

B.Sc. BIOTECHNOLOGY

Syllabus

BASED ON OUTCOME BASED EDUCATION

(Under Choice Based Credit System)

For the students admitted in the academic year 2021–2022



DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

BISHOP HEBER COLLEGE (Autonomous)

(Affiliated to Bharathidasan University)

(Nationally Reaccredited at the 'A' Grade by NAAC with the CGPA of 3.58 out of 4)

(Recognized by UGC as "College with potential for Excellence")

TIRUCHIRAPPALLI-620 017.

TAMILNADU, INDIA

DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

OUTCOME BASED EDUCATION

VISION

The Department seeks to create holistic development through teaching, research and extension activities with mutual love, social commitment and conscience.

MISSION

The Department of Biotechnology & Bioinformatics aims,

- To develop students in technical education and research by imparting knowledge and skill to attain academic excellence and professional competence.
- To serve humanity with exemplary values and professional ethics

PROGRAM OUTCOMES (POs)

B.Sc. BIOTECHNOLOGY

On Successful completion of the Program, the Post grandaunt of Biotechnology will be able to: exhibit the following abilities in the respective domains

KNOWLEDGE

PO1: Exhibit advanced knowledge in the biotechnological concepts and principles in real life in both orally and in writing, with confidence and share their views/ideas.

PO2: Critically analyze and evaluate existing hypotheses and knowledge gained through various sources, to solve long standing problems and discover new breakthrough

SKILLS

PO3: Display research-related skills through practical and project work as they are trained to plan, execute, analyze and report their experiments and also publish their findings.

PO4: Apply skills necessary to analyze and interpret qualitative as well as quantitative data independently to develop models with an open mind.

PO5: Demonstrate the outcomes of holistic education for their employment in biotechnology-related jobs and for pursuing higher education in reputed institutions by developing technical and communication skills.

PO6: Trained to identify and address the socially relevant pressing problems both in the national and global setting by using the skills acquired from the programme.

ATTITUDES

PO7: Explore and engage in lifelong learning by accessing library and ICT facilities to evolve new technologies based on the need of the job market.

ETHICAL & SOCIAL VALUES

PO8: Exhibit the art of teamwork and to conduct themselves with responsibility and character while they pursue shared/group projects and assignments.

PO9: Practice moral and social values in personal and social life to meet the needs of the society as responsible citizens.

Program Specific Outcomes

Upon Successful Completion of the program, students would have acquired the following competencies:

Knowledge & Skills Domain

PSO1 : Relate the connections between Cell biology, Biochemistry, Genetics and Immunology

PSO2 : Apply animals, plants and microbes in the field of biotechnology to meet the industrial needs and improve the level of commercialization of bioproducts.

Practical Skill

PSO3 : Choose and perform the relevant experimental techniques in the area of Biochemistry, Molecular biology, Cell biology, Microbiology, Genomics, Immunology, Food Biotechnology, Plant and Animal Biotechnology with skill and ease by following standard laboratory protocols.

PSO4 : Practice professional skills and ethical values in personal and social life to serve the society at large.

PROGRAMME ARTICULATION MATRIX
B.Sc. Biotechnology Programme (2021 onwards)

COURSE TITLE	COURSE CODE	Correlation with Programme Outcomes and Programme Specific Outcomes													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	
Cell Biology	U20BT101	H	-	-	M	H	-	-	-	M	H	-	L	M	
Cell Biology lab	U16BT1P1	M		H	H	M	-		-	-	H	-	M	M	
Fundamentals of Microbiology	U16BT1Y1	M		M	M	-	-	H	M	M	H	-	M	M	
Fundamentals and Applied Microbiology lab	U16BTYP1	H	-	-	M	M	-	-	-	H	M	-	H	M	
Biochemistry	U16BT202	H	-	M	M	-	-	-	-	-	H	-	L	-	
Biochemistry Lab	U16BT2P2	M	-	-	M	M	-	-	-	M	M	-	H	H	
Applied Microbiology	U16BT2Y2	M		H	H	M	-	M	-	-	H	-	M	M	
Fundamentals and Applied Microbiology Lab	U16BTYP1	H		H	M	M	-	M	-	-	H	-	M	M	
Basics of Bioinformatics	U16BT2S1	M		M	H	M	-	M	-	-	L	-	M	M	

Genetics	U20BT303	M		M	H	M	-	M	-	-	H	-	M	M
Genetics Lab	U21BT3P3	M		H	H	M	-	L	-	-	M	-	M	M
NMEC I	U21BT3E1	H	-	M	M	M	-	-	-	-	H	L	H	-
Basics of Immunology	U20BT404	H		H	M	M	-	M	-	-	H	-	L	M
Basics of Immunology Lab	U16BT4P4	M		H	H	M	-	M	-	-	H	-	M	M
NMEC II	U16BT4E2	H	-	M	M	M	-	-	-	-	H	L	H	-
Molecular Biology	U21BT505	M		H	L	M	-	M	-	-	H	-	M	M
Genetic Engineering	U21BT506	H		H	H	M	-	H	-	-	H	-	M	M
Molecular Biology & Genetic Engineering Lab	U16BT5P5	H		H	M	M	-	M	-	-	H	-	M	M
Plant Physiology	U21BT5:1	H	-	-	-	M	-	-	-	-	L	H	M	-
/Ecology	U21BT5:A	H	-	M	-	M	M	-	-	-	M	H	H	-
Developmental biology/	U21BT5:2	H	-	M	-	M	H	-	-	-	H	H	M	M
Basics of evolution	U21BT5:A	H	-	M	-	M	M	-	-	-	M	H	H	-
Basics of Biostatistics	U21BT5S2	M	H	M	M	L	L	H	-	-	M	-	M	-
Food Biotechnology	U21BT5S3	H	-	M	M	M	-	-	-	-	H	L	H	-

Industrial Biotechnology	U21BT607	M	H	L	M	M	M	-	-	H	H	L	M	-
Animal Biotechnology	U21BT608	H	-	M	-	M	M	-	-	-	H	M	M	L
Plant Biotechnology	U21BT609	M	-	M	-	M	M	-	-	-	H	H	M	
Industrial, Plant & Animal Biotechnology lab	U16BT6P6	M	-	-	M	M	-	-	-	M	H	-	M	L
Human physiology	U21BT6:3/	M	-	-	-	M	-	-	-	-	H	M	M	-
Bioethics and IPR	U21BT6:A	H	H	M	-	-	L	-	M	H	M	M	H	M

B.Sc., BIOTECHNOLOGY PROGRAMME STRUCTURE

B.Sc Biotechnology Programme (2021–2022 onwards)

(CBCS System)

Sem	Part	Course	Course title	Course code	Hours / week	Credits	Marks			
							CIA	ESE	Total	
I	I	Tamil I /*	செய்யுள், இலக்கிய வரலாறு, உரைநடை, மொழிப்பயிற்சியும் படைப்பாக்கமும்	U18TM1L1	6	3	25	75	100	
	II	English I	Language through Literature : Prose and Short Stories	U21EGNL1	6	3	40	60	100	
	III	Core I	Cell Biology		U20BT101	4	4	25	75	100
		Core Prac. I	Cell Biology Lab		U16BT1P1	3	2	40	60	100
		Allied I	Fundamentals of Microbiology		U16BT1Y1	4	4	25	75	100
		Allied Prac. I	Fundamentals and Applied Microbiology Lab		U16BTYP1	3	--	--	--	--
	IV	Env. Studies	Environmental Studies		U16EST11	2	2	25	75	100
		Val. Edu.	Value Education (RI/MI)		U15VL1:1/ U15VL1:2	2	2	25	75	100
II	I	Tamil II /*	செய்யுள், இலக்கிய வரலாறு, சிறுகதைத் திரட்டு, மொழிப்பயிற்சி மற்றும் படைப்பாக்கமும்	U18TM2L2	6	3	25	75	100	
	II	English II	Language through Literature : Poetry and Shakespeare	U21EGNL2	6	3	40	60	100	
	III	Core II	Biochemistry		U16BT202	6	6	25	75	100
		Core Prac. II	Biochemistry Lab		U16BT2P2	3	2	40	60	100
		Allied II	Applied Microbiology		U16BT2Y2	4	4	25	75	100
		Allied Prac. I	Fundamentals and Applied Microbiology Lab		U16BTYP1	3	3	40	60	100
	IV	SBEC I	Basics of Bioinformatics		U16BT2S1	2	2	25	75	100
	III	I	Tamil III /*	செய்யுள்-காப்பியம், புராணம், சிற்றிலக்கியம், இலக்கிய வரலாறு, நாவல், மொழிப்பயிற்சி	U18TM3L3	6	3	25	75	100
II		English III	English for Competitive Examinations	U21EGNL3	6	3	40	60	100	
III		Core III	Genetics		U20BT303	6	5	25	75	100
		Core Prac. III	Genetics Lab		U21BT3P3	3	2	40	60	100
		Allied III	Allied Chemistry-I		U19BTC33	4	4	25	75	100
		Allied Prac.II	Volumetric and Organic analysis lab		U19BTCP2	3	--	--	--	--
IV		NMEC –	To be selected from the courses			2	2	25	75	100

	I	offered by other disciplines						
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Sem	Part	Course	Course title	Course code	Hours/week	Credits	Marks			
							CIA	ESE	Total	
IV	I	Tamil IV /*	செய்யுள்(மேற்கணக்கு,கீழ்கணக்கு), இலக்கிய வரலாறு , நாடகம், மொழிப்பயிற்சி	U18TM4L4	5	3	25	75	100	
	II	English IV	English through Literature	U21EGNL4	5	3	40	60	100	
	III	Core IV	Basics of Immunology		U20BT404	6	6	25	75	100
		Core Prac. IV	Basics of Immunology Lab		U16BT4P4	3	2	40	60	100
		Allied IV	Chemistry for Life Sciences		U19BTC44	4	3	25	75	100
		Allied Prac. II	Volumetric and Organic Analysis Lab		U19BTCP2	3	3	40	60	100
	IV	NMEC II	Students have to opt from other Major		--	2	2	25	75	100
		Soft Skills	Life Skills		U16LFS41	2	1	--	--	100
	V	Extension Activities	NSS, NCC, Rotaract, Leo club, etc ...		U16ETA41	--	1	--	--	--
	V	III	Core V	Molecular Biology		U21BT505	6	6	25	75
Core VI			Genetic Engineering		U21BT506	6	6	25	75	100
Core Prac. V			Molecular Biology / Genetic Engineering Lab		U16BT5P5	4	2	40	60	100
Elective I			Plant Physiology / Ecology		U21BT5:1/ U21BT5:A	5	5	25	75	100
Elective II			Developmental Biology / Basics of Evolution		U21BT5:2/ U21BT5:A	5	5	25	75	100
SBEC II			Basics of Biostatistics		U21BT5S2	2	2	25	75	100
SBEC III			Food Biotechnology		U21BT5S3	2	2	25	75	100
VI	III	Core VII	Industrial Biotechnology		U21BT607	6	6	25	75	100
		Core VIII	Animal Biotechnology		U21BT608	6	5	25	75	100
		Core IX	Plant Biotechnology		U21BT609	6	5	25	75	100
		Core Prac. VI	Industrial, Plant and Animal Biotechnology Lab		U16BT6P6	3	2	40	60	100
		Elective III	Human Physiology / Bioethics and IPR		U21BT6:3/ U21BT6:A	5	5	25	75	100
		Core Project	Project		U16BT6PJ	4	2	--	--	100
	V	Gender Studies	Gender Studies		U16GST61	--	1	--	--	100

Total credits

140

SBEC – Skill Based Elective Courses; NMEC – Non Major Elective Courses

*Other Languages	Hindi	Sanskrit	French		Hindi	Sanskrit	French
Semester I	U14HD1L1	U14SK1L1	U14FR1L1	Semester III	U14HD3L3	U14SK3L3	U14FR3L3
Semester II	U14HD2L2	U14SK2L2	U14FR2L2	Semester IV	U14HD4L4	U14SK4L4	U14FR4L4
Part I : 4	Core theory : 9		Core Project : 1		Allied Theory : 4		
NMEC 2	Environmental studies:1		Value Education : 1				
Part II :4	Core Practical : 6		Allied Practicals : 2		Elective: 3		
SBEC : 3	Extension Activities : 1		Gender Studies : 1		Soft skills:1		

Total courses : 43

NMEC offered by the department:

Sem	Part	Course	Course title	Course code	Pre-requisites	Hrs/wk	Credits	Marks		
								CIA	ESE	Total
III	IV	NMEC –I	Basics of Biotechnology	U21BT3E1	-	2	2	25	75	100
IV	IV	NMEC – II	Applied Biotechnology	U16BT4E2	U16BT3E1	2	2	25	75	100

**STRUCTURE OF THE CURRICULUM FOR B.SC.BIOTECHNOLOGY
(2021-2022)**

Parts of the Curriculum			No. of Courses	No. of Hours	Credits	Total Credits
Part-I :Language			4	23	12	12
Part- II : English			4	23	12	12
Part-III						
Major Core (Theory)			9	52	49	63
Core(Practical)			6	19	12	
Core(Project)			1	4	2	
Elective(Theory)			3	15	15	15
Allied (Microbiology)	Microbiology	T	2	8	8	21
		P	1	6	3	
Allied(Chemistry)	T	2	8	7	3	
	P	1	6	3		
Part-IV						
SBEC			3	6	6	14
NMEC			2	4	4	
VLO			1	2	2	
Env.Studies			1	2	2	
Part-V						
Extension			1	-	2	3
GenderStudies			1	-	-	
LifeSkills			1	2	1	
Total			43	180	140	140

TotalCourses:43 TotalCredits:140 TotalHours:180
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SEMESTER 1

SEMESTER : 1

COURSE CODE : U20BT101

CREDITS : 4

HOURS/WEEK : 4

CORE COURSE I: CELL BIOLOGY

1. Course Outcomes

At the end of this course, the student will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO 1	Recall the diversity of cells, and their evolution, appearance, organization, genetic make-up and function	K2	I
CO 2	List the definite significance and role of various cellular organelles.	K1	II
CO3	Correlate the mobility of cells with the mechanism of specific cellular components.	K4	III
CO4	Define the mechanism of cell division and species proliferation that depends on individual cell types.	K2	IV
CO5	Analyze the cellular networking with biochemical pathways based on receptor – ligand concept.	K4	V
CO6	Predict the consequences and regulation of cell cycle that leads to cellular deformities.	K5	V

2. A. Syllabus

UNIT-I

12Hrs

Overview of cells: Overview -historical origin and discovery of cell:Cell theory and protoplasm theory-Structure of prokaryotic (E.coli) & eukaryotic (plant and animal) cells - Cellular organization-Chromosome and Genes - Major components of cell : cell membrane and nucleus-structure, organization and functions-cell: physio-chemical nature of plasma membrane and cytoplasm -fluid mosaic model.

UNIT-II

12Hrs

Cellular Organelles-structure and functions: Cellular Organelles-structure and functions :Mitochondria,Endoplasmic Reticulum –types- rough and smooth, Ribosomes, Dictyosomes,Golgiapparatus,Chloroplast, Plastids, Vacuoles, Lysosomes, Peroxisomes,Glyoxysome and Micro bodies.

UNIT-III

12Hrs

Cell junction: –Major types - anchoring junctions:Adherensjunctions,desmosomes and hemidesmosomes- communicating junction :Gap junctions-occluding junctions-Tight

junctions. Cell mobility: Overview, Structure and Organization. Cytoskeleton- Microtubules, Intermediate filaments and Microfilaments. Cell movement.

UNIT-IV

12Hrs

Cell division: mitosis and meiosis: Cell cycle-regulation - types -proper (Apoptosis) and improper (Cancer)-Molecular and biochemical characteristics of cancer cells, Phases-metastasis, Genes associated (Tumour suppressing gene),Cell ageing and cell death-senescence and regulation.

UNIT-V

12Hrs

Cell signaling: Overview Cell migration and Cell-cell interaction-Forms of cell signaling– Cell membrane trafficking -cell surface – transmembrane receptors, G-protein coupled receptor system–classification –structure –physiological roles-principal signaling pathwaysAMP and phosphatidylinositol.

B. Topics for Self Study

S.No.	Topics	Web Links
1	Quorum sensing	https://www.hindawi.com/journals/bmri/2019/2015978/
2	Cytoskeletal dynamics	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4427793/
3	Stem cell and cancer stem cell	http://www.cellstemcell.org/index.php/PS/C/article/view/124
4	Mechanobiology	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2943884/

C. Text Books

1. Verma P.S. and Agarwal V.K. Cell Biology ,Cytology, Biomolecules, Molecular Biology, Paperback, S. Chand and Company Ltd,2016
2. Kumar P. and Mina U. Life Sciences: Fundamentals and Practice, Part-I, 6th Edn., Pathfinder Publication, 2018.

D. Reference Books

1. Hardin J. and Bertoni G. Becker's World of the Cell. 9th Edn (Global Edition). Pearson Education Ltd., p. 923,2017.
2. Karp G., Iwasa J. and Masall W. Karp's Cell and Molecular Biology – Concepts and Experiments. 8th Edn. John Wiley and Sons. p.832,2015
3. Cooper G.M. The Cell – A Molecular Approach, 8th Edn.,Sinauer Associates Inc., Oxford University Press p.813,2019.
4. Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B. Campbell Biology in Focus. Pearson Education. p.1080,2014.
5. Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. Essential Cell Biology 5th Edn., W.W. Norton & Company p.864,2018.
6. Mason K.A., Losos J.B. and Singer S.R. Raven and Johnson's Biology. 9th Edn. McGraw Hill publications. p.1406. 2011.

7. Alberts B., Johnson B., Lewis J., Morgan D., Raff M., Roberts K. and Walter P. Molecular biology of cell, 6th edn., Garland Science, Taylor and Francis, p. 1465, 2015
8. Challoner J. The Cell: A visual tour of the building block of life, The University of Chicago Press and Ivy Press Ltd., p.193 ,2015.

E. Weblinks:

1. <https://nptel.ac.in/courses/102/103/102103012/>
2. https://onlinecourses.swayam2.ac.in/cec19_bt12/preview

3. Specific Learning Outcomes (SLO)

Unit	Course Content	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Overview of cells		
1.1	Overview - historical origin and discovery of cell: Cell theory and protoplasm theory-	Recollect the origination and theories related with cell and its findings	K 1
		Relate the cell theory in accordance to origin and evolution	K2
		Deduce the theory that describes the cell and protoplasm	K4
1.2	Structure of prokaryotic (Ecoli) & eukaryotic (plant and animal) cells	Relate both the morphological and functional features of cellular components present in various organisms.	K2
		Contrast the structural differentiation among plant, animal and microorganisms	K2
		List the specific organelles present in the respective organism	K1
1.3	Cellular organization-Chromosome and Genes - Major components of	Associate the various structural aspects of	K2

	cell: Cell membrane and nucleus-structure, organization and functions- Cell: physio -chemical nature of plasma membrane and cytoplasm fluid mosaic model.	foremost cellular constituents	
		Differentiate the cell from plasma membrane	K4
		Relate the various physio-chemical models and substantiate the significance of fluid mosaic model	K2
2	Cellular Organelles-structure and functions		
2.1	Cellular Organelles-structure and functions : Mitochondria,Endo plasmic Reticulum –types-rough and smooth,	Compare the unique features and role of one organelle from the other.	K2
		Describe the specific functions and structure of organelles	K2
		Relate precise organelle and the reasons to be present in specific organism	K2
2.2	Ribosomes, Dictyosomes, Golgi apparatus,Chloroplast, Plastids, Vacuoles, Lysosomes, Peroxisomes ,Glyoxysome and Micro bodies.	Identify the specific functions of the various organells.	K3
		Illustrate the morphological differences among organelles by pictorial representations.	K3
		Interpret the individual benefits of the organells in various organisms	K2
3	Cell junction		
3.1	Cell junction –Major types-anchoring junctions: Adherens junctions, desmosomes and hemidesmosomes-communicating junction :Gap junctions-occluding junctions-Tight junctions	Extend the reason for the presence of cell junctions that facilitates cellular interactions	K 2
		Connect the extracellular	K4

		and intracellular matrix	
		Identify the importance of the various cell junctions in association to skeletal systems	K3
3.2	Cell mobility: Overview, Structure and Organization Cytoskeleton- Micro tubules intermediate filaments and Microfilaments Cell movement.	Describe the structural features of cytoskeleton and their cellular mechanisms	K 2
		Tabulate the differences among cytoskeletal structures	K2
		Classify the various cellular appendages based on their specific function	K2
4	Cell division		
4.1	Cell division: mitosis and meiosis	Perceive the significance of growth cycle in an organism's development	K 1
4.2	Cell cycle-regulation - types -proper (Apoptosis) and improper(Cancer)	Differentiate somatic and sexual cell growth	K2
		Distinguish various events taking place in respective phases	K2
		Infer the metabolic activity of cell growth and its regulation.	K 2
		Relate the cellular events with biological ailments like cancer	K2
4.3	Molecular and biochemical characteristics of cancer cells	Differentiate the cancer cells from cells based on behavior	K 2

		Contrast the reasons for the development of the ailment.	K2
		Infer the molecular mechanisms and associate with specific events of cell	K2
4.5	Phases- metastasis, Genes associated (Tumour suppressing gene)	Enumerate the role of genes involved in appropriating of cell events	K 3
		Deduce the specific phase related to tumor	K2
		Recognize the importance of tumor suppression genes as therapeutics	K4
4.5	Cell ageing and cell death - senescence and regulation	Recognize the complications of senescence and cell death	K 3
		Associate the events that facilitate cell aging	K2
		Enumerate the mechanisms involved in regulation of aging	K2
5	Cell signaling		
5.1	Cell signaling: Overview Cell migration and Cell-cell interaction - Forms of cell signaling –	Identify the significance of stimulus and its relation with signaling	K3
		Infer the mechanisms involved in cell migration and interaction	K2

		Relate the role of organelles incorporated in cell signaling	K2
5.2	Cell membrane trafficking -cell surface – transmembrane receptors	List out the receptors of cell transport system	K2
		Classify the transmembrane response based on morphology	K2
		Infer the role of receptor system and their communications among cells.	K2
5.3	G-protein coupled receptor system – classification –structure – physiological roles- principal signaling pathways cAMP andphosphatidylinositol	Explainthe significance and mechanism of signaling pathway	K2
		Illustrate the structural features of G Protein	K3
		Identify the secondary messengers involved in cell signaling	K2

4. Mapping Scheme

U20BT101	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 2	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 3	H	H	-	H	M	-	-	-	-	H	L	H	-
CO 4	H	H	-	H	M	-	H	-	-	H	L	H	-
CO 5	H	H	-	H	M	-	H	-	-	H	L	H	H
CO 6	H	H	-	H	M	-	H	-	-	H	L	H	M

L: Low

M: Moderate

H: High

5. Course Assessment Methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : 1

COURSE CODE : U16BT1Y1

CREDITS : 4

HOURS/WEEK : 4

ALLIED I : FUNDAMENTALS OF MICROBIOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Recall the history of microbiology - Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch	K1	I
CO2	Explain various types of microscopy and staining techniques.	K2	II
CO3	Describe the different stages of microbial growth and measurement techniques	K2	III
CO4	Discuss the procedures used in preparing media needed for culturing microorganisms staining techniques	K2	IV
CO5	Illustrate the decontamination and sterilization process using an autoclave	K2	V
CO6	Analyze the various mechanisms of microbial control by using the different antimicrobial agents.	K3	V

2. A. Syllabus

UNIT-I

12Hrs

Definition and scope of microbiology – History of microbiology. The origin of microbial life – Theory of spontaneous generation. Contributions of Leeuwenhoek, Louis Pasteur, Robert Koch. Characteristics of major group of microorganisms - Bacteria, Viruses, Fungi, Protozoa and Algae.

UNIT-II

12Hrs

Introduction to Microscopy: Light microscopy – Compound, Dark field, Phase contrast, Fluorescence & Electron Microscopy. Microbial evolution and diversity – Binomial nomenclature of Microbes. Classification of three kingdom, five kingdom concept.

UNIT-III

12Hrs

Microbial growth – growth curve; Measurement of microbial growth - dry weight, colony count, packed cell volume, turbidimetry and haemocytometer. Factors affecting growth - Water, oxygen, temperature, hydrogen ion concentration, osmotic pressure.

UNIT IV

12Hrs

Bacterial Anatomy - Structure of Gram positive and negative cell wall, cytoplasmic membrane, Capsule, Flagella, Fimbriae, Bacterial spores. Bacterial Reproduction - Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT-V

12Hrs

Sterilization methods - Dry heat, moist heat, radiation, filtration and chemicals and Disinfection. Antimicrobial chemotherapy –Antibiotics –mode of actions –antimicrobial resistance -tests for sensitivity to antimicrobial agents

B. Topics for Self-Study

S.No.	Topics	Web Links
1	Forest microbiome	https://academic.oup.com/femsre/article/41/2/109/2674172
2	Microbial food webs	https://www.nature.com/articles/419565a
3	Mycoplasma	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/mycoplasma
4	Probiotics	https://www.medicinenet.com/probiotics/article.htm

C. Text Books

1. Pelczar Jr. M.J, Chan. E.C.S and Kreig. N.R, Microbiology- Fifth Edition, McGraw Hill Inc, New York, 2006
2. Dubey, R.C. and Maheswari, D.K, A Text book of Microbiology. S. Chand & Company Ltd. New Delhi, 2005
3. Anathanarayan and Paniker Text book of Microbiology - Ninth Edition, Universities press. New Delhi, 2014.

D. Reference Books

1. Gerard J. Tortora, Berdell R. Funke, Christine & L. Case, Microbiology an Introduction. Benjamin Cummings, 2001
2. Danial Lim, Microbiology, McGraw-Hill Companies, New York, 1998,
3. Stainer, R.Y., Ingraham, J.L., Wheelis, M.L and Painter, P.R, General Microbiology, Mac Milan Education Ltd. London, 1986.

E. Web Links

1. <https://nptel.ac.in/courses/102/103/102103015/>
2. https://onlinecourses.swayam2.ac.in/cec19_bt11/preview
3. <https://dth.ac.in/medical/course.php>

3. Specific Learning Outcomes (SLO)

Unit	Course Content	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Definition and scope of microbiology		
1.1	Definition and scope of microbiology, History	Define the study of microbiology	K1
		List out the contributions of scientists in microbiology field	K1
		Describe the biological role of microbes	K2
1.2	The origin of microbial life- Spontaneous generation theory	Recall the origin of microorganisms	K1
		Explain the theory of spontaneous regeneration	K2
		Interpret the evolutionary relationship among organisms	K3
1.3	Discovery and contribution of various scientist	Describe the contributions of great scientists towards the growth of microbiology	K2
		List out the milestone inventions of microbiology	K1
1.4	Characteristic features of bacteria Fungi Algae Protozoa	Explain the principles involved in classifying microorganisms	K1
		Describes the characteristic features of multicellular organism	K2
2	Introduction to microscopy		
2.1	Microscopy and its types	Classify microscope based on working principles	K2
		Label the distinguished parts of	K2

		different microscopes	
		Appraise the usage of microscopes in different organisms	· K3
2.2	Classification of bacteria-3 kingdom Classification of bacteria – 5 kingdom	Classify bacteria	· K2
		Discuss the growth of bacteria	K1
		Relate the evolutionary origination of specific organisms	K2
3	Microbial Growth		
3.1	Microbial Growth introduction - Growth curve	Enumerate microbial growth and its importance	K2
		Discuss about differentiate the stages of microbial growth	K2
	Measurement of bacterial growth	Discuss the methods of measuring the microbial growth	K2
		Interpret microbial growth through graphical representation	K2
3.2	Factors affecting bacterial growth	Describe the factors influencing the bacterial growth	K1
		Identify the growth controlling parameters of microbes	K2
4	Bacterial Anatomy		
4.1	Bacterial Anatomy	Describe the structure of bacteria	K3
		Differentiate Gram negative and positive bacteria based on cell wall composition	K4
4.2	Bacterial reproduction and its types	Distinguish the different types of bacterial reproduction	K2
		Recognize the specialized reproductive structure	K1
5	Sterilization methods		

5.1	Introduction to sterilization methods	List out the physical and chemical methods of sterilization	K1
		Explain the mechanisms of sterilization methods	K2
5.2	Methods of sterilization, Disinfection	Discuss the mechanism of disinfection	K2
5.3	Antimicrobial chemotherapy	Explain the mechanism of antimicrobial agents	K1
		Classify the various antimicrobial agents based on its mechanisms	K1

4. Mapping scheme

U16BT1Y1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	M	L	L	L	L	L	L	L	H	M	H	-
CO2	H	H	L	L	L	L	L	L	L	H	M	H	-
CO3	H	H	-	H	M	-	-	-	-	H	L	H	-
CO4	H	H	-	H	M	-	H	-	-	H	L	H	-
CO5	-	-	H	H	H	-	-	-	-	-	-	H	M
CO6	H	H	-	H	M	-	H	-	-	H	L	H	M

L: Low

M: Moderate

H: High

5. Course Assessment Methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : 1

COURSE CODE : U16BT1P1

CREDITS : 2

HOURS/WEEK : 3

CORE PRACTICAL I : CELL BIOLOGY LAB

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Experiments
CO1	Visualize and differentiate the structural features of cells of plants and animals	K2	1,4
CO2	Identify the different stages of cell division and illustrate their specific morphological features.	K2	1, 2
CO3	Examine the genetic components of organisms and their related mechanisms.	K2	4
CO4	Distinguish the detailed cellular structures by different staining methods .	K4	4,5
CO5	Usedifferenttypes of microscopes effectively	K3	1-4,6
CO6	Differentiate Meiosis and Mitosis	K4	1, 2

2. A. Syllabus

List of Experiments

1. Mitosis in onion root tips.
2. Meiosis in Grasshopper.
3. Barr body staining from buccal epithelial cells.
4. Preparation of giant /Polytene chromosomes from chironomus larvae.
5. DNA isolation from buccal cells.
6. Cell Staining – lignin

B. Reference Books

1. Rajan, S, Experimental Procedures in Life Sciences. Anjanaa Book House, 2010
2. Karp, G,Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.2010.

C. Web Links

1. <https://www.youtube.com/watch?v=QDn677IO3us>
2. https://onlinecourses.nptel.ac.in/noc21_bt36/preview

3. Specific Learning Outcomes (SLO)

Exercises	Lab Exercises	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
Ex 1	Mitosis in onion root tips.	Recollect the various phases of mitosis and visualize it with an experimentation set up.	K 1
		Differentiate the stages based on the morphology and staining patterns.	K 2
		Relate the significance of mitosis in an unhealthy condition	K 2
Ex 2	Meiosis in Grasshopper	Enumerate the theoretically studied steps and mechanism of meiosis by a practical approach.	K1
		recognize the various divisions and their patterns under microscopic examination.	K2
		Develop the skill of staining and handling microscopes.	K6
Ex 3	Barr body staining from buccal epithelial cells.	Differentiate the X-linked inheritance and identify the sex of an organism by the presence of Barr body	K2
Ex 4	Preparation of giant /Polytene chromosomes from chironomus larvae.	Justifying the type of cell and sex pattern.	K3
		dissect polytene chromosomes from a small organism.	
		Examine the morphological features of the giant chromosomes	
Ex 5	DNA isolation from buccal cells	Appraise the technique of DNA isolation.	K 5
		Deduce the chemicals involved and their role in separating DNA	K 4

Ex 6	Cell Staining – lignin	Identify the presence of lignin by microscopic examination.	K 2
		Practice thin tissue sectioning and staining.	K 5
		Discriminate the region of lignin from others by the specific staining patterns.	K 4

4. Mapping Scheme

U16BT1P1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	H	M	-	-	-	-	H	-	H	-
CO2	H	-	-	H	M	L	-	-	-	H	H	H	M
CO3	M	-	-	H	M	-	-	-	-	M	-	H	-
CO4	M	-	-	H	M	-	-	-	-	M	-	H	L
CO5	M	-	-	H	H	-	-	-	-	-	-	H	-
CO6	M	-	-	H	M	-	-	H	M	M	-	L	H

L: Low

M: Moderate

H: High

5. Course Assessment Methods

Direct

1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination

Indirect

1. Course-end survey

SEMESTER : II/I

COURSE CODE : U16BTYP1

CREDITS : 2

HOURS/WEEK : 3

**ALLIED PRACTICAL I : FUNDAMENTALS AND APPLIED MICROBIOLOGY
LAB**

1.Course Outcomes

At the end of this course, the students will be able to:

CO. No	Course Outcomes	Level	Experiments
CO 1	Explain various types of microscopy and staining techniques.	K2	5-7, 13
CO 2	Identify the different stages of bacterial growth curve.	K2	4
CO 3	Examine the composition of bacterial cell wall	K2	7
CO 4	Distinguish the detailed bacterial structures by different staining methods.	K4	7
CO 5	Choose the appropriate staining techniques.	K4	5-7, 13
CO 6	Prepare media and develop pure cultures .	K3	1-3, 8,-12

2. Syllabus

A. List of Experiments

FUNDAMENTALS OF MICROBIOLOGY

1. Sterilization principle and methods-moist heat - dry heat and filtration methods
2. Media preparation: Liquid media, Solid media, Agar deep, Agar slants, Agar plates
3. Pure culture technique: Streak plate, pour plate, spread plate, serial dilution
4. Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description
5. Motility demonstration: Hanging drop preparation
6. Simple staining
7. Gram's staining

APPLIED MICROBIOLOGY LAB

1. Antibiotic sensitivity testing: Disc diffusion test – Quality control with standards strains
2. Biochemical characteristics: IMViC test
3. Isolation of Rhizobium sp.
4. Isolation of Cellulolytic organisms

5. Isolation of Lactobacillus sp.
6. Fungal staining

B. Reference Books

1. Rajan, S, Experimental Procedures in Life Sciences, Anjanaa Book House, 2010
2. Gunasekaran, P, Lab Manual in Microbiology, New Age International Publications, 2007.

C. Web Links

1. <https://nptel.ac.in/courses/113/108/113108055/>
2. <https://www.vlab.co.in/ba-nptel-labs-biotechnology-and-biomedical-engineering>

3. Specific Learning Outcomes (SLO)

Exercises	Lab Exercises	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
Ex 1	Sterilization principle and methods-moist heat - dry heat and filtration methods	Practice the various sterilization methods.	K 2
Ex 2	Media preparation: Liquid media, Solid media, Agar deep, Agar slants, Agar plates	Prepare the different types of media	K2
Ex 3	Pure culture technique: Streak plate, pour plate, spread plate, serial dilution	Use th different types of streak plate methods.	K2
		Apply the basic bacterial culturing techniques for pure culture preparation	K3
Ex 4	Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description	Plot the bacterial growth curve.	K5
		Interpret the bacterial growth characteristics.	K5
Ex 5	Motility demonstration: Hanging drop preparation	Examine the morphological features during bacterial	K 1

		movement.	
Ex 6	Simple staining	Identify the morphological structure of bacteria under microscopic examination.	K 2
		Practice the technique of bacterial staining procedure	K 5
Ex 7	Gram's staining	Categorize the Gram negative and positive bacteria based on cell wall composition.	K 2
Ex 8	Applied microbiology lab Antibiotic sensitivity testing: Disc diffusion test – Quality control with standards strains	Experiment the Antibiotic sensitivity nature of bacteria.	K3
Ex 9	Biochemical characteristics: IMViC test	Predict the biochemical characteristics of bacteria by performing biochemical tests.	K5
Ex 10	Isolation of Rhizobium sp.	Identify the Rhizobium bacteria.	K2
Ex 11	Isolation of Cellulolytic organisms	Isolate and identify the Cellulolytic organisms	K2
Ex 12	Isolation of Lactobacillus sp.	Identify the Lactobacillus bacteria from different samples	K2
Ex 13	Fungal staining	Discriminate the presence of fungal structure under microscopic examination.	K 4

3. Mapping scheme

U16BTYP1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	H	M	-	-	-	-	H	-	H	-
CO2	H	-	-	H	M	L	-	-	-	H	H	H	M
CO3	M	-	-	H	M	-	-	-	-	M	-	H	-
CO4	M	-	-	H	M	-	-	-	-	M	-	H	L
CO5	M	-	-	H	H	-	-	-	-	-	-	H	-
CO6	M	-	-	H	M	-	-	H	M	M	-	L	H

L-Low

M-Moderate

H- High

4. Course Assessment Methods

Direct

1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination

Indirect

1. Course-end survey

SEMESTER 2

SEMESTER : II

COURSE CODE : U16BT202

CREDITS : 6

HOURS/WEEK : 6

CORE II : BIOCHEMISTRY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Recall the basic chemistry of elements & molecules learnt in high school and describe the structure-function aspects of biomolecules.	K2	I
CO2	Illustrate the influence of chemical bonding through intra and intermolecular forces in assemblage of higher order structures.	K2	II
CO3	Explain the methods of purification and qualitative & quantitative chemical analysis of various biomolecules.	K3	III
CO4	Analyze, the structure and function of biomolecules and their commercial uses.	K4	IV
CO5	Explain the theories pertaining to mechanisms of biomolecular action and physiological correlations thereof.	K2	V
CO6	Formulate strategies to isolate, purify and assay novel biomolecules from various sources.	K6	V

2. A. Syllabus

UNIT – I

18Hrs

Basic chemistry in life science: Structure and properties of water. Measurement of pH, determination of pKa (Henderson Harselbalch equation). Buffers, buffer actions (strong & weak acids) and biological buffer systems.

UNIT – II

18Hrs

Carbohydrates: Classification, properties, structure and biological functions of mono saccharides (glucose, fructose) Oligo saccharides (lactose,galactose) and polysaccharides.(glycogen, starch, cellulose, agarose).

UNIT – III

18Hrs

Amino acids & Proteins: Structure, classification, physical and chemical properties. Proteins: classification and Biological importance. Primary structure, Secondary, tertiary and

quaternary structure- forces stabilizing the structure of proteins. Denaturation, precipitation, separation by solubility differences- isoelectric pH.

UNIT – IV

18Hrs

Lipids and Vitamins: Nomenclature, classification and Biological significance of simple lipids (triglycerides, homolipids) compound lipids (heterolipids) derived lipids, glycerol and fatty acids. Vitamins- Source, structure, biological role, daily requirement and deficiency manifestation of vitamin A, B, C, D, E and K.

UNIT – V

18Hrs

Nucleic acids & Enzymes: Types of DNA and RNA. Composition and structure - their biological importance hydrolysis of nucleic acids by acids, bases and enzymes. Denaturation and renaturation. Enzymes: Nomenclature and classification, enzyme activity; Factors affecting activity, enzyme kinetics–MichaelisMenton equation.

B. Topics for Self-Study

S.No.	Topics	Web Links
1	1. Redox enzymology: Oxidation and reduction reactions, Nernst equation, measurement of redox potentials	https://ecampusontario.pressbooks.pub/microbio/chapter/energy-matter-and-enzymes/ http://www.chem.ox.ac.uk/vrchemistry/potential/Text/redox1.htm
2	Protein purification methods: role of buffers and detergents	https://www.thermofisher.com/in/en/home/life-science/protein-biology/protein-purification-isolation/protein-purification.html
3	Methods for determining biomolecular structure	https://www.photophysics.com/circular-dichroism/biophysical-characterization/
4	Biochemistry of signal transduction	https://www.tocris.com/cell-biology/signal-transduction#:~:text=Signal%20transduction%20(also%20known%20as,initiated%20by%20cell%20surface%20receptors. https://www.sinobiological.com/research/signal-transduction
5	Reactive oxygen species in health and disease.	https://www.biotek.com/resources/white-papers/an-introduction-to-reactive-oxygen-species-measurement-of-ros-in-cells/

C. Text Book

1. Jain, J.L., Sunjay Jain and Nitin Jain, Fundamentals of Biochemistry, Fifth Edition, S. Chand and Company Ltd, New Delhi, 2010.

D. Reference Books

1. Berg, J.M., Tymoczko, J.L., Stryer, L., Biochemistry, 7th Edition, W.H.Freeman, USA, 2010.
2. Campbell, M.K., Farrell, S.O, Biochemistry, 6th Edition, Brooks Cole Publishing Company, USA, 2007.
3. Mathews, C. K., Van Holde, K.E., Ahern, K.G, Biochemistry, 3rd Edition, Addison Wesley, USA, 2000.
4. Voet, D., Voet, J.G. and Pratt, C.W, Principles of Biochemistry, 3rd Edition, John Wiley & Sons, USA, 2008.
5. Zubay, G.L, Biochemistry, 7th Edition, William C Brown Publishers, New York, 1995.
6. Nelson, D.L., Cox, M.M, Lehninger, Principles of Biochemistry, 5th Edition, W.H Freeman and Company, USA, 2008.

E. Weblinks:

1. <https://nptel.ac.in/courses/102/103/102103012/>
2. <https://nptel.ac.in/courses/104/105/102105034/>

3. Specific Learning Outcomes (SLO)

Unit	Course Content	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Chemistry of Biomolecules		
1.1	Structure of atoms, molecules and chemical bonds	Compare the different elements of the periodic table	K2
		Categorize the different kinds of atomic, molecular structure and chemical bonding	K2
		Explain the properties of matter based on their atomic/molecular bonding and structure	K2

1.2	Covalent and Noncovalent interactions - Van der Waals, Electrostatic, Hydrogen bonding and hydrophobic interactions	Define the physicochemical properties of compounds based on bonding	K1
		Illustrate the various kinds of bonds	K2
		Interpret the influence of different kinds of bonding on chemical behaviour and reactivity	K3
		Describe the effects of different kinds of bonds in stabilizing macromolecular structures (proteins and nucleic acids)	K2
1.3	Chemical foundations of Biology pH,pK, acids, bases and buffers	Differentiate the properties acids and bases	K1
		Explain the chemical foundations of biology	K1
		Identify the roles of acids and bases in biochemical reactions	K3
		Measure the pH of biological solutions using pH meter	K4
		Estimate the concentration of hydrogen ion or hydroxyl ion in solutions	K5
		Calculate the pK values and pH-based chemical interaction of the compounds	K5
1.4	Henderson – Hasselbach (HH) equation	Apply HH equation to determine the pH of a given solution	K3
		Solve pH related changes in biological fluids	K5
1.5	Buffers, buffer actions (strong	Explain the attributes of	K2

	& weak acids) and biological buffer systems	acid or base	
		Classify biological buffers based on pH	K2
		Solve biochemical/medical problems related to acid-base imbalance	K3
		Describe the mechanisms of buffering in blood and cells	K2
		Explain the effects of acid-base imbalance	K2
2	Carbohydrates		
2.1	Classification of carbohydrates	Differentiate the structural features of sugars	K1
		Explain the physicochemical properties of carbohydrates	K2
		Identify sugars based on their chemical properties	K3
		Expalin the methods of Estimation of carbohydrates	K2
2.2	Properties, structure and biological functions of monosaccharides	Define and classify homoglycans based on their chemical and physical properties	K2
		Describe the importance and role of monosaccharides in cell biology and biochemistry	K2
		classify homoglycans based on their source and functions	K3
		Discuss the structures of homoglycans and their importance in	K3

		biochemistry	
2.3	Oligosaccharides and polysaccharides (glycogen, starch, cellulose, agarose)	Illustrate the structure-function aspects of homo and heteropolysaccharides	K2
		Identify potential applications of natural carbohydrate polymers	K3
		Describe the uses of homo and heteroglycans for human welfare	K2
		Estimate homo and heteroglycans in samples and discuss their importance in health and human welfare	K5
		Identify potential applications of natural carbohydrate polymers	K3
3	Amino acids and Proteins		
3.1	Amino acids: Structure, classification, physical and chemical properties	List out the common and uncommon aminoacids	K1
		Classify aminoacids based on their charge, size, side chain and pKa	K2
		Identify the behaviour of aminoacids in proteins based on side chain and pH	K3
		Infer the role of aminoacids in proteins	K4
		Estimate aminoacids using biochemical assays	K5
		List out the common and uncommon aminoacids	K1
3.2	Proteins: classification and	Find the importance of proteins in cellular structure and signalling	K1
		Demonstrate clear	K2

	Biological importance	knowledge of protein classification based on structure-function aspects	
		Describe the methods to estimate proteins	K5
		Discuss the specific roles of proteins through use of specific biophysical methods	K6
3.3	Primary structure, Secondary, tertiary and quaternary structure-	Decipher the reasons for the stability of proteins	K1
		Illustrate various bonds- both covalent and non-covalent in protein structure	K2
		Develop strategies to study protein structure	K3
		Describe the mechanisms of protein folding and how enzymes function	K4
		Decipher the reasons for the stability of proteins	K1
3.4	Forces stabilizing the structure of proteins	Differentiate the strong and weak forces in protein structure	K2
		Outline the general strategies for studying bonding in proteins	K1
		Compare various biophysical methods and Identify avenues to preserve the native structure of proteins	K2
3.5		Calculate the properties of protein - pH, temperature, salt/ions	K4
		Compare various methods to manipulate proteins for purification	K2

	Denaturation, precipitation, separation by solubility differences- isoelectric pH	Identify the role of protein side chains on isoelectric pH	K3
		Explain methods used for protein purification	K5
		Determine how denaturation and renaturation can be used in biotechnology	K5
4	Lipids and Vitamins		
4.1	Nomenclature, classification and Biological significance	Define various types of lipids and outline their biological importance	K2
		Organize lipids into various classes, subclasses based on their structure	K3
		Classify lipids based on their reactivity	K2
4.2	Triglycerides, homolipids, compound lipids(heterolipids), derived lipids, glycerol and fatty acids	Define fatty acids based on composition, chain length and saturation	K1
		Classify lipids based on structure, function and their physicochemical aspects	K2
		Identify the analytical methods for lipid analysis	K3
		Describe the biochemical roles of various lipids	K4
		Determine the concentration of lipids using biochemical and analytical techniques	K5
			Discuss the role of lipids in health and disease
4.3		Find the composition and sources of vitamins-fat	K1

		soluble and water soluble	
	Vitamins- Source, structure, biological role	Illustrate how vitamin structure influences biological action	K2
		Discuss how vitamins work as coenzymes or hormones	K3
		Assess the natural sources of vitamins	K4
		Explain the physiological ramifications of vitamin excess and deficiency	K2
4.4		Daily requirement and deficiency manifestation of vitamin A, B, C, D, E and K	Discuss the Daily requirement and deficiency manifestation of vitamin A, B, C, D, E and K
5	Nucleic acids and Enzymes		
5.1	Types of DNA and RNA	Define various types of nitrogenous bases	K1
		Outline the biological importance of DNA and RNA	K2
		Organize nucleic acids based on structure	K3
		Explain how nucleic acids form single, double strand RNA/DNA in various organisms	K5
5.2	Composition and structure - their biological importance	Define the structure of DNA and RNA based on organism type and chemical composition	K2
		Classify nucleotides and genetic material based on structure	K2
		Identify methods used to study nucleic acid structure	K3
		Describe the mechanisms of nucleic acid function	K4

		based on base composition	
		Determine the concentration of nucleic acids using biochemical and analytical techniques	K5
		Discuss the mechanisms of mutagenesis and how mutations affect structure-function correlations	K2
5.3	Hydrolysis of nucleic acids by acids, bases and enzymes; Denaturation and renaturation	Find and comprehend the interactions which stabilize DNA structure	K1
		Illustrate the mechanisms of denaturation and renaturation	K2
		Assess how denaturation can be used as a tool in biotechnology	K3
		Explain physiological implications of DNA/RNA modifications by enzymes and how such processes can be used in diagnosis and in research	K5
5.4	Enzymes: Nomenclature and classification	Define enzymes and outline their mechanisms of action	K2
		Organize enzymes into various classes, subclasses based on their reaction type	K3
		Classify enzymes based on IUB guidelines	K2
	Enzyme activity; Factors affecting activity	Identify the mechanism of enzyme catalysis based on theories of enzyme action-lock and key and induced fit theory	K1
		Explain theories of enzyme action	K2
		Illustrate thermodynamics	K3

		of enzyme action	
		Describe the intricate mechanisms of ES formation and catalysis	K4
5.5	Enzyme kinetics –Michaelis Menten equation	Describe the MM equation and its mathematical transformations	K1
		Interpret enzymatic rates, MM reaction constants	K5
		Solve for K_M , K_d , K_i and other related MM parameters	K6

4. Mapping Scheme:

U16BT202	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	M	M	L	H	L	L	H	M	L	L
CO2	H	H	H	H	H	M	H	M	L	H	L	M	L
CO3	H	H	H	H	H	H	H	H	M	H	H	H	M
CO4	H	H	H	M	M	M	H	L	M	M	H	M	M
CO5	H	H	H	H	H	H	H	M	L	H	H	M	L
CO6	H	H	H	H	H	H	H	H	L	H	H	H	L

L: Low

M: Moderate

H: High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

5. Course end survey (Feedback)

SEMESTER : II

COURSE CODE : U16BT2Y2

CREDITS : 4

HOURS/WEEK : 4

ALLIED II : APPLIED MICROBIOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Relate the concepts and integrate various areas like aquatic, medical, environment and agricultural microbiology where this technology can be applied to solve biological problems	K1	I
CO2	Assess the quality of water and report whether it is potable	K2	I
CO3	Evaluate the significance of biofertilizers & biopesticides over chemical methods.	K3	III
CO4	Apply food preservation techniques	K4	II
CO5	Translate their theoretical knowledge of waste water treatment into practice.	K5	IV
CO6	Analyze the modes of transmission of microbial diseases & their control.	K6	V

2. A. Syllabus

UNIT –I

12Hrs

Aquatic Microbiology: Potability of water – Microbial assessment of water quality – major water borne diseases and their control measures. Physical, chemical and microbial assessment of water and potability test for water. Colour, pH, alkalinity, acidity, COD, BOD, anions and cations.

UNIT-II

12Hrs

Food Microbiology: Contamination, spoilage and preservation of various food products. Food borne diseases, intoxication and food poisoning. Food preservations: principles-methods of preservation-Physical and chemical methods. Food sanitations - GMP-HACCP

UNIT-III

12Hrs

Agricultural Microbiology: Biofertilizer- types of biofertilizer (symbiotic and non symbiotic) microorganisms used as biofertilizer, Bio-control of Microbial pathogens-BT toxin, Biopesticides -application of biopesticides, plant promoters, Secondary metabolites.

UNIT-IV

12Hrs

Environmental Microbiology: Positive and negative roles of microbes in environment: Waste water recycling, Biodegradation of recalcitrant compounds - lignin – pesticides. Bioaccumulation of metals and detoxification. Biopesticides, Biodeterioration of paper. Leather, wood, textiles and metal corrosions.

UNIT-V

12Hrs

Medical Microbiology: Microbial Disease- Bacterial (Cholera, Typhoid), Protozoan (Malaria), Viral disease (HIV), Fungal (Candidiasis), Zoonotic and Nosocomial infections.

B. Topics for Self-Study

S.No	Topics	Web Links
1	Microbial Type Culture Collection and Gene Bank (MTCC)	https://mtccindia.res.in/
2	Pasteur Institute of India	http://pasteurinstituteindia.com/index.html
3	The Future of Patents on Genetically Modified Organisms in India	https://www.ipwatchdog.com/2019/04/27/future-patents-genetically-modified-organisms-india/id=108582/
4	Microbes in Human Welfare	https://ncert.nic.in/ncerts/l/lebo110.pdf

C. Text Book

Chan E.C.S., and Noel R.K., Microbiology (Pelczar), An Application Based Approach, Tata McGraw Hill Education Private Limited, New Delhi, 2010

D. Reference Books

1. Subba Rao, N.S., Soil Microorganism and plant growth, oxford and IBH publishing co.pvt. Ltd, 1995
2. Frazier, W.C., and Westhoff, D.C., Food microbiology, Fourth edition, McGraw Hill NY, 1988
3. Adams M.M. R., and Moss M.O., Food microbiology, New International (P) Ltd. Publishers, 1995
4. Alexander., Introduction to soil Microbiology, John Wiley and Sons, 1997.

E. Web Links.

1. <https://nptel.ac.in/courses/105/107/105107173/>

2. <https://www.digimat.in/nptel/courses/medical/microbiology/MB11.html>

3. Specific Learning Outcomes (SLO)

Unit	Course Content	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Aquatic Microbiology		
1.1	Water borne diseases & control	Explain the spread of diseases through water	K1
1.2	Microbial assessment of water	Assess the quality of water	K2
1.3	Potability test for water	Evaluate the quality of water	K3
2	Food Microbiology		
2.1	Spoilage & Preservation of various foods	Illustrate the causes of food spoilage	K4
2.2	Food borne diseases & food poisoning	Interpret the reasons behind food poisoning	K2
2.3	Food preservation methods	Explain the methods of food preservation	K2
2.4	Food sanitation	Plan methods of food sanitation	K2
3	Agricultural Microbiology		
3.1	Biofertilizers	Apply biofertilizers to enhance crop production	K3
3.2	Biopesticides	Identify the significance of biopesticides over chemical pesticides	K3
3.3	Secondary metabolites	Outline the role of secondary metabolites	K1
4	Environmental Microbiology		
4.1	Role of microbes in	Identify the role of microbes in	K1

	environment	environment	
4.2	Waste water recycling	Illustrate the process of waste water recycling	K2
4.3	Biodegradation of recalcitrant compounds-lignin, pesticides	Apply microbes in degradation of recalcitrant compounds	K5
4.4	Bioaccumulation of metals & detoxification	Explain the process of accumulation of metals by biological methods	K5
4.5	Biodeterioration of paper, leather, wood, textiles & metal corrosions	Interpret the role of microbes in deterioration of few products	K5
5	Medical Microbiology		
5.1	Cholera	Appraise the cause, transmission and control of specific microbial diseases	K4
5.2	Typhoid		
5.3	Malaria		
5.4	HIV		
5.5	Candidiasis		
5.6	Zoonotic infections	Identify the cause and spread of zoonotic infections	K3
5.7	Nosocomial infections	Describe the causes of spread of nosocomial infection	K2

4. Mapping scheme

U16BT2Y2	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	M	M	M	M	M	M	M	M	M	M	M
CO 2	M	H	L	M	H	M	M	M	M	M	M	M	M
CO 3	H	H	M	M	H	H	M	M	H	M	M	M	M
CO 4	M	M	M	M	M	H	L	M	L	L	M	M	M
CO 5	H	H	M	M	H	M	M	H	M	M	M	H	H
CO 6	M	H	M	M	M	H	M	H	M	M	M	H	H

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : II

COURSE CODE : U16BT2P2

CREDITS : 2

HOURS/WEEK : 3

CORE PRACTICAL II : BIOCHEMISTRY LAB

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Experiments
CO 1	Observe and examine how theory can be translated into practice	K1	1-7
CO 2	Learn to estimate the concentration of biomolecules and to report findings.	K1	4
CO 3	Familiar with calculations pertaining to preparation of reagents and buffers	K2	1
CO 4	Inculcate ability to devise experiments and to correlate the results with underlying mechanisms	K2	2-5
CO 5	Summarize their findings in the form of lab reports	K2	1-7
CO 6	Formulate methodologies to purify and estimate biomolecules	K4	6 & 7

2. A. Syllabus

Experiment List

1. Preparation of solutions: Normality, Molarity, Molality and Percentage solutions.
2. pH metry -Determination of pH from unknown biological samples using pH paper and pHmeter.
3. Colorimetry – Preparation of standard curve and estimation of the concentration of solute in an unknown sample
4. Estimation of biomolecules: 1.Sugars –Anthrone method 2. Proteins –Bradford method
5. Lipids- Zak’s method
6. Chromatography –Paper Chromatography - Determining the Rf value of aminoacids and its separation- Thin layer Chromatography- Separation of Plant pigments
7. Demonstration of gel electrophoresis. (PAGE/AGE)

B. Reference Books

1. ArunRastogi, Mathur, N.B.L Mathur, N.B. L, An Introduction to Practical Biochemistry, Anmol Publications, India, 2010.
2. Joshi, R.A. and Saraswat, M, A Textbook of Practical Biochemistry. Jain Publishers privatelimited, India, 2002.
3. Malhotra, V.K, Practical Biochemistry for Students, Jaypee Brothers Publishers, India, 2003.
4. Rajan, S, Experimental Procedures in Life Sciences, Anjanaa Book House, 2010.
5. SashidharRao and Vijay Deshpande, Experimental Biochemistry, I K International PublishingHouse, 2009.

C. Web Links.

1. <https://nptel.ac.in/courses/104/105/104105102/>
2. <https://www.youtube.com/watch?v=oPjvW3vwsSw>

3. Specific Learning Outcomes (SLO)

Exercises	Lab Exercises	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
Ex 1	Preparation of solutions: Normality, Molarity, Molality and Percentage solutions	Compare the different kinds of solutions	K1
		Categorize solutions based on their nature – normal, molar, molal and % solutions (W/V and V/V)	K2
		Describe the methods used for preparing reagents in the laboratory setting	K4
Ex 2	pH metry -Determination of pH from unknown biological samples using pH paper and pH meter	Recall the importance of buffers in biological research	K1
		Define pH, Ka, pKa, buffer action and buffer capacity	K2
		Compare different kinds of	K2

		buffers and their applications	
		Contrast buffers based on pKa	K2
		Measure the pH of buffers and solutions	K5
Ex 3	Colorimetry – Preparation of standard curve and estimation of the concentration of solute in an unknown sample	Define Beer-Lambert's law	K2
		Illustrate the importance of Beer-Lambert's law in analytical biochemistry and spectroscopy	K2
		Interpret the effect of solute concentration on absorbance	K3
		Apply a standard graph and test the concentration of solute in an unknown solution	K3
Ex 4	Estimation of biomolecules: 1. Sugars –Anthrone method 2. Proteins –Bradford method 3. Lipids- Zak's method	Define spectrophotometer	K2
		Explain the roles of the parts of a spectrophotometer	K2
		Identify the importance of analytical biochemistry in everyday life	K3
Ex 5	Estimation of biomolecules: 1. Sugars –Anthrone method 2. Proteins –Bradford method 3. Lipids- Zak's method	Determine and Analyze – a) wavescan b) single wavelength c) kinetics d) λ_{\max} e) isoelectric point	K5
		Estimate the concentration of solutes in a given solution	K6
		deduce the solute concentration from absorbance in estimation of proteins, carbohydrates and cholesterol	K4
		Apply findings in real sample analysis in clinical and analytical biochemistry fields	K3
Ex 6	Chromatography –Paper Chromatography - Determining the Rf value of aminoacids and its separation- Thin layer	Recall and define the principles of chromatography	K1
		Explain the importance of solvents	K2

	Chromatography- Separation of Plant pigments	Compare the effect of hydrophilic and hydrophobic solvents on solute separation	K2
		Apply chromatography techniques to analyse Biomolecules and other samples	K4
		Measure the R _f value of separated solutes	K5
Ex 7	Demonstration of gel electrophoresis. (PAGE/AGE)	Show the basic principles of electrophoresis	K1
		Explain the mechanism of separation of DNA based on size	K4
		Identify DNA bands and know the importance of DNA ladder	K3
		Estimate the amount of DNA based on gel estimation and gel densitometry	K5
		Formulate strategies to separate DNA molecules after digestion/restriction cutting	K6

4.Mapping scheme

U16BT2P2	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	H	M	-	-	-	-	H	-	H	-
CO2	H	-	-	H	M	L	-	-	-	H	H	H	M
CO3	M	-	-	H	M	-	-	-	-	M	-	H	-
CO4	M	-	-	H	M	-	-	-	-	M	-	H	L
CO5	M	-	-	H	H	-	-	-	-	-	-	H	-
CO6	M	-	-	H	M	-	-	H	M	M	-	L	H

L-Low M-Moderate H- High

5. Course Assessment Methods

Direct

1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination

Indirect

1. Course-end-survey

SEMESTER : II

COURSE CODE : U16BT2S1

CREDITS : 2

HOURS/WEEK : 2

SBEC I : BASICS OF BIOINFORMATICS

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Develop the basic skills of Bioinformatics concepts and its applications	K3	I
CO2	Analyze the biological importance of nucleic acid from the structural data bases	K4	II
CO3	Describe the features of the databases of local and multiple alignments	K2	III
CO4	Explain the aspects of protein-protein interaction, and visualization tools	K2	IV
CO5	Discuss the importance of biological database collections	K2	II
CO6	Design the molecular modification of lead compound and develop the drugs	K6	V

2. A. Syllabus

Unit I

6Hrs

Introduction to Bioinformatics - History, scope and applications. Research areas of Bioinformatics, Bioinformatics industries and Institutions in India & Worldwide.

Unit II

6Hrs

Introduction to Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDB sum).

Unit III

6Hrs

Introduction to sequence alignment; Pairwise Alignment, Local and Global Alignment concept, Needleman wunch method and Smith waterman method, Fasta and Blast, Multiple Sequence Alignment-Clustal W.

Unit IV

6Hrs

Basics of Proteins- Different types of protein structures: Primary, Secondary, Tertiary. Protein structure visualization tools – Rasmol, SPDBv, PyMol,. Tools and Server for protein structure prediction – Phyre2, I-TASSER, SWISS-Model, Modeller.

Unit-V**6Hrs**

Basics and parameters of drug – ADMET properties; Need for developing new drugs: Molecular modification of lead compounds; Active site determination of enzymes; Basics of Docking studies; Types, Steps and tools used for drug designing.

B. Topics for Self-Study

S.No.	Topics	Web Links
1.	Data Analyzing for Human Diseases (covid19)	https://www.intechopen.com/books/bioinformatics-updated-features-and-applications/bioinformatics-for-rna-seq-data-analysis
2.	Computational algorithms for Text mining	Ibrokhim Y. Abdurakhmonov (July 27th 2016). Bioinformatics
3.	Genomics and Metabolomic data analysis	https://www.pnas.org/content/117/15/8494
4.	Application of computational tools	https://link.springer.com/chapter/10.1007/978-981-10-7455-4_1

C. Text Books

1. Harshawardhan, P., Bioinformatics principles and application, Tata Mc-Graw Hill. Publishers, New Delhi, 2005
2. Lesk, A.M., Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003
3. Sundarajan. S., and Balaji, R., Introduction of Bioinformatics, Himalaya Publishing House, Mumbai, 2005

D. Reference Books

1. Attwood, T.K., and Parry Smith, D.J., Introduction to Bioinformatics, Pearson Education Ltd., New Delhi, 2004
2. ManikandVijayaraj., Bioinformatics for beginners, KalaikathirAchchagam, Coimbatore, 2002
3. Mount, D.W., Bioinformatics Sequence and genome analysis, Second Edition, CBS Publishers, New Delhi, 2005
4. Westhead, D.R., Parish, H.J., and Twyman, R.M., Bioinformatics, Vivabooks Private Ltd. New Delhi, 2003
5. Pennington & Dunn., Proteomics, Viva books publishers, New Delhi, 2002
6. Andreas Baxevanis and Francis Ouellette., Bioinformatics- A practical guide to the analysis of genes & protein, Wiley-Blackwell, Third Edition, 2004
7. The ABCs of internet, Christian Crumlish, SybexInc.,U.S, 199

E. Web Links

1. https://onlinecourses.nptel.ac.in/noc21_bt06/preview
2. https://onlinecourses.swayam2.ac.in/cec21_bt04/preview

3. Specific Learning Outcomes (SLO)

Unit	Course Content	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Introduction to Bioinformatics		
1.1	Introduction to Bioinformatics - History, scope and applications. Research areas of Bioinformatics, Bioinformatics industries and Institutions in India & Worldwide.	Describe the computational biological resources Collect the relevant information from experiments and databases	K2
		Explain how to locate and extract data from key bioinformatics databases and resources	K3
		Describe the computational biological resources Collect the relevant information from experiments and databases	K2
2	Introduction to Biological Databases		
2.1	Introduction to Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL).	Describe the different types of data found at the NCBI and EBI resources.	K2
2.2	Protein databases (Primary,		

	Composite, and Secondary).	Differentiate the various Level of protein database based on their structure.	
2.3	Specialized Genome databases: (SGD, TIGR, and ACeDB).		
2.4	Structure databases (CATH, SCOP, and PDBsum).		K2
3	Introduction to Sequence Alignment		
3.1	3.1 Introduction to sequence alignment; Pairwise Alignment, Local and Global Alignment concept, Needleman wunch method and Smith waterman method, Fasta and Blast, Multiple Sequence Alignment-Clustal W.	Apply the molecular biology network through PUBMED center.	K3
		Extract a DNA/Protein sequence and save it in the correct format	K2
4	Basics of Proteins		
4.1	Basics of Proteins- Different types of protein structures: Primary, Secondary, Tertiary.	Describe the different types of protein structures.	K2
		Recognize main difference between nucleotide and protein sequences	K4
		Retrieve relvant protein structures from from the Biological databases.	K6
4.2	Protein structure visualization tools – Rasmol, SPDBv, PyMol,.	Explain the application of predicting protein structures	K2
		Describe the different types of protein structures.	K2
		Recognize main difference between nucleotide and protein sequences	K4
			K4

		Retrieve relevant protein structures from the Biological databases.	
4.3	Tools and Server for protein structure prediction – Phyre2, I-TASSER, SWISS-Model, Modeller.	Explain the application of predicting protein structures	K2
5	Basics and parameters of drug		
5.1	Basics and parameters of drug – ADMET properties; Need for developing new drugs: Molecular modification of lead compounds; Active site determination of enzymes;	Describe the process and principles of molecular docking.	K2
5.2	Basics of Docking studies; Types, Steps and tools used for drug designing.	Interpret the geometric and ACE score for developing new drugs.	K3

4. Mapping Scheme

U16BT2S1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	H	M	L	H	-	M	H	-	H	-
CO2	M	H	H	H	-	-	H	-	M	H	L	H	L
CO3	H	H	M	H	M	L	H	-	M	H	-	H	-
CO4	H	H	M	H	M	L	H	-	M	H	-	H	-
CO5	M	H	H	H	H	-	H	-	M	H	L	H	-
CO6	H	H	M	H	M	L	H	H	M	H	H	H	M

L - Low

M - Moderate

H - High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER 3

SEMESTER : III

COURSE CODE : U20BT303

CREDITS : 5

HOURS/WEEK : 6

CORE III : GENETICS

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
333CO 1	Explain the genetic concepts, chemical basis of heredity, Mendelism and its influential methodologies.	K2	I
CO2	Recognize the role of inheritance in sex determination and Perform pedigree analyses to establish genetic linkages.	K2	II
CO3	Summarize the experimental evidences for DNA as genetic material and gene transfer mechanisms in prokaryotes.	K2	III
CO4	Use phylogenetic tree construction and relate closed species.	K3	V
CO5	Analyse the variations in chromosome structure and number	K4	IV
CO6	Assess the factors responsible for genetic disorders and provide counseling.	K5	V

2. A. Syllabus

UNIT - I

6Hrs

Milestones in Genetics - Mendelism : The Basic Principles of Inheritance - Dominance, Segregation, Independent Assortment. Applications of Mendel's Principles : The Punnett Square method, The Forked-Line Method, The Probability Method. Testing Genetic Hypothesis - The Chi-Square test. Extensions of Mendelism : codominance, Incomplete dominance, Over dominance.

UNIT – II

6Hrs

Allele, Multiple alleles, Pseudoallele and complementation tests. The relationship between Genes and traits. Genetic symbols. Gene action- influence of the environment, phenocopy, penetrance and expressivity, gene interactions, epistasis, pleiotropy, lethality and lethal genes, Genetic anticipation, genomic imprinting. Chromosomal theory of inheritance - Sex chromosomes and sex determination. Sex linkage, linkage ratio and crossing over, Pedigree analysis, lod score genetic Mapping scheme - Human.

UNIT – III

6Hrs

Experimental evidence for DNA as the genetic material - transformation, transduction, conjugation. Chromosome organization, Fine structure of Gene, cistron and recon, Structure

of Prokaryotic and Eukaryotic gene, maternal inheritance - cytoplasmic genetic systems- mitochondria and chloroplast DNA.

UNIT – IV

6Hrs

Chromosomal Variation – Special types of chromosomes – giant chromosomes and B chromosomes, Changes in structure - Deletion, duplications, inversions, translocations, Changes in number – aneuploidy and euploidy, Mutation.

UNIT – V

6Hrs

Developmental genetics of Drosophila, Arabidopsis and C. elegans. Population genetics, calculating gene frequency - Hardy-Weinberg equation, factors affecting gene frequency. Phylogenetic tree construction. Genetic Counseling.

B. Topic for Self Study

S.No	Topics	Web Links
1	Genomic imprinting	Genetics: A conceptual approach, Benjamin A.Pierce, W.H.Freeman and Company, Newyork, 3 rd edition, 2008
2	Heterosis and hybrid vigour	Genetics: A conceptual approach, Benjamin A.Pierce, W.H.Freeman and Company, Newyork, 3 rd edition, 2008
3	Genetic symbol	Genetics: A conceptual approach, Benjamin A.Pierce, W.H.Freeman and Company, Newyork, 3 rd edition, 2008
4	Homeostasis	Genetics: A conceptual approach, Benjamin A.Pierce, W.H.Freeman and Company, Newyork, 3 rd edition, 2008

C. Text Books

1. Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A, Killian D, Concepts of Genetics. Eleventh edition, Pearson Education Limited, England, 2016, ISBN 10: 1-292-07726-3
2. Brooker R. J, Genetics: analysis & principles, fourth edition, The McGraw-Hill Companies, New York, 2012, ISBN 978-0-07-352528-0
3. Snustad D. P., Simmons M. J, Principles of Genetics, Sixth edition, John Wiley & Sons, England, 2012, ISBN 978-0-470-90359-9

D. Reference Books

1. Gardner E. J., Principles of Genetics, Eighth edition, John Wiley & Sons Inc, England, 1991, ISBN-13: 978-0471537281
2. Sambamurty, A.V.S.S, Molecular Genetics, First edition Alpha Science International Ltd, 2007.
3. Benjamin A. Pierce, Genetics: A Conceptual Approach, 5th Edition, W. H. Freeman company, 2013, ISBN-13: 978-1464109461.
4. Hancock, J.T, Molecular Genetics. Viva Books Private Limited, 2008.

5. Griffiths, A.J.F, Introduction to genetic analysis. W.H. Freeman, 2008.
6. Hartl D, L. Jones E.W, Genetics Analysis of Genes and Genomes. Seventh edition, Jones and Bartlett Publishers, 2009.

E. Web Links.

1. https://onlinecourses.swayam2.ac.in/cec20_bt03/preview
2. <https://www.classcentral.com/course/swayam-principles-of-genetics-23082>

3. Specific Learning Outcomes (SLO)

Unit	Course Content	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Milestones in Genetics		
1.1	Milestones in Genetics	List out the contribution of scientists	K1
		Define the basic concepts of genetics	K1
1.2	Mendelism : The Basic Principles of Inheritance - Dominance, Segregation, Independent Assortment	State the law of Mendelism	K1
		Summarize the principles of inheritance	K2
1.3	The Punnett Square method	Explain the concept of Punnett square method	K2
		Interpret the generation of the parents using Punnett square	K2
1.4	The Forked-Line Method and The Probability Method	Illustrate dihybrid and multihybrid crosses using The Forked-Line method	K1
		Explain the Estimate the proportions of offspring expected to exhibit each phenotype through the Probability Method	K3
1.5	Testing Genetic Hypothesis - The Chi-Square test.	Use chi-squared test on data from dihybrid crosses	K3
		Construct a table of frequencies (observed	K3

		versus expected) using Chi-Square test	
1.6	Extensions of Mendelism : codominance, Incomplete dominance, Over dominance.	Explain the extensions of Mendelism	K2
		Compare and distinguish codominance, Incomplete dominance, Over dominance	K4
2	Allele and Genes		
2.1	Allele, Multiple alleles, Pseudoallele and complementation tests	Compare Allele, Multiple alleles, Pseudoalleles	K2
		Identify whether two mutations associated with a specific phenotype using complementation test	K2
2.2	The relationship between Genes and traits	Relate the role of genes in trait determination	K1
2.3	Genetic symbols	Identify the character responsible for particular genetic symbols	K2
2.4	Gene action- influence of the environment, phenocopy, penetrance and expressivity,	Summarize the action of genes on traits	K2
		Explain the effects of gene action	K2
2.5	gene interactions, epistasis, pleiotropy, lethality and lethal genes, Genetic anticipation, genomic imprinting.	Compare the gene interactions and its effects	K1
		Describe the gene interactive effects on traits	K2
2.6	Chromosomal theory of inheritance - Sex chromosomes and sex determination	State the Chromosomal theory of inheritance Relate the role of chromosomes with sex determination	K2

2.7	Pedigree analysis, lod score	Perform Pedigree analysis	K3
		Determine the mode of inheritance of a particular disease or trait in generations.	K3
		Predict the probability of traits appearance among offsprings	K4
2.8	genetic Mapping scheme – Human	Describe the human genome organization	K1
3	Experimental evidence for DNA as the genetic evidence		
3.1	Experimental evidence for DNA as the genetic material – Transformation, Transduction, Conjugation	Explain the concept of DNA as the genetic material in prokaryotes and eukaryotes	K2
3.2	Chromosome organization	Describe the Chromosome organization	K1
3.3	Fine structure of Gene, cistron and recon	Memorize and explain the structure of gene	K2
3.4	Structure of Prokaryotic and Eukaryotic gene	Compare the structural differences between Prokaryotic and Eukaryotic genes	K2
3.5	Maternal inheritance - cytoplasmic genetic systems- mitochondria and chloroplast DNA	Define and state maternal inheritance	K2
		Analyze the cytoplasmic genetic systems	K4
4	Chromosomal Variation		
4.1	Special types of chromosomes – giant chromosomes and B chromosomes	Classify the special types of chromosomes	K2
		Illustrate the structure and features of special chromosomes	K2
4.2	Changes in chromosome structure -	Analyze the effects of changes in chromosome	K4

	Deletion, duplications, inversions, translocations	structure	
		Locate the changes of chromosome based on effects	K2
4.3	Changes in number – aneuploidy and euploid	Report the number of the chromosome of an organism	K2
4.4	Mutation	Differentiate the various types of mutation	K2
		Discuss the effect of mutation caused by different agents	K2
5	Developmental Genetics		
5.1	Developmental genetics of - Drosophila - Arabidopsis - C. Elegans	Identify the genes responsible of developmental pattern of model organisms	K2
		Compare the developmental system of different life forms	K2
5.2	Population genetics	Explain the genetic composition of biological populations	K2
		Report the effects of changes in genetic composition on population	K2
5.3	Calculating gene frequency - Hardy-Weinberg equation	Compare a population's actual genetic structure over time (gene frequency)	K2
5.4	Factors affecting gene frequency	Identify the factors that affect gene frequency	K3
		Analyze the effects of different factors on gene frequency	K4
5.5	Phylogenetic tree construction	Analyze the relationship of species by phylogenetic tree	K5
		Construct phylogenetic tree using nucleotide	K5

		sequences	
		Identify the unknown species using nucleotide sequences of the particular species and soft wares	K5
5.6	Genetic Counseling	Categorize genetic disorders	K4
		Report the specific genetic change responsible for particular genetic disease	K4
		Analyze the probability in familial genetic disorders	K4

4.Mapping scheme

U20BT303	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	L	L	L	L	L	-	-	-	H	H	M	L
CO 2	H	L	M	L	M	L	-	-	-	M	L	H	L
CO 3	H	M	H	H	M	L	-	-	-	H	M	H	L
CO 4	H	L	L	-	L	-	L	-	-	H	-	M	-
CO 5	M	M	M	H	M	M	-	-	-	M	L	M	L
CO 6	M	M	M	M	M	L	-	-	L	H	M	M	L

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : III

COURSE CODE : U21BT3P3

CREDITS : 2

HOURS/WEEK : 3

CORE PRACTICAL III : GENETICS LAB

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Experiments
CO1	Design the media to culture Drosophila	K6	1,2
CO2	Test the capability of the chemical to cause mutation	K6	3
CO3	Analyze the polyploidy in onion root	K2	4
CO4	Create Models based on the Mendel law	K	5
CO5	Analyse the human karyotype	K4	6
CO6	Identify sex chromatin in buccal smear	K3	7

2. A. Syllabus

Experiment List

1. Drosophila – Morphology, Section culture and maintenance.
2. Isolation of DNA from Drosophilla
3. Identification of Mutants - Physical and Chemical Methods.
4. Study of polyploidy in onion root tip.
5. Experiments to determine Mendel’s law.
6. Human karyotype - demonstration.
7. Sex chromatin (buccal smear) identification.

B. Reference Books

1. Sambrook, J., Russell, D.W, Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press, 2001.
2. Bisen, P.S, Laboratory Protocols in Applied Life Sciences. CRC Press, 2014

C. Web Links

1. <https://nptel.ac.in/courses/102/103/102103083/>
2. <https://www.youtube.com/watch?v=I4uaBXwaXXw>

3. Specific Learning Outcomes (SLO)

Exercises	Lab Exercises	Learning outcomes	Highest Bloom's Taxonomic Level of Transaction
Ex1	Drosophila – Morphology, Section culture and maintenance	Design culture media to culture drosophila	K6
Ex 2	Isolation of DNA from Drosophilla	Methods and technique to isolate the DNA from cultured Drosophilla	K6
Ex 3	Identification of Mutants— Physical and Chemical Methods	Test the chemical and physical mutagen	K6
Ex 4	Study of polyploidy in onion root tip.	Analyse polyploidy in onion root tip	K4
Ex 5	Experiments to determine Mendel's law	Illustrate Mendel's law	K2
Ex 6	Human karyotype - demonstration	Analyze the karyogram	K4
Ex 7	Sex chromatin (buccal smear) identification	Identify the presence of Barr Body	K3

4. Mapping scheme

U21BT3P3	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	H	M	-	-	-	-	H	-	H	-
CO2	H	-	-	H	M	L	-	-	-	H	H	H	M
CO3	M	-	-	H	M	-	-	-	-	M	-	H	-
CO4	M	-	-	H	M	-	-	-	-	M	-	H	L
CO5	M	-	-	H	H	-	-	-	-	-	-	H	-
CO6	M	-	-	H	M	-	-	H	M	M	-	L	H

L: Low M: Medium H: High

5. Course assessment methods

Direct

1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination

Indirect

1. Course-end survey

3.3 Acids and bases: Arrhenius, Lowry- Bronsted, Lewis concepts- strong and weak acids and Bases-pH, pK_a , pK_b , buffer solutions, Derivation of Henderson – Hasselbalch equation.

Unit- IV Chemical Kinetics and Catalysis

12 Hours

4.1 Chemical kinetics: rate of reaction, order, molecularity, first order rate law, half life period and derivation of the first order rate equation.

4.2 Catalysis–homogeneous and heterogeneous catalysis, intermediate complex formation theory and adsorption theory, Positive and Negative Catalysts, Promoters and poisons, Auto catalysis, applications.

4.3 Enzyme catalysis –Mechanism and Michaelis-Menton Equation (No derivation)- Factors affecting enzyme catalysis.

Unit- V Colloids

12 Hours

5.1 Colloids – Types with examples – classification based on affinity (Lyophilic & Lyophobic).

5.2 Optical, Kinetic and Electrical properties of colloids– Electrophoresis, Electro-osmosis, Peptization, Coagulation.

5.3 Applications of colloids- Dialysis, Desalination of water, Artificial Rain.

Web Links:

1. [https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_\(Wade\)/04%3A_The_Study_of_Chemical_Reactions/5.01%3A_Introduction](https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Wade)/04%3A_The_Study_of_Chemical_Reactions/5.01%3A_Introduction)
2. [https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Principles_of_Modern_Chemistry_\(Oxtoby_et_al.\)/Unit_5%3A_Rates_of_Chemical_and_Physical_Processes/18%3A_Chemical_Kinetics/18.7%3A_Kinetics_of_Catalysis](https://chem.libretexts.org/Bookshelves/General_Chemistry/Map%3A_Principles_of_Modern_Chemistry_(Oxtoby_et_al.)/Unit_5%3A_Rates_of_Chemical_and_Physical_Processes/18%3A_Chemical_Kinetics/18.7%3A_Kinetics_of_Catalysis)

Self Study Topics:

1. https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/Syllabus/MIT3_091SCF09_aln02.pdf
2. https://profiles.uonbi.ac.ke/sderese/files/h-sch_102_-_types_of_organic_reactions_and_mechanisms.pdf
3. <https://www.askiitians.com/revision-notes/chemistry/solutions/>
4. <https://www.britannica.com/science/catalysis>
5. <https://nios.ac.in/media/documents/313courseE/L10.pdf>

Text Books

1. B.R. Puri, L.R. Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, New Delhi, 2017 (**Unit I, II, III**)
2. Arun Bahl and B.S. Bahl, Advanced Organic Chemistry, S. Chand & Co. Ltd., New Delhi, 2012 (**Unit IV**)
3. B.R. Puri, L.R. Sharma and Madan S. Pathania, Principles of Physical Chemistry Vishal Publishing Co., Jalandhar, 2017 (**Unit V**)

- P.L.Soni, H.M. Chawla, Text Book of Organic Chemistry , Sultan Chand & Sons, New Delhi, 2004
- R.L. Madan and G.D. Tuli, Inorganic Chemistry, S. Chand Co. Ltd., New Delhi, 2010
- Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut, 2016.

Recommended Reference Books

- J.D. Lee, "Concise Inorganic Chemistry", Oxford University Press, New Delhi, 2008.
- Morrison and Boyd "Organic Chemistry" Pearson Education, 2016.
- Peter Atkins and Julio de Paula, "Physical Chemistry" Oxford University Press, 2018.

Specific Learning Outcomes:

Unit	Course Contents	Learning Outcomes	Blooms Taxonomic levels of Transaction
Unit-1 :Chemical Bonding			
1.1	Ionic bond - Nature of ionic bond; Factors influencing the formation of ionic bond	Recall the concepts of formation	K1
		Explain the factors influencing the formation of ionic bond.	K2
1.1	Structure of NaCl, KCl and CsCl	Compare the structure of NaCl, KCl and CsCl	K2
1.2	Covalent bond; Nature of Covalent bond	Explain the concept of Covalent bond with examples	K2
1.2	VSEPR theory	Predict the shape of a given molecule based on VSEPR theory	K4
1.3	Coordinate bond; Nature of Coordinate bond	Explain the concept of Coordinate bond	K2
1.3	Werner's theory and structure of some complexes	Infer the structure of some complexes with the aid of Werner's theory	K2
1.4	Hydrogen bonding; Theory and types of hydrogen bonding; Consequence of hydrogen bonding	Compare the types of hydrogen bonding in compounds	K4
1.5	Van der Waals forces and London Dispersive forces	Identify the various forces of attraction in molecules	K3

Unit 2: Types of Reactions			
2.1	Types of intermediates – Electrophiles, Nucleophiles and Free radicals	Compare the different types of radical intermediates	K2
2.2	Substitution reactions – Electrophilic, Nucleophilic with mechanism	Explain the electrophilic and nucleophilic substitutions along with mechanism	K3
2.2	Addition reaction – Addition of HBr on alkenes	Apply the mechanistic pathway for addition reaction to alkenes	K3
2.2	Elimination reactions – Dehalogenation of alkyl halides	Apply the mechanistic pathway for Dehalogenation of alkyl halides	K3
2.2	Condensation reactions – formation of ester	Explain the condensation reaction with an example	K2
2.3	Polymerization reactions – formation of poly vinyl chloride	Describe the preparation method of PVC	K2
2.3	Reduction reactions – hydrogenation of oil	Explain the reaction of hydrogenation of oil	K2
2.3	Oxidation reactions – conversion of benzaldehyde to benzoic acid	Write the mechanism for conversion of benzaldehyde to benzoic acid	K3
Unit 3: Solutions			
3.1	Homogeneous and Heterogeneous solutions Saturated and Unsaturated solutions	Identify the different types of solutions	K2
3.1	Mole concept – Normality, Molarity, Molality and Parts per Million – problems	Calculate strength of given solution based on mole concept	K2
3.2	Primary and secondary standard solutions and preparation	Identify the primary and secondary standard solutions	K2
3.3	Arrhenius theory	Outline the Arrhenius theory concept of acids and bases.	K2
3.3	Lowry-Bronsted theory	Explain the Lowry-Bronsted theory concept of acids and bases.	K2
3.3	Lewis acid base theory (strong and weak)	Classify strong and weak acids and bases with the aid of Lewis acid base theory	K2
3.3	Buffer solutions Henderson-Hasselbalch equation	Predict the pH of the buffer solution based on Henderson-Hasselbalch equation	K2
Unit 4 Chemical Kinetics and Catalysis			
4.1	Rate law	Explain the rate of chemical reaction	K2
4.1	Order and Molecularity of a chemical reaction	Compare the order and molecularity of chemical reaction	K2
4.1	Half life period	Illustrate the half life period of particular reactions	K2

4.1	First order rate constant equation	Develop the rate constant equation for first order reaction	K3
4.2	Homogeneous and Heterogeneous catalysis	Compare the homogeneous and heterogeneous catalysis	K2
4.2	Intermediate complex formation theory	Explain the formation of intermediate complex theory	K2
4.2	Adsorption theories of catalysis	To explain the theories of adsorption of catalysis	K2
4.2	Positive catalyst, Negative catalyst, Auto catalyst, promoters and poisons	Classify the catalyst based on their function	K2
4.2	Application of catalysis	Summarize the application of catalysis	K2
4.3	Enzyme catalysis – mechanism Michaelis – Menton Equation (no derivation)	Explain the mechanism of enzyme catalysis based on Michaelis-Menton Equation .	K2
4.3	Factors affecting the enzyme catalysis	Explain the factors which affect the enzyme catalysis	K2
Unit 5: Colloids			
5.1	Colloids and its types with examples; Lyophilic and Lyophobic colloids	Classify the types of colloids with examples	K2
5.2	Optical and Kinetic properties of colloids (electrophoresis, electro osmosis)	Compare the optical and kinetic properties of colloids	K2
5.3	Peptization and Coagulation	Differentiate the properties of peptization and coagulation	K2
5.4	Applications of colloids – Dialysis, Desalination of water and Artificial Rain	Identify different applications of colloids in day-to-day life	K2

Mapping of COs with POs and PSOs for B.Sc.Bio-Technology

Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	L	H	L	-	-	-	L	-	L				
CO2	H	H	L	-	-	-	L	-	L				
CO3	M	H	M	-	L	-	L	-	L				
CO4	L	H	L	-	-	-	L	-	L				
CO5	L	H	L	-	-	-	L	-	L				
CO6	M	H	H	-	L	-	L	-	L				

SEMESTER: IV
CREDITS: 3

COURSE CODE: U19BTC2
HOURS/WEEK.:3

ALLIED PRAC:III VOLUMETRIC AND ORGANIC ANALYSIS LAB

Course Outcomes:

After the completion of the course the students will be able to:

S.No.	Course Outcomes	Level
CO1	Relate the basic principles and types of volumetric analysis.	K2
CO2	Infer the redox reaction concept.	K3
CO3	Estimate the strength of the given solution.	K3
CO4	Apply complexation concept to check water quality	K3
CO5	Identify organic compounds and quantifying.	K5
CO6	Classify the primary standard solutions and to prepare standard solutions in different concentration units.	K3

I. Preparation of standard solution (Molar, ppm & Normal) & basic principles of organic analysis

II. Volumetric Analysis

1. Estimation of hydrochloric acid (Acidimetry and Alkalimetry)
2. Estimation of sodium hydroxide (Acidimetry and Alkalimetry)
3. Estimation of oxalic acid using KMnO_4 (Permanganometry)
4. Estimation of ferrous sulphate KMnO_4 (Permanganometry)

III. Organic Analysis: Analysis of organic compounds (Carbohydrate, Diamide, Aldehyde, Ketone and Carboxylic Acid) with the following tests for,

- a. Aromatic/ Aliphatic nature,
- b. Saturation / unsaturation
- c. Solubility in common solvents and
- d. Presence of nitrogen

Text Book

Venkateswaran, R. Veerasamy, A.R. Kulandaivelu, Basic Principles of Practical, Chemistry, Sultan Chand & Sons, New Delhi, 1997

Web link:

1. <http://www.ecs.umass.edu/cee/reckhow/courses/572/572bk16/572BK16.html>
2. https://www.csub.edu/chemistry/organic/manual/Lab14_QualitativeAnalysis.pdf

Self Study Topics:

1. <https://www.aplustopper.com/prepare-standard-solution/>
2. http://wwwchem.uwimona.edu.jm/lab_manuals/c10expt25.html

Specific Learning Outcomes:

S.No.	Course Content	Learning Out Comes	Blooms Taxonomic levels of Transaction
Volumetric Analysis			
1	Preparation of standard solution (Molar, ppm & Normal)	To relate the basic principles and types of volumetric analysis. To classify primary standard substances To prepare standard solutions in different concentration units.	K2 K3 K3
2.	Estimation of Hydrochloric acid	To estimate the acid base neutralization reaction. To select indicators for acid base titration with different pH value.	K3
3	Estimation of Sodium Hydroxide	To estimate the acid base neutralization reaction. To select indicators for acid base titration with different pH value.	K3
4	Estimation of oxalic acid using $KMnO_4$	To infer the redox reaction concept.	K3
5	Estimation of ferrous sulphate using $KMnO_4$	To estimate the strength of the given Oxalic acid/ $FeSO_4$ solution.	K3
Organic Analysis			
6	Analysis of organic compounds (Carbohydrate, Diamide, Aldehyde, Ketone and Carboxylic Acid) with the following tests for (i) Aromatic/ Aliphatic nature, (ii) Saturation/ unsaturation (iii) Solubility in common solvents (iv) Presence of nitrogen	To infer aromatic substitution reaction To relate addition reaction to saturation test. To analyse unknown samples systematically and report the same	K3 K3 K5

Mapping of COs with POs and PSOs

Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PS O1	PSO2	PSO 3	PS 04
CO1	H	----	M	----	M	M	L	M	----	H	H	H	H
CO2	M	-----	M	-----	M	M	L	M	-----	H	M	M	M
CO3	M	-----	M	----	M	M	L	M	-----	H	H	H	M
CO4	H	M	M	L	M	L	L	M	-----	H	H	H	---
CO5	M	-----	M	-----	H	M	L	-----	-----	H	H	----	H
CO6	M	-----	M	-----	----	L	L	M	-----	H	H	H	M

SEMESTER 4

SEMESTER : IV

COURSE CODE : U20BT404

CREDITS : 6

HOURS/WEEK : 6

CORE IV : BASICS OF IMMUNOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Describe the structure and functions of the organs and cells of the immune system.	K2	II
CO2	Differentiate cell mediated and humoral immunity based on mechanism.	K4	I
CO3	Illustrate the characteristics of antigens and antibodies	K2	III
CO4	Compare the mechanisms of processing and presentation of endogenous and exogenous antigens.	K2	IV
CO5	Explain the activation pathways of T cells, B cells and complement system.	K2	IV
CO6	Demonstrate the immunological techniques used in Clinical Diagnosis.	K4	V

2. A. Syllabus

UNIT-I

18Hrs

History and scope of Immunology: Historical perspective of Immunology, Early theories of Immunology, Types of Immunity Innate, Adaptive (cell mediated and humoral). Passive: Artificial and Natural Immunity, Active: Artificial and Natural Immunity. Vaccines – Types and vaccination schedule.

UNIT-II

18Hrs

Immune system and its mechanism: Primary and Secondary organs of immune system – structure and Function, Hematopoiesis- Significance -Origin and differentiation of lymphocytes: T-cells, B-cells, myeloid cells, antigen presenting cells and cell mediated subset of T-Cells, helper and suppressor cells, natural killer cells.

UNIT-III

18Hrs

Cellular and molecular interactions: Antigens: Structure and properties - Immunogenicity vs antigenicity, factors affecting antigenicity, epitopes, haptens, adjuvants.Immunoglobulins: Structure, types, distribution and biological functions. Antigen antibody interactions: precipitation and agglutination.

UNIT-IV

18Hrs

Immune response: Recognition of antigen: MHC, antigen processing and presentation, T-cell and B - cell activation. Cell mediated-Mechanism and target cell lysis, Humoral

response, antibody dependent cell mediated cytotoxicity, Complements - Classical and Alternative pathways.

UNIT-V

18Hrs

Clinical Immunology: Organ transplantation- types of graft, mechanism of allograft rejection, Immunosuppression, Allergic reactions- Immunology & types of hypersensitivity. Auto antibodies – Autoimmune diseases. Immunological Techniques in Clinical Diagnosis: Widal test, Pregnancy test, ELISA

B. Topic for Self Study

S.No	Topics	Web Links
1	Chemokine	Immunology, Kuby, W.H.Freeman and Company, Newyork, 6 th edition, 2007
2	Antigen presentation	Immunology, Kuby, W.H.Freeman and Company, Newyork, 6 th edition, 2007
3	Early vaccination study	Immunology, Kuby, W.H.Freeman and Company, Newyork, 6 th edition, 2007
4	Anti-inflammatory agents	Immunology, Kuby, W.H.Freeman and Company, Newyork, 6 th edition, 2007

C. Text Books

1. Kuby, J, Immunology. (Sixth edition) W.H.Freeman and company, New York, 2007.
2. Abbas AK, Lichtman AH, Pillai S, Cellular and Molecular Immunology 6th edition, Saunders Publication, Philadelphia, 2007.

D. Reference Books

1. Roitt. E, Essential Immunology 12th Edition, Wiley& Blackwell, 2011
2. Richard M. Hyde, Microbiology and Immunology, 3rd Edition. Springer Science & Business Media, 2012.
3. Brostoff J, Seaddin JK, Male D, Roitt IM, Clinical Immunology, 6th Edition. Gower Medical Publishing, 2002.
4. Paul, Fundamental of Immunology, 4th Edition, Lippencott Raven, 1999.
5. Janeway, Immunobiology, 4th Edition, J Current Biology publications, 1999.
6. Weir D. M.,JohnStewart, Immunology, 8th Edition, Churchill Livingstone, 1997.
7. Delves P.J., I S.J.Artin, I D.R.Burton and I I.M.Roitt, Essential Immunotechnology, 12th Edition. Wiley & Blackwell, 2006.

E. Web Links.

1. <https://nptel.ac.in/courses/102/105/102105083/>

2. <http://www.digimat.in/nptel/courses/video/104108055/L05.html>

3. Specific Learning outcomes (SLO)

Unit	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	History and Scope of Immunology		
1.1	Historical perspective of Immunology	List out the inventions and scientists in the field of immunology	K1
		Name the Nobel prize winners of immunology inventions	
1.2	Early theories of Immunology	State the theories proposed by scientists	K1
1.3	Innate and Adaptive Immunity	Compare the components of innate and adaptive Immunity	K2
1.4	Cell mediated and humoral immunity	Distinguish the mechanism of cell mediated and humoral immunity	K4
1.5	Passive and active immunity	Interpret the type of immunity based on its occurrence	K2
1.6	Vaccines – Types and vaccination schedule	Describe the preparation of vaccines	K2
		Identify the time of vaccination of particular vaccine	
2	Immune System and its mechanism		
2.1	Hematopoiesis - Origin and differentiation of lymphocytes	Arrange the origin of each lymphocyte	K1
		Sketch out the hematopoietic pathway	K3

2.2	Primary and Secondary organs of immune system	Locate the place of immune organs of our body system	K2
			K3
		Illustrate the organization of organs of immune system	
2.3	Cells of immune system	Illustrate the structural organization of immune cells	K3
		Distinguish the immune cells based on their nucleus structure	K4
		Describe the functions of immune cells	K2
3	Cellular and Molecular Interactions		
3.1	Antigens: Structure and properties	Discuss the properties of antigens	K3
		List out the natural and synthetic antigens	K1
3.2	Immunogenicity vs antigenicity, factors affecting antigenicity	Compare immunogenicity and antigenicity based on their effect	K3
	3.3 Epitopes, haptens, adjuvants	Differentiate haptens and adjuvants based on their properties	K3
3.4	Immunoglobulins: Structure, types, distribution and biological functions	Distinguish the structure of antibodies	K3
		Select appropriate antibody responsible for particular function	K1
		Describe the structure and functions of antibodies	K2
3.5	Antigen antibody interactions: precipitation	Analyze the interactive properties of antigen and antibody	K4
		Estimate the concentration of antigen and antibody	K2

3.6	Antigen antibody interactions: agglutination	Identify the blood group of an individual using agglutination reaction	K2
4	Immune response: Recognition of Antigen		
4.1	Recognition of antigen: Role of MHC molecules	Interpret the role of MHC molecules	K2
		Illustrate the structure of MHC molecules	K3
4.2	Antigen processing and presentation – endocytic pathway and cytosolic pathway	Sketch out the mechanisms of antigen processing and presentation	K3
		Analyze and differentiate the components of endocytic pathway and cytosolic pathway	K4
4.3	B and T - cell activation	Describe the process of B and T cell activation	K2
4.4	Cell mediated-Mechanism and target cell lysis	Summarize the mechanism of cell mediated mechanism	K2
4.5	Humoral response, antibody dependent cell mediated cytotoxicity	Describe the mechanism of B cell mediated immune response	K2
4.6	Complements - Classical and Alternative pathways	Sketch the different activation pathways of complements	K3
		Describe the structure and functions of complement proteins	K2
5	Clinical Immunology		
5.1	Organ transplantation- types of graft, mechanism of rejection	Explain the types and mechanism of organ transplantation	K2
5.2	Immunosuppression	Describe the process of Immunosuppression	K2
		List out immunosuppressive	K1

		drugs	
5.3	Allergic reactions	Identify allergens and allergic reactions	K2
5.4	Hypersensitivity – Type I, II, III and IV	Differentiate and compare the hypersensitivity reactions	K4
		Summarize the immune components involved in HR reactions	K2
5.5	Autoimmune diseases	Analyze the pathology of autoimmune diseases	K4
		Differentiate local and systemic autoimmune diseases	
5.6	Immunological Techniques - Widal test, Pregnancy test	Perform Widal test and Pregnancy test	K3
		Explain the methodology of immunological techniques	K2
5.7	Immunological Technique – ELISA	Categorize the types of ELISA based on the procedure	K4
		Describe the methodology of ELISA assay	K2

4. Mapping scheme4. Mapping scheme

U20BT404	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	M	-	-	-	L	-	-	-	H	H	H	L
CO2	H	H	M	L	L	-	-	-	-	H	M	H	L
CO3	H	H	M	L	L	-	-	-	-	H	M	H	L
CO4	H	H	M	L	L	-	-	-	L	H	M	H	L
CO5	H	H	M	L	L	L	-	-	-	H	M	H	L
CO6	H	H	H	M	H	M	-	-	L	H	M	H	L

L: Low M: Medium H: High

5. COURSE ASSESSMENT METHODS

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : IV

COURSE CODE : U16BT4P4

CREDITS : 2

HOURS/WEEK : 3

CORE PRACTICAL II :BASICS OF IMMUNOLOGY LAB

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Experiments
CO1	Explain the composition of the human blood	K2	1-3
CO2	Calculate the level of red blood cells and white blood cells in specific volume of blood	K3	2
CO3	Distinguish the various types of white blood cells based on nucleus morphology	K2	2,3
CO4	Analyze the blood group of an individual through blood grouping test	K4	4
CO5	Calculate the interactions of antigen and antibody through immunological assays	K4	5-6
CO6	Explain the preparation of antibodies and immunization techniques.	K2	7,8

2. A. Syllabus

List of Experiments

1. Preparation of serum from blood
2. To perform total WBC and RBC counting
3. Differential Leukocyte count
4. Agglutination reactions: blood grouping
5. Rocket Immunodiffusion
6. Dot Elisa Assay
7. Demonstration: Preparation of Antibodies.
8. Demonstration: A preface to Immunization and bleeding techniques

B. Reference Books

1. Lesile Hudson, Frank C.Hay, III edition. Practical Immunology, Blackwell Scientific Publication, 1989.
2. Peakman M, and Vergani D, Basic and Clinical Immunology, 2nd edition Churchill Livingstone Publishers, Edinberg, 2009.
3. Richard C and Geiffrey S, Immunology, 6th edition, Wiley Blackwell Publications, 2009.
4. Murphy K, Travers P, Walport M, Janeway's Immunobiology, 7th edition Garland Science Publishers, New York, 2008.

C. Web Links.

1. <https://nptel.ac.in/courses/102/105/102105083/>

2. <https://www.digimat.in/nptel/courses/video/104108055/L03.html>

3. Specific Learning Outcomes (SLO)

Exercises	Lab Exercises	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
Ex 1	Preparation of serum from blood	Use centrifuge to separate serum from the blood sample.	K3
Ex 2	To perform total WBC and RBC counting	Estimate the WBC and RBC present in the blood sample	K2
Ex 3.	Differential Leukocyte count	Differentiate the leukocytes based on the appearance of stained nuclei	K4
Ex 4.	Agglutination reactions: blood grouping	Identify the blood group and D antigen of an individual	K2
Ex 5.	Rocket Immunodiffusion	Estimate the concentration of antigen present in the sample using known concentration of antigen standards	K2
Ex 6.	Dot Elisa Assay	Test the presence of antigens based on Dot ELISA assay	K4
Ex 7.	Demonstration: Preparation of Antibodies.	Describe the antibody preparation methods	K2
Ex 8.	Demonstration: A preface to Immunization and bleeding techniques	Explain the methodology of immunization and bleeding techniques.	K2

4. Mapping scheme

U16BT4P4	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	-	-	-	-	-	-	M	-	H	-
CO2	H	-	-	-	-	L	-	-	-	M	-	H	-
CO3	M	-	-	-	-	-	-	-	-	M	-	H	-
CO4	M	-	-	-	-	-	-	-	-	M	-	H	L
CO5	M	-	-	-	-	-	-	-	-	-	-	H	-
CO6	M	-	-	-	-	-	-	-	-	M	-	L	-

L-Low

M-Moderate

H- High

5. COURSE ASSESSMENT METHODS

Direct

1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination

Indirect

1. Course-end survey

4.1 Chromatography-introduction-principle, sampling and applications of paper, thin layer and column chromatography.

4.2 Photochemistry: Laws of Photochemistry, components of a colorimeter (Block diagram), application(estimation of iron).

4.3Purification methods – Steam distillation, Vacuum Distillation, Fractional Distillation, Solvent extraction, Crystallization and Sublimation.

Unit- V

Industrial Chemistry

12 Hours

5.1-Synthetic Polymers: Preparation, Properties and uses of Teflon, Polyester, Nylon-66 PVC, Polyethylene.

5.2 – Halogen containing compounds: Preparation and uses of Freons, CH_2Cl_2 , CHCl_3 , CCl_4 , Pesticides- DDT, BHC- Preparation and uses.

5.3- Fuel gases: Water gas, Producer gas, LPG, Gobar gas, Natural Gas- Manufacture and uses.

5.4- Cosmetics: Basic ingredients, Additives and fragrances used in Soaps, Toothpaste, Lipstick, Perfumes, Deodorants and Antiperspirants. Basic tests for identification of good and bad cosmetics-pH test.

Text Books

1. Tiwari K.S., Melhotra S.N., Vishnoi N.K, A Text book of Organic Chemistry, Vikas Publishing House Pvt. Ltd., New Delhi, 2017. **(Unit-I, V)**.
2. R. Gopalan, P. S. Subramanian and K. Rengarajan, Elements of Analytical Chemistry, Sultan Chand and Sons, New Delhi, 1997. **(Unit- IV)**.
3. Puri B.R., Sharma L. R., Kalia K.K, Principles of Inorganic Chemistry, 23rd Edition, New Delhi, Shoban Lal Nagin Chand & Co, 2107. **(Unit- I, III)**
4. Puri B.R., Sharma L. R., Kalia K.K, Principles of physical Chemistry, 23rd Edition, New Delhi, Shoban Lal Nagin Chand & Co, 2017. **(Unit-II)**.
5. B.K. Sharma, Industrial Chemistry, Goel Publishing Co., 1997.

Recommended Reference Books

1. R.T. Morrison &R.N.Boyd, Study Guide to Organic Chemistry, Pearson Education, New Delhi, 2016.
2. R.L. Madan and G.D.Tuli, Inorganic Chemistry, S. Chand Co., Ltd., New Delhi, 2010
3. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut, 2016.

Web Links :

1. Biomolecules: http://med.fau.edu/students/md_m1_orientation/Overview.pdf
2. Water Chemistry:<https://dnr.mo.gov/env/wpp/vmqmp/docs/chpt-07-intro-water-chemistry-1-09.pdf>
3. Analytical Chemistry: <http://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/Manahan%20-%20Fundamentals%20of%20Environmental%20Chemistry/1491Ch25.pdf>

Self Study Topics:

1. Water Chemistry: https://www.cusd80.com/cms/lib/AZ01001175/Centricity/Domain/586/Lecture_Water.pdf
2. Polymer Chemistry: <https://www.ch.ntu.edu.tw/~sfcheng/HTML/material94/Polymer-1.pdf>

3. Analytical Techniques: <https://www.lucideon.com/testing-characterization/analytical-techniques-chemical-analysis>

Specific Learning Outcomes:

Unit	Course Contents	Learning Outcomes	Blooms Taxonomic levels of Transaction
Unit I: Chemistry of Biomolecules			
1.1	Classification of carbohydrates- glucose & fructose. preparation, properties.	Classify carbohydrates and explain the preparations and properties	K2
1.1	Muta-rotation, Inter-conversion of glucose and fructose,	Explain the dependence of optical rotation with the structure of carbohydrates under study.	K2
1.1	manufacture of sucrose	Describe the manufacturing processes of sucrose.	K2
1.1	Test for sugars.	Identify the sugar using the standard chemical test	K2
1.2	Amino acids—preparation and properties of glycine and alanine, peptides (elementary treatment)	Recite the preparation and properties of glycine.	K1
1.2	proteins-classification based on physical properties and biological functions	Categorize proteins into different types based on the biological functions	K4
1.2	Structure of proteins – primary and secondary.	Explain primary and secondary structures of proteins	K2
1.2	Test for proteins	Identify the protein using the standard chemical test	K3
1.3	Coordination compounds- biological role hemoglobin and chlorophyll.	Explain the importance of metalloporphyrin on oxygen transfer and photosynthesis	K2
Unit II: Chemistry of Water			
2.1	Water as a universal solvent.	Describe the important role of water in everyday life	K2
2.1	Hardness of water- permanent and temporary hardness, disadvantages of hard water	Discuss the impact of hardness in water.	K2
		Classify hardness of water as permanent and Temporary	K2
2.1	DO, BOD and COD - definition,	Apply the BOD and COD	K3

	Methods of determination (any one method).	concepts to determine the quality of water.	
2.2	Water Softening methods - Zeolite process, Reverse Osmosis.	Describe the Zeolite and Reverse Osmosis processes of water softening.	K2
2.3	Preparation of De-ionized water-Distilled water-Double Distilled water-Packaged drinking water	Explain the processes of water purification.	K2
Unit III : Basics of Quantitative Analysis			
3.1	Error analysis: accuracy, precision, determinate and indeterminate errors, relative error, absolute error.	Identify the types of errors in the given set of data	K2
3.2	Quantitative analysis: Titrimetry-principle, acid-base titrations and redox titrations with examples - End point and equivalence point.	Illustrate the principles behind the various kind of titrations.	K2
		Identify the difference between the end point and equivalence point.	K2
3.3	Theory of Indicators- Types of indicators - Quinonoid theory.	Select suitable indicators for various kind of titrations..	K2
Unit IV : Analytical techniques			
4.1	Chromatography-introduction-principle, sampling and applications of paper, thin layer and column chromatography.	Outline the principles of various Chromatographic technique.	K2
4.2	Photochemistry: Laws of Photochemistry, components of a colorimeter (Block diagram), application (estimation of iron).	Describe the colorimetric procedure to find the strength of iron in a given solution.	K2
4.3	Purification methods – Steam distillation, Vacuum Distillation, Fractional Distillation, Solvent extraction, Crystallization and Sublimation.	Outline the principles behind various purification technique	K2
Unit V : Industrial chemistry			
5.1	Synthetic Polymers: Preparation, Properties and uses of Teflon, Polyester, Nylon-66 PVC, Polyethylene.	Explain the preparations, properties and uses of various polymers.	K2
5.2	Halogen containing compounds: Preparation and uses of Freons, CH ₂ Cl ₂ , CHCl ₃ , CCl ₄ ..	Explain the preparation and uses of alkyl derivatives of chlorine.	K2
5.2	Pesticides- DDT, BHC- Preparation and uses	Compare the properties and uses of pesticides	K2
5.3	Fuel gases: Water gas, Producer gas, LPG, Gobar gas, Natural Gas- Manufacture and uses.	Describe the manufacturing process of various fuel gases and its usage.	K2

5.4	Cosmetics: Basic ingredients, Additives and fragrances used in Soaps, Toothpaste, Lipstick, Perfumes, Deodorants and Antiperspirants.	Identify the ingredients and Additives in various cosmetics available in the market.	K2
5.4	Basic tests for identification of good and bad cosmetics - pH test.	Identify good and bad cosmetics using pH	K2

Mapping of COs with POs and PSOs of B.Sc. Bio-Technology

Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
CO1	H	H	H	H	M	L	L	M	M				
CO2	H	H	H	H	M	L	L	M	M				
CO3	H	H	H	H	H	L	L	M	M				
CO4	H	H	H	H	M	L	L	M	M				
CO5	H	H	H	H	M	L	L	M	M				
CO6	H	H	H	H	M	L	L	M	M				

SEMESTER 5

SEMESTER : V

COURSE CODE : U21BT505

CREDITS : 6

HOURS/WEEK : 6

CORE V : MOLECULAR BIOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Recollect the structure and functions of nucleic acids.	K2	I
CO2	Explain the principles and mechanism of replication, Recombination DNA repair and transposition.	K2	I,III
CO3	Distinguish the types of mutation and its detection methods.	K4	II
CO4	Describe gene expression and regulation mechanism of prokaryotes and eukaryotes.	K4	III
CO5	Integrate the concept of central dogma and genetic code.	K5	IV
CO6	Justify the importance of post transcriptional and post translational modification.	K5	V

2. A. Syllabus

UNIT-I

18Hrs

1.0 Structure of DNA and RNA- Composition and Functions. Types of DNA: A-DNA, B-DNA and Z-DNA ; types of RNA: mRNA, rRNA and tRNA, Replication. Mechanisms – unidirectional & bidirectional replication, Semi conservative- Meselson and Stahl experiment, continuous and discontinuous, various models of DNA replication including rolling circle. Enzymes involved in replication- DNA polymerases, DNA ligase, Primase, helicase, topoisomerase.

UNIT-II

18Hrs

Mutation: Origin and Classification; Mutagens-physical & chemical mutagens-Spontaneous and Induced mutations- Molecular Mechanism of Mutation- Detection of DNA damage at molecular level, Ames test, cytogenetic analysis in mammalian cells- invitro and in vivo- Host mediated assay.

UNIT-III

18Hrs

DNA repair and recombination mechanisms. Transposons and transposable elements- Mechanism of transposition. Transcription and RNA processing: Transcription in Prokaryotes and Eukaryotes. Difference between prokaryotic and eukaryotic transcription- -Post transcriptional modifications: mRNA Capping-splicing-Polyadenylation.

UNIT-IV

18Hrs

Genetic code and Translation: Features of genetic code -Deciphering of the codon-wobble hypothesis. Translation in Prokaryotes and Eukaryotes Difference between prokaryotic and

eukaryotic translation Post translational modifications: phosphorylation, glycosylation, sulfation, methylation and hydroxylation. Protein targeting.

UNIT-V

18Hrs

Regulation of Gene expression: Regulation of gene expression in prokaryotes and eukaryotes -positive and negative control in prokaryotes- Operon models- Lac, Trp, Ara. Spatial and Temporal regulation of eukaryotic genes, mi RNA, siRNA, Micro-satellites.

B. Topic for Self Study

S.No	Topics	Web Links
1	RNA editing	https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/rna-editing
2	Denaturation and Renaturation kinetics	https://www.biologydiscussion.com/biomolecules/denaturation-and-renaturation-of-dna/25558
3	Riboswitch	https://www.nature.com/scitable/topicpage/riboswitches-a-common-rna-regulatory-element-14262702/
4	DNA binding Protein	https://www.nature.com/subjects/dna-binding-proteins
5.	Molecular chaperons	https://www.nature.com/articles/nature10317

C. Text Books

1. Gupta. P.K, Cell and Molecular biology, Rastogi Publications, India, 2005.
2. Rastogi, S.C, Cell and Molecular Biology, 3rd Edition. New Age International, Publishers, India, 2012.
3. Benjamin A. Pierce, Genetics: A Conceptual Approach, 5th Edition, W. H. Freeman company, 2013.

D. Reference Books

1. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P, Essential Cell Biology, 3rd Edition. Garland science, USA, 2009.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P, Molecular Biology of the Cell, 5th Edition, Garland Science, USA, 2008.
3. Lodish, H. Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M., Scott, M.P. Lawrence Z., Darnell, J, Molecular cell biology, 5th Edition. W. H. Freeman, USA, 2003.
4. Sathyanarayana U, Biochemistry, 3rd Edition. New Central Book Agency(p) Ltd, 1999.
5. Karp, G, Cell and Molecular Biology: Concepts and Experiments. 5th Edition. John Wiley and Sons, USA, 2007.
6. Cooper, G.M., Hausman, R.E, The cell Molecular approach, 5th Edition. American Society of Microbiology press, USA, 2009.

E. Web Links.

1. <https://nptel.ac.in/courses/102/106/102106025>
2. <https://nptel.ac.in/courses/102/104/102104052>

3. Specific Learning Outcomes (SLO)

Unit	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Structure of DNA and RNA		
1.1	Structure of DNA and NA- Composition, Types and Functions.	Define the Basic structure of DNA and RNA.	K1
		Discuss the various types of Nucleic acids.	K2
		List the diverse functions of DNA and RNA.	KI
1.2	Replication. Mechanisms – unidirectional & bidirectional replication, Semi conservative- Meselson & Stahl experiment, continuous and discontinuous. Various models of DNA replication including rolling circle.	Illustrate General mechanism of Replication.	K2
		Explain the different types of replication.	K4
		Distinguish Various models of DNA replication .	K2
1.3	Enzymes involved in replication-DNA polymerases, DNA ligase, Primase, helicase, topoisomerase.	Summarize the Enzymes involved in replication and its significance.	K2
2	Mutation-Origin and Classification		
2.1	Mutation: Origin and Classification; Mutagens- physical & chemical mutagens.	Classify the mutation based on the mutagens.	K2
		Differentiate chemical and physical mutagens.	K4

		Analyse the role of mutant to create mutation.	K4
2.2	Spontaneous and Induced mutations- Molecular Mechanism of Mutation.	Review the concept of Spontaneous and Induced mutations.	K2
		Discuss the various Molecular Mechanism of Mutation.	K2
2.3	Detection of DNA damage at molecular level, Ames test, cytogenetic analysis in mammalian cells- in vitro and in vivo- Host mediated assay.	Illustrate how the DNA damage are detected at molecular level	K2
		Explain the various invitro and in vivo mutant detection assay.	K4
		Distinguish between in vitro and in vivo- Host mediated assay.	K2
3	DNA Repair and Recombination mechanisms		
3.1	DNA repair and recombination mechanisms.	Analyse the mechanism of DNADNA repair in cells.	K4
		Explain various types of DNA repair mechanisms.	K2
		Interpret the concept of recombination mechanisms.	K2
3.2	Transposons and transposable elements- Mechanism of transposition.	Describe the importance of transposable elements.	K2
		List the different classes of Transposons.	K1
		Explain the mechanism of	K2

		transposition.	
		Analyse the applications of transposable elements.	K4
3.3	Transcription and RNA processing: Transcription in Prokaryotes and Eukaryotes - Post transcriptional modifications. mRNA Capping-splicing-Polyadenylation	Describe the process of RNA regulation and transcription	K2
		Distinguish the prokaryotic and Eukaryotic transcription.	K4
		Discuss the various methods of Post transcriptional modifications such as mRNA Capping-splicing-Polyadenylation.	K2
4	Genetic code and Translation		
4.1	Genetic code and Translation: Features of genetic code - Deciphering of the codon-wobble hypothesis.	Summarize the characteristics of genetic code.	K2
		Describe how the genetic code influence to make a protein in cellular systems.	K2
		Explain wobble hypothesis the mechanisms.	K3
		Relate the concept of central dogma and genetic code	K4
4.2	Translation in Prokaryotes and Eukaryotes		K1
		Apply the knowledge of stem cells in the treatment of autoimmune diseases.	K3
4.3	Post translation modifications-Protein targeting.	Describe about the Post translation modifications with its	K2

		significance in protein synthesis mechanisms.	
		Acquire knowledge about target specification of proteins	K4
5	Regulation of gene expression in prokaryotes		
5.1	Regulation of gene expression in prokaryotes positive and negative control in prokaryotes- Operon models.	Describe the regulation of gene expression in prokaryotes .	K2
		Contrast positive and negative control in prokaryotic gene expression	K2
		Discuss about different Operon models such as Lac, Tryp, Arb.	K2
5.2	Regulation of gene expression in Eukaryotes Spatial and Temporal regulation of eukaryotic genes, mi RNA, siRNA, Micro-satellites..	Explain different types of eukaryotic regulation.	K2
		Comprehend the mi RNA, siRNA, Micro-satellites..	K1
		Interpret the importance siRNA in gene silencing mechanism.	K2

4. Mapping Scheme:

U21BT505	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 2	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 3	H	H	-	H	M	-	-	-	-	H	L	H	-
CO 4	H	H	-	H	M	-	H	-	-	H	L	H	-
CO 5	H	H	-	H	M	-	H	-	-	H	L	H	H
CO 6	H	H	-	H	M	-	H	-	-	H	L	H	M

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE : U21BT506

CREDITS : 6

HOURS/WEEK : 6

CORE VI : GENETIC ENGINEERING

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Explainthe concept of genetic engineering.	K1	I
CO2	Relate the role of enzymes used in the construction of gene cassettes and vectors	K2	II
CO3	Apply the biological methods of gene transfer in molecular cloning	K3	III
CO4	Analyze and identify the recombinant bacteria by blue- white colony screening and conform the result from Immunological techniques.	K4	IV
CO5	Summarize the gene cloning techniques at molecular level.	K5	III
CO6	Infer the applications of recombinant DNA in scientific research	K2	V

2. A. Syllabus

Unit –I

18Hrs

Enzymes in Recombinant Technology: Enzymes in Genetic engineering- Nucleases- types-exonuclease ,endonucleseRestriction endonucleases Types,, DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, T4 DNA ligase, Terminal deoxynucleotidyl transferase, Reverse transcriptase, DNase, RNase, SI nuclease. Enzymes in Molecular Biology: Nucleases, T4polynucleotide kinase, linker, adaptors and homopolymer tails.

Unit-II

18Hrs

Vector: Different kinds of vector- Cloning and expression vectors. Cloning vectors for E. coli-Bacterial artificial chromosome, Gateway cloning, Cloning vectors for Eukaryotes: Yeast shuttle vector, Yeast artificial chromosome, HAC, Phage life cycle- Viral vector, phage vector-Phage M13, phagemids, cosmids, Insertion vector, Fusion vector, replacement vector

Unit-III

18Hrs

Molecular cloning: Cloning strategies. Cloning System for amplifying different sized fragments, Cloning System for producing single-stranded and mutagenized DNA.Methods of introduction DNA into the cell Microinjection, lipofection, electroporation, calcium precipitation, DEAE and biolistic. Biological methods-Agrobacterium mediated gene transfer. Expression system : Prokaryotes- Bacteria. Eukaryotes- Yeast, mammalian and insect cell lines. Chromosomal walking and jumping.

Unit –IV**18Hrs**

Recombinant selection and screening: Construction of genomic libraries and cDNA Libraries. Principle of Nucleic acid hybridization assays, and microarrays. Screening and Selection method. Insertion inactivation, blue-white selection, radioactive antibody test, Immunological techniques. Southern hybridization, Colony hybridization, Dot blot technique. Reporter genes.

Unit –V**18Hrs**

Polymerase chain Reaction and DNA sequencing: Polymerase chain reaction (PCR): key concepts, Applications of PCR: Ligase chain reaction, LAMP, RACE. Molecular Techniques: DNA Fingerprinting, RFLP, AFLP and RAPD. Sequencing (chemical degradation; chain termination and automated sequence). Introduction to NGS (Next generation sequencing). Pyrosequencing, whole genome short gun sequencing.

B. Topics for Self-Study

S.No.	Topics	Web Links
1.	Tissue Engineering for Skin Replacement	https://www.intechopen.com/books/stem-cells-in-clinical-practice-and-tissue-engineering/tissue-engineering-for-skin-replacement-methods
2.	Synthetic genome engineering associated infectious disease	https://grademiners.com/blog/the-basics-of-choosing-genetic-research-paper-topics https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5651789/figure/fig01/
3.	Bactofection of mammalian cells	https://www.nature.com/articles/3302105
4.	Minigene construct for covid 19	https://www.centerwatch.com/clinical-trials/listings/238132/pathogen-infection-covid-19-infection-immunity-safety-covid-19-synthetic/

C. Text Books

1. Brown T.A., Gene Cloning and DNA analysis: An Introduction, Sixth Edition, Wiley-Blackwell, USA, 2010.
2. Primrose S.B., Twyman R.M., Principles of Gene Manipulation, Seventh Edition, Wiley-Blackwell, USA, 2006.
3. Jogdand, S.N., Gene Biotechnology, Himalaya Publishing House, 2009.

D. Reference Books

1. Old R.W., and Primrose S.B., 1996. Principles of Gene Manipulation: An Introduction to Genetic Engineering. Blackwell Scientific Publications, Oxford.

2. Glover D.M., and Hames B.D., 1995. DNA Cloning: A Practical Approach, IRL Press, Oxford.
3. Innis M.A., Gelfand D.H., and Sninsky J.J., 1995. PCR Strategies, Academic Press, San Diego.
4. Persing D.H., Smith K.T.F., Tenover F.C., and White T.J., 1993. Diagnostic Molecular Microbiology, ASM Press, Washington D.C.
5. Watson J.D., Gilman M., Witkowski J., and Zoller M., 1992. Recombinant DNA, Scientific American Books, New York.
6. Tvan R.S., 1997. Recombinant Gene Expression Protocols, Humana Press Inc, Tokowa.

E. Web Links.

1. <https://nptel.ac.in/courses/102/103/102103013/>
2. <https://nptel.ac.in/courses/102/103/102103074/>

3. Specific Learning Outcomes (SLO)

Unit	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Enzymes in Recombinant Technology		
1.1	Enzymes in recombinant Technology: Enzymes in Genetic engineering-	Explain the role of enzymes in Gene cloning methods	K2
1.2	Restriction endonucleases Types, DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, T4 DNA ligase, Terminal deoxynucleotidyl transferase, Reverse transcriptase. DNase, RNase, SI nuclease	List out the enzymes involved in genetic engineering	K1
		Enumerate the role of enzymes in molecular cloning	K2
2	Vectors		
2.1	Vector: Different kinds of vector- Cloning and expression vectors. Cloning vectors for E. coli-Bacterial artificial chromosome. Gateway cloning	List out the feature of cloning vectors employed in the biological systems	K2

2.2	Cloning vectors for Eukaryotes: Yeast shuttle vector, Yeast artificial chromosome, HAC, Phage life cycle- Viral	Illustrate the components of different cloning vectors.	K2
	vector, phage vector-Phage M13, phagemids, cosmids.Insertion vector, Fusion vector, replacement vector	Substantiate the choice of cloning vector for specific gene cloning studies.	K2
3	Molecular Cloning:Cloning Strategies		
3.1	Molecular cloning: Cloning strategies. Cloning System for amplifying different sized fragments, Cloning System for producing single-stranded and mutagenized DNA.	Describe the process of molecular and cellular cloning.	K4
		Infer the various strategies to manipulate DNA.	K3
3.2	Methods of introduction DNA into the cell Microinjection, lipofection, electroporation, calcium precipitation, DEAE and biolistic.Biological methods-Agrobacterium mediated gene transfer.	Apply the different types of methods involved in gene transfer.	K3
		Restate the specific methods in accordance to their properties and mechanisms	K2
3.3	Expression system Prokaryotes- Bacteria Eukaryotes- Yeast, mammalian and insect cell lines. Chromosomal walking and jumping	Explain the importance of prokaryotic and eukaryotic expression system.	K2
4	Recombinant Selection and Screening		
4.1	4.1 Recombinant selection and screening - Construction of genomic libraries and cDNA Libraries. Principle of Nucleic acid hybridization assays, and microarrays.	Differentiate recombinant from non-transformed cells.	K2
		Explain the different nucleic acid hybridization assays	K2

4.2	Screening and Selection method Insertion inactivation, blue-white selection, radioactive antibody test, Immunological techniques. Southern hybridization, Colony hybridization, Dot blot technique. Reporter genes.	Distinguish recombinants from non recombinants	K2
		Analyze the intensity of gene transfer	K4
5	Polymerase chain Reaction and DNA sequencing		
5.1	Polymerase chain Reaction and DNA sequencing: Polymerase chain reaction (PCR): key concepts, Applications of PCR: Ligase chain reaction. LAMP, RACE. Molecular Techniques: DNA Finger printing, RFLP, AFLP and RAPD. Sequencing (chemical degradation; chain termination and automated sequence). Introduction to NGS (Next generation sequencing). Introduction to NGS (Next generation sequencing). Pyrosequencing, whole genome short gun sequencing.	Explain the principles of molecular techniques	K2
		Relate the definite techniques to specific experiments	K2

4. Mapping scheme

U21BT506	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	M	H	L	L	L	-	-	-	H	-	-	-
CO2	M	H	H	H	M	M	-	-	-	H	-	-	M
CO3	L	H	H	M	H	M	-	-	L	M	H	M	M
CO4	M	H	H	H	M	M	-	-	-	H	H	M	M
CO5	M	H	H	H	M	M	-	-	-	-	H	M	-
CO6	M	H	H	M	H	H	-	-	-		H	M	M

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE : U16BT5P5

CREDITS : 2

HOURS/WEEK : 4

CORE VI : MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Experiment s
CO1	Relate the basic experimental knowledge about the molecular techniques and genetic engineering	K2	1-10
CO2	Perform the gel electrophoresis (AGE & PAGE)	K1	5
CO3	Explain molecular and reproductive cloning strategies	K2	6, 9, 10
CO4	Describe the uses of biotechnology in medicine and agriculture	K1	1-3
CO5	Identify the purpose of screening and selection of gene transformation	K2	10
CO6	Explain the genetic engineering techniques at a molecular level	K2	5-10

2. A. Syllabus

List of Experiments

1. Isolation of plasmid DNA from bacteria
2. Isolation of genomic DNA from animal tissue
3. Isolation of genomic DNA from plant
4. Isolation of buccal cell DNA
5. Agarose gel electrophoresis of plasmid and genomic DNA
6. Restriction digestion of DNA. - Single and double digestion*
7. PCR amplification*, RFLP*
8. Southern blotting*
9. Ligation*
10. Transformation of E. coli with plasmid DNA using CaCl₂ *

* Practical by demonstration only

B. TEXT BOOKS

1. Bisen P.S., Laboratory Protocols in Applied Life Sciences, CRC Press, 2014

2. Sambrook J., Russell D.W., Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press, 2001.

C. Web Links.

1. <https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-bt32/>
2. <https://nptel.ac.in/courses/102/103/102103083/>

3. Specific Learning Outcomes (SLO)

Exercises	Lab Exercises	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
Ex 1	Isolation of plasmid DNA from bacteria	Isolate the extra chromosomal DNA that are derived from microorganisms	K3
Ex 2	Isolation of genomic DNA from animal tissue	Extract genomic DNA from a specific animal tissue sample	K3
Ex 3	Isolation of genomic DNA from plant	Perform plant DNA isolation using CTAB method.	K4
Ex 4	Isolation of buccal cell DNA	Extract DNA from buccal epithelial cells	K1
Ex 5	Agarose gel electrophoresis of plasmid and genomic DNA	Recognize the presence and size of the DNA	K1
Ex 6	Restriction digestion of DNA. - Single and double digestion*	Experiment the skill of of DNA fragmentation using specific enzymes	K4
		Interpret the patterns of restriction fragments separated on agarose gels.	K3
Ex 7	PCR amplification*,	To compare PCR and genomic cloning as strategies for isolating a gene.	K4
	RFLP*	Demonstrate the technique of gene profiling	K2

	Ligation of DNA *	Infer the process of rejoining fragmented DNA by using enzymes	K2
	Southern blotting*	Recognize the technique of gene probing	K1
Ex 8	Transformation of E. coli with plasmid DNA using CaCl ₂ *	Describe methods used to introduce DNA into prokaryotic cells	K2

4. Mapping scheme

U16BT5P5	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	H	M	-	-	-	-	H	-	H	-
CO2	H	-	-	H	M	L	-	-	-	H	H	H	M
CO3	M	-	-	H	M	-	-	-	-	M	-	H	-
CO4	M	-	-	H	M	-	-	-	-	M	-	H	L
CO5	M	-	-	H	H	-	-	-	-	-	-	H	-
CO6	M	-	-	H	M	-	-	H	M	M	-	L	H

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct

1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination

Indirect

1. Course-end survey

SEMESTER : V

COURSE CODE : U21BT5:1

CREDITS : 5

HOURS/WEEK : 5

ELECTIVE I : PLANT PHYSIOLOGY

1. Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	UnitCovered
CO1	Acquire a basic knowledge on the photosynthesis mechanism of plants	K1	I
CO2	Understand the plant respiration	K2	II
CO3	Illustrate the physiological activities carried out within the plant	K3	II
CO4	Analyse the mechanism of nitrogen metabolism takes place in plants.	K4	III
CO5	Differentiate short distance transport from long distance transport in plants	K4	IV
CO6	Summarize the capability of the plants to withstand the environmental stresses	K5	V

A. Syllabus

UNIT – I

15Hrs

Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO₂ fixation-C₃, C₄ and CAM pathways.

UNIT – II

15Hrs

Respiration and photorespiration: Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

UNIT – III

15Hrs

Nitrogen metabolism: Nitrogen cycle- nitrogen fixation-biological and nonbiological, mechanism of nitrogen fixation-symbiotic and non symbiotic. Nitrate and ammonium assimilation; amino acid biosynthesis.

UNIT – IV

15Hrs

Solute transport and photo assimilate translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem. Plant Water Relation- Hypertonic Hypotonic and Isotonic Solutions- Passive Transport and Active Transport- Short Distance Transport – Plasmolysis. Osmosis. Imbibition- Long Distance Transport-transpiration; mechanisms of loading and unloading of photo assimilates.

UNIT- V**15Hrs**

Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

B. Topic for Self Study

S.No.	Topics	Reference
1.	Flower and fruit development	William G. Hopkins And Norman P. A. Huner, Introduction to Plant Physiology, 4 th Edition, John Wiley & Sons, Inc. 2008 ISBN: 978-0-470-24766-
2.	Shikimic acid pathway	Herrmann, K. M.; Weaver, L. M. (1999). "The Shikimate Pathway". Annual Review of Plant Physiology and Plant Molecular Biology. 50 : 473–503.
3.	Plant hormones	https://en.wikipedia.org/wiki/Plant_hormone
4.	Seed Dormancy	https://en.wikipedia.org/wiki/Seed_dormancy

C. Text Books

1. Jain V.K., Fundamentals of Plant Physiology, Fifth Edition. S Chand & Co Ltd; New Delhi, 2000
2. Salisbury F. B., and Ross E., Plant Physiology, Wadsworth, Belmont, California, USA, 1992
3. Verma S. K., Plant Physiology, S. Chand & Co., New Delhi, 1999

D. Reference Books

1. Devlin R. M., and Baker., Photosynthesis, Reinhold Affiliated East-West Press Pvt.Ltd, New Delhi, 1973
2. Harold F.M., The vital force; A study of bioenergetics, Freeman & Co., New York, 1986
3. Hewitt E.J., and Cutting C.V., Nitrogen metabolism of plants, Academic Press, 1979
4. Leopold A.C., Plant Growth and Development, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1973
5. Meyer, Anderson and Bonning, Introduction to Plant Physiology, D. VanNostrand, 1965
6. Noggle R., and Fritz G.I., Introductory Plant Physiology, Second Edition, Prentice Hall, New Delhi, 1989

E. Web Links.

1. https://onlinecourses.nptel.ac.in/noc19_bt17/preview

2. https://onlinecourses.swayam2.ac.in/cec19_bt09/preview

2. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Photosynthesis		
1.1	Light harvesting complexes; mechanisms of electron transport;	Explain the light harvesting processes	K2
		Explore the mechanism of electron transport	K2
1.2	Photoprotective mechanisms;	Determine the photoprotective mechanism in plants	K3
1.3	CO ₂ fixation - C ₃ , C ₄ and CAM pathways.	Illustrate C ₃ , C ₄ and CAM pathway in plants	K3
2	Respiration and photorespiration		
2.1	Citric acid cycle;	Discuss the steps in the citric acid cycle	K2
2.2	Plant mitochondrial electron transport and ATP synthesis;	Explain the electron transport chain and ATP synthesis	K4
2.3	Alternate oxidase; photorespiratory pathway.	Assess the outcomes of alternate oxidase and photorespiratory pathway	K5
3	Nitrogen metabolism		
3.1	Nitrate and ammonium assimilation;	Illustrate the steps in Nitrogen Cycle.	K2
		Evaluate the significance of nitrate and ammonium assimilation	K5
3.2	Amino acid biosynthesis.	Describe the biosynthesis of amino acid	K3
4.	Solute transport and photo assimilate translocation		
4.1	Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; Transpiration;	Differentiate short distance transport from long distance transport in plants	K4
		Explain the process of transpiration in plants	K3
4.2	Mechanisms of loading and unloading of photo assimilates.	Report the mechanism of loading and unloading of photoassimilates	K6
5	Stress physiology		

5.1	Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses;	Predict the responses of plants to biotic and abiotic factors.	K5
5.2	Mechanisms of resistance to biotic stress and tolerance to abiotic stress.	Interpret the mechanism of Biotic and abiotic stress tolerance	K3

5. Mapping Scheme

U21BT5:1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 2	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 3	H	H	-	H	M	-	-	-	-	H	L	H	-
CO 4	H	H	-	H	M	-	H	-	-	H	L	H	-
CO 5	H	H	-	H	M	-	H	-	M	H	L	H	H
CO 6	H	H	-	H	M	-	H	-	-	H	L	H	M

L: Low M: Medium H: High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE : U21BT5:A

CREDITS : 5

HOURS/WEEK : 5

ELECTIVE I : ECOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Differentiate between biotic and abiotic components based on their characteristics	K4	I
CO2	Summarize the characteristics features of different types of ecosystem	K2	II
CO3	Describe the population and community ecology	K2	III
CO4	Design strategy to treat/reuse the liquid and solid waste	K6	IV
CO5	Differentiate the effect of different pollutants	K2	V
CO6	Report about national environment policy	K2	II

2. A. Syllabus

UNIT –I

15Hrs

Concept of an Ecosystem: Definition: Characteristics of an Ecosystem, Complete Nature of Ecosystem; Components of Ecosystems: Biotic (Producers and Consumers) and Abiotic Components(Light, Temperature, Water and Physiographic Factor).

UNIT-II

15Hrs

Ecosystems and Conservation Biology: Introduction, types and characteristic features of the Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystem: Pond ecosystem, Ocean ecosystems. Principles of conservation- Major approaches to management, Indian case studies on conservation/management strategy- Project Tiger-Biosphere Reserves-

UNIT-III

15Hrs

Population and Community Ecology: Basic concepts, Population characteristics, Population dynamics, Characteristics of a community, Community structure, Community dynamics (ecological succession), Concept of Habitat and Niche.

UNIT-IV

15Hrs

Environmental Pollution: Cause, effects and control measures of : Air (CO², SO₂, NO_x, O₃, CFC, PAN, Green house effect), Water (Cd, Hg, Pb, F, As, BOD), Noise and Radiation(Strontium and Cesium) pollution., Solid waste management, Biomagnification, Methalmoglobinemia, Global warming and Climate change (cause and consequences).

UNIT-V**15Hrs****Environmental Laws and Applied Ecology**

Environmental Impact Assessment, Environmental planning and National Environment Policy :Objectives, principles, strategies and actions. Biodiversity Status, Biodiversity Monitoring, Biodiversity Documentation, Major Drivers of Biodiversity Change, Biodiversity Management Approaches

B. Topic for Self Study

S.No	Topics	Reference
1	Ecology and Human Welfare	P.S. Verma And V.K. Agarwal, Cell Biology, Genetics, Molecular Biology, Evolution And Ecology, S. Chand & Company Ltd, 2005
2	Wildlife Management	P.S. Verma And V.K. Agarwal, Cell Biology, Genetics, Molecular Biology, Evolution And Ecology, S. Chand & Company Ltd, 2005
3	Biogeography	P.S. Verma And V.K. Agarwal, Cell Biology, Genetics, Molecular Biology, Evolution And Ecology, S. Chand & Company Ltd, 2005
4	Adaptation	P.S. Verma And V.K. Agarwal, Cell Biology, Genetics, Molecular Biology, Evolution And Ecology, S. Chand & Company Ltd, 2005

C. Text Book

1. Misra S.P. and S.N. Pandey, Essential Environmental Studies. Anne Books Pvt.,Ltd.,New Delhi, 2008.

D. Reference Books

1. Sharma P.D, Environmental Biology and Toxicology, Rastogi publications, 2005.
2. Chapman, J.L. and M.J. Reiss, Ecology, Principle and Applications, Cambridge, University Press,1995.
3. De, A.K., Environmental Chemistry, Wiley Eastern Ltd., 1993.
4. Kormondy, E.J, Concept of Ecology, Prentice-Hall of India Pvt. Ltd., 1989.
5. Abbasi, S.A. and Abbasi, N, Renewable Energy Sources and their Environmental, Impact, Prentice-Hall of India Pvt. Ltd., New Delhi, 2002.
6. Biotechnology of Biofertilizers. Edited by SadasivamKannaiyan, Kluwer Academic Publishers, 2002.

E. Web Links.

1. <https://www.coursera.org/learn/ecology-conservation#Syllabus>
2. <https://nptel.ac.in/courses/105/104/105104099/>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Concept of an Ecosystem		
1.1	Definition: Characteristics an Ecosystem, Complete Nature of Ecosystem	Define the energy flow in ecosystem	K1
1.2	Components of Ecosystems: Biotic (Producers and Consumers)	Distinguish the organism present in the habitat based on nutrition uptake/synthesis	K4
1.3	Abiotic Components (Light, Temperature, Water and Physiographic Factor)	Describe the physical and chemical factors of abiotic components	K2
2	Ecosystems and and Conservation Biology		
2.1	Ecosystems: Introduction, types and characteristic features of the Forest ecosystem, Grassland ecosystem	Classify the forest and grassland ecosystem based on its physical environment	K2
2.2	Desert ecosystem	Summarize the plant and animals adapted to the desert ecosystem	K2
2.3	Aquatic ecosystem: Pond ecosystem, Ocean ecosystems	Differentiate the freshwater and marine ecosystem based on physico-chemical aspects	K4
2.4	Principles of conservation	To list out the principles of conservation	K1
2.5	Major approaches to management	To explain the Major approaches to management	K2
2.6	Indian case studies on conservation/management strategy	To analyse the Indian case studies on conservation/management strategy	K4

2.7	Project Tiger	To explain about Project Tiger	K2
2.8	Biosphere Reserves	To explain about Biosphere Reserves	K2
3	Population and Community Ecology		
3.1	Population and Community Ecology Basic concepts, Population characteristics	Enumerate population characteristics based on its size, density and age Calculate growth rate of the population	K1 K3
	3.2 Population dynamics	Compare different types of stratification	K2
3.3	Characteristics of a community, Community structure, Community dynamics (ecological succession)	Differentiate between three types of ecological niche	K2
3.4	Concept of Habitat and Niche.	Enumerate population characteristics based on its size, density and age	K1
4	Environmental Pollution		
4.1	Environmental Pollution Cause, effects and control measures of : Air (CO ₂ , SO ₂ , NO _x , O ₃ CFC, PAN, Green house effect), Water (Cd, Hg, Pb, F, As, BOD),	Analyse the different types of pollutant based on its effect on human beings	K4 K2
4.2	Noise and Radiation (Strontium and Cesium) pollution.,	Suggest the control measures available to remove the pollutants	K5
4.3	Solid waste management,	Manage the solid waste disposal	K1
4.4	Biomagnification, Methalmoglobinemia	Discuss biomagnifications	K1
5	Environmental Laws and Applied Ecology		
5.1	Environmental Laws	List the environmental law	K1
5.2	Environmental Impact Assessment, Environmental planning and National Environment Policy :Objectives, principles, strategies and actions.	State the objective and principle of national environment policy	K2
5.3	Biodiversity Status	To summarize the Biodiversity Status	K2

5.4	Biodiversity Monitoring	To analyse the Biodiversity Monitoring	K4
5.5	Biodiversity Documentation	To recall the Biodiversity Documentation	K1
5.5	Major Drivers of Biodiversity Change	To analyse the Major Drivers of Biodiversity Change	K4
5.6	Biodiversity Management Approaches	To explain Biodiversity Management Approaches	K2

2. Mapping Scheme

U21BT5: A	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	M	H	L	M	H	-	-	L	L	M	M	L
CO2	H	H	L	-	-	-	M	-	M	L	H	M	L
CO3	H	H	H	-	-	-	M	-	L	L	H	M	L
CO4	H	H	H	H	H	H	-	M	H	M	H	H	H
CO5	H	H	H	-	-	-	-	-	H	H	H	-	H
CO6	H	M	-	-	L	M	-	L	H	L	L	L	H

L: Low M: Medium H: High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE : U21BT5:2

CREDITS : 5

HOURS/WEEK : 5

ELECTIVE II : DEVELOPMENTAL BIOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Define the origin of development pattern and to explain the principles of development design the life cycle.	K1	I
CO2	Illustrate of early embryonic development and its stages.	K2	II
CO3	Explain the later embryonic development with the classification of germ layers.	K3	III
CO4	Infer Post embryonic development, with the regeneration mode.	K4	IV
CO5	Explain about implications of developmental biology.	K5	V
CO6	Explain the Medical implications of developmental biology, determine the infertility, and diagnosis infertility of IVF	K5	V

2. A. Syllabus

UNIT-I

15Hrs

Origin of developmental patterns: History, Anatomical tradition, Principles and concepts of development - life cycles, Overview of Development and Cell Specification, Developmental patterns and evolution of differentiation, Experimental embryology-Amniocentesis, Role of genes in development.

UNIT-II

15Hrs

Early Embryonic Development: Growth and Human Development Gametogenesis-Spermatogenesis and oogenesis, Types of eggs, Fertilization changes in gametes, mono and polyspermy; Morphogenesis: Adhesion and Cleavage , Gastrulation and Neurulation , Migrations,the early development of C. elegans -The early development of Xenopus cleavage, Gastrulation, Embryonic induction and organizers; the early development of chick cleavage, Gastrulation.

UNIT-III

15Hrs

Later Embryonic Development:Patterning the Vertebrate Body in Animal Models , Axis Formation ,Differentiation of germ layers-Formation of neural tube (development of CNS and eye), skin, notochord, somites, coelom and digestive tube (upto rudiments), Extraembryonic membranes in birds and human, Implantation of embryo, Placentation – structure, types and physiology of placenta.

UNIT-IV

15Hrs

Post-Embryonic Development: Cell Differentiation: Control of Gene Expression, Metamorphosis changes and hormonal regulation of metamorphosis in insects

and amphibians, Regeneration modes of regeneration epimorphosis, Morphallaxis and compensatory regeneration (with one example), Aging concepts and model (C. elegans).

UNIT-V

15Hrs

Implications of Developmental Biology: Medical implications: Infertility –Diagnosing Infertility, IVF, Teratogenesis – teratogenic agents and effect of teratogens on embryonic development;The Plasticity of Gene Expression , Embryonic stem cells –A new generation stem cells in biomedical field

B. Topic for Self Study

S.No.	Topics	Web Links
1	Production of Sperms	https://www.kobo.com/us/en/ebook/the-sperm-cell-1
2	Sex Determination in Animals	https://www.researchgate.net/publication/265092990_A_novel_method_for_sex_determination_by_detecting_the_number_of_X_chromosomes
3	Fetal Development	https://ebook.vip-files.de/cell-lineage-and-fate-determination-moody-sally-a.pdf
4	Production of Ovaries	https://www.researchgate.net/publication/257531491_Gamete_production_patterns_ploidy_and_population_genetics_reveal_evolutionary_significant_units_in_hybrid_water_frogs_Pelophylax_esculentus

C. Text Book

1. Agarwal V.K., and Verma P.S., Chordate Embryology, S. Chand Publishing, New Delhi, 1995

D. References Books

1. Scott F Gilbert., Developmental Biology, X Edition, Sinauer Jonathan M. W. Slack., Essential Developmental Biology, Wiley-Blackwell, Hoboken, New Jersey, United States, 2012
4. Kalthoff., Analysis of Biological Development, Second Edition, McGraw Hill Professional, New York, USA, 2000 Associates, Inc., Publishers, Sunderland, Massachusetts, USA, 2013
2. Balinsky B.I., An introduction to Embryology, International Thomson Computer Press, London, UK, 2008

E. Web Links.

1. <https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/>
2. https://onlinecourses.nptel.ac.in/noc20_bt35/preview
3. <https://www.classcentral.com/course/swayam-introduction-to-developmental-biology-19906>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Origin of Developmental patterns		
1.1.	Origin	Define developmental pattern and origin of pattern.	K1
1.2	History and anatomy	Recall the history and anatomical developmental pattern	K1
1.3	Principles of life cycle	Outline the principles of development with its life cycle.	K1
1.4	Concept	Distinguish developmental biology and embryology	K4
1.5	Overview of Development and Cell Specification	Outline the uniqueness of developmental patterns in each organism.	K4
1.6	Developmental patterns and evolution of differentiation,	Substantiate the origination of organisms and their specific developmental pattern with experimental proof.	K4
1.7	Genes in development & Experimental embryology Amniocentesis	Recognize the role of genes involved in development & amniocentesis	K1
2	Early embryonic development		
2.1	Growth and Human Development	Enumerate Early embryonic development.	K1
2.2	Gametogenesis	Define Gametogenesis	K2
		Infer the various phases of	K2

		Gametogenesis.	
2.3	Spermatogenesis	Define spermatogenesis.	K1
		Explain spermatogenesis and its process.	K2
2.4	Oogenesis	Define oogenesis.	K1
		Explain the mechanism of oogenesis.	K2
		Interpret the control of oogenesis.	K2
2.5	Types of eggs, fertilization changes in gametes	Classify the types of eggs and their specific fertilization pattern	K2
2.6	Mono & Polyspermy	Differentiate Mono and polyspermy	K2
		Analyze the role of mono and poly sperm in fertilization and zygote formation	K4
2.7	Morphogenesis: Adhesion and Cleavage , Gastrulation and Neurulation , Migration	Organize the different phases of morphogenesis and know its unique role in development .	K4
2.8	Early development of C.elegans	Identify the morphological pattern formation of C.elegans	K1
		Infer the mode of cell division and Cleavage in C.elegans	K2
2.9	Early development of Xenopus Cleavage, Gastrulation	Recognize the cleavage pattern of xenopus	K1
		Elaborate the process of fertilization in xenopus.	K2
2.10	Induction & organizers, early development of chick cleavage, gastrulation	Interpret the model of organization in chick embryos.	K2
		Explain on chick cleavage and gastrulation in chick	K2

3	Later Embryonic development		
3.1	Patterning the Vertebrate Body in Animal Models	Relate the morphological changes during development in various animal models.	K1
3.2	Axis Formation	Infer the primary axis pattern among animals	K2
3.3	Later embryonic development, differentiation of germ layers, formation of neural tube	Restate the neural induction and establishment of neural cells.	K2
3.4	Skin, notochord, somites, coelom and digestive tubes	Illustrate embryonic development with appropriate diagrams.	K3
3.5	Extra embryonic membranes in birds and humans	List out extra embryonic membranes in birds and humans.	K1
3.6	Implantation of embryo	Define implantation	K1
		Illustrate the process of embryonic implantation	K2
3.7	Placentation-structure, types & physiology of placenta	Elucidate the structure of placenta. Classify the types of placenta.	K1
4	Post embryonic development		
4.1	Cell Differentiation: Control of Gene Expression	Interpret the influential role of genes in development	K5
4.2	Post embryonic development metamorphosis changes	Discuss on post embryonic development and metamorphic changes.	K2
4.3	Hormonal regulation of metamorphosis in insects and amphibians	Summarize on metamorphosis in amphibian, and insects	K2
4.4	mode of regeneration epimorphosis	Define epimorphosis	K1
		Describe the mode of epimorphosis	K3
4.5	morphallaxis &	Interpretation on	K5

	compensatory regeneration	morphallaxis regeneration in hydra.	
4.6	aging concepts and model	Define ageing	K1
		Analyze the concept of ageing.	K4
5	Implications of Developmental biology		
5.1	Implications of developmental biology	List out the implications of developmental biology	K1
5.2	medical implications, infertility diagnosis	Analyze the test for infertility diagnosis.	K4
5.3	IVF	Explain the process of IVF.	K2
5.4	Teratogenesis-teratogenic agents and effects of teratogenic development.	Define Teratogenesis.	K1
		Relate the environmental assaults on human development in Teratogenesis.	K2
5.5	The Plasticity of Gene Expression	Infer the significance of gene expression in tissue regeneration .	K4
5.6	Embryonic stem cells new generation stem cells in biomedical field.	Define embryonic stem cells.	K1
		Distinguish stem cells in accordance to their role in Tissue/Organ regeneration.	K4

4.Mapping scheme

U21BT5:2	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 2	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 3	H	H	-	H	M	-	-	-	-	H	L	H	-
CO 4	H	H	-	H	M	-	H	-	-	H	L	H	-
CO 5	H	H	-	H	M	-	H	-	M	H	L	H	H
CO 6	M	H	H	H	M	H	-	-	M	H	M	H	H

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE : U21BT5:A

CREDITS : 5

HOURS/WEEK : 5

ELECTIVE II: BASICS OF EVOLUTION

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Summarize the theories of evolution	K2	I
CO2	Interpret the fossil record	K3	II
CO3	Apply the Hardy-Weinberg principles to calculate the genotype frequency in the Population	K3	III
CO4	Differentiate the species isolation mechanism	K4	IV
CO5	Illustrate the phylogenetic tree of Homosapiens	K2	V
CO6	Review the speciation mode in particular population	K2	IV

2. A. Syllabus

UNIT-I

15Hrs

History of Life & Evolutionary Theories: Life's Beginnings: Chemogeny, Biogeny, Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism. (Including Synthetic theory of Evolution). Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

UNIT-II

15Hrs

Evidences of Evolution & Processes of Evolutionary Change: Geological time scale: Fossils, types and its importance; biogeographical evidence, anatomical evidence. Sources of variations: Heritable variations and their role in evolution. Phylogenetic tree and its utility.

UNIT-III

15Hrs

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population Evolutionary forces upsetting H-W equilibrium. Natural selection and Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies.

UNIT-IV**15Hrs**

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches)

UNIT-V**15Hrs**

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homosapiens, molecular analysis of human origin.

B. Topic for Self Study

S.No	Topics	Reference
1	Coevolution	Douglas J. Futuyma, Scot V Edwards and John R True, Evolution, Sinauer Associates, Inc. PublishersSunderland, Massachusetts U.S.A., 2005
2	Evolution of Genes and Proteins	Douglas J. Futuyma, Scot V Edwards and John R True, Evolution, Sinauer Associates, Inc. PublishersSunderland, Massachusetts U.S.A., 2005
3	Genome diversity and evolution	Douglas J. Futuyma, Scot V Edwards and John R True, Evolution, Sinauer Associates, Inc. PublishersSunderland, Massachusetts U.S.A., 2005
4	Origin of new genes	Douglas J. Futuyma, Scot V Edwards and John R True, Evolution, Sinauer Associates, Inc. PublishersSunderland, Massachusetts U.S.A., 2005

C. Text Book

Agarwal, V.K and Verma, P.S. “Basis of Evolution” S.Chand Publishing, New Delhi, 1995

D. Reference Books

1. Ridley M, Evolution, II Edition, Oxford University Press, 2004
2. Hall, B.K. and Hallgrimson, B., Evolution, IV Edition, Jones and Barlett Publishers,2008.
3. Reece J.B,Urry L.A, Cain, M.L, Campbell Biology, IX Edition,Benjamin Cummings, 2011.
4. Douglas, J. Futuyma, Evolutionary Biology. Sinauer Associates, 1997
5. Pevsner, J, Bioinformatics and Functional Genomics. II Edition Wiley- Blackwell, 2009.
6. Minkoff, E, Evolutionary Biology. Addison-Wesley, 1983.

E. Web Links.

1. <https://nptel.ac.in/courses/122/103/122103039/>
2. <https://nptel.ac.in/courses/103/101/103101127/>

3. Specific Learning Outcomes

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	History of Life & Evolutionary Theories		
1.1	History of Life & Evolutionary Theories: Life's Beginnings: Chemogeny, Biogeny	Describe chemical evolution and formation of self-reproducing biological units	K2
1.2	Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism. (Including Synthetic theory of Evolution)	Explain the hypothesis proposed by Lamarckism and Darwinism	K2
2	Evidences of Evolution & Processes of Evolutionary Change		
2.1	Evidences of Evolution & Processes of Evolutionary Change: Geological time scale: Fossils, types and its importance; biogeographical evidence, anatomical evidence.	Interpret the fossils based on nature, type and significance	K3
2.2	Sources of variations: Heritable variations and their role in evolution. Phylogenetic tree and its utility	Describe the heritable variation and its role in evolution	K2
3	Population genetics		
3.1	Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population Evolutionary forces upsetting H-W equilibrium	Apply Hardy-Weinberg equation to calculate the genotype	K3
		List out the factors that will affect the Hardy-Weinberg law	K1

3.2	Natural selection	Define Natural Selection	K1
3.3	Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies	Describe genetic drift and factors affecting the change in allele frequency	K1
4	Product of Evolution		
4.1	Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept), macroevolution (exemplified by Galapagos finches)	Extend microevolution and macroevolution	K2
4.2	Isolating mechanisms	Distinguish different types of isolating mechanism	K4
4.3	Modes of Speciation—allopatric, sympatric, Adaptive radiation	Summarize how new species are formed after isolation mechanism	K2
5	Origin and evolution of man		
5.1	Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homosapiens, molecular analysis of human origin	Illustrate the phylogenetic tree of Homosapiens	K2
		Recall the origin and evolution of man	K2

4. Mapping scheme

U21BT5: A	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	H	-	-	H	-	H	-	-	H	L	H	L
CO 2	H	H	H	-	-	-	H	-	-	L	-	L	-
CO 3	H	H	H	-	M	-	H	-	-	H	L	H	L
CO 4	H	H	H	-	M	-	H	-	-	H	L	H	L
CO 5	H	H	H	-	M	-	H	-	-	H	L	H	L
CO 6	H	H	H	-	M	-	H	-	-	H	L	L	L

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE : U21BT5S2

CREDITS : 2

HOURS/WEEK : 2

SBEC II: BASICS OF BIOSTATISTICS

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Define the Concept of Biostatistics	K1	I
CO2	Describe the characteristics of Data and it's Sources	K2	II
CO3	Articulate the basic Calculations in Average	K3	III,IV
CO4	Analyze and categorize the concepts of Measuring Central Tendency	K4	III
CO5	Describe the principle of Mean, Median, and Mode	K2	III
CO6	Appraise the accession and passing arguments using Software in Biostatistics	K3	V

2. A. Syllabus

UNIT-I

6 Hrs

Biostatistics -definition -statistical methods-basic principles.Variables-measurements, functions, limitations and uses of statistics. Scope of biostatistics in biological and clinical research.

UNIT-II

6 Hrs

Collection of data primary and secondary -types and methods of data collection procedures. merits and demerits of primary and secondary research. Classification -tabulation and presentation of data -sampling methods. Various types of clinical trials – observational vs. interventional. Various types of studies - Case reports, cross-sectional, case series, case-control, cohort studies. Article search databases – Google Scholar, PubMed Central, Cochrane database, Science Direct. Systematic review and systematic review tools - PICO, PICOS, SPIDER, PRISMA, CASP tool. Meta-analysis and meta-analysis tools.

UNIT-III

6 Hrs

Measures of dispersion: Measures of central tendency -mean, median, mode, geometric mean -merits & demerits. Measures of dispersion -range, standard deviation, mean deviation, quartile deviation -merits and demerits; Co-efficient of variations.

UNIT-IV

6 Hrs

Correlation-types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression.

UNIT-V

6 Hrs

Statistical inference -hypothesis generation and testing - null hypothesis and alternate hypothesis -simple hypothesis -student't' test, chi-square test, ANOVA,SPSS. Uses of One-way ANOVA and two-way ANOVA. Kaplan-Meier survival curves.

B. Topic for Self Study

S.No.	Topics	Web Links
1	Indian Statistical Research Institute	https://www.isical.ac.in/
2	Census Method in India	https://censusindia.gov.in/
3	Tiger Census in India	http://moef.gov.in/wp-content/uploads/2020/07/Tiger-Status-Report-2018_For-Web_compressed_compressed.pdf
4	Field Survey of Wild Animals	zsi.gov.in/App/content.aspx?link=1602

C. Text Books

1. PannerSelvam R., Research Methodology, Prentice- Hall of India Private Limited, New Delhi, 2006
2. Pillai. R.S.N., and Bhavathy V., Statistics, S.Chand Company Ltd, 2005

D. Reference Books

1. Palanisamy S., and Manoharan, M., Statistical Methods for Biologists, Palani Paramount Publication, Anna Nagar, Palani, T. N, 2002
2. Gupta S.C., and Kapoor K., Fundamentals of Applied Statistics, Third Edition, Sultan Sons Educational Publisher, N.D, 2002
3. Gurumani N., An introduction to Biostatistics, MJP Publishers, Chennai, 2002
4. Vittal P.R., and Malini V., Statistical and Numerical Methods, Margham Publications, Chennai,2002
5. Thomas Clover and Kevin Mitchell, An introduction to Biostatistics, McGraw Hill Higher Education N., 2002
6. Daniel W.W., Biostatistics, New York, John Wiley Sons 1987
7. Littell JH, Corcoran J, Pillai V. Systematic reviews and meta-analysis. Oxford University Press; 2008
- 7.

C. Web Links.

1. <https://www.coursera.org/specializations/biostatistics-public-health>
2. <https://www.edx.org/learn/biostatistics3>.
3. https://onlinecourses.nptel.ac.in/noc19_bt19/preview

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Biostatistics -definition -statistical methods		
1.1	Biostatistics -definition -statistical methods-basic principles.	Define the Basic Concepts of Biostatistics	K1
		Explain the different Statistical Methods	K2
1.2	Variables-measurements, functions,limitations and uses of statistics.	Take cognizance of research variables as well as pros and cons of statistics	K2
1.3	Scope of biostatistics in biological and clinical research	Identify and list the scope of biostatistics in various research fields in biology and life science	K3, K4
2	Collection of data		
2.1	Collection of data primary and secondary -types and methods of data collection procedures merits and demerits of primary and secondary research and their data collection methods	Extend to collect the data and its types.	K2
		Summarize the merits & demerits of Data collection methods.	K2
2.2	Classification -tabulation and presentation of data -sampling methods.	Tabulate the method of presenting data using tabulation and graphical representation.	K1
		Classify the various types of sampling methods.	K2
2.3	Various types of clinical trials – observational vs. interventional	Perceive the differences between observational and interventional studies	K5

2.4	Various types of studies - Case reports, cross-sectional, case series, case-control, cohort studies	Understand and distinguish the different types of clinical trials and the statistical methods involved	K2, K4
2.5	Article search databases – Google Scholar, PubMed Central, Cochrane database, Science Direct	Utilize various internet repositories for data collection and article scoping	K3
2.6	Systematic review and systematic review tools - PICO, PICOS, SPIDER, PRISMA, CASP tool	Understand the fundamentals of systematic review and statistical tools used therein	K2
2.7	Meta-analysis and meta-analysis tools	Conduct meta-analyses and determine the size effect and gauge several studies	K5
3	Measures of dispersion		
3.1	Measures of dispersion -range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co-efficient of variations.	Calculate the data using different measures of tendency .	K3
4	Correlation-types and methods of correlation		
4.1	Correlation-types and methods of correlation	Classify the types of Correlation Methods	K2
4.2		Estimate the correlation coefficient from the given Data.	K2
	Regression, simple regression equation, fitting prediction	Relate the concept of regression and its role in statistics.	K2
4.3	Similarities and dissimilarities of correlation and regression.	Classify the concepts and theory between correlation and	K2

		regression.	
5	Statistical inference		
5.1	Statistical inference -hypothesis generation and testing- null hypothesis and alternate hypothesis-simple hypothesis -	State the principle of Hypothesis	K1
		Explain the facts involved in Hypothesis writing.	K2
5.2	student 't' test -chi square test,	Outline the formula and methods of Student "t" Test.	K2
		Demonstrate the applications of Student "t" Test.	K3
5.3	ANOVA,SPSS.	Solve statistical problems using SPSS Software.	K3
5.4	Uses of One-way ANOVA and two-way ANOVA	Demonstrate the applications of ANOVA	K3
5.5	Kaplan-Meier survival curves	Construct, analyze and evaluate the effect of a treatment on survival and life span	K3-K5

4.Mapping scheme

U21BT5S2	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	H	M	L	H	-	M	H	-	H	-
CO2	M	H	H	H	-	-	H	-	M	H	L	H	L
CO3	H	H	M	H	M	L	H	-	M	H	-	H	-
CO4	H	H	M	H	M	L	H	-	M	H	-	H	-
CO5	M	H	H	H	H	-	H	-	M	H	L	H	-
CO6	H	H	M	H	M	L	H	H	M	H	H	H	M

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE : U21BT5S3

CREDITS : 2

HOURS/WEEK : 2

SBEC III: FOOD BIOTECHNOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Define food and its uses.	K1	I
CO2	Analyze the constituents of food.	K2	II
CO3	Differentiate the intentional and non intentional food additives.	K3	II
CO4	Classify the concepts of raw material characteristics.	K4	III
CO5	Asses the techniques followed in the food processing.	K5	IV
CO6	Evaluate the techniques followed in food preservation	K5	V

2. A. Syllabus

Course Outcomes:

At the end of this course, the students will be able to:

Unit I

6 Hrs

Food – Uses, Nutrition – types of Nutrition, Food used in different ages – infants, children, school age, adult, pregnant women and old age. Importance of mother milk.Nutrient foods to overcome malnutrition defects Nutritive values in Indian food

Unit II

6 Hrs

Food chemistry: Constituent of food - contribution to texture, flavor and organoleptic properties of food; food additives - intentional and non intentional and their functions; enzymes in food processing. Role of food proteins in the growth and survival, Chemistry of Lipids and vitamins in daily foods

Unit III

6 Hrs

Food Processing; Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations - mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.Advantages and disadvantages in processed foods, Processed foods in everyday life and its role

Unit IV

6 Hrs

Food Preservation; Use of high temperatures - sterilization, pasteurization, blanching, canning- concept, procedure & application; Low temperature storage - freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods. Impact of food preservation on food waste, Traditional and modern methods of food preservation

Unit V

6 Hrs

Manufacture of food products: Bread and baked goods, dairy products - milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

B. Topic for Self Study

S.No.	Topics	Web Links
1	Ministry of Food Processing Industries	https://mofpi.nic.in/
2	Jung Foods and their Impact	https://www.researchgate.net/publication/285169531_Fast_foods_and_their_impact_on_health
3	Food Adulteration In India	https://www.researchgate.net/publication/269859425_Food_adulteration_and_contamination_in_India_Occurrence_implication_and_safety_measures
4	Traditional Food Practices	https://food.ndtv.com/food-drinks/a-bite-at-a-time-foods-traditions-from-ancient-india-1206447

C. Text Books

1. Crosby N.T., Food packaging, Materials Applied Science Publishers, London, 1981.
2. David S. Robinson., Food Chemistry and Nutritive value, Longman group, UK, 1997.
3. Frazier W.C., and Westhoff D.C., Food Microbiology, Fourth Edition. McGraw-Hill, New York, 1988.
4. Pyke M., Food Science and Technology. Fourth Edition, John Murray, London, 1981.
5. Sivasankar B., Food processing and preservation, Prentice Hall, New Delhi, 2002.

D. Reference Books

1. Brenner J.G., Butters J.R., Cowell N.D., and Lilly A.E.V., Food engineering Operations, Second Edition, Applied Sciences Pub. Ltd., London, 1979.
2. Desrosier N.W., The Technology of Food Preservation, CBS Publishers and Distributors, New Delhi, 1996.
3. Fennema O.R., Principles of food science: Part I, Food chemistry, Marcel Dekker, New York, 1976.
4. Lindsay W., Biotechnology, Challenges for the flavor and food Industries, Elsevier Applied Science, 1988.

E. Web Links

1. <https://nptel.ac.in/courses/103/107/103107088/>

2. <https://nptel.ac.in/courses/126/105/126105011/>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Food -Uses and Nutrition		
1.1	Brief introduction on Food and its uses	Define food.	K1
		List out the functions of food.	K1
1.2	Nutrition and its types	Define nutrition.	K1
		Classify the types of nutrition with example and nutritive value	K2
1.3	Foods used in different ages- infants, children, schoolage, adult, pregnant women and old age	Classify the food used in different ages.	K2
		Compare the nutritive value of different food sources.	K2
1.4	Importance of Mothers milk	Explain the importance of Mothers milk	K2
1.5	Nutrient foods to overcome malnutrition defects	Classify about nutrient foods and focus towards the c malnutrition defects	K2
1.6	Nutritive values in indian foods	Explain the nutrition values	K2
2	Food Chemistry		
2.1	Constituents of food- contribution to Texture, flavor and Organoleptic properties of food.	Classify the constituents of food.	K2
		Interpret the	K2

		organoleptic properties of food	
2.2	Introduction on Food additives-intentional and non intentional and their function	List out the food additives and types of food adulterants.	K1
		Contrast the variations between intentional adulterants and incidental adulterants	K2
2.3	Enzymes and their Role in food processing	Associate the role of enzymes on food processing.	K2
2.4	Role of food proteins in the growth and survival	Classify the food proteins	K2
2.5	Chemistry of lipids and vitamins in daily foods	List out the lipids and vitamins importance	K2
3	Food processing		
3.1	Food processing- Introduction on Raw material characteristic.	Enumerate the characteristics of raw material.	K1
3.2	Cleaning grading and sorting of foods	Classify the various methods of cleaning, grading and sorting of foods in food processing	K2
3.3	Physical conversion operations - mixing, emulsification, extraction	Define physical conversion operation.	K1
		Discuss on mixing process, emulsification and extraction methods of food processing.	K2
3.4	Filtration, centrifugation, membrane separation	Summarize on the techniques of filtration ,centrifugation and membrane	K2

		separation methods	
3.5	Crystallization and heat processing	Describe the process of crystallization and heat processing	K2
3.6	Advantages and disadvantages in processed foods	Discuss about the processed foods	K2
3.7	Processed foods in everyday life and its role	Describe the importance of processed foods	K2
4	Food preservation		
4.1	Introduction on Food preservation	Describe Food preservation.	K1
		Interpret the methods of preservation.	K2
4.2	High temperature-sterilization, pasteurization, blanching, canning	Explain sterilization, pasturisation, canning and blanching.	K2
		Summarize the methodology of sterilization, pasteurization, canning and blanching.	K2
4.3	Low temperature storage, freezing curve characteristics,	Define low temperature storage.	K1
		Discuss the methods of preservation by low temperature	K2
		Explain the freezing curve characteristics.	K2
4.4	Factors affecting quality.	Indicate the factors which are affecting	K2

		the quality	
4.5	Irradiation preservation of food	Discuss on food irradiation .	K2
4.6	Impact of food preservation on food waste	Explain about the food preservation	K2
4.7	Traditional and modern methods of food preservation	Discuss about the traditional and modern importance of processed foods	K2
5	Manufacture of food products		
5.1	Introduction on manufacturer of food products	Explain the manufacturer of various food products.	K1
5.2	Bread goods baked	Summarize the processes of manufacturing bread and baked foods.	K2
5.3	Dairy products-milk processing, cheese, butter, ice-cream.	Elaborate on processing techniques of milk products.	K2
5.4	Vegetables and fruit products edible oils, and fats.	Illustrate the manufacturing products of vegetables, fruits, edible oils, and fats.	K3
5.5	Meat, poultry and fish products, confectionary, beverages	Apply the techniques followed in manufacturer of meat poultry, confectionary and beverages.	K3

4. Mapping scheme

U21BT5S3	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	M	M	M	M	-	M	M	M	M	M	M
CO 2	M	H	L	M	H	M	-	M	M	M	M	M	M
CO 3	H	H	M	M	H	H	-	M	H	M	M	M	M
CO 4	M	M	M	M	M	H	-	M	L	L	M	M	M
CO 5	H	H	M	M	H	M	-	H	M	M	M	H	H
CO 6	M	H	M	M	M	H	-	H	M	M	M	H	H

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER 6

SEMESTER : VI

COURSE CODE : U21BT607

CREDITS : 6

HOURS/WEEK : 6

CORE VII : INDUSTRIAL BIOTECHNOLOGY

1. Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO 1	Describe the methods of strain development	K1	I
CO 2	Explain the techniques to screen industrially important microorganisms.	K2	I
CO 3	Determine the fermentation media preparation, immobilization methods and downstream processing	K3	II
CO 4	Diagrammatically represent the fermentor design and its types	K4	II
CO 5	Summarize the production of pharmaceutically important products like antibiotics and enzymes	K5	III, IV
CO 6	Assess the production of commercially important beverages and biofuels	K5	V

2. A. Syllabus

UNIT-I

18Hrs

Exploitation of microorganisms and their products: screening-primary,secondary, strain development strategies- mutation, genetic engineering, immobilization methods, fermentation media, raw material used in media production, antifoaming agents, buffers, downstream processing-filtration, centrifugation; isolation of products-Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation -ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods; final product finishing-Crystallization, drying and lyophilization in final product formulation.

UNIT-II

18Hrs

Fermentation equipment and its uses: Fermentation equipment- Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Types of fermenters-Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Solid state fermenter, Animal and plant cell bioreactors. Types of fermentations- single, batch, continuous, multiple, surface, submerged and solid state.

UNIT-III

18Hrs

Industrial products from microorganisms: antibiotics: production of penicillin, streptomycin. Interferons, vaccines-recombinant vaccines, hormones-insulin, vitamins-vitamin B.

UNIT-IV**18Hrs**

Enzymes from microbes: amylase, protease. Organic acids: citric acid, acetic acid, amino acids: glutamic acid, lysine.

UNIT-V**18Hrs**

Production of alcoholic beverages: beer and wine, biofuels: ethanol, methane, biogas.

B. Topic for Self Study

S. No.	Topics	Reference
1.	Production of Natural Flavors	Elisabetta Brenna, Fabio Parmeggiani Biotechnological Production of Flavors , Wiley Online Library, 2016. https://doi.org/10.1002/9783527807833.ch9
2.	Application of immobilized cell technology in industrial processes	Xumeng Ge, Liangcheng Yang and Jianfeng Xu, Cell Immobilization: Fundamentals, Technologies, and Applications, Wiley Online Library, 2016. https://doi.org/10.1002/9783527807833.ch7
3.	Nutraceuticals are important natural bioactive compounds	Sanjay Guleria, Jingwen Zhou and Mattheos A.G. Koffas, Nutraceuticals (Vitamin C, Carotenoids, Resveratrol), Wiley Online Library, 2016. https://doi.org/10.1002/9783527807833.ch10
4.	Microbial production of w-butanol	Sio Si Wong, Luo Mi and James C. Liao Microbial Production of Butanols, Wiley Online Library, 2016. https://doi.org/10.1002/9783527807833.ch19

C. Text Books

1. Dubey R.C., and Maheswari D.K., A Text Book of Microbiology, S. Chand & Company Ltd. New Delhi, 2005
2. Patel, A.H., Industrial Microbiology, Macmillan, 2011

B. Reference Books

1. Stanbury P.F., & Whitakar A., Principles of Fermentation Technology, Pergamon Press, 1984.
2. Mansi E.M.T.E., & Bryce, C.F.A., Fermentation Microbiology and Biotechnology, Third Edition, CRC Press, 2011.

3. Bailey and Ollis, Biochemical Engineering Fundamentals, McGrawHill, Newyork,1986.
4. CasidaL.E.Jr., Industrial Microbiology, New Age International Publishers, 2007.

E. Web Links.

1. <https://www.careers360.com/university/indian-institute-of-technology-kharagpur/industrial-biotechnology-certification-course>
2. <https://www.coursera.org/learn/industrial-biotech>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Exploitation of microorganisms and their products		
1.1	Screening of industrially important microorganisms	List out the industrially important microorganisms and their products	K1
1.2	Strain development strategies	Describe the primary screening techniques . Classify the secondary screening techniques	K2 K4
1.3	Immobilization methods	Categorize the different immobilization methods	K4
1.4	Fermentation media, raw material used in media production, antifoaming agents, buffers,	Write about the significance of the fermentation media and other products.	K3
1.5	Downstream processing	Summarize the various steps involved in downstream processing	K5
2	Fermentation equipment and its uses		
2.1	Fermentor design	Diagrammatically represent the fermentor	K4

		design and its types	
2.2	Types of fermentors – Air Lift, Tower, Bubble Column, Anaerobic	Explain the working principle and applications of different types of fermentors	K4
2.3	Types of fermentations- single, batch, continuous, multiple, surface, submerged and solid state.	Distinguish various methods of fermentation and its significance	K5
3	Industrial products from microorganisms		
3.1	Antibiotics: production of penicillin, streptomycin.	Summarize the production of pharmaceutically important products like antibiotics	K5
3.2	Interferons, vaccines, hormones, vitamins.	Describe the production of interferons, vaccines, hormones-insulin and vitamins-vitamin B.	K2
4	Enzymes from microbes		
4.1	Enzymes from microbes: amylase, protease.	Explain the production of enzymes	K2
4.2	Organic acids: citric acid, acetic acid,	Analyze the methodology involved in the production of Organic acids.	K4
4.3	Amino acids: glutamic acid, lysine.	Explain the production of Amino acids	K4
5	Production of alcoholic beverages		
5.1	Production of alcoholic beverages: beer and wine	Infer the production strategies used in the production of alcoholic beverages	K4
5.2	Biofuels: ethanol, methane, biogas.	Assess the production of commercial biofuels	K5

4. Mapping Scheme

U21BT607	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	M	M	M	M	-	M	M	M	M	M	M
CO 2	M	H	L	M	H	M	-	M	M	M	M	M	M
CO 3	H	H	M	M	H	H	-	M	H	M	M	M	M
CO 4	M	M	M	M	M	H	-	M	L	L	M	M	M
CO 5	H	H	M	M	H	M	-	H	M	M	M	H	H
CO 6	M	H	M	M	M	H	-	H	M	M	M	H	H

L: Low M: Medium H: High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : VI

COURSE CODE : U21BT608

CREDITS : 5

HOURS/WEEK : 6

CORE VIII : ANIMAL BIOTECHNOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	List out the methods and uses of animal cell culture.	K1	I
CO2	Describe the basic principles involved in Invitro fertilization and embryo transfer technology.	K2	III
CO	Assist in the choice of vectors that can be used to deliver the constructed DNA.	K3	II
CO4	Demonstrate the possible therapy methods that use DNA and proteins to cure diseases instead of the usual antibiotics.	K4	IV
CO5	Codify microorganisms to get useful products based on our needs.	K6	V
CO6	Propose the applications of recombinant DNA technology in animal agriculture or production of therapeutic proteins.	K5	V

2. A. Syllabus

UNIT I

18Hrs

Basic techniques in animal cell culture and organ culture: History and Scope of Animal tissue culture, Basic techniques in animal cell culture and its application and organ culture, Cell lines- types and isolation, culture media-types and supplements, balanced salt solution and its quality, cell fusion, cell differentiation, characterization of cell lines, maintenance and preservation of cell lines, Applications of animal cell culture in regenerative medicine and vaccine preparation, Stem cells-types, preparation and applications.

UNIT-II

18Hrs

Gene transfer: Gene transfer methods-mechanical, chemical, Embryo splitting, Invitro fertilization, biological-viral-Adenovirus, Herpes simplex, Retrovirus. Bioreactors for large scale culture of cells.

UNIT-III

18Hrs

Transgenesis: Transgenic animals production, applications of transgenic in agriculture and medicine, In-vitro fertilization and embryo transfer , Ethical values in animal biotechnology, Molecular genetics.

UNIT-IV

18Hrs

Applications: Development of recombinant vaccines, Molecular pharming, monoclonal antibody their applications, human genome project and gene therapy. Role of Biotechnology in treating animal diseases

UNIT-V

18Hrs

Valuable products from cell culture-Bioreactors for large scale culture of cells, Production of insulin, growth hormones, interferons and other products. Bioethics in animal genetic engineering.

B. Topic for Self Study

S.No.	Topics	Web Links
1	Animal genetics	https://www.animalgenetics.us/
2	Animal breeding	https://nifa.usda.gov/topic/animal-breeding
3	Dairy biotechnology	http://ecoursesonline.iasri.res.in/mod/page/view.php?id=101754
4	Genetically modified organisms	https://www.britannica.com/science/genetically-modified-organism https://www.nationalgeographic.org/encyclopedia/genetically-modified-organisms/

C. Text Books

1. Ramadass P., Animal Biotechnology: Recent Concepts and Developments. MJP Publishers, India, 2011
2. Singh B., Gautam S.K., Chauhan M.S., Text Book of Animal Biotechnology, The Energy and Resources Institute, TERI, 2013
3. Sudha Gangal, Animal Tissue culture. Second edition. University Press (India) Pvt Ltd. Hyderabad.

D. Reference Books

1. Ian Freshney R., Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition, Wiley Publications, 2016
2. Mather J.P., and Barnes D., Animal Cell Culture Methods, Methods in Cell Biology, Vol. 57, Academic Press, London, 1998
3. Mehta V., Animal Biotechnology, Campus Books International, New Delhi, India, 2010

4. Sasidhara S., Animal Biotechnology, MJP publishers, India, 2011
5. Holland A.J., Johnson A., Animal Biotechnology and Ethics, Springer, 1998

E. Web Links

1. <https://www.coursera.org/lecture/methods-of-molecular-biology/animal-biotechnology-and-its-methods-0DFte>
2. <https://nptel.ac.in/courses/102/103/102103041/>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Basic techniques in animal cell culture and organ culture		
1.1	History and Scope of Animal tissue culture, Basic techniques in animal cell culture and its application, organ culture: Cell lines- types and isolation, culture media-types and supplements, balanced salt solution and its quality cell fusion, cell differentiation, characterization of cell lines, maintenance and preservation of cell lines, Applications of animal cell culture in regenerative medicine and vaccine preparation	Role of contributors in animal tissue culture Describe the fundamental methods and types involved in animal cell culture	K2
1.2	Stem cells-types, preparation and applications	Identify the role of stem cells in cell culture	K2
2	Gene transfer methods		
2.1	Gene transfer: Gene transfer methods-mechanical, chemical, Embryosplitting, biological-viral-Adenovirus, Herpes simplex, Retrovirus.	Recall the different methods used in transferring the genes	K1
2.2	Bioreactors for large scale culture of cells.	Employ bioreactors for culturing cells	K3
3	Transgenesis		
3.1	Transgenesis: Transgenic animals production,	Express the transgenic technology	K2
3.2	Applications of transgenic in	Employ transgenic	K3

	agriculture and medicine,	technology in animal rearing	
3.3	In-vitro fertilization and embryo transfer	Fertilization and Methods to transfer with ethical value in animals	K4
3.4	Molecular genetics	Devise methods used in producing transgenic livestock	
4	Applications		
4.1	Applications: Development of recombinant vaccines, Molecular pharming monoclonal antibody their applications,	Assess the possibility of producing novel products	K5
4.2	human genome project and gene therapy.	Extend the applications of recombinant technology	K2
4.3	Role of Biotechnology in treating animal diseases	Recommend gene technology to cure diseased animals	K5
5	Valuable products from cell culture		
5.1	Valuable products from cell culture-Bioreactors for large scale culture of cells,	Develop methods to culture cells	K3
5.2	Production of insulin, growth hormones, interferons and other products.	Employ the large scale production of novel products	K3
5.3	Bioethics in animal genetic engineering.	Appraise the significance of bioethics	K5

4.Mapping scheme

U21BT608	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS O 1	PS O 2	PS O 3	PS O 4
CO1	M	L	M	L	M	L	L	-	-	H	H	H	L
CO2	M	M	M	M	M	M	L	-	M	H	H	H	H
CO3	M	L	M	L	M	L	L	-	-	H	H	H	L
CO4	M	M	M	M	M	M	L	-	H	H	H	H	H
CO5	M	M	M	H	H	M	L	-	H	H	H	H	H
CO6	M	M	H	M	H	M	L	-	M	H	H	H	H

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : VI

COURSE CODE : U21BT609

CREDITS : 5

HOURS/WEEK : 6

CORE IX : PLANT BIOTECHNOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Acquire knowledge about the role of growth regulators under in vitro condition.	K1	I
CO2	Discuss various culture techniques for haploid production	K2	II
CO3	Demonstrate Gene transfer techniques to produce genetically modified plants	K3	III
CO4	Analyze the various methods of plant micropropagation strategies.	K4	IV
CO5	Defend endangered species of plants through plant tissue culture.	K5	V
CO6	Describe the secondary metabolite production and its applications on biodiversity conservation.	K5	V

2. A. Syllabus

UNIT-I

18Hrs

Introductory history - Laboratory organization - sterilization techniques – nutrition for plant cells, types of media – MS – Nitsch&Nitsch media, Gamborg’s media, White’s Media. Structure and function of Growth regulators – Auxins, Cytokinins and Gibberellins.

UNIT-II

18Hrs

Establishment and maintenance of callus and suspension cultures. Somatic embryo genesis, cytology of callus. Haploid production, Anther and microspore culture. Gynogenesis, embryo culture and rescue in agricultural and horticultural crops. In vitro pollination and fertilization. Green house effect.

UNIT-III

18Hrs

Protoplast isolation, Culture regeneration, fusion. Somatic hybrids, cybrids, cryopreservation, Synthetic seeds – Terminator seed concept. Gene transfer techniques in plants: Agrobacterium tumefaciens mediated gene transfer- Features of Ti Plasmid, molecular mechanism of T-DNA transfer. Physical gene transfer methods – Particle Bombardment, Electroporation and Microinjection. Applications of transgenic plants.

UNIT-IV**18Hrs**

Plant micro propagation – micro grafting – invitro clonal multiplication – clonal orchards– meristem culture and virus elimination shoot tip culture. Edible vaccines from plants – Banana, Watermelon.

UNIT-V**18Hrs**

Somaclonal and Gamatoclonal variation in vitro cultures, Secondary metabolites in plants - production –screening - applications. Role of tissue culture in agriculture, forestry. Biodiversity and conservation, Crop Improvement in terms of yield, Crop Improvement in terms of Quality, Molecular Markers in Crop Improvement Programme, Transgenic Plant resistant to insects

Topic for Self Study

S.No.	Topics	Web Links
1	Plant hormone biosynthesis	https://link.springer.com/chapter/10.1007/978-3-642-67704-5_5
2	Stress physiology of plants	https://link.springer.com/book/10.1007/978-81-322-0807-5
3	plant breeders rights	https://www.ipaustralia.gov.au/plant-breeders-rights
4	Role of bioreactors in secondary metabolite production	https://link.springer.com/chapter/10.1007/978-94-007-6603-7-2.

C. Text Books

1. Bhojwani, S.S., Razdon. R. Plant Tissue Culture: Theory and Practice, Elsevier 2010.
2. Chawla, H.S.. Plant Biotechnology, Oxford and IBH, New Delhi, 2000.
3. Glick, B.R., Pasternak, J.J. Molecular biotechnology, Principle and applications of Recombinant DNA. ASM Press, Washington, D.C., 2002.

D. Reference Books

1. Gupta, P.K. Plant Biotechnology. Rastogi Publications, India. 2010.
2. Mahipal Singh Shekhawat and Vikrant. S. Plant Biotechnology: In Vitro Principles, Techniques and Applications.MJP Publishers, 2010.
4. Near Stewart, C., Plant Biotechnology and Genetics: Principles, Techniques and Applications. Wiley India Private Limited. 2013.
5. Singh, B.D. Plant Biotechnology. Kalyani Publishers, India 2010.
6. Slater, A., Scott, N., Fowler, M.. Plant Biotechnology: The genetic manipulation of plants, 2nd Edition. Oxford University Press, USA 2008.

E. Web Links.

1. <https://nptel.ac.in/courses/102/103/102103016/>
2. <https://nptel.ac.in/courses/102/106/102106080/>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Lab Organization and Sterilization		
1.1	Introduction - history - laboratory organization - sterilization techniques.	Define the Basic structure of plant tissue culture laboratory organization.	K1
		Discuss the various types of sterilization techniques.	K2
1.2	Nutrition for plant cells, types of media – MS – Nitsch & Nitsch media, Gamborg's media, White's Media.	Illustrate the nutrition pattern of plant cells.	K3
		Explain the different types of plant tissue culture media..	K2
		Distinguish Various types of media.	K2
1.3	Structure and function of Growth regulators – Auxins, Cytokinins and Gibberellins.	Interpret the Structure and function of Growth regulators.	K2
2	Establishment and maintenance of callus and suspension cultures		
2.1	Establishment and maintenance of callus and suspension cultures. Somatic embryogenesis, cytology of callus.	Classify the various culture methods.	K2
		Contrast callus and suspension cultures.	K2
		Describe the applications of somatic	K2

		embryogenesis.	
2.2	Haploid production, Anther and microspore culture. Gynogenesis, embryo culture and rescue in agricultural and horticultural crops	Describe the concept of Haploid production,	K2
		Demonstrate the various types haploid production methods.	K3
		Discuss the importance of various embryo culture and rescue in agricultural and horticultural crops .	K2
2.3	Invitro pollination and fertilization. Green house effect	Illustrate the process of Invitro pollination and fertilization.	K3
		Extend the various applications of Invitro pollination and fertilization.	K2
		Interpret the Green house effect with its significance.	K2
3	Culture regeneration and gene transfer methods		
3.1	Protoplast isolation, Culture regeneration, fusion.Somatic hybrids, cybrids, cryopreservation, Synthetic seeds – Terminator seed concept..	Compare various methods of isolation of Protoplast.	K2
		Interpret the concept of Terminator seed concept .	K2
		Differentiate cybrid and hybrid.	K2
3.2	Gene transfer techniques in plants: Agrobacterium tumifaciens mediated gene transfer- Features of	Distinguish the importance of transposable elements.	K2

	TiPlasmid,molecular mechanism of T-DNA transfer. Physical gene transfer methods – ParticleBombardment, Electroporation and Microinjection	List out the different classes of Transposons.	K1
		Explain the mechanism of transposition.	K2
3.3	Applications of transgenic plants.	Describe the applications of transgenic plants.	K2
4	Plant micro propagation		
4.1	Plant micro propagation – micro grafting – invitro clonal multiplication – clonal orchards	Infer the methods of plant micropropagation.	K2
		Explain about clonal orchards.	K2
4.2	Meristem culture and virus elimination shoot tip culture	Apply the knowledge of meristem culture to produce virus free plants.	K3
		Differentiate meristem culture and shoot tip culture.	K2
4.3	Edible vaccines from plants – Banana, Watermelon.	Interpret the method of edible vaccine production.	K2,
		Build a knowledge about applications of edible vaccine.	K4
5	Somaclonal and Gamatoclonal variation in invitro cultures		
5.1	Somaclonal and Gamatoclonal variation in vitro cultures	Contrast Somaclonal and Gamatoclonal variation .	K2
		Evaluate the importance of Somaclonal and Gamatoclonal variation.	K5

5.2	Secondary metabolites in plants - production –screening - applications .	Interpret the secondary metabolites production methods and screening in plants -.	K2
		Analyse the importance of secondary metabolite production.	K4
5.3	Role of tissue culture in agriculture, forestry. Biodiversity and conservation.	Indicate the importance of tissue culture in forestry.	K2
		Associate the importance of Biodiversity and conservation.	K2
		Summarize the various methods of Biodiversity and conservation.	K2
5.4	Crop Improvement in terms of yield	To design an strategy to improve the crop yield	K6
5.5	Crop Improvement in terms of Quality	To design an strategy to improve the crop quality	K6
5.6	Molecular Markers in Crop Improvement Programme,	To list the molecular markers	K2
5.7	Transgenic Plant resistant to insects	To develop a method to confer insect resistant to plants	K6

4. Mapping scheme

U21BT609	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	M	M	L	M	-	-	-	L	M	H	L
CO2	H	M	H	H	L	L	-	-	-	L	M	H	L
CO3	H	H	M	H	M	M	-	-	-	M	H	H	L
CO4	H	M	H	H	M	L	-	-	-	L	M	H	L
CO5	H	H	H	M	M	M	-	-	-	L	H	H	L
CO6	H	M	H	L	M	L	-	-	-	H	H	H	M

L: Low M: Medium H: High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : VI

COURSE CODE : U16BT6P6

CREDITS : 2

HOURS/WEEK : 3

CORE PRACTICAL IV : INDUSTRIAL, PLANT AND ANIMAL BIOTECHNOLOGY LAB

1. Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Experiments
CO 1	Knowledge of techniques used in milk quality analysis	K1	2, 3
CO 2	Report the significance of extra cellular enzyme producers	K2	1
CO 3	Describe basic working processes of fermentor	K2	6
CO 4	Practice the preparation of plant and animal culture media	K4	7-12
CO 5	Differentiate viable and non- viable cells	K5	13
CO 6	Develop practical skills in plant and animal tissue culture techniques	K5	7-12

2. A. Syllabus

INDUSTRIAL BIOTECHNOLOGY LAB

1. Bacteriological analysis of food products.
2. Determining the quality of milk by MBRT.
3. Lactobacillus isolation from milk sample.
4. Wine production & alcohol fermentation process.
5. Screening and isolation of extra cellular enzyme producing organisms
6. Demonstration of fermentor assembly and operations

PLANT BIOTECHNOLOGY LAB

7. Aseptic seed germination
8. Direct organogenesis – shoot and root induction
9. Indirect organogenesis – callus induction
10. Seed culture technique - Production of Synthetic seeds.

ANIMAL BIOTECHNOLOGY LAB

11. Preparation of animal cell culture media and sterilization
12. Demonstration of primary cell culture.
13. Viability and cell counting by trypan blue.

B. Reference Books

1. Chawala, H.S. Plant Biotechnology: Laboratory Manual for Plant Biotechnology. Oxford and IBM Publishing Co. Pvt Ltd, 2008
2. Gunasekaran, P. Lab Manual in Microbiology. New Age International Publications, 2007
3. Ian Freshney, R. Culture of animal cells: A manual of Basic technique and specialized application. Sixth Edition, Wiley Blackwell, 2011
4. Purohit, S.S. Plant Biotechnology a Laboratory Manual. Agro-Bios, 2002
5. Rajan, S. Experimental Procedures in Life Sciences. Anjanaa Book House, 2010

C. Web Links.

1. <https://nptel.ac.in/courses/102/105/102105058/>
2. https://onlinecourses.nptel.ac.in/noc20_me04/preview

3. Specific Learning Outcomes (SLO)

Exercises	Lab Exercises	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
	Industrial Biotechnology		
Ex 1	Bacteriological analysis of food products	Remember the media composition for bacterial analysis.	K1
		Perform the Bacteriological technique to identify the bacterial load in the food sample	K3
Ex 2.	Determining the quality of milk by MBRT	Define the quality of milk by MBRT	K1
Ex 3	Lactobacillus isolation from milk sample.	Evaluate the presence of lactobacillus in MRS medium	K6
Ex 4	Wine production & alcohol fermentation process.	Demonstrate the protocol of Wine production & alcohol fermentation process.	K3
Ex 5	Screening and isolation of extra cellular enzyme producing organisms	Identify the extra cellular enzyme producers from soil sample.	K2

Ex 6	Demonstration of fermentor assembly and operations	Demonstrate the working mechanisms of fermentor.	K3
Plant Biotechnology			
Ex 1.	Aseptic seed germination	Execute the preparation of MS medium from the basic chemicals.	K3
		Explain the concept of aseptic seed germination.	K3
Ex 2.	Direct organogenesis – shoot and root induction	Illustrate the technique of micropropagation	K3
Ex 3.	indirect organogenesis – callus induction	Employ the technique of callus induction	K3
Ex 4.	Synthetic seeds	Prepare synthetic seeds	K2
Animal Biotechnology			
Ex 1.	. Preparation of animal cell culture media and sterilization	Remember the media composition and the significance of all components	K3
		Perform the technique of filter sterilization	K5
Ex 2.	Demonstration of primary cell culture.	Demonstrate the protocol of isolating cells from organs	K4
Ex 3.	Viability and cell counting by trypan blue.	Assess the live and dead cells by trypan blue method	K3

4.Mapping scheme

U16BT6P6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	-	L	H	M	-	-	-	-	H	-	H	-
CO2	H	-	-	H	M	L	-	-	-	H	H	H	M
CO3	M	-	-	H	M	-	-	-	-	M	-	H	-
CO4	M	-	-	H	M	-	-	-	-	M	-	H	L
CO5	M	-	-	H	H	-	-	-	-	-	-	H	-
CO6	M	-	-	H	M	-	-	H	M	M	-	L	H

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct

1. Periodical Assessment
2. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
3. Model Practical Examination
4. End Semester Practical Examination

Indirect

1. Course-end survey

SEMESTER : VI

COURSE CODE : U21BT6:3

CREDITS : 5

HOURS/WEEK : 5

ELECTIVE III : HUMAN PHYSIOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Reproduce the components of mammalian physiology	K1	I
CO2	List out the functions of the human physiology from a regional perspective for the systems	K1	II
CO3	Describe the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems	K2	III
CO4	Infer the working mechanism of the human system	K2	IV
CO5	Distinguish the major structures of the human anatomy and analyze the mechanisms of human physiology	K4	V
CO6	Tell briefly the basic components and functions of the gastrointestinal, renal/ urinary, endocrine/metabolic, hepatic/biliary, genital/ reproductive and immunologic, systems.	K1	V

2. A Syllabus

UNIT-I

15Hrs

Digestive system: Anatomy of the digestive system, Organs of Digestive system, Salivary, Gastric and Biliary Secretions functions. Physiology of Digestive system-Food Ingestion and Breakdown- Food Propulsion- Swallowing and Peristalsis-Food Breakdown and Absorption- Digestion and absorption of carbohydrates, Lipids and proteins. Digestive system associated diseases and disorders.

UNIT-II

15Hrs

Circulation, Musculoskeletal System:Introduction, Structure of Heart and blood vessels, Functions of heart. Organs of circulatory system, Intrinsic conduction of System of the Heart, The pathway of the Conduction System, Cardiac cycle and Heart Sounds-Physiology of Circulation- Cardiovascular Vital Signs-Blood circulation through the Heart-Capillary Exchange of Gases and Nutrients-Circulatory system associated diseases and disorders. Musculo skeletal system, bones, muscles and joints, Functions of the musculoskeletal system.

UNIT-III**15Hrs**

Respiration and Body fluids: Anatomy, and physiology of respiration. Organs of respiratory system. Structure of the lungs and respiratory pump-Ventilation and dynamics of breathing-Distribution of Ventilation-Transport of gases-Aspects of the regulation of the breathing pattern-Respiratory diseases and disorders. Plasma, Lymph & Blood. Blood- cells, Hemoglobin, blood coagulation.

UNIT-IV**15Hrs**

Excretory system: Structure and functions of kidney. Steps of the excretory system Organs of excretory system. Urine- composition and formation. Mechanism of urine formation-Role of kidneys in maintaining the blood pH- Loop Diuretics-Renal Physiology-Renal regulation of acid-base balance. Excretory system associated diseases and disorders

UNIT-V**15Hrs**

Central nervous system: General organization. Conduction of nerve impulse-Properties of synapse- Ascending Tracts-Descending Tracts-CSF and Blood brain barrier-Cerebellum-Basal ganglia- Synaptic transmission. Brain chemical composition, neurotransmitters and Camp. Biochemical aspects of learning and memory. Central nervous system associated diseases and disorders-Parkinson's Disease-Alzheimer's disease-Physiology of memory and Epilepsy-Functions of Hypothalamus-

B. Topic for Self Study

S.No	Topics	Weblinks
1	<u>LOX plays a number of key roles in promoting skin and organ fibrosis in scleroderma</u>	https://www.news-medical.net/news/20201117/LOX-plays-a-number-of-key-roles-in-promoting-skin-and-organ-fibrosis-in-scleroderma.aspx
2	No 'gay gene': Massive study homes in on genetic basis of human sexuality	https://www.nature.com/articles/d41586-019-02585-6
3	Stimulating ideas for disorders of breathing, speech and swallowing	https://physoc.onlinelibrary.wiley.com/doi/10.1113/JP280665

4	Study identifies new factor that offers potential strategy for treating obesity	https://www.news-medical.net/news/20201117/Study-identifies-new-factor-that-offers-potential-strategy-for-treating-obesity.aspx
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C. Text Book

1. Martini Frederick., Human Anatomy and Physiology, Ninth Edition, Pearson, Benjamin Cummings,2012

D. References

1. Chatterjee, Human Physiology: Vol I & II,CBS Publishing, 11 Edition,2016
2. Guyton A.C., Functions of the Human body, Saunders (W.B.) Co Ltd, Fourth Edition, 1974
3. Best C.H., Taylor N.B., The living Body, Chapman & Hall Publishing,1954
4. Swaminathan., Human Nutrition and Dietetics, Bangalore Printing and Pulv. Co. Ltd, 1996
6. Barrett K., Ganong’s Review of Medical Physiology, McGraw Hill Education, 24th Edition,2012

E. Web Links

- 1.[https://nptel.ac.in/courses/127/106/127106001/-](https://nptel.ac.in/courses/127/106/127106001/)
- 2.https://onlinecourses.nptel.ac.in/noc20_ch18/preview

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom’s Taxonomic Level of Transaction
1	Digestive system		
1.1	Anatomy of the digestive system. Organs of Digestive system	Define the digestive system	K1
		Recall organs of digestive system	K2

1.2	Salivary, Gastric and Biliary Secretions functions.	Illustrate the activity of salivary amylase activity	K3
		Compare the functions of Gastric and Biliary Secretions	K2
1.3	Physiology of Digestive system- Food Ingestion and Breakdown- Food Propulsion- Swallowing and Peristalsis- Food Breakdown and Absorption-	Relate the food ingestion ,breakdown and absorption system of human.	K2
1.43	Digestion and absorption of carbohydrates, Lipids and proteins.	Relate the Digestion and absorption system of human.	K2
1.4	Digestive system associated diseases and disorders.	Indicate diseases and disorders of digestive system.	K2
2	Respiration and Body fluids		
2.1	Circulation, Musculoskeletal System Introduction, Structure of Heart and blood vessels, Functions of heart	Define the circulatory system	K1
		Recollect the structure of heart	K1
		Relate the dependent mechanism of heart and blood vessels	K2

2.2	Organs of circulatory system. Intrinsic conduction of System of the Heart, The pathway of the Conduction System, Cardiac cycle and Heart Sounds-	Compare the organs of circulatory system	K2
2.3	Physiology of Circulation- Cardiovascular Vital Signs- Blood circulation through the Heart- Capillary Exchange of Gases and Nutrients-	Analyse the circulatory system	K4
2.4	Circulatory system associated diseases and disorders.	Analyze diseases and disorders of circulatory system.	K4
2.5	Musculoskeletal system, bones, muscles and joints, Functions of the musculoskeletal system	Enumerate Musculoskeletal system, bones, muscles and joints	K1
		Analyze the functions of the musculoskeletal system	K4
3	Respiration and Body fluids		
3.1	Respiration and Body fluids Anatomy, and physiology of respiration.	Explain the anatomy, and physiology of respiration.	K2

3.2	Organs of respiratory system. Structure of the lungs and respiratory pump-Ventilation and dynamics of breathing-Distribution of Ventilation-Transport of gases-Aspects of the regulation of the breathing pattern-	Reproduce the organs of respiratory system	K1
3.3	Respiratory diseases and disorders.	Indicate the diseases and disorders of respiratory system.	K2
3.4	Plasma, Lymph & Blood. Blood-cells, Hemoglobin, blood coagulation.	Compare the plasma, lymph & blood	K2
		Differentiate blood-cells and hemoglobin	K2
4	Excretory system		
4.1	Structure and functions of kidney. Steps of the excretory system	Recall the excretory system	K1
		Reproduce the structure of kidney	K1
		Explain the significance of kidney.	K2
4.2	Organs of excretory system.	Label the parts of excretory system	K1

4.3	Urine- composition and formation. Mechanism of urine formation-Role of kidneys in maintaining the blood pH- Loop Diuretics Renal regulation of acid-base balance.	Distinguish the components of urine-	K4
		Summarize the mechanism involved in urine synthesis	K2
		Explain the renal regulation of acid-base balance.	K2
4.4	Excretory system associated diseases and disorders	Classify diseases and disorders of excretory system.	K2
5	Central nervous system		
5.1	General organization. Conduction of nerve impulse.Properties of synapse-Ascending Tracts-Descending Tracts-CSF and Blood brain barrier-Cerebellum-Basal ganglia- Synaptic transmission.	Describe the central nervous system	K2
		Interpret the general organization & conduction of nerve impulse	K2
		Explain the Synaptic transmission	K2
5.2	Brain chemical composition, neurotransmitters and Camp.	List out the brain chemical composition	K1

		Describe the neurotransmitters and the association of cAMP.	K2
5.3	Biochemical aspects of learning and memory.	Connect the biochemical components with learning and memory system	K4
5.4	Central nervous system associated diseases and disorders Parkinson's Disease- Alzheimer's disease-Physiology of memory and Epilepsy- Functions of Hypothalamus	Appraise the diseases and disorders of central nervous system.	K4

4.Mapping

U21BT6:3	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 2	H	M	L	L	L	L	L	L	L	H	M	H	-
CO 3	H	H	-	H	M	-	-	-	-	H	L	H	-
CO 4	H	H	-	H	M	-	-	-	-	H	L	H	-
CO 5	H	H	-	H	M	-	-	-	M	H	L	H	L
CO 6	H	H	-	H	M	-	-	-	-	H	L	H	M

L-Low

M-Moderate

H- High

5. Course Assessment Methods

Direct
<ol style="list-style-type: none">1. Continuous Assessment Test I,II2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc.3. End Semester Examination
Indirect
<ol style="list-style-type: none">1. Course-end survey

SEMESTER : VI

COURSE CODE : U21BT6:A

CREDITS : 5

HOURS/WEEK : 5

ELECTIVE III : BIOETHICS AND IPR

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Interpret the basis of biosafety and bioethics and to know its impact on all the biological Sciences	K2	I
CO2	Explain the rules of biosafety practices and guidelines in research	K2	II
CO3	Realize the need of patents to safeguard novel research and innovations	K2	II,III
CO4	Discuss about the ethical issues related to biomedical research	K2	IV
CO5	Criticize the benefits and limitations of GM technology	K5	V
CO6	Substantiate the significance of in vivo study and clinical trials under ethical guidance.	K3	V

2. A. Syllabus

Unit – I

15Hrs

Introduction to Intellectual Property: Types of IPR: Patents, Trademarks, Copyright & Related Rights, Design, Draft design, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO). IP rights in India - IPs of relevance to Biotechnology – few Case Studies. Established WIPO is a member state-led, intergovernmental organization, with its Headquarters

Unit – II

15Hrs

Patent Filing Procedures : National & PCT filing procedure ; Time frame And Cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies. Importance of IPR - Patent licensing of Applications

Unit – III

15Hrs

IPR Agreements and Treaties :History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act

1970 & recent amendments. Trade secret are intellectual property (IP) rights on confidential information which may be sold or licensed. Patent and copyright Infringement, Patent and copyright misappropriation, and enforcement. Trade secret-Historical and legal background of the Agreement and its place in world Trade. Application of Indian Acts roles and regulations.Hague Agreement allows applicants to register an industrial designs registration patent

Unit – IV

15Hrs

Bioethics:Introduction to ethics/bioethics – framework for ethical decision making; Benefits and risks of genetic engineering of applications purpose and principles of bioethics, Bioethics in medical – drug testing, Informed consent and human cloning, Bioethics on religious rules and guidelines.Ethical issues of human cloning. Importance of Bioethics in medical and drug testing.Principles of bioethics and applications.

Unit – V

15Hrs

Biotechnology and ethics: Benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare; Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO’s – biotechnology and biopiracy – Ethical implications of human genome project

B. Topic for Self Study

S.No	Topics	Weblinks
1	Major IP Laws in India	. V.K.Ahuja, Law relating to Intellectual Property rights, 2 nd Edition, (2013) LexisNexis
2	Application of different form of IPR	Bhandari, M.K. Law relating to IPR, Central Law Publication, (4th Edition 2015)
3	Registration procedure of Patent	Hyde William Cornish, Intellectual Property Right, New Delhi: Global Vision Publication House
4	IPR and constitution of India	. V.K.Ahuja, Law relating to Intellectual Property rights, 2 nd Edition, (2013) LexisNexis

C. Text Books

1. Traynor P.C., Frederic R., and Koch M., Biosafety Board of Trustees, Michigan State University, USA, 2002
2. Sasson A., Biotechnologies and Development, UNESCO Publications, 1988

D. Reference Books

1. Paul R.C., Situation of Human Rights in India, Efficient Offset Printers, 2000
2. Belmont T.L., and Leroy W., Cotemporary issue in Bioethics, Wards worth Publishing Co Belmont, California. 1999,
3. Vadakar Praveen, Theories and Practice of Human Rights, Rajat Publication, 2000.

E. Web Links.

1. <https://nptel.ac.in/courses/110/105/110105139/>
2. https://onlinecourses.nptel.ac.in/noc20_hs55/preview

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Introduction to Intellectual Property		
1.1	Introduction to Intellectual Property: Types of IPR: Patents, Trademarks, Copyright & Related Rights, Design, Draft design, Traditional Knowledge, Geographical	Describe the Intellectual property rights and Copyright is a legal means of protecting an author's work.	K2
1.2	Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectualproperty rights organization (WIPO).	Explain the process of Patents, Utility Models Cultural, artistic and literary works, including computer software and compilation of data Copyright	K2
1.3	IP rights in India - IPs of relevance to Biotechnology – few Case Studies	State the rules and agreements of world trade organization.	K2
1.4	IP rights in India - IPs of relevance to Biotechnology – few Case Studies.	Discuss about case studies of IPR	K2
1.5	Established WIPO is a member state-led, intergovernmental organization, with its Headquarters.	Describe the organization of WIPO and headquarters.	K2

2	IPR Agreements and Treaties		
2.1	Patent Filing Procedures : National & PCT filing procedure; Time frame and cost; Status of the patent applications filed;	Enumerate the procedure of patenting	K1
2.2	Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting.	Infer the process of applying financial assistance (FA) for patenting	K2
2.3	Introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope.	Discuss about patent license agreement paid to the patent owner.	K2
2.4	Introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope.	Discuss about a patent about patent license agreement paid to the patent owner.	K2
2.5	Importance of IPR - Patent licensing of Applications.	Define the patent of licensing and applications roles regulations	K2
3	IPR Agreements and Treaties		
3.1	IPR Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.	Describe the norms of IPR agreements	K1
3.2	Patent and copyright Infringement, Patent and copyright misappropriation, and enforcement. Trade secret.	Classify the agreements in accordance to their specialty	K2
3.3	Historical and legal background of the Agreement and its place in the world Trade.	Explain the procedures and processing of Patents for products	K3
3.4	Application of Indian Acts roles and regulations	Discuss about the Indian acts roles and regulations	K2
3.5	Hague Agreement allows applicants to register an industrial designs registration patent	Explain about patent register and agreements of applications.	K3

4	Bioethics		
4.1	Bioethics: Introduction to ethics/bioethics – framework for ethical decision making; purpose and principles of bioethics.	Interpret the principal and procedures of Bioethics.	K2
4.2	Bioethics in medical – drug testing, Informed consent and human cloning, Bioethics on religious rules and guidelines.	Deduce the ethical, legal, and social issues with related to human cloning	K4
4.3	Ethical issues of human cloning	Dissues about Ethical and policy issues of human cloning	K2
4.4	Importance of Bioethics in medical and drug testing.	Define Bioethics involves medical ethics and studying about equilibrium between benefits	K2
4.5	Principles of bioethics and applications.	Define the guidelines of bioethics	K2
5	Biotechnology and ethics		
5.1	Biotechnology and ethics: Benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and bio warfare;	State the principal mechanisms of Genetic engineering.	K1
		Use Genetic testing to detect the development of genetic disease.	K3
		Infer the influence of genetically modified foods on health	K2
		Describe the ethical implications of different cloning methods	K2
		State the principal mechanisms of Genetic engineering.	K1
5.2	Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopiracy – Ethical implications of human genome project		

4. Mapping scheme

U21BT6: A	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	M	H	-	M	L	L	-	L	L	H	H	H	H
CO2	M	H	-	M	L	L	-	L	L	-	-	H	L
CO3	M	H	-	M	L	L	-	L	L	M	M	M	H
CO4	M	H	-	M	L	L	-	L	L	M	H	M	H
CO5	M	H	-	M	L	L	-	L	L	H	H	M	H
CO6	M	H	-	M	L	L	-	L	L	H	H	M	H

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

NMEC COURSES

SEMESTER : III

COURSE CODE : U21BT3E1

CREDITS : 2

HOURS/WEEK : 2

NMEC I : BASICS OF BIOTECHNOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO 1	Outline the basic idea of Biotechnology and how it evolved into a new branch	K2	I
CO 2	Describe the information regarding the various tools and techniques involved in making a recombinant DNA molecule	K2	II
CO 3	Interpret the construction of recombinant DNA using vectors	K3	III
CO 4	Indicate the various gene transfer methods that are in existence	K2	IV
CO 5	Verify the properties of the transformed DNA molecule by screening methods	K2	V
CO 6	Debate how to apply these acquired ideas in Biotechnology and put them into practice.	K4	V

2. A. Syllabus

UNIT-I

6hrs

The annotation of Biotechnology - Definition and History -Time lines, Conventional and modern biotechnology, Scope and current usages in medical, food and industry sectors

UNIT-II

6hrs

The molecules behind biotechnology -Genomic Organization – Types of nucleic acids - components of DNA and RNA, Double helical structure of DNA (Watson-Crick model)

UNIT-III

6hrs

Gene Biotechnology- deciphering of genetic code, Central dogma - transcription and translation -phases and mechanism

UNIT-IV

6hrs

Genetic manipulation and biotechnology – Tools of Genetic Engineering -Cutting and Joining DNA – Restriction Endonuclease, Amplifying DNA-PCR-,Steps in Gene Cloning & vectors-outline

UNIT-V**6hrs**

Concerns and legal Perspectives of Biotechnology -Technology and Applications of Biotechnology, Global market and Biotech Products, Biotechnology in India and Global Trend

C. Text Book

1. Dubey R.C., A Text Book of Biotechnology, S. Chand & Company Ltd. New Delhi, 2014

D. Reference Books

1. Old & Primrose, Principles of Gene Manipulation, Third Edition, Blackwell Scientific Publications, Oxford, 2006
2. Satyanarayana U., Biotechnology, Books and Allied (p) Ltd, 2008
3. Gupta P.K., Biotechnology and Genomics, Rastogi Publication, 2017
5. Brown T.A., Gene Cloning and DNA Analysis, Blackwell Science, Osney Mead, Oxford, 2010
6. Singh B. D., Biotechnology, Kalyani Publishers, New Delhi, 2015

E. Web Links.

1. <https://nptel.ac.in/courses/102/103/102103045/>
1. <https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ma07/>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	The annotation of Biotechnology		
1.1	Definition and History –Time lines, Conventional and modern biotechnology	Describe the annotation of Biotechnology subject	K2
1.2	Scope and current usages in medical, food and industry sectors	Explain the Scope and current usages in medical, food and industry sectors	K2
2	The molecules behind biotechnology -Genomic Organization		
2.1	Types of nucleic acids - components of DNA and RNA	Explain types of nucleic acids - components of DNA	K2

		and RNA	
2.2	Double helical structure of DNA (Watson-Crick model)	Contrast the alternate method for gene cloning	K2
3	Gene Biotechnology		
3.1	Deciphering of genetic code	Discuss the characteristics features of genetic code.	K2
3.2	Central dogma - transcription and translation -phases and mechanism	Compare and distinguish the various steps involved in gene expression.	K2
4	Genetic manipulation and biotechnology		
4.1	Tools of Genetic Engineering - Cutting and Joining DNA – Restriction Endonuclease	Interpret the Tools are used in Genetic Engineering .	K3
4.2	Amplifying DNA-PCR-,Steps in Gene Cloning & vectors-outline	Explain the steps are involved in PCR.	K3
5	Concerns and legal Perspectives of Biotechnology		
5.1	Technology and Applications of Biotechnology,	Elaborate the applications of technology.	K5
5.2	Global market and Biotech Products, Biotechnology in India and Global Trend.	Point out the global market and biotech products. Discuss the status of biotechnology in India	K4 K3

4.Mapping scheme

U21BT3E 1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS O 1	PS O 2	PS O 3	PS O 4
CO1	H	M	L	M	L	H	M	-	L	H	H	H	M
CO2	H	M	M	H	M	L	L	-	L	H	H	H	-
CO3	H	M	M	H	M	L	L	-	L	H	H	H	-
CO4	H	M	M	H	M	L	L	-	L	H	H	H	-
CO5	H	M	M	H	M	L	L	-	L	H	H	H	-
CO6	H	H	M	H	M	L	L	-	L	H	H	H	-

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : IV
CREDITS : 2

COURSE CODE : U16BT4E2
HOURS/WEEK : 2

NMEC II : APPLIED BIOTECHNOLOGY

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Describe the basic idea of Plant Biotechnology and how valuable products can be obtained	K2	I
CO2	Outline the informations regarding the various cell lines and techniques involved in making a transgenic animal	K2	II
CO3	Select the appropriate vectors to deliver the chimeric DNA	K3	III
CO4	Specify the possible therapy methods that use DNA and proteins to cure diseases instead of the usual antibiotics	K4	IV
CO5	Apply the knowledge gained by basic principles in biotechnology to get better commercial useful products.	K3	V
CO6	Illustrate the methodology for the manipulation of genetically engineered microorganisms	K3	V

2. Syllabus

UNIT-I

6 Hrs

Plant biotechnology-Role of tissue culture in agriculture, horticulture and forestry, Edible Vaccines from plants – Banana, Watermelon.

UNIT-II

6 Hrs

Animal biotechnology-Production of Vaccines in animal Cells, Transgenic Animals – cloning, Applications of Transgenic mice and sheep.

UNIT-III

6 Hrs

Medical biotechnology-Gene therapy, Production and Applications of monoclonal antibodies, Somatic and Germ line Engineering, molecular diagnosis.

UNIT-IV

6 Hrs

Industrial biotechnology-Production of Microbial products- Alcoholic Beverage – Beer, Antibiotic – Penicillin Industrial uses of enzymes – Detergents, Leather, food and Pharmaceutical.

UNIT-V**6 Hrs**

Environmental biotechnology-Microorganisms as Bio indicators, Genetic engineered microorganisms to degrade xenobiotics, Biological weapons and bioterrorism.

C. Text Book

1. Dubey R. C., A Text Book of Biotechnology, Rajendra Printer, New Delhi, 2010

D. Reference Books

1. Old & Primrose, Principles of Gene Manipulation, Blackwell Scientific Publications, Oxford, 2006
2. Ranga M. M., Animal Biotechnology, Agrobios, India, 2018
3. Ian Freshney R., Culture of Animal Cells, Wiley-Blackwell; Sixth Revised Edition, 2016
4. Hawla., Introduction to Plant Biotechnology, Second Edition, Oxford and IBH Publishers, 2003
5. Satyanarayana U., Books and Allied (p) Ltd, 2008
6. Patel A.H., Industrial Microbiology, Laxmi Publications, Second Edition, 2011
7. Gupta P.K., Biotechnology and Genomics, Rastogi Publication, Sixth Reprint, 2017
8. Brown T.A., Gene Cloning and DNA Analysis, Blackwell Science, Osney Mead, Oxford, 2010

E. Web Links

1. <https://nptel.ac.in/courses/102/105/102105058/>
2. <https://nptel.ac.in/courses/102/105/102105058/>

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Plant biotechnology		
1.1	Plant biotechnology-Role of tissue culture in agriculture, horticulture and forestry,	Describe the importance of biotechnology in plant science	K2
1.2	Edible Vaccines from plants – Banana, Watermelon.	Sketch out the outline of edible vaccine production using recombinant technology	K3
2	Animal biotechnology		
2.1	Animal biotechnology- Production of Vaccines in	Relate the methods of vaccine production among	K3

	animal Cells,	different animals.	
2.2	Transgenic Animals – cloning, Applications of Transgenic mice and sheep.	Explain the methods of creating animals with new features	K3
3	Medical biotechnology		
3.1	Medical biotechnology-Gene therapy,	Show the possibility of therapy with genes	K2
3.2	Production and Applications of monoclonal antibodies,	Illustrate the production of useful proteins using gene cloning	K2
3.3	Somatic and Germ line Engineering, molecular diagnosis.	Express their views on genetic based diseases and its relevant diagnosis.	K2
4	Industrial biotechnology		
4.1	Industrial biotechnology-Production of Microbial products-	Identify the significance and benefits of biotechnology by using Microorganisms	K1
4.2	Alcoholic Beverage – Beer, Antibiotic – Penicillin, Industrial uses of enzymes – Detergents, Leather, food and Pharmaceutical.	Discuss the production strategies of various products obtained with the help of biotechnological ideas	K2
5	Environmental biotechnology		
5.1	Environmental biotechnology-Microorganisms as Bio indicators, Genetic engineered microorganisms to degrade xenobiotics,	Explain the various methods of creating microbes for useful purpose with the help of biotechnology ideas	K2
5.2	Biological weapons and bioterrorism.	Criticize the drawbacks of gene manipulation	K4

4.Mapping scheme

U16BT4E2	P O 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS O 1	PS O 2	PS O 3	PS O 4
CO1	H	H	M	M	L	M	L	-	M	H	H	M	L
CO2	H	H	M	M	L	L	L	-	M	H	L	M	L
CO3	H	H	M	M	L	L	L	-	L	H	L	M	L
CO4	H	H	M	M	M	M	L	-	M	H	H	M	L
CO5	H	H	H	M	M	M	L	-	H	H	H	M	L
CO6	H	H	H	M	M	M	L	-	H	H	H	M	L

L-Low

M-Moderate

H- High

5. Course assessment methods

Direct:

1. Continuous Assessment Test: T1, T2 (Theory & Practical Components): Closed Book
2. Open Book Test
3. Cooperative Learning Report, Assignment, Group Presentation, Group Discussion, project Report, Field Visit Report, Poster Presentation, Seminar, Quiz (written).
4. Pre-Semester & End Semester Theory Examination

Indirect:

Course end survey (Feedback)

SEMESTER : V

COURSE CODE :

CREDITS : 2

TOTAL HOURS : 30

BIO- ENTREPRENEURSHIP

1.Course Outcomes

At the end of this course, the students will be able to:

CO.No	Course Outcomes	Level	Unit Covered
CO1	Explain the biological process systematically and to promote it commercially. (K1)	K1	I
CO2	Describe strategies for successful implementation of ideas. (K2)	K2	II
CO3	Manipulate the preparations of various bio formulations that can benefit the society. (K3)	K3	III
CO4	Analyze about the cultivation methods of commercially important organisms. (K4)	K4	IV
CO5	Access the skills about various organic farming strategies. (K5)	K5	V
CO6	Appraise the marketing strategies of bio products. (K5)	K5	II

2. A. Syllabus

Unit 1

6 Hrs

Introduction to Bio-Entrepreneurship : Structure of a biotechnology company; scientific principles; start-up of the biotechnology company; support mechanism for entrepreneurship in India;

Unit II

6 Hrs

Sources of Finance and marketing strategies: Source of finance, marketing strategies.Import-export license of bio based products. List of Biotech Company in India.

Unit III

6 Hrs

Bio formulations Preparation: Herbal shampoo preparation, Herbal sanitizer's preparation, Aloe vera gel based products, bio moisturizer preparation, biogel preparation (hair conditioner).Cheese preparation, Probiotic Preparation: Yogurt

Unit IV

6 Hrs

Cultivation of Commercially important organisms : Mushroom cultivation, SCP cultivation, Azolla cultivation. Seweed cultivation

Unit V

6 Hrs

Organic farming: Panchagavya, Navagavya, Vermicompost preparation. Any 4 : Case study on biotech based entrepreneurship in India.

B. Topic for Self Study

S.No.	Topics	Web Links
1	The budget for a biotechnological start-up company	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4214775/
2	Fermented probiotic milk	https://www.sciencedirect.com/science/article/pii/S1043452620300371
3	Business model for bio- entrepreneur	https://www.nature.com/articles/nbt0598supp_16
4	Seaweed cultivation	https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/seaweed-farming

C. Text Books

1. Gaur A.C.,. Handbook of Organic Farming and Biofertilizers, Ambica Book Agency,Jaipur. (2006)
2. Adams, D. J., & Sparrow, J. C.. Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion. (2008).
3. Dubey R. C., A Text Book of Biotechnology, Rajendra Printer, New Delhi, 2010

D. Reference books:

1. Shimasaki, C. D.. Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier. (2014)
2. Tripathi PC and PN Reddy, Principles of management Tata McGraw Hill,2005
3. Charantimath PM, Entrepreneurship Development by Small Business Enterprises: Pearson Education.2006
4. Khanka SS,Entrepreneurship Development by, S Chand & Co.2018

E. Web Link

1. https://onlinecourses.swayam2.ac.in/nos20_ge07/preview
2. https://onlinecourses.swayam2.ac.in/cec21_ag03/preview

3. Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom's Taxonomic Level of Transaction
1	Introduction to Bio-Entrepreneurship		
1.1	Introduction to Bio-Entrepreneurship: Structure of a biotechnology company;	Define the Basic Concepts of Bio-Entrepreneurship.	K1
		Discuss the Structure of a biotechnology company.	K2
1.2	Scientific principles; start-up of the biotechnology company; support mechanism for entrepreneurship in India.	Illustrate General scientific principles of biotechnology company.	K2
		Explain the support mechanism for entrepreneurship in India.	K2
2	Sources of Finance and marketing strategies		
2.1	Sources of Finance and marketing strategies: Source of finance, marketing strategies. Import-export license of biobased products.	Classify the various marketing strategies of biotech company.	K2
		Describe about import-export license of biobased products.	K1
		Discuss the importance of source of finance to become an entrepreneur.	K2
2.2	List of Biotech Company in India	Analyse the progression of various Biotech Company in India.	K4
3	Bioformulations Preparation		
3.1	Bioformulations Preparation: Herbal shampoo preparation, Herbal sanitizer's preparation,	Formulate various biobased products such as Herbal	K5

	Aloevera gel based products	shampoo preparation, Herbal sanitizer's preparation, Aloevera gel based products.	
		Appraise the applications of biobased products.	K4
3.2	Bio moisturizer preparation, biogel preparation (hair conditioner).	Interpret the importance of bio moisturizer preparation, biogel preparation.	K3
		Explain the protocols procedures involved in bio moisturizer preparation, biogel preparation.	K2
3.3	Cheese preparation, Probiotic Preparation: Yogurt	Rate the significance of probiotic preparation.	K3
		Explain the protocols procedures involved in cheese and Yogurt preparation,	K2
4	Cultivation of Commercially important organisms		
4.1	Cultivation of Commercially important organisms: Mushroom cultivation	Enumerate the various applications Mushroom.	K1
		Devise methods for Mushroom cultivation.	K4
4.2	CP cultivation	Adapt different strategies to cultivate SCP.	K6
		List out the commercial applications of SCP.	K1
4.3	Azolla cultivation	Create an idea about Azolla cultivation.	K4
		Analyse about the contemporary	K4

		methods involved in Azolla cultivation.	
4.4	Seaweed cultivation	Explain the methods of Seaweed cultivation	K2
		Explain the commercial applications of seaweed cultivation.	K2
5	Organic farming		
5.1	Organic farming: Panchagavya, Navagavya, Vermicompost preparation.	Interpret about the knowledge of Organic farming.	K2
		Formulate various organic preparations such as Panchagavya, Navagavya, Vermicompost	K6
		Collaborate about importance of Organic farming with its significance.	K6
5.2	Any 4: Case study on biotech based entrepreneurship in India.	Create the confidence to become successful entrepreneur from the case study analysis.	K5

4.Mapping scheme

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4
CO1	H	H	-	-	L	-	-	-	-	H	-	-	-
CO2	-	M	-	-	L	-	-	-	-	H	-	L	-
CO3	L		H	H	M	-	-	-	-	H	M	H	M
CO4	M	L	-	M	L	-	L	-	-	H	-	M	-
CO5	M	-	H	-	-	L	-	-	-	M	H	H	M
CO6	M	-	H	L	M	L	-	-	-	H	H	H	M

L-Low

M-Moderate

H- High

COURSE ASSESSMENT METHODS

Direct
<ol style="list-style-type: none">1. Continuous Assessment Test I,II2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc.3. End Semester Examination
Indirect
<ol style="list-style-type: none">1. Course-end survey