2. Reddy, S.M. (2015), *Basic Food Science and Technology*, (First edition), New Age International Pvt Ltd Publishers, ISBN 13: 9788122438154
3. Robertson Gordon, L., *Food Packaging-Principles and Practice*, (Third edition), CRC Press (2016).

REFERENCE BOOKS:

1. Frazier W.C and Westhoff D.C. (2013), *Food Microbiology, (*Fifth edition), Tata McGraw Hills Publications, New Delhi,
2. Gary Tucker S. (2016), *Food Preservation and Bio deterioration*, (second edition), Wiley-Blackwell Publications, ISBN: 978-1-118-90462-6

THIRD SEMESTER

Course Title: Core Paper 3: Skill Enhancement Course - Bioinstrumentation

Course Code :	**Credits : 04**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the students gain knowledge on different spectroscopic, centrifugation, electrophoretic and chromatographic techniques and its applications.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Describe the various centrifugation and chromatography used in separating biomolecules based on various characters such as molecular weight, charge etc.
CO2	Apply absorbance and transmittance of light and outline the instruments operating with these light rays for identifying biomolecules.
CO3	Practice the electrophoretic techniques to identify the quality of nucleic acids and proteins.
CO4	Illustrate the importance of advanced electrophoretic techniques in identifying variations in nucleic acid molecules.
CO5	Explain the role of radiography and biosensors in medicine and diagnosis of biological entity.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	3	3	3	2	2	2	3	3	3	2
CO 2	2	2	3	3	3	2	2	2	3	3	3	2
CO 3	2	2	3	3	3	3	2	2	3	3	3	2
CO 4	2	2	3	3	3	3	2	2	3	3	3	2
CO 5	2	2	3	3	3	3	2	2	3	3	3	2

Sl. NO.	CONTENTS OF MODULE	Hrs	Cos
1	Centrifugation: Small bench top centrifuges, large capacity refrigerated, centrifuges, High speed refrigerated centrifuges, preparative and analytical ultracentrifuge, Differential and Density gradient centrifugation.	18	CO1 CO2
2	Chromatography - Fundamentals of Chromatography, van Deemter curve, Dialysis, Paper and Thin layer chromatography, Ion exchange chromatography, Gel filtration chromatography, Reversed-phase chromatography, Affinity chromatography, High performance liquid chromatography, Gas chromatography – Principle, instrumentation and applications.	18	CO2
3	General principles of electrophoretic techniques. Agarose gel electrophoresis of DNA and RNA, Poly Acryl amide Gel Electrophoresis, Iso- electric focusing, Isotachophoresis, 2-D Electrophoresis, Capillary electrophoresis, Blotting techniques – Northern, southern and western blotting – Principle, working and applications.	18	CO3
4	Colorimetry and Spectrphotometry – measurement of transmittance and absorbance, Beer Lambert's law. Principles, instrumentation and applications of UV, visible, infrared, Circular Dichroism, Spectrofluorimetry and mass spectrometry, X-ray diffraction- Bragg's equation, Fourier Transform Infrared Spectroscopy.	18	CO4
5	Radioactive isotopes, radioactive decay and their types, radioactive techniques-RIA, Autoradiography, Applications in Medicine & Diagnosis. Biosensors- Principle and applications of Electrochemical, Thermometric, and Optical biosensors	18	CO5

TEXT BOOKS:

1. David T. Plummer (2017), *An introduction to Practical Biochemistry*, (3rdEdition), Tata McGraw Hill, ISBN 13: 9780070994874.
2. Keith Wilson and John Walker (2010) *Practical Biochemistry - Principles and techniques*, (7th Edition), Cambridge University Press, U.K, ISBN 978-0-521-73167-6
3. Upadhayay and Nath (2019), *Biophysical chemistry: Principles and Techniques,* ,(4thReview Edition). Himalaya publishing house, ISBN Number : 978-93-5142-227-3
4. M.L. Srivastava (2011), *Bioanalytical Techniques*, Narosa Publishing House, New Delhi, ISBN 13: 9788173198526

REFERENCE BOOKS:

1. Rapley and Walker (2008*), Molecular Biomethods Handbook*, Humana Press, NewYork.
2. SVS Rana (2018) ,*Biotechniques: Theory & Practice*,(Second Edition), Rustogi Publications.
3. Saroj Dua And Neera Garg (2013), *Biochemical Methods of Analysis*, Narosa Publishing House, New Delhi.

Course Title: Allied Paper 3: Biochemistry

Course Code :	**Credits : 03**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to study the structure, functions and interactions of Biological macromolecules such as proteins, nucleic acid, carbohydrates and lipids.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Define and relate the acidity and alkalinity with the biological buffer systems.
CO2	Classify and analyze the structure, composition and function of biomolecules such as carbohydrates and proteins
CO3	Discuss the metabolic pathways and significance of biomolecules such as lipids and nucleic acids
CO4	Discriminate the types and the various roles of prostaglandins and porphyrins.
CO5	Tabulate the sources, structure, function and deficiency diseases relating to fat soluble and water soluble vitamins and minerals

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	1	3	2	2	1	2	2	2	2	2	1	2
CO 2	2	3	2	3	2	2	2	2	2	2	2	2
CO 3	2	3	2	3	2	2	2	2	2	3	2	2
CO 4	1	2	2	2	2	2	2	2	2	2	2	2
CO 5	2	2	2	2	2	3	2	2	2	3	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Definition of pH; pOH; buffers; acids; bases; Zwitter ions. Derivation & significance of Henderson-Hasselbalch equation. Measurement of pH. Normality, Molarity & Molality and their biological significance, Buffer systems.	18	CO1
2	Carbohydrates – Classification, Structure and general properties of monosaccharides (glucose, fructose, mannose) and disaccharides (maltose, lactose, sucrose).Polysaccharides-Homopolysaccharides (Starch, glycogen, cellulose) and Heteropolysaccharides (Heparin and chondroitin sulphate). Glycolysis, TCA cycle, Gluconeogenesis. Amino acids – Classification, properties and structure of essential and non-essential amino acids. Proteins-classification, structure (primary, secondary and tertiary) and properties.	18	CO2
3	Lipids – Classification-Simple lipids, fatty acids, Compound lipids, Derived lipids, Properties –physical, chemical and functions. Biosynthesis and Oxidation of fatty acids. Ketogenesis. Nucleic acids: Structures of Purine and pyrimidine bases, nucleosides, nucleotides and polynucleotides. Denovo synthesis of nucleotides- Purines and pyrimidines. DNA structure, types and properties. RNA- types, Structure and functions.	18	CO3
4	Classification of porphyrins, their structure & properties - Metalloporphyrins-haeme and chlorophyll. Prostaglandins – interleukins and interferons. Enzyme: Classification, Nomenclature, and Mechanism of enzyme action: Lock and Key model and Induced fit model.	18	CO4
5	Vitamins – Definition, Classification - Fat soluble vitamins-A, D, E and K; vitamins – B complex and C - biochemical roles, daily requirements and deficiency diseases. Water soluble. Biologically significant minerals-Calcium, Phosphorus, Potassium, Sodium, Iron and Zinc. Hormones – Insulin and Thyroxine hormones.	18	CO5

TEXT BOOKS:

1. Satyanarayana .U, Chakrapani.U, (2019). *Essentials Of Biochemistry* (3rd ed.). Books & Allied PvtLtd, ISBN : 9788193897492
2. Nelson David L, Cox Michael M, L. Lehninger Albert L. (2017). *Lehninger Principles of Biochemistry* (7th ed.). NewYork, W. H. Freeman publishers
3. RajanKatoch (2011). *Analytical Techniques in Biochemistry and Molecular Biology*. Springer, ISBN 9781-1-4419-9784-5

REFERENCE BOOKS:

1. Donald Voet, Judith Voet G. (2010).*Biochemistry* (4th ed.). New Jersey, John Wiley & Sons, Inc, ISBN-13: 978-0470570951
2. Jeremy Berg M, John Tymoczko L, LubertStryer (2011). *Biochemistry*. (7th ed.). Palgrave MacMillan, ISBN-13: 978-1429276351

Course Title: Core Practical – III: Bioinstrumentation

Course Code :	**Credits : 03**
L:T:P:S :0:0:3:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to employ the basic analytical techniques for the separation of biomolecules.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Record lab safety rules and apply the same in safe access of laboratory wares.
CO2	Practice, experiment with and apply the basic instruments in the laboratory such as weighing balance, pH meter, shaker, incubator etc. in various research processes.
CO3	Predict the functionality of Beer – Lambart's law in identifying and quantifying a biomolecule such as protein, pigment etc.
CO4	Employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation and chromatography by molecular weight, charge etc .
CO5	Apply electrophoretic techniques to qualify nucleic acid and to identify various proteins based on their molecular weight.
CO6	Observe and record the operation of FTIR, HPLC and GCMS for identifying a compound.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	3	2	2	2	2	2	3	3	2
CO 2	2	2	2	3	2	2	2	2	3	3	3	2
CO 3	2	2	2	3	2	3	2	2	3	3	3	2
CO 4	2	2	2	3	3	2	2	2	3	3	3	2
CO 5	2	2	2	3	3	3	2	2	3	3	3	2
CO 6	2	2	2	3	3	3	2	2	3	3	3	2

Sl. No	Contents of Module	Hrs	Cos
1.	Laboratory safety rules and Introduction to basic instruments and its uses (Weighing balance, pH meter, Laminar Airflow Chamber, Autoclave, Cyclomixer, Shaker incubator.	**10**	**CO1** **CO2**
2.	Verification of Beer – Lambarts law by Colorimetry. Application of UV – Visible spectroscopy in identifying a compound – Pigment To determine an unknown protein concentration by using UV – Visible spectroscopy.	**10**	**CO3**
3.	Subcellular fractionation by differential centrifugation. Separation of biomolecules by paper chromatography Separation of Lipids by TLC	**10**	**CO4**
4.	Demo on Agarose gel electrophoresis of DNA SDS – PAGE	**8**	**CO5**
5.	Demo on Gel permeation chromatography Separation of plant pigments by gel permeation chromatography	**7**	**CO6**

REFERENCE BOOKS:

1. Bhomwik (2011),*Analytical techniques in Biotechnology – A complete laboratory manual*, MGH Publisher, ISBN-13 : 978-0070700130
2. P. Palanivelu (2017), *Analytical Biochemistry and Separation techniques – A laboratory manual*, (5^{th} Edition), Twentyfirst century publishers, ISBN: 978-81-908489-0-9

Course Title: Allied Practical – III: Biochemistry

Course Code :	**Credits : 02**
L:T:P:S : 0:0:3:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to deduce various chemical solutions and to analyze and estimate the chemicals qualitatively and quantitatively.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Deduce how to standardise various chemical solutions.
CO2	Estimate the amount of chemicals such as glycine, glucose and ascorbic acid volumetrically
CO3	Estimate the amount of glucose and inorganic phosphorus colorimetrically
CO4	Analyze the sugars such as glucose, fructose, lactose and sucrose qualitatively
CO5	Analyze the aminoacids such as Arginine, Cysteine, Tyrosine and Tryptophan qualitatively

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	3	2	2	2	2	2	3	2	2
CO 2	2	2	3	3	2	2	2	2	2	3	2	2
CO 3	2	2	2	2	2	2	2	2	2	3	2	2
CO 4	2	2	2	3	3	3	2	2	2	3	2	2
CO 5	2	2	2	3	2	2	2	2	2	3	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	I. Volumetric analysis 1. Estimation of Glycine by formal titration. 2. Estimation of Glucose by Benedict's method. 3. Estimation of Ascorbic acid by dichlorophenol indophenol method	**9**	**CO1** **CO2**
2	II. Colorimetric analysis 4. Estimation of Glucose by ortho toluidine method 5. Estimation of Protein by Lowrys's method	6	**CO3**
3	III. Qualitative analysis of sugars 6. Glucose 7. Fructose 8. Lactose 9. Sucrose 10. Starch	12	**CO4**
4	IV. Qualitative analysis of aminoacids 11. Cysteine 12. Tryptophan 13. Tyrosine 14. Arginine	12	**CO5**

REFERENCE BOOKS:

1. Soundravally Rajendiran Pooja Dhiman, (2019), *Biochemistry Practical Manual*,(1st ed.). Elsevier India, ISBN: 9788131253519.
2. Vasudevan D.M., Das S.K. (2013).*Practical Textbook of Biochemistry for Medical Students*,(2nd ed.).Jaypee Brothers Medical Publishers,ISBN 9789352705146.

FOURTH SEMESTER

Course Title: Core Paper 4: Skill Enhancement Course - Genetic Engineering

Course Code :	**Credits : 04**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to acquire knowledge on molecular techniques that is required to be a successful genetic engineer of plants, animals and microorganisms.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Demonstrate the basic principles that govern the genetic engineering techniques
CO2	Illustrate the significance of enzymes and nucleic acids in molecular techniques and the specificity of vectors for cloning and advantages.
CO3	Enumerate various recombinant techniques and gene probes and molecular markers identification
CO4	Analyze and detect nucleic acid components from different sources using advanced molecular techniques.
CO5	Exhibit knowledge in sequencing technologies and protein engineering techniques
CO6	Explore the strategies for Gene cloning and its application in research, medicine and agriculture

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	3	2	3	3	2	2	2	3	2	3
CO 2	2	2	3	3	3	2	2	2	2	3	3	3
CO 3	2	2	3	2	2	2	3	2	2	3	2	2
CO 4	2	2	2	2	2	2	3	2	2	2	2	2
CO 5	2	2	3	2	3	2	2	2	2	3	2	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Core techniques in gene manipulation. Cutting and joining of nucleic acids, reverse transcriptase, DNA ligase. Types of Restriction enzymes, Modification enzymes nucleic acid manipulating enzymes. Restriction and modification systems in bacteria. Cloning strategies.	18	CO1
2	Introduction to cloning vectors. classification of Plasmids and Properties -Plasmid vectors- pBR322, pUC vectors-pUC8,pUC19 Phage vectors- λ and M13 vectors,Yeast vectors, shuttle vector, Ti plasmid vector, caMV vector,SV40 vector, Artificial chromosome - BAC and YAC	18	CO2
3	Selection and screening of recombinants: Construction of genomic DNA library screening of DNA library and cDNA libraries. Methods of labelling gene probes; Principles and Applications – Restrction Fragment Length Polymorphism, Random Amplification of Polymorphic DNA.	18	CO3 CO4
4	DNA Bar coding – Introduction, components of DNA barcoding, DNA sequencing-Maxam and Gilbert method, Site directed mutagenesis and protein engineering.	18	CO5
5	DNA amplification using polymerase chain reaction (PCR)- Principle, Steps involved in PCR, Types of PCR, application of PCR, DNA finger printing – Methods and its applications.	18	CO6

TEXT BOOKS:

1. David Clark Nanette Pazdernik Michelle McGehee (2018), *Molecular Biology techniques*,(3rd edition).
2. Anton Byron (2019), *Introduction to Gene Cloning*, Publisher: Oxford Book Company.

REFERENCE BOOKS:

1. Monika Jain (2012), *Recombinant DNA technology*, (I edition), Alpha Science International. ISBN-13 : 978-1842656679
2. Primrose.S.B (2014), *Principles of gene manipulation*, (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3

Course Title: Allied Paper 4: Fundamentals of Computers and Biostatistics

Course Code :	**Credits : 03**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will understand the importance and applications of computer knowledge and statistical tools in the field of Biotechnology.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Enumerate the basics of computers architecture and storage devices
CO2	Explain the basics of working with MS-word, Excel and powerpoint
CO3	Demonstrate the basic methods of data collection, graph construction and sampling techniques
CO4	Calculate measures of central tendency and interpret biological data via various probabilistic distribution methods.
CO5	Correlate and analyze biological data through various statistical methods.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	3	2	2	2	2	2	1	3	2
CO 2	2	2	2	2	2	2	2	2	2	1	3	2
CO 3	3	2	2	2	3	2	2	2	2	3	2	2
CO 4	3	2	3	3	2	2	3	2	2	2	3	3
CO 5	3	2	3	2	2	2	2	2	2	2	3	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Fundamentals of Computers:** Introduction, Characteristics of a Computer, Criteria for Using Computers, History of Computers, Generations of Computer, Classification of Computers, Applications of Computer, Basic Components of PC, Computer Architecture Computer in Biological Research - Components of Computer - storage device, computer peripherals, Computer virus Protection.	18	CO1
2	**MS Office and Internet:** Word Basics- Creating and working with documents, working with text Tables, Using EXCEL-working with work sheet, Creating chart- working with formula and functions, Using power point-working with power point user interface, Using templates and wizard for Slide Presentation, Creating charts and tables, Internet and WWW, Electronic mail- internet browsing	18	CO2
3	**Introduction to biostatistics:** Basic definitions and applications, sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: types of data, methods of collection of primary and secondary data, methods of data collection, graphical representation by histogram, polygon, ogive curves and pie diagram.	18	CO3
4	**Measures of central tendency and Concept of Test of Hypothesis:** Measures of central tendency – (Arithmetic, harmonic and geometric mean), median and mode, Measures of dispersion – Range, interquartile range, and standard deviation; Variance, Coefficient of Variation, Skewness – Kurtosis. Concept of Test of Hypothesis. Applications of t-test statistics to biological problems/data: Chisquare test, statistic applications in Biology	18	CO4
5	**Regression, correlations and Probability Distribution :** Correlation and regression: positive and negative correlation and calculation of karl pearsons co-efficient of correlation, Spearman's Rank Correlation; Regression – Formation of Regression lines – Uses of Regression lines; Concept of analysis of variance- ANOVA, one and two way classification Probability theory – probability distribution, Binomial, poisson and normal distribution, correlation and regression analysis.	18	CO5

TEXT BOOKS:

1. Mohammad AmjadManaullahAbid. (2019). *Fundamentals of Computers*. (1st Ed.)DreamtechPress, ISBN-978-93-89520-39-2
2. S.P. Gupta (2019), *Biostatistical methods* (1st Ed.)Sultan Chand and Sons, ISBN 93-5161-112-7
3. Veer BalaRastogi (2018). *Biostatistics*. Medtech Publisher, ISBN: 9789384007591, 9384007595

REFERENCE BOOKS:

1. Jerrold H. Zar (2014*), Biostatistical Analysis* (5th Ed), New Delhi: Pearson Education
2. Priti Sinha Pradeep K. Sinha (2018). *Computer Fundamentals* (6th Ed.) BPB Publications; Reprint Edition, ISBN: 9788176567527

Course Title: Core Practical IV: Genetic Engineering

Course Code :	**Credits : 03**
L:T:P:S : 0:0:3:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to apply the advanced molecular techniques for the DNA studies.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Isolate the Plasmid DNA and Genomic DNA.
CO2	Predict the molecular weight of DNA by agarose gel electrophoresis
CO3	Estimate the DNA using UV-Visible spectrophotometry. Determine the restriction digestion and ligation of DNA
CO4	Determine the restriction digestion of DNA.
CO5	Amplify the DNA using PCR and to explicate the proteins using SDS– PAGE.
CO6	Prepare the competent cells and perform bacterial transformation

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	2	1	3	2	2	3	3	3	3
CO 2	2	2	2	1	2	2	2	2	2	3	3	1
CO 3	2	2	2	3	2	2	2	2	3	3	3	1
CO 4	2	2	2	2	2	3	1	2	3	3	3	2
CO 5	2	2	2	3	2	1	1	2	3	3	3	1
CO 6	2	2	2	2	2	2	2	2	3	3	3	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	1. Isolation of genomic DNA from various sources 2. Isolation of plasmid DNA from various sources	9	CO1 CO2
2	3. Isolation of RNA from various sources 4. Separation of nucleic acids using agarose gel electrophoresis	9	CO2 CO3
3	5. Estimation of Nucleic acidbySpectrophotometry 6. Restriction digestion of DNA 7. DNA ligation	9	CO3
4	8. PCR amplification of marker gene 9. SDS – PAGE for analysis of protein	9	CO4
5	10. Bacterial Transformation 11. Demo on Blotting techniques (Southern and Western)	9	CO5

REFERENCE BOOKS:

1. Vennison, S. J. (2009).,*Laboratory Manual for Genetic Engineering* (1st edition). Delhi. PHI Publishers, ISBN : 9788120338142.

Course Title: Allied Practical IV: Fundamentals of Computers and Biostatistics

Course Code :	**Credits : 02**
L:T:P:S : 0:0:3:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to represent and interpret the biological data in graphical form.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Represent data in to graphical form
CO2	Determine averages of the biological data
CO3	Test the level of significance of biological data and interpret the results
CO4	Enhance skills in working with MS-word, powerpoint and Excel
CO5	Create E-mail and use of various search engines

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	3	2	2	2	2	2	2	2	3	2
CO 2	2	2	2	3	3	2	2	2	3	2	3	2
CO 3	2	2	3	2	2	2	2	2	2	3	2	3
CO 4	3	2	2	3	2	2	2	2	2	2	3	2
CO 5	2	3	2	2	3	2	2	2	2	2	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Representation of statistical data by a) Histogram b) Ogive curve c) Pie diagram	9	CO1
2	Determination of statistical averages / central tendencies. a) Arithmetic mean b) Median c) Mode.	9	CO2
3	Determination of measure of dispersion. a) Mean deviation. b) Standard deviation and coefficient of variation. c) Quartile deviation. Tests of significance-Application of following. a) Chi-square test. b) t-test c) standard error	9	CO3
4	Creating files, folders and directories; Application of computers in biology using MS-office. a) MS-word b) Excel c) Power point.	9	CO4
5	Creating and e-mail account, sending and receiving mails; An introduction to Internet, search engines, websites, browsing and downloading	9	CO5

REFERENCE BOOKS:

1. Bittu Kumar (2017), *Computers Basics*, V & S Publishers, ISBN 9789350578612
2. Mendel Suchmacher and Mauro Gueller. (2012), *Practical Biostatistics* (1st Ed.) Academic Press, ISBN: 9780124157941

FIFTH SEMESTER

Course Title: Core Paper 5: Immunology

Course Code :	**Credits : 04**
L:T:P:S : 5:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to understand the immune cells organization structure and its functions in elaborate.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Grasp the basic concepts of immunity while distinguishing between innate and acquired immunity
CO2	Define the role of various cells/ organs involved in bodily defense mechanisms
CO3	Classify antigens/antibodies and Monoclonal antibody production and learn the pathways of complement systems
CO4	Gain an in-depth understanding of the development of T & B cells and explain the role of MHC in cell and antibody mediated immune response.
CO5	Demonstrate the role of cytokines in immune response and explain the types of hypersensitivity and auto immune diseases
CO6	Demonstrate the antigen –antibody reactions in various immune techniques and also gain knowledge of production of vaccines.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	3	2	2	2	2	3	2	2	2
CO 2	2	2	3	2	2	2	2	2	2	3	2	2
CO 3	2	2	2	2	2	3	3	2	2	3	2	2
CO 4	2	2	2	3	2	2	2	2	2	3	2	2
CO 5	2	2	3	2	3	2	3	2	2	3	3	2
CO 6	2	2	2	2	3	2	3	2	3	2	2	2

Sl. No	CONTENTS OF MODULE	Hrs	Cos
1.	Historical perspective of the immune system; innate immunity and acquired immunity. Structure and functions of primary and secondary Lymphoid organs. Cells of the immune system- granulocytes & agranulocytes-and their functions- Inflammation and Phagocytosis.	15	CO1& CO2
2.	Antigens: Types and properties-Structure, epitope, adjuvant, hapten. Classes and functions of antibodies; Antigenic receptors. Effector components of an immune response. Monoclonal antibody production and its uses. Pathways of complement systems – Classical and Alternate pathway and its biological effects.	15	CO3
3.	An introduction to MHC I and MHC II. Immune response- T cells – receptors, Maturation, activation and differentiation- Cell mediated response. B cells- receptors, maturation and activation of B cells by T cell dependent and independent antigens and differentiation-Antibody mediated response.	15	CO4
4.	Cytokines- types and its functions. Auto immune diseases- organ specific- Rheumatoid arthritis and non-organ specific -Systemic lupus erythematosus. Types of hypersensitivity-Type I, II, II, IV and V-Mechanism with examples.	15	CO5
5.	Antigen and antibody interactions- Antibody affinity, avidity, specificity, cross reactivity. Immunodiffusion-SID & DID agglutination, Immuno electrophoresis-counter current and rocket, ELISA. Infectious diseases – Bacterial and viral. Vaccine production-Recombinant and DNA vaccines.	15	CO6

TEXT BOOKS:

1. Joshi, K.R & Osama, N.O. Immunology, 4th edition, *Agro Botanica Bikaner*, 1998.
2. D.M.Weir. (1978*), Handbook of Experimental Immunology*, Volume 3, *Blackwell Scientific Publication*, ISBN 13: 978063200975
3. Abdul Abbas, Andrew H. Lichtman, Shiv Pillai, (2017), *Cellular and Molecular Immunology,(*9thedition), Elsevier Publishing Company, ISBN: 9780323479783
4. Kenneth Murphy, Paul Travers and Mark Walport, (2009), *Immunobiology,(* 7th edition), Garland Science, New York,ISBN 978-0-8153-4123-9

REFERENCE BOOKS:

1. Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osbourne.(2006*), Kuby Immunology* (6th edition), *W. H. Freeman & Company*, ISBN-13: 978-1429202114
2. Ivan M. Roitt, Seamus J. Martin, Dennis R. Burton and Peter J. Delvis., *Essential Immunology*,(13thedition) , *Wiley Blackwell, USA*, 2017.

Course Title: Core Paper 6: Bioinformatics

Course Code :	**Credits : 04**
L:T:P:S : 5:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to realize how bioinformatics tools aid in drug designing process in connection with chemoinformatics and pharmacogenomics. This course also helps the student to analyze and interpret the biological data like amino acid sequences, protein domains and protein structures.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Discuss about various biological databases and its analysis
CO2	Compare the genomic data from databases and to interpret in meaningful manner.
CO3	Demonstrate the principles of human genome project and genome organization techniques
CO4	Explore the steps in sequence alignment algorithms and various sequence alignment programs used.
CO5	Use various protein databases and proteomics analysis tools
CO6	Identify novel lead compounds using ligand based and structure based drug designing process
CO7	Exhibit knowledge in microarray data analysis using gene expression tools

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	3	2	3	2	2	3	3	3	2
CO 2	3	2	3	2	2	3	2	2	3	2	3	1
CO 3	3	2	2	3	2	2	2	2	3	3	2	2
CO 4	3	2	2	2	2	3	3	2	2	2	2	2
CO 5	3	2	2	3	2	3	2	2	2	2	3	1
CO 6	3	2	2	2	2	3	2	2	3	2	3	2
CO 7	3	3	3	3	3	2	3	2	3	2	3	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Biological Databases:** Bioinformatics - definition, introduction, history and scope. Databanks –. Literature DataBanks – PubMed. Biological databases -nucleic acids – NCBI, EMBL, DDBJ. Protein – Uniprot and PIR; Structural databases – PDB, CATH, SCOP	15	CO1
2	**Genome analysis tools and Genome Sequencing:** Genome Structure, Human Genome Project; Genome Databases-GDB, TIGR, Ensembl genomes, Flybase, SGD, Gene disease database; Comparative Genomics – Determining gene function by sequence comparison. Fragment Assembly, Genome Sequence Assembly; Next Generation Sequencing	15	CO2 CO3
3	**Sequence Analysis:** Analysis- Sequence Alignment: Alignment algorithms - Pair wise alignment-Global and Local – Significance, Dynamic Programming in Sequence Alignment, Dot Matrices, Substitution Matrices – PAM, BLOSUM, Homology search Using FASTA and BLAST Programs; Multiple Sequence Alignment methods	15	CO4
4	**Protein structure prediction and Phylogenetic analysis:** Protein structure prediction methods- Primary, secondary, tertiary structure prediction Protein domains and motifs; Phylogenetics - Tree construction methods –Distance based methods and character based methods	15	CO5 CO6
5	**Microarrays:** Concept of Gene Expression, Types of Microarrays; Making Microarrays; Spotted Microarrays; -Microarrays - Sample Preparation and Labeling, Hybridization, Washing, Image Acquisition; Protein arrays; GEO Database. Application of Microarrays	15	CO7

TEXT BOOKS:

1. S. C. Rastogi, NamitaMendiratta, ParagRastogi. (2013). *Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery*. PHI Learning Pvt. Ltd, ISBN 978-81-203-4585-4
2. Ruchi Singh. (2014),*Bioinformatics: Genomics and Proteomics.* Vikas Publishing House, ISBN 9789325978553
3. David Mount. (2004).*Bioinformatics: Sequence and Genome Analysis*(2nd Ed.), Cold Spring Harbor Laboratory Press, ISBN 87969-687-7

REFERENCE BOOKS:

1. Lesk Arthur. (2019), *Introduction to Bioinformatics.*(5th Ed.)., UK:Oxford University Press, ISBN: 9780198794141
2. Baxevanis, Andreas D. and Francis B.F. Ouellette. (2005), *Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins*, (3rded.) USA: John Wiley, ISBN: 978-0-471-47878-2

Course Title: Core Paper 7: Bioprocess Technology

Course Code :	**Credits : 04**
L:T:P:S : 5:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student learns the Industrial aspects of microbial usage along with the functional aspects of metabolites.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Illustrate the significance of cultivation and preservation of different types of industrial microbes.
CO2	Distinguish the principle and application of various fermentors used in different industries.
CO3	Depict the various methods involved in the downstream processing for various metabolites.
CO4	Compare the different methods of extraction, purification and drying process for different metabolites products.
CO5	Summarize the microbial role and economic importance of various primary and secondary metabolites.
CO6	Speculate the role and importance of microorganisms behind the production of Biopesticides and Biofertilisers.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	1	1	2	1	2	2	3	1	3	3	1	2
CO 2	3	2	2	1	2	2	2	1	3	3	1	2
CO 3	3	2	2	2	2	2	2	1	3	2	2	2
CO 4	3	2	2	2	2	2	2	1	3	2	2	2
CO 5	2	1	2	2	2	2	2	1	3	2	2	2
CO 6	2	3	2	2	3	3	2	1	3	3	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	History and scope, applications of bioprocess technology; Fermentation and its types; Screening of industrially important microorganism – Strain improvement – inoculum development – Media formulation, sterilization - Cultivation and preservation of industrial microorganisms	15	CO1
2	Batch culture and continuous culture; Fermentor- Design, parts and their function; Types of fermentor - batch fermentor, continuous stirred tank fermentor, Air lift fermentor, Bubble column, tower fermentor.	15	CO2
3	Downstream Processing: Filtration and its types, Cell disruption – Mechanical and non-mechanical, Precipitation, Solid liquid separation – Flotation, Flocculation, Centrifugation and its types	12	CO3
4	Liquid-liquid extraction - aqueous two-phase extraction, supercritical extraction; Chromatography and its types; Membrane process – Ultrafiltration, reverse osmosis, liquid membranes, Drying and its types, Crystallization.	16	CO4
5	Production of primary metabolites: citric acid, Glutamic acid, amylase, protease; Production of secondary metabolites: Penicillin, Steroids, Growth factors; Production of other microbial products: Cheese, beer, ethanol, Biopesticides, Biofertilisers, Biopreservatives (nisin)	17	CO5 CO6

TEXT BOOKS:

1. R C Dubey,(2014), *Advanced Biotechnology*, (1st Edition), S. Chand Publishing, ISBN 9788121942904
2. NdukaOkafor, Benedict C. Okeke, (2018), *Modern Industrial Microbiology and Biotechnology*, (2nd Edition), CRC Press, ISBN 9781315147161
3. NeelamTyagi (2012), *Industrial Microbiology and Biotechnology*, (1st Edition), Agrotech Press

REFERENCE BOOKS:

1. Peter F. Stanbury Allan Whitaker Stephen Hall.(2016*)*, *Principles of Fermentation Technology*, (3rd Edition), Butterworth-Heinemann,. ISBN: 9780080999531
2. El-Mansi, E, Nielsen, J, Mousdale, D, Carlson(2019), R. *Fermentation Microbiology and Biotechnology*,(4th Edition). CRC Press, ISBN 9780367656706

Course Title: Core Paper 8- Skill Enhancement Course: Food Biotechnology

Course Code :	**Credits : 04**
L:T:P:S : 5:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to understand the basic concepts of food industry and also to establish an ecological balance to prevent soil fertility or pest problems.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Discover the role of biotechnology in food processing industries.
CO2	Execute the biotechnological production of commercially important metabolites.
CO3	Apply the principle of downstream processing and explain the various stages involved in downstream processing.
CO4	Evaluate the molecular diagnostic techniques pertaining to identification of food adulterants.
CO5	Assess the safety aspects and social issues related to applications and implications of genetically modified foods.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	2	2	2	3	2	2	2
CO 2	3	2	2	3	3	2	2	2	3	2	2	2
CO 3	3	2	2	3	2	2	2	2	3	2	2	2
CO 4	3	2	3	3	2	2	2	2	3	2	2	2
CO 5	3	2	2	2	2	2	2	2	2	2	2	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Fundamentals of food biotechnology**: Biotechnology relating to the food industry – Role of bio process engineering in biotechnology industry- Regulatory and social aspects of biotechnology in foods- Application of biotechnology in waste treatment of food industries.	15	CO1
2	**Industrial production of food products:** Technological aspects of industrial production of beer and wine, lactic acid, baker's yeast, single cell protein- Bacteriocin production and its use in food preservation- Biotechnological approaches to improve nutritional qualities and shelf life of fruits and vegetables by gene modification.	15	CO2
3	**Downstream processing:** Principle of downstream processing -stages in downstream processing- solid liquid separation- flotation- flocculation-filtration-types-centrifugation-cell disruption-concentration-evaporation –liquid- liquid extraction-membrane filtration- precipitation-adsorption-purification by ion exchange chromatography.	15	CO3
4	**Food adulterants & molecular diagnostic tools:** Types of food adulterants – test to detect adulterants in foods – metal contaminants - contaminants of processed foods- Food products as analytical samples, general aspects of biosensors- biosensors for food contaminant analysis, commercially available biosensors for food analysis.	15	CO4
5	**Food safety and ethical issues:** Risk associated with GM foods – Allergens, toxins, antibiotic resistance, soil contamination - Creation of superbugs and super weeds - Increased risk of immune suppression and cancer- GMOs- current guidelines for the production, release and movement of GMOs; labeling and traceability; trade related aspects.	15	CO5

TEXT BOOKS:

1. Joshi, V.K. and Singh, R.S., A. (2013), *Food Biotechnology- Principles and practices,* I.K.International Publishing House Pvt. Ltd., New Delhi,.
2. RavishankarRai, V,(2015), *Advances in Food Biotechnology*, (First edition), John Wiley & Sons, Inc, ISBN 9781118864555
3. Foster, G.N., (2020), *Food Biotechnology*, (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348

REFERENCE BOOKS:

1. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin(2005), *Food Biotechnology*, (2nd edition), *CRC Press*, ISBN 9780824753290
2. Perry Johnson-Green.(2018), *Introduction to Food Biotechnology*, Special Indian Edition, *CRC Press*, ISBN 9781315275703

Course Title: Elective 1A -Marine Biotechnology

Course Code :	**Credits : 05**
L: T: P: S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to understand marine ecosystem and its importance to humans in biotechnology perspectives.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Demonstrate the importance of aquaculture, selection of cultivable species and its commercial importance.
CO2	Discuss the design, construction and management practices of aqua farms.
CO3	Compile the various cultivation methods of marine organisms and to explain the marine pollution and sea food infections.
CO4	Comprehend the uses of marine organisms, their significance, interaction and impacts on the environment.
CO5	Describe the growing use of marine natural products in food, cosmetics, agriculture and to analyze the concepts on bio fouling and antifouling.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	2	2	1	2	2	2	3	1
CO 2	3	2	2	1	1	2	2	2	2	2	3	3
CO 3	3	2	2	2	2	1	3	2	1	2	2	2
CO 4	3	2	2	1	2	2	2	2	1	1	2	3
CO 5	3	2	2	1	2	2	2	2	2	2	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Historical background, Overview of present status of marine biotechnology, Importance of coastal aquaculture, Criteria for selecting cultivable species, Commercially important and potential species.	12	CO1
2	Aqua farms - Design and construction of culture systems, management practices-Extensive, Semi intensive and intensive culture practices, mass spawning, Artificial insemination, invitro fertilization.	12	CO2
3	Cultivation of microalgae, macro algae, shrimp, carps, mud crab, live feed culture technique &feed formulation. Sea food microbiology - normal genera associated with fish. Marine pollution - major pollutants, biological indicators (marine microbes, algae& crustaceans).	12	CO3
4	Marine natural products - Chemicals, Marine Biomedical & Bioactive compounds from microalgae & marine organism. Commercial bio products from marine organisms. Marine biotechnology for economic development and environmental problem solving, transgenic marine organism.	12	CO4
5	Bio fouling-marine fouling & boring organism, biofilm formation, bio-remediation, antifouling & antiboring treatments, corrosion process - control of marine structure.	12	CO5

TEXT BOOKS:

1. Gloria Sanchez, Elizabeth Hernandez,(2019*), Environmental Biotechnology and cleaner Bioprocess*, (1st edition), CRC Press, ISBN 9780367455552
2. Kirchman, D.L.Gasol, J.M. (2018), Microbial ecology of the oceans, (3rdedition), Wiley – Blackwell.

REFERENCE BOOKS:

1. Bradach, J.E., H.H. Ryther and W.D. MC Larney, (2014), *Aquaculture, farming and husbandry and fresh and marine organisms*, Wiley lnterscience, New York, ISBN: 978-0-471-04826-8
2. Kim Se-Kwon, (2019), *Essentials in Marine Biotechnology*, Springer.

Course Title: Elective Paper 1B: Agricultural Biotechnology

Course Code :	**Credits : 05**
L:T:P:S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to manage sustainable exploitation of plant and microbial resources in an environmentally sensitive manner and also the emerging concepts in agrobiotechnology.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Discuss crop improvement hybridization and plant breeding techniques.
CO2	Demonstrate *in vitro* production of disease free plants and the molecular basis of plant resistance to various abiotic stresses
CO3	Illustrate the plant growth promoting microorganisms and phosphate solubilizing bacteria.
CO4	Describe the impact of transgenic plants in agriculture and Horticulture and produce transgenic plants for fungal, bacterial and viral disease resistance
CO5	Apply the principles of bioethics on GM crops and recall the various plant variety protection acts.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	2	3	3	2	2	2	2	3	1
CO 2	2	2	2	2	3	2	2	2	2	2	3	2
CO 3	2	2	2	2	2	2	2	2	2	2	3	2
CO 4	3	2	2	2	3	2	2	2	3	2	3	1
CO 5	3	2	2	2	3	2	2	2	3	2	3	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Introduction: Scope and application of agriculture. Crop improvement hybridization and plant breeding techniques. Clonal Germplasm: Micro propagation, *In* vitro production of disease free plants; Seed pathology.	12	CO1
2	Plant Resistance: Molecular and biochemical basis of plant disease resistance, Molecular basis of plant resistance to various abiotic stresses like drought, salinity, heavy metals, high temperature. Methods for crop improvement for resistance to biotic and abiotic stress.	12	CO2
3	Plant growth promoting microorganisms: Plant Growth promoting bacteria: Nitrogen fixation- and nodulation genes. Biochemistry of nitrogen fixation, Nif genes. Biofertilizers: Azolla and Anabena, Rhizobium, Phosphate solubilizing bacteria. Biopesticide – Trichoderma and Bt.	12	CO3
4	Applications: Commercial production of Transgenic crops- Impact of transgenic plants in agriculture and Horticulture. Production of transgenic plants for fungal, bacterial and viral disease resistance; herbicide resistance, drought and other abiotic stress resistance.	12	CO4
5	Bioethics: Bioethical issue on GM crops. Biosafety norms and controlled field trials and release of transgenics (GMO). Plant Variety Protection Act: TRIPS and WTO. Regulatory issues of biotechnology improved plants.	12	CO5

TEXT BOOKS:

1. Nirmala C.B, Rajalakshmi. G and Karthik. C (2009). *Plant Biotechnology* (1st ed.). MJP Publishers. ISBN-13: 978-8180940378
2. Kumar HD. (2016). *Agricultural Biotechnology*, New Delhi. Daya Publishing house. ISBN 9788170354123
3. Joshi Rajmohan. (2006). *Agricultural Biotechnology*, Isha Books. ISBN 10: 8182053803ISBN 13: 9788182053809

REFERENCE BOOKS:

1. Ahindra Nag. (2008). *Text book of Agricultural Biotechnology*, New Delhi.PHI Learning Private Limited. ISBN : 9788120335929
2. Arie Altman, Rita Colwell.R.(2001).*Agricultural Biotechnology*, New York. Marcel Dekker. ISBN 13: 9780824794392

Course Title: Elective Paper 1C: Basics in stem cell Biology

Course Code :	**Credits : 05**
L:T:P:S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to understand animal/stem cell culture and reproductive manipulation techniques.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Exhibit knowledge on the types and sources of embryonic, adult and induced pluripotent stem cells and to differentiate the potential of embryonic stem cells with adult stem cells.
CO2	Understand the properties, differentiation and regulation stem cells.
CO3	Share insights into techniques involved in isolation, expansion and identification of stem cells.
CO4	Evaluate the role of stem cells in clinical applications for human health and improvement. Discuss about animal models for regeneration.
CO5	Acquire a deeper understanding of stem cell banks and its importance .Understand the national & international guidelines of stem cell research and also recent advancements.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	2	2	2	2	2	3	3	2	2
CO 2	2	2	2	2	3	2	2	2	2	2	3	2
CO 3	3	2	2	2	3	2	2	2	3	3	3	2
CO 4	3	2	2	3	2	2	2	2	2	2	2	2
CO 5	2	3	2	2	2	3	2	2	2	2	2	2

Sl. No	CONTENTS OF MODULE	Hrs	Cos
1.	Introduction to concepts in stem cell biology, unipotent, multipotent, totipotent and pluripotent stem cell. Types and Sources of stem cells- Embryonic stem cells, Adult stem cells, mesenchymal, hematapoietic and induced pluripotent stem cells.	12	CO1
2.	Properties of stem cells- self renewal and differentiation, regulation of stem cell-cell cycle regulation, gene expression, epigenetic regulation and miRNA roles.	12	CO2
3.	Isolation of stem cells by fluorescence based cell sorting, culture and genetic manipulation of stem cells, expansion of stem cells using biochemical and molecular approach. Identification of stem cells using specific markers.	12	CO3
4.	Applications of stem cells: Stem cells used organogenesis in animals and humans. Animal models of regeneration. Stem cells used for therapy- Parkinson's disease, spinal cord injury and Muscular dystrophy.	12	CO4
5.	Stem cell banking- sperm and ova bank and its role. Cryopreservation techniques, National ethical guide lines of stem cell research by ICMR, and international guide lines by International society for Stem Cell Research (ISSCR), advances in stem cell biology.	12	CO5

TEXT BOOKS:

1. Jonathan slack(2012), *Stem Cells: A Very Short Introduction* , oxford University press.
2. IndumathiSomasundaram, DhanasekaranMarrappagounder,Pankajkaigade (2019),*Stem cell Biology*, Evincepub Publishing , ISBN-10: 9389774357
3. KursadTurksen(2014), *Adult and Embryonic Stem Cells -Stem Cell Biology and Regenerative Medicin*e, (2nd edition) ,Humana press
4. Ann A Kiessling ,Scott C Anderson(2006*), Human Embryonic Stem Cells*, Jones and Bartlett Publishers, Inc; (2nd Revised edition), ISBN-13: 978-0763743864

REFERENCE BOOKS:

1. Federico Calegari,Claudiawaskov (2014), *Stem Cells: From Basic Research to Therapy*, Volume 1 Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms ,CRC Press. ISBN-13: 978-1482207750
2. Robert Lanza, Anthony Atala(2013), *Essentials of stemcell biology(*III ed) copyright:Academic Press ,Hardcover ISBN:9780124095038eBook ISBN: 9780124104273. ISBN:9780124095038

Course Title: Core Practical V: Immunology, Bioinformatics, Bioprocess Technology & Food Biotechnology

Course Code :	**Credits : 03**
L:T:P:S : 6:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to employ the immunological techniques, bioinformatics tools, quantify the microbial metabolites and to enumerate the microorganisms present in food samples.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Perform blood grouping and determine blood type and to conduct serological diagnostic tests such as ASO, CRP and RA
CO2	Diagnose syphilis by carrying out TPHA and enteric fever by Widal test.
CO3	Acquire technical skills required for immunodiffusion and know the principle behind the techniques.
CO4	Retrieve biological data from various protein and nucleotide sequence database
CO5	Perform pairwise and multiple sequence analysis using various alignment programs
CO6	Predict sequence similarity, ORF, domains, motif using various sequence analysis tools
CO7	Isolate and screen industrially important microbes for the production of different metabolites.
CO8	Quantify and validate the presence of microbial metabolites using various techniques.
CO9	Perform serial dilution and plating in order to enumerate the microorganisms present in food samples.
CO10	Acquire skills to isolate lactic acid bacteria and manufacture whey.
CO11	Gain basic skills to detect adulterants in food.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	3	2	2	2	3	2	3	2
CO 2	2	2	2	3	3	2	3	2	3	3	3	2
CO 3	2	2	3	2	2	2	2	2	2	3	3	2
CO 4	2	2	2	2	2	2	2	2	3	3	3	2
CO 5	2	2	2	2	3	2	2	2	3	2	3	2
CO 6	2	2	3	3	2	2	2	2	3	2	2	2
CO 7	2	2	2	3	2	3	2	2	3	2	3	2
CO 8	2	2	2	1	2	2	2	2	3	3	2	2
CO 9	2	2	2	2	3	2	2	2	2	2	3	2
CO 10	2	2	2	3	2	2	2	2	2	3	3	2
CO 11	2	2	2	3	2	3	2	2	3	3	3	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Immunology** 1. ABO Blood grouping and Rh factor typing by slide agglutination test, Particle agglutination test -ASOC- reactive protein detection by agglutination reaction, 2. Detection of Rheumatoid arthritis (RA) factors by agglutination method-WIDAL-tube and slide agglutination test, Passive haemagglutination-TPHA (*Treponema pallidum* particle agglutination test) 3. Precipitation reaction- RID (Radial Immunodiffusion) 4. Precipitation reaction- ODD (Ouchterlony Double Immunodiffusion) 5. ELISA (demonstration), VDRL- slide flocculation test	15	CO1 CO2 CO3
2	**Bioinformatics** 1. Sequence & Structure Database: Nucleotide: NCBI ; Protein : Uniprot, TrEMBL, PDB 2. Sequence alignment – Global and Local alignment; Multiple sequence alignment – Clustal omega 3. Profile and Domain analysis: Prosite, Pfam 4. Protein Sequence analysis : Protparam, GOR IV, 5. Homology Search tool: BLASTp, BLASTn, Visualization Tool: RasMol,	20	CO4 CO5 CO6
3	**Bioprocess Technology** 1. Isolation of industrially important microorganism. 2. Production & estimation of biomass - dry weight & Wet weight methods. 3. Immobilization of yeast cells, Screening and production of Protease from microbes 4. Production and estimation of ethanol	20	CO7 CO8
4	**Food Technology** 1. Quantitative Enumeration of microorganisms from the given sample by serial dilution technique: Milk, Food, Curd , Bread (Yeast and mold count) 2. Isolation of lactic acid bacteria from curd 3. Determination of adulterants in milk 4. Determination of adulterants in spices	20	CO9 CO10 CO11

REFERENCE BOOKS:

1. Frank C. Hay, Westwood M.R., (2008), *Practical Immunology*, Fourth edition, Wiley Publications, ISBN: 978-1-405-14673-9
2. Peter M. Rice, Alan J. Bleasby, Jon C. Ison Lisa Mullan, Guy Bottu. (2020). *EMBOSS User's Guide: Practical Bioinformatics*. Cambridge University press. ISBN-13: 978-0521607254
3. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed., (1983), *A Manual of Laboratory Techniques*, National Institute of Nutrition, ICMR, Hyderabad.
4. Aneja K R, *Laboratory Manual of Microbiology and Biotechnology*, MEDTECH, 2014. ISBN-13 : 978-9381714553
5. Vijaya Ramesh, (2007), *Food Microbiology*, MJP Publishers, Chennai, ISBN-13 : 978-8180940194

SIXTH SEMESTER

Course Title: Core Paper 9: Animal Biotechnology

Course Code :	**Credits : 04**
L:T:P:S : 5:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to understand animal cell culture techniques to improve the quality and quantity of the animal derived product.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Outline the techniques in assisted reproductive technology, embryo technology and artificial insemination.
CO2	Describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.
CO3	Discuss the strategies for gene transfer, treatment and transgenic animals.
CO4	Acquire knowledge on transgenic animals and animal diseases.
CO5	Explain the genetic modification in medicine and the ethics involved in it.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	3	2	3	2	2	2	2	3	3	3	3
CO 2	3	2	2	2	2	3	2	2	2	3	3	2
CO 3	3	1	2	3	2	2	2	2	3	2	3	2
CO 4	3	2	2	3	2	2	3	2	3	3	2	2
CO 5	3	2	2	2	3	2	2	2	3	2	3	1

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Basic principles of Biotechnology – manipulation of reproductive process – Artificial insemination – freezing of semen – Embryo technology – in vitro maturation and fertilization – Pregnancy diagnosis – Assisted reproductive technology.	15	CO1
2	Introduction of animal cell culture substrate, culture media, preservation and maintenance of cell lines. Dissagregation of tissue and primary culture, Trypsinization (warm and cold method), cell counting and viability counting, maintenance and culture of primary, secondary and continuous cell lines – applications.	15	CO2
3	Strategies for gene transfer- Transfer to animal cell/embryos, Treatment through microinjection, Retrovirus-gene transfer.	15	CO3
4	Transgenic animals- Mice, cow, sheep, pig, goat, birds, insect, fish. Animal diseases of biotechnological importance - foot and mouth disease, coccidiosis, Trypanosomiasis, Theileriosis.	15	CO4
5	Genetic modification in medicine- gene therapy, types of gene therapy, human genetic engineering, applications, problems and ethics involved in gene therapy.	15	CO5

TEXT BOOKS:

1. Satyanarayana U (2017), "*Biotechnology* " Books & Allied (P) Ltd, ISBN 8187134909
2. Dubey, R.C. (2017), "*A Textbook of Biotechnology* " S. Chand & Co. Ltd, ISBN 9788121926089
3. Srivastava A K (2018), *Animal Biotechnology*, Oxford & IBH Publishing Co Pvt. Ltd. ISBN -13 : 978-8120416482

REFERENCE BOOKS:

1. Freshney R.I; (2006), *Culture Of Animal Cells- A Manual of Basic Techniques*, (5th edition), John Wiley & Sons Pvt Ltd, ISBN: 978-0-471-74759-8
2. AshishVarma and Anchal Singh (2013), *Animal Biotechnology*,(1st edition), Elsevier (Academic Press), ISBN: 9780124160026

Course Title: Core Paper 10: Skill Enhancement Course: Plant Biotechnology

Course Code :	**Credits : 04**
L:T:P:S : 5:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

Upon taking this course, the students will gain vast knowledge on applications of plant tissue culture and related genetic engineering techniques.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Outline the history of plant biotechnology and state its importance during the different stages of plant development.
CO2	Explain regulation and control of gene expression
CO3	Illustrate about various culture medium preparations, haploid, triploid plant production and its application.
CO4	Learn in-depth the basic techniques of plant tissue culture and its application.
CO5	Recollect the role of phyto-hormones in plants
CO6	Develop molecular technique skills in plant tissue culture using Ti plasmid vectors in agrobacterium and use of transgenic plants.
CO7	Elaborate the genetic engineering and construction of DNA libraries in development of transgenic plants and its application

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	3	2	2	2	2	3	3	3	3
CO 2	3	2	2	2	2	3	2	2	2	3	3	2
CO 3	3	2	2	3	2	2	2	2	3	3	3	2
CO 4	3	2	2	3	2	2	3	2	3	3	2	1
CO 5	3	2	2	2	3	2	2	2	3	2	3	1
CO 6	3	2	3	2	2	2	3	2	3	3	3	2
CO 7	3	2	2	2	2	3	3	2	3	3	2	1

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	History of plant biotechnology, Conservation of Plant using Biotechnology. Plant genome organization: structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome and mitochondrial genome, Regulation and control of gene expression.	15	CO1
2	Culture Medium preparation, Dedifferentiation and Redifferentiation, 'Explant' for plant tissue culture - callus formation, Organogenesis (direct and indirect), Suspension culture technique, Production of haploid plants and triploid plants, micropropagation, somatic embryogenesis, Protoplast isolation, applications, Production of Artificial seeds.	15	CO2
3	Plant hormones – Auxins, Cytokinins, Gibberllins, Abscissic acid and Ethylene. Phytochrome – role in morphogenesis, Seed storage proteins.	15	CO3
4	Gene transformation of plants by Agrobacterium – crown gall tumours, Ti plasmid vectors – molecular mechanism of T- DNA transfer, Use of transgenic plants, Symbiotic nitrogen fixation in legumes by Rhizobia – biochemistry and molecular biology.	15	CO4
5	Genetic engineering in plants, selectable markers, reporter genes and promoters used in plant vectors. Construction of genome libraries and cDNA libraries. Recombinants selection and screening – analysis of recombinant DNA. Transgenic plants and their applications, molecular pharming.	15	CO5

TEXT BOOKS:

1. Razdan, M.K. (2019). *Plant tissue culture*, (3rd edition).New Delhi. Oxford & IBH Publishing company, ISBN-13 : 978-8120417939
2. Chawala, H.S. (2010), *Introduction to Plant Biotechnology*. New Delhi. Oxford & IBH Publishing company, ISBN 13: 9781578081301
3. Satyanarayana, U. (2017), Biotechnology, (2nd edition). Kolkata. Books & Allied (P) Ltd, ISBN-13 : 978-8187134909

REFERENCE BOOKS:

1. Slater, (2008), *Plant Biotechnology- The Genetic Manipulation of Plants*, (2nd edition), New Jersey.Humana Press.
2. Das, H.K. (2018), *Text Book of Biotechnology*, (5th edition).New Jersey, Wiley Dreamtech, India Pvt. Ltd

Course Title: Core Paper 11: Environmental Biotechnology

Course Code :	**Credits : 03**
L:T:P:S : 5:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to understand new trends such as biofuels, renewable energy sources and different microbial technologies that can minimize the harmful impact of pollutants in the environment.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Analyze the scope of environmental Biotechnology and importance of Biogeo cycles
CO2	Explain the different types of environmental pollution and their impacts
CO3	Explain the process of waste water collection and waste water treatment in various methods.
CO4	Establish the role of denitrifying bacteria in maintaining Environment
CO5	Describe the principle and application of reactors used in different industries
CO6	Explain the process of drinking water treatment and summarize the sludge treatment process

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	3	2	2	2	2	2	2	3	2
CO 2	3	2	3	2	2	3	2	2	3	3	2	2
CO 3	3	3	2	3	2	2	3	2	3	2	3	2
CO 4	2	2	2	3	2	3	2	2	2	2	3	2
CO 5	2	2	3	2	3	2	2	2	2	3	2	3
CO 6	3	2	2	3	2	3	2	2	2	2	3	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Concept and scope of environmental Biotechnology, the biogeo cycles of environment (Hydrological, Oxygen, Nitrogen, Phosphate and Sulphur cycle), Air pollutants, sources of water pollution, Water Pollution and its Control.	12	CO1 CO2
2	Waste water collection, Waste water treatment-physical, chemical and biological treatment process. Microbiology of Waste Water Treatments, Aerobic Process; activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums oxidation ponds.	12	CO3
3	Bioremediation-in situ and ex situ , Engineering strategies of Bioremediation, Biodegradation, Biodegrading of problem Environmental contaminants-synthetic detergents, pesticides, hydrocarbons	12	CO4
4	Reactors-Reactor types- batch reactor- continuous-flow stirred tank reactor, plug flow reactor, Using alternate rate models, Engineering design of reactors	12	CO5
5	Denitrification; physiology of denitrifying bacteria – Tertiary denitrification- one- sludge denitrification – drinking water treatment: anaerobic treatment by methanogenesis – uses of methanogenic treatment	12	CO6

TEXT BOOKS:

1. Pramanik Krishna et.al. (2014), *Industrial environmental Biotechnology*. Studium Press (India) pvt.ltd, ISBN-13 : 978-9380012674
2. Sohal,H.S. and Srinvastava, A.K.(1994), *Environment and Biotechnonolgy,(*First edition) Ashish publishing House, New Delhi, ISBN-13 : 978-8131310076
3. Debajit Borah (2018), *Environmental Biotechnology Theory and Lab Practices Hardcover* – (2nd edition),Global Vision Publishing House.

REFERENCE BOOKS:

1. Bruce Rittmann, Perry Mccarty,(2017), *Environmental biotechnology.Principles and applications*. McGraw-Hill; Indian Edition, ISBN-13: 978-0071181846
2. Daniel Vallero (2015), *Environmental biotechnology*. (2nd edition) *A Biosystems Approach.* Academic Press, ISBN: 9780124077768

Course Title: Elective Paper 2A: Entrepreneurship, Biosafety, Bioethics and Intellectual property rights

Course Code :	**Credits : 05**
L:T:P:S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to gain knowledge on basic human rights, Intellectual property rights, the basic laboratory guidelines and understanding bioethical issues related to biotechnological inventions

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Summarize the impact of entrepreneurship in Biotechnology
CO2	Describe the biosafety practices and guidelines for research in transgenic plants and analyze the risk assessment, handling and manufacturing practices of good laboratories.
CO3	Describe the human rights and solve the social issues prevailing in the society
CO4	Analyze the ethical basis concerning, reproduction technologies, prenatal diagnosis, sex selection and abortion.
CO5	Discuss the various forms of Intellectual property rights

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	1	2	2	3	1	2	2	2	3	3	2
CO 2	3	2	1	2	3	2	2	2	2	3	3	2
CO 3	3	2	2	2	2	2	2	2	3	2	1	3
CO 4	2	2	2	3	2	2	2	2	2	3	2	3
CO 5	3	2	2	2	2	2	2	2	3	3	3	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Entrepreneurship: Definition, Principles of marketing and management. Personality and attitude, Organizational behavior and Leadership. Factors affecting biotech business (finance, infrastructure, equipment, manpower, resources, project location). Marketing research. Industries in Biotechnology.	12	CO1
2	Biosafety - General guidelines - Risk assessment studies- Hazardous materials used in Biotechnology – Handling and Disposal – Good manufacturing practices & Good Laboratory practices – Regulation on field experiments and release of GMO's - Labelling of GM foods – Guidelines for rDNA research activity – Containment facilities and Biosafety practices – Guidelines for research in transgenic plants.	12	CO2
3	Human Rights: Definition, Classification and Scope of Human Rights. United Nations Commission for Human Rights, National and State Human Rights Commission. Article 21 of Indian Constitution – UDHR. Social issues of Human rights.	12	CO3
4	Bioethics-Issues concerning reproduction, Birth, life and Death (Artificial insemination, egg donation, IVF, embryo transplants, Prenatal diagnosis and sex selection & Abortion).	12	CO4
5	Intellectual Property Rights: Patents, Trademarks, Copyrights, Trade secrets and Geographical indications. Plant Variety protection. Infringment.	12	CO5

TEXT BOOKS:

1. Ignacimuthu, S(2009), *Bioethics*, Narosa Publication house, ISBN: 978-81-7319-966-0
2. V. Sree Krishna . V (2007), *Bioethics and Biosafety in Biotechnology*, (1st ed.), New Age International Private Limited

REFERENCE BOOKS:

1. Rhona Smith.(2003), *International Human rights*, Blackstone Press.
2. Trayer, P.C, Fredrick.R., and Koch, M.(2002), *Biosafety*. Michigan State University

Course Title: Elective Paper 2B: Biofertilizer

Course Code :	**Credits : 05**
L:T:P:S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to understand the importance of living microorganisms, which, when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Identify the role played by the various soil microbes in enriching soil fertility.
CO2	Understand the process and technology concerned with the mass production of biofertilizers.
CO3	Establish the function of soil bacteria like Azospirillium & Azotobacter as potent nitrogen fertilizers and learn the significance of VA-Mycorrhizal association.
CO4	Predict the role of cyanobacteria as a potent biofertilizer and its application on rice cultivationand crop yield.
CO5	Recycle organic/industrial waste for soil amendment and production of useful compounds like methane gas.

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	2	2	2	2	2	2	2	2	3	3	3	2
CO 2	2	3	2	2	2	2	2	2	3	3	2	2
CO 3	2	2	2	2	3	2	3	2	3	3	1	2
CO 4	1	2	2	2	2	2	2	2	3	2	3	1
CO 5	2	2	2	2	2	3	2	2	1	3	2	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Introduction to Biofertilizers: Definition and types, importance of biofertilizers in agriculture. Characteristics of biofertilizers: Rhizobium, Azotobactor, Azospirillum, Phosphate solubilizing microorganisms, cyanobacteria, Azolla, Mycorrhizae.	12	CO1
2	Production technology: Strain selection, sterilization, growth and fermentation, mass production of various biofertilizers. Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings.	12	CO2
3	Azospirillum, isolation and mass multiplication- Career based inoculant, associative effect of different microorganisms. Azotobacter-Classification, characteristics-crop response to azotobacter inoculum, maintenance and mass multiplication. VA-Mycorrhizal association, types of mycorrhizal association, occurrence and distribution-colonization.	12	CO3
4	Cyanobacteria, Azolla and Anabaena association, nitrogen fixation, factors affecting growth, Application of cyanobacteria in rice cultivation. The Use of Cyanobacteria in the Study of the Structure and Function of Photosystem II and The Cytochrome Complex; Photosystem I in Cyanobacteria and its influence on growth and yield of crop plants.	12	CO4
5	Farming: Recycling of biodegradable municipal, agriculture and industrial wastes- Bio compost making methods, types and method of vermicomposting- field application. Renewable bioenergy using microorganisms – Methanogenesis.	12	CO5

TEXT BOOKS:

1. Krishnendu Acharya, SurjitSen, ManjulaRai,(2019), *Biofertilizers and Biopesticides*, Techno world, ISBN: 978-93-88347-23-5
2. SubbaRao, N.S (2000), *Soil Microbiology*, Oxford & IBH Publishers, New Delhi, ISBN: 9788120413832
3. Dubey R.C., (2005), *A Text book of Biotechnology*, S.Chand & Co., New Delhi, ISBN: 9788121926089
4. Kumaresan V.(2005), *Biotechnology*, Saras Publications, New Delhi, ISBN : 978-93-84826-10-9

REFERENCE BOOKS:

1. John Jothi Prakash, E. (2004*), Outlines of plant Biotechnology*. Embay Publication, New Delhi.
2. Kannaiyan S (2003)., *Biotechnology of Biofertilizers*, CHIPS, Texas,.
3. Mahendra K. Rai, (2005), *Hand book of Microbial biofertilizers*, The Haworth Press, Inc. New York,. ISBN 13: 978-1-56022-269-9

Course Title: Elective Paper 2C: Medical Biotechnology

Course Code :	**Credits : 05**
L:T:P:S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to gain knowledge on the advanced research in medicine, molecular diagnosis, immunodiagnostics techniques, ethical issues concerned in research.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Discuss the different types of vaccines available in market for treating diseases and the current research processes conducted in vaccine development
CO2	Find various diagnosis techniques used in identifying inborn errors of metabolism
CO3	Describe molecular techniques such as PCR, rDNA technology, etc., utilized in identifying genetic diseases
CO4	List various types of viral diseases and identify various techniques used in identifying those viral infections and other infectious disease
CO5	Illustrate immunotechniques used for identification of infectious antigens and allergens
CO6	Summarize the production of therapeutic agents such as cytokines and interferon
CO7	Identify the importance of various levels of clinical trials to be performed for successful production of a therapeutic product
CO8	Justify the ethics to be followed in performing clinical trials

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	2	2	2	2	2	2	3	3	3	3	1
CO 2	2	2	3	2	2	2	2	3	2	3	3	1
CO 3	3	2	3	2	2	2	3	3	3	3	3	1
CO 4	2	2	2	2	3	2	2	3	3	3	3	3
CO 5	2	2	3	2	3	2	2	3	3	3	3	1
CO 6	2	2	3	2	2	2	3	3	3	3	3	3
CO 7	2	2	2	2	2	2	2	3	2	3	3	2
CO 8	2	2	2	3	3	2	2	3	3	2	3	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Molecular Medicine: Antibodies and vaccines - Therapeutic production of antibodies, antibody mediated drug delivery of vaccines, different kind of vaccines and applications of recombinant vaccines. Diagnosis - Biochemical diagnostics, inborn errors of metabolism, haemoglobinopathies.	12	CO1
2	Molecular Diagnosis - Molecular basis of disease, Recombinant DNA Technology in medicine, gene probes as molecular diagnostic reagents. Polymerase Chain Reaction in clinical diagnostics, DNA sequencing of representative clones to detect mutations.	12	CO2
3	Immunodiagnostics – Diagnosis of infectious diseases, Viral diseases – HIV, influenza; bacterial diseases - enteric diseases, mycobacterium diseases; immunoarrays. FACs immunocytochemical staining, ELISA, FISH techniques.	12	CO3
4	Immunofluorescence technique - Immunoblot analysis of antigens and allergens. Production of therapeutic agents – Productions and application of therapeutic agents, Production of cytokines and interferon.	12	CO4
5	Clinical trial and ethics: Principles of project management in Clinical trials and its application. Principles of research ethics; Ethical issues in clinical trials; Use of humans in Scientific Experiments; Introduction to ethical codes and conduct; Introduction to animal ethics. Animal rights and use of animals in the advancement of medical technology.	12	CO5

TEXT BOOKS:

1. Roli, M. (2017). *National Ethical Guidelines for Biomedical and Health Research Involving Human Participants,* ISBN: 978-81-910091-94
2. Lela, B. and Maribeth, L. F. (2011). *Molecular Diagnostics: Fundamentals, Methods and Clinical Applications*, (1st Edition) . Philadelphia, USA. F A Davis Company. ISBN-13: 978-0803626775
3. Bernard, R. G. Terry, L.D. and Cherryl, L.P. (2014). *Medical Biotechnology*, (2^{nd} edition). Washington. DC. ASM Press.

REFERENCE BOOKS:

1. Patrick, R.M. Kenneth, S.R. and Michael, A.P. (2016). *Medical Microbiology*, (8^{th} edition). USA. Elsevier Publishers, eBook ISBN: 9780323388504
2. Pamela, G. Michelle, M, (2009). *Molecular Therapeutics: 21st century medicine,* (1st Edition). Hoboken, New Jersey. Wiley Publishers.

Course Title: Open Elective 3: Public Health and Hygiene

Course Code :	**Credits : 05**
L:T:P:S : 4:0:0:0	**CIA Marks : 50**
Exam Hours : 03	**ESE Marks : 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to illustrate the factors influencing the public health and hygiene among the community and to promote healthy living.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Describe the scope and importance of public health and hygiene; also the various factors influence the healthy condition among the community
CO2	Distinguish the between the various types of causes and effects of environmental pollution
CO3	Depict the various types of hygiene measures to be followed and links between healthful housing and healthy living.
CO4	Gain knowledge on the causes and preventive measures of various non-communicable diseases.
CO5	Illustrate the significance and development of various organizations related with public health.
CO6	Gain knowledge on the various legal act pertaining to public health and hygiene

Mapping of Course Outcomes to POs/PSOs:

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	1	1	2	1	2	2	3	1	2	2	1	3
CO 2	2	2	2	2	2	2	2	1	2	2	1	3
CO 3	2	2	2	2	2	3	2	1	2	2	1	3
CO 4	2	2	2	2	2	2	3	1	2	2	1	3
CO 5	2	2	2	2	2	3	3	1	2	1	1	3
CO 6	2	2	2	2	2	3	2	1	2	1	1	3

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	Definition and scope of Public health and Hygiene – basic aspects of personal hygiene – Health and Nutrition- definition, components, principles of health education; factors that influence health; Nutritional needs of body, role of nutrients, foods classification, food groups.	12	CO1
2	Environment and Health - Types of Environmental Pollution - causes and effects of Air Pollution, Water Pollution, Soil Pollution, Noise Pollution; Solid waste and excreta disposal management	12	CO2
3	Hygiene: Definition – personal hygiene, oral hygiene, feminine hygiene, sleep hygiene, Social hygiene, occupational hygiene, medical hygiene; Standards of Housing, Maintenance of Houses for Healthy Living, Ventilation for Houses.	12	CO3
4	Non-Communicable diseases – Causes, symptoms, diagnosis, treatment and preventive measures - Hypertension, Coronary Heart diseases, Stroke, Diabetes, Obesity and Mental ill-health.	12	CO4
5	First Aid and Health awareness - Health organizations - Malaria and AIDs Control- NHP, WHO, UNICEF; Health Education in India – Health care legislation in India – Termination of pregnancy act, Maternity benefit act, Biomedical waste act, ESI act.	12	CO5 CO6

TEXT BOOKS:

1. S. Lal, (2018), Vikas. *Public Health Management Principles And Practice*, 2nd Edition, CBS Publishers and Distributors Pvt Ltd, ISBN: 978-93-87742-93-2.
2. Mary-Jane Schneider (2016), *Introduction to Public Health*,(5th Edition), Jones & Bartlett Learning,. ISBN-13: 978-1284197594

REFERENCE BOOKS:

1. Carolyn D. Berdanier, Johanna T. Dwyer, David Heber (2013), *Handbook of Nutrition and Food*, (3rd Edition), CRC Press,. ISBN 9781466505711
2. Sue Reed, Dino Pisaniello, GezaBenke, Kerrie Burton. (2013), *Principles of Occupational Health and Hygiene: An Introduction, (* 2nd Revised ed. Edition), Allen &Unwin,
3. V. Kumaresan, R. Sorna Raj, *(*2012) *Public Health and Hygiene*,(1st Edition), Saras Publication.

Course Title: Core Practical VI: Animal Biotechnology, Plant Biotechnology & Environmental Biotechnology

Course Code	**: 1912632**	**Credits**	**: 04**
L:T:P:S	**: 6:0:0:0**	**CIA Marks**	**: 50**
Exam Hours	**: 03**	**ESE Marks**	**: 50**

LEARNING OBJECTIVES:

On taking this course the student will be able to illustrate the tissue culture techniques for plant and animal cells and to analyze water samples pertaining to environmental factors.

Course Outcomes: At the end of the Course, the Student will be able to:

CO1	Make use of the techniques used in preparing tissue culture medium and membrane filtration in culturing animal cells and prepare single cell suspension from spleen
CO2	Evaluate cell viability and cell count
CO3	Experiment with cryopreservation
CO4	Examine the importance of trypsinization in monolayer and subculture
CO5	Explain and infer the role of serum in cell culture
CO6	Evaluate the principles and application of plant biotechnology such as cell and tissue culture
CO7	Explain Invitro germination of plants and Organogenesis of plant tissue
CO8	Illustrate Callus Development and Micropropagation of plants
CO9	Develop technical skills in Protoplast isolation and Isolation of genomic DNA from plant samples
CO10	Demonstrate of soil microorganisms mediated gene transfer.
CO11	To identify the coliform bacteria using MPN technique.
CO12	To Analyze the dissolved oxygen concentration of water sample.
CO13	To estimate the chemical oxygen demand

Mapping of Course Outcomes to Program Outcomes

CO/PO/PSO	**PO**							**PSO**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**	**4**	**5**
CO 1	3	3	2	2	3	2	2	1	2	2	1	3
CO 2	3	2	3	2	2	2	2	1	2	2	1	3
CO 3	3	3	2	3	2	2	2	1	2	2	2	2
CO 4	3	2	2	3	2	2	3	1	2	2	2	3
CO 5	3	2	2	2	2	2	3	1	2	1	1	2
CO 6	3	2	2	3	2	2	3	1	2	1	1	2
CO 7	3	2	2	2	2	2	3	2	3	2	2	2
CO 8	3	2	2	3	2	2	2	2	2	2	2	3
CO 9	3	2	2	3	2	2	3	2	2	2	2	2
CO 10	3	2	2	2	2	3	2	2	2	2	2	2
CO 11	3	2	2	2	2	2	2	2	1	1	2	2
CO 12	2	2	2	3	2	1	2	2	2	2	2	2
CO 13	3	1	2	2	2	2	2	2	2	2	2	2

Sl NO	CONTENTS OF MODULE	Hrs	Cos
1	**Animal Biotechnology** 1. Preparation of Tissue culture medium and membrane filtration. 2. Preparation of single cell suspension from Spleen. 3. Cell counting by Hemocytometer	10	CO1 CO2
2	4. Cell Viability by Tryphan Blue Method. 5. Trypsinization of Monolayer and Subculturing. 6. Cryopreservation and Thawing. 7. Role of Serum in Cell culture	15	CO3 CO4 CO5
3	**Plant Biotechnology** 1. Hands on training in cell and tissue culture and maintenance of culture lines 2. Invitro germination of plants 3. Callus Development	15	CO6 CO7 CO8
4	4. Micropropagation of plants 5. Organogenesis of plant tissue 6. Protoplast isolation and fusion 7. Cell suspension culture	10	CO9
5	8. Isolation of genomic DNA from plant samples 9. Agrobacterium mediated gene transfer (Demo) Southern blotting (Demo)	5	CO10
6.	**Environmental Biotechnology** 1. Water analysis by MPN technique – presumptive coliform test – confirmed coliform test and completed coliform test 2. Determination of biological oxygen demand 3. Determination of chemical oxygen demand 4. Microbial degradation of cellulose	20	CO11 CO12 CO13

REFERENCE BOOKS:

1. S. Lal, Vikas. (2018), *Public Health Management Principles And Practice*, (2nd Edition), CBS Publishers and Distributors Pvt Ltd, ISBN 13: 9789387742932
2. S. Harisha. (2012), *Biotechnology procedures and experiments handbook*, ISBN13 9781934015117
3. Debajit Borah (2018), *Environmental Biotechnology Theory and Lab Practices*, (2nd edition), Hardcover – Global Vision Publishing House, ISBN: 9788182205840

VALUE ADDITION COURSE - 1

Duration : 30 Hours

Course Title : **Clinical Research & Clinical Data Management**

Course Provider : Indian Health Care BPO, Chennai

SYLLABUS:

Module	CONTENTS OF MODULE
	CLINICAL RESEARCH
1	Clinical Research Introduction
2	Clinical Research Key Definitions
3	Different Types of Designs in Clinical Trial
4	Clinical Trial Players, Their Roles & Responsibilities
5	Different Types of Clinical Trials
6	Phases Of Clinical Trial
7	Drug Discovery
8	INDA, NDA
9	ANDA
10	Ethical Principles in CR
11	Ethic Committee
12	Sponsor & PI Responsibilities
13	ICH- GCP Principles
14	ICF & IB
15	Protocol & Essential Documents
16	Schedule Y
17	Declaration of HELSINKI
18	Clinical Trial other than Drugs
	CLINICAL DATA MANAGEMENT
19	Introduction
20	Objectives, Phases of CDM

21	Case Report Form
22	Data Capture
23	EDC
24	Data Validation
25	Quality Assurance & Quality Control
26	MEDRA Coding
27	Database Design
28	Computer System & Development of Clinical System
29	Software Validation
30	21 CFR PART 11 / Interview Preparation

Course Outcomes: At the end of the Course, the Student will be able to:

1	To gain knowledge on clinical research and clinical data management.
2	To understand the various phases of drug discovery and the systematic protocols adapted for clinical trials.
3	To know the ICH Good clinical practices and validation protocol.
4	To gain insights on medical coding and ethical principles in clinical research.
5	To acquire information related to Databases, their design, usage, validation and to use software for clinical data management.

VALUE ADDITION COURSE - 2

Duration : 30 Hours

Course Title : **Mushroom Cultivation, Bio-Agriculture, Organic and Microbial Fertilizer Preparation.**

Course Provider: VJ Biotech, Coimbatore

SYLLABUS:

Modules	**CONTENTS OF MODULE**
	MUSHROOM CULTIVATION
Unit I	Introduction to Mushroom Cultivation, Designing and construction of Mushroom farm.
Unit II	Role of composting in Mushroom Cultivation and methods of composting, know the methods and harvesting of Mushroom.
Unit III	Different types of mushroom Cultivation and Nutritional properties and medicinal usages of mushroom.
Unit IV	Know the methods of grading, packing and storing of Mushroom.
Unit V	Know about preparation and value -added products out of Mushroom. Exporting strategies of different countries
Modules	**BIO-AGRICULTURE**
Unit I	Pure Organic Farming – Definition, Concept & Benefits
Unit II	Traditional food production and cultivation of Millets, Rye, Sorghum etc.,
Unit III	Culinary spinach cultivation and selling, intercropping system, water and irrigation system for the organic farming.
Unit IV	Organic terrace gardening, create a *terrace* & home *garden* and grow their own vegetables.

Unit V	Scope and Present status of organic farming; national and international status.
Modules	**ORGANIC AND MICROBIAL FERTILIZER PREPARATION**
Unit I	Introduction: Vermicompost preparation from waste, Nutrient composition from cow waste.
Unit II	Microbial fertilizer production, Preparation of Enrichment compost and nano-compost.
Unit III	Production of Traditional fertilizers: Panjakavya, Dhasakaya and to prepare the fish acid.
Unit IV	Bio- pesticide production: Production of Neem pesticide, Nano- pesticide to control the insects and pest.
Unit V	Recycling of Organic matter in organic maul preparation, Coir pellet preparation.

Course Outcomes: At the end of the Course, the Student will be able to:

1	To predict and analyze the methods to improve agriculture, horticulture, tissue culture and mushroom cultivation, as a profitable business.
2	To develop entrepreneur skills to initiate bio-concerns in the above-mentioned areas.
3	To realize the health benefits of organic farming and other natural foods to maintain the ecological balance.
4	To recognize the demands and commercial value of organic foods in International and National markets.
5	To adapt and practice recycling methods to derive wealth out of waste, to maintain a sustainable environment.

APPENDIX A

OUTCOME BASED EDUCATION

Outcome-based education (OBE) is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience each student should have achieved the goal. There is no specified style of teaching or assessment in OBE; instead classes, opportunities, and assessments should all help students achieve the specified outcomes.

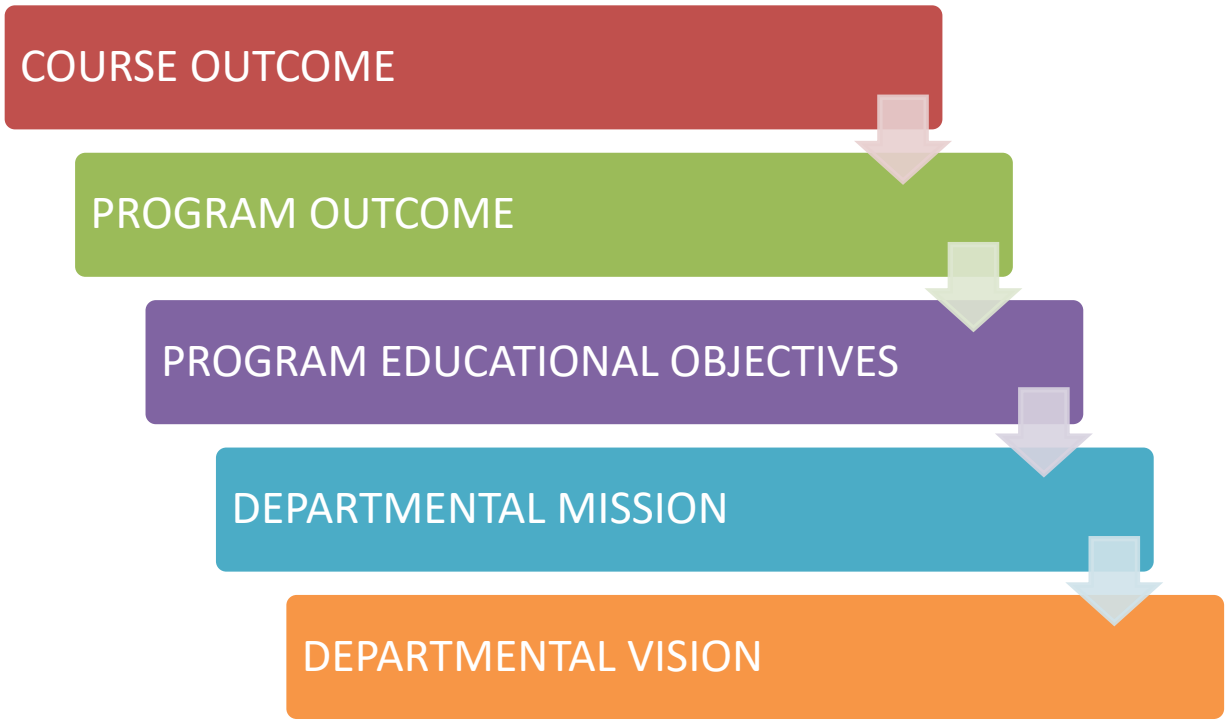
There are three educational Outcomes as defined by the National Board of Accreditation:

Program Educational Objectives: The Educational objectives of an engineering degree program are the statements that describe the expected achievements of graduate in their career and also in particular what the graduates are expected to perform and achieve during the first few years after graduation. [nbaindia.org]

Program Outcomes: What the student would demonstrate upon graduation. Graduate attributes are separately listed in Appendix B.

Course Outcome: The specific outcome/s of each course/subject that is a part of the program curriculum. Each subject/course is expected to have a set of Course Outcomes.

MAPPING OF OUTCOMES



APPENDIX B

GRADUATE ATTRIBUTES

At the completion of the B.Sc. Biotechnology program, the students of our department will be able to:

S.NO	GRADUATE ATTRIBUTES	PROGRAMME OUTCOMES
1.	**Knowledge**	To participate in various types of employment, development activities and public discourses particularly in response to the needs of the community one serves. **(PO1)**
2.	**Problem Solving**	To understand the need and have the competencies to support local, regional and national development. **(PO2)**
3.	**Critical thinking**	To develop critical and analytical thinking. **(PO3)**
4.	**Usage of modern tools**	To develop conceptual understanding, problem solving and application of skills. **(PO4)**
5.	**Independent and Reflective Learning**	To provoke entrepreneurship among the students along with strong ethics and communication skills. **(PO5)**
6.	**Ethical Practices and Social Responsibility**	To develop a questioning mind in diverse environments for better outcomes. **(PO6)**
7.	**Life-long Learning**	To engage in lifelong learning and enduring proficient progress. **(PO7)**

APPENDIX C

BLOOM'S TAXONOMY

Bloom's taxonomy is a classification system used to define and distinguish different levels of human cognition—i.e., thinking, learning, and understanding. Educators have typically used Bloom's taxonomy to inform or guide the development of assessments (tests and other evaluations of student learning), curriculum (units, lessons, projects, and other learning activities), and instructional methods such as questioning strategies. [eduglosarry.org].