B.Sc., BIOTECHNOLOGY

OBE SYLLABUS

(For the students admitted in the academic year 2020–2021)

DEPARTMENT OF BIOTECHNOLOGY &BIOINFORMATICS

BISHOP HEBER COLLEGE (Autonomous)

(Affiliated to Bharathidsasan 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 (2020–2021 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**
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	U16BT3P3	**M**		**H**	**H**	**M**	**-**	**L**	**-**	**-**	**M**	**-**	**M**	**M**
NMEC I	U16BT3E1	**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	U20BT505	**M**		**H**	**L**	**M**	**-**	**M**	**-**	**-**	**H**	**-**	**M**	**M**
Genetic Engineering	U20BT506	**H**		**H**	**H**	**M**	**-**	**H**	**-**	**-**	**H**	**-**	**M**	**M**
Molecular Biology & Genetic Engineering Lab	U16BT5P5	**H**		**H**	**M**	**M**	**-**	**M**	**-**	**-**	**H**	**-**	**M**	**M**
Plant Physiology	U16BT5:1	**H**	**-**	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**L**	**H**	**M**	**-**
/Ecology	U16BT5:2	**H**	**-**	**M**	**-**	**M**	**M**	**-**	**-**	**-**	**M**	**H**	**H**	**-**
Developmental biology/	U19BT5:3	**H**	**-**	**M**	**-**	**M**	**H**	**-**	**-**	**-**	**H**	**H**	**M**	**M**
Basics of evolution	U16BT5:4	**H**	**-**	**M**	**-**	**M**	**M**	**-**	**-**	**-**	**M**	**H**	**H**	**-**
Basics of Biostatistics	U16BT5S2	**M**	**H**	**M**	**M**	**L**	**L**	**H**	**-**	**-**	**M**	**-**	**M**	**-**
Food Biotechnology	U16BT5S3	**H**	**-**	**M**	**M**	**M**	**-**	**-**	**-**	**-**	**H**	**L**	**H**	**-**
Industrial Biotechnology	U20BT607	**M**	**H**	**L**	**M**	**M**	**M**	**-**	**-**	**H**	**H**	**L**	**M**	**-**
Animal Biotechnology	U19BT608	**H**	**-**	**M**	**-**	**M**	**M**	**-**	**-**	**-**	**H**	**M**	**M**	**L**
Plant Biotechnology	U19BT609	**M**	**-**	**M**	**-**	**M**	**M**	**-**	**-**	**-**	**H**	**H**	**M**	
Industrial, Plant & Animal Biotechnology lab	U16BT6P6	**M**	**-**	**-**	**M**	**M**	**-**	**-**	**-**	**M**	**H**	**-**	**M**	**L**
Human physiology	U20BT6:1	**M**	**-**	**-**	**-**	**M**	**-**	**-**	**-**	**-**	**H**	**M**	**M**	**-**
Bioethics and IPR	U16BT6:2	**H**	**H**	**M**	**-**	**-**	**L**	**-**	**M**	**H**	**M**	**M**	**H**	**M**

B.Sc., BIOTECHNOLOGY PROGRAMME STRUCTURE

B.Sc Biotechnology Programme (2020–2021 onwards)

(CBCS System)

Sem.	Part	Course	Course Title	Course Code	Hours / wee k	Credits	Marks		
							CIA	ESE	Total
I	I	Tamil I /*	செய்யுள், இலக்கிய வரலாறு, உரைநடை, மொழிப்பயிற்சியும் படைப்பாக்கமும்	U18TM1L1	6	3	25	75	100
	II	English I	Literature and Language : Prose and Short Stories	U20EGNL1	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	Literature and Language : Poetry and Shakespeare	U20EGNL2	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	U16EGNL3	6	3	40	60	100
	III	Core III	Genetics	U20BT303	6	5	25	75	100
		Core Prac. III	Genetics Lab	U16BT3P3	3	2	40	60	100
		Allied III	Allied Chemistry – I	U19BTC33	4	4	25	75	100
	IV	Allied Prac. II	Volumetric and Organic Analysis	U19BTCP2	3	--	--	--	--
		NMEC I	Basics of Biotechnology	U16BT3E1	2	2	25	75	100
IV	I	Tamil IV /*	செய்யுள்(மேற்கணக்கு,கீழ்கணக்கு), இலக்கிய வரலாறு , நாடகம், மொழிப்பயிற்சி	U18TM4L4	5	3	25	75	100
	II	English IV	English through Literature	U16EGNL4	5	3	40	60	100
	III	Core IV	Basics of Immunology	U20BT404	6	6	25	75	100

		Core Prac. IV	Basics of Immunology Lab (28.11.2017)	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	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	Extensio n	NSS, NCC, Rotaract,Leo Club, etc …	U16ETA41	--	1	--	--	--
V	III	Core V	Molecular Biology	U20BT505	6	6	25	75	100
		Core VI	Genetic Engineering	U20BT506	6	6	25	75	100
		Core Prac. V	Molecular Biology & Genetic Engineering Lab	U16BT5P5	4	2	40	60	100
		Elective I	Plant Physiology / Ecology	U16BT5:1/ U16BT5:2	5	5	25	75	100
		Elective II	Developmental Biology /	U19BT5:3/	5	5	25	75	100
	IV	SBEC II	Basics of Biostatistics	U16BT5S2	2	2	25	75	100
		SBEC III	Food Biotechnology (02.06.2018)	U16BT5S3	**2**	**2**	**25**	**75**	**100**
VI	III	Core VII	Industrial Biotechnology	U20BT607	6	6	25	75	100
		Core VIII	Animal Biotechnology	U19BT608	6	5	25	75	100
		Core IX	Plant Biotechnology	U19BT609	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	U20BT6:1/ U16BT6:2	5	5	25	75	100
		Project	Project	U16BT6PJ	4	2	--	--	100
	V	Gender Studies	Gender Studies	U16GST61	-	1	--	--	100

SBEC : Skill Based Elective Courses NMEC : Non Major Elective Courses **Total Credits : 140**

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*** 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 Env. Studies : 1	Total : 43
Part II : 4 Core Prac. : 6 Allied Prac.: 2 Elective : 3 SBEC : 3 Exten. Act. : 1	
Soft Skills : 1 Value Education : 1 Gender Studies : 1	

NMEC offered by the Department: 1.Basics of Biotechnology - U16BT3E1
2. Applied Biotechnology - U16BT4E2

STRUCTURE OF THE CURRICULUM FOR B.SC. BIOTECHNOLOGY (2020 - 2021)

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) Core(Practical) Core(Project)			 9 6 1	 52 19 4	 49 12 2	63
Elective(Theory)			3	15	15	15
Allied (Microbiology)	Microbiology	T	2	8	8	21
		P	1	6	3	
Allied(Chemistry)	T		2	8	7	
	P		1	6	3	
Part–IV SBEC NMEC VLO Env.Studies			 3 2 1 1	 6 4 2 2	 6 4 2 2	14
Part–V Extension GenderStudies LifeSkills			 1 1 1	 - - 2	 2 - 1	3
Total			**43**	**180**	**140**	**140**

Total Courses: 43
Total Credits: 140
Total Hours : 180

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 pathwayscAMP and phosphatidylinositol.

B. Topics for Self Study

S.No.	Topics	Web Links
1	Quorum sensing	https://www.hindawi.com/journals/bmri/2019/2015978/
2	Cytoskeltal dynamics	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4427793/
3	Stem cell and cancer stem cell	http://www.cellstemcell.org/index.php/PSC/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'sTaxonomic 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 cell: Cell membrane and nucleus- structure, organization and functions-Cell: physio -chemical nature of plasma membrane and cytoplasm fluid mosaic model.	Associate the various structural aspects of foremost cellular constituents	K2
		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	Extend the reason for the presence of cell junctions that facilitates	K 2

	hemidesmosomes-communicating junction :Gap junctions-occluding junctions-Tight junctions	cellular interactions	
		Connect the extracellular and intracellular matrix	K4
		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

High – H **Medium- M** **Low- L**

***5.* Course Assessment Methods**

Direct
1.Continuous Assessment Test I,II 2.Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation,Posterpreparation,PrototypeorProductDemonstrationetc. 3.End Semester Examination
Indirect
1. Course-end survey

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'sTaxonomic 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	Explainthe principles involved in classifying microorganisms	K1
		Describes the characteristic features of multicellular organism	K2
2	**Introduction to microscopy**		

2.1	Introduction to microscopy and its types	Classify microscope based on working principles	K2
		Label the distinguished parts of different microscopes	K2
		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	Describe the structure of	K3

	Anatomy	bacteria	
		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

U16BTY01	**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

High – H **Medium- M** **Low- L**

5. Course Assessment Methods

Direct
1.Continuous Assessment Test I,II 2.Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3.End Semester Examination
Indirect
1. Course-end survey

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	1,3
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	6
CO5	Usedifferntttypes of microscopes effectively	K3	3
CO6	Differentiate Meiosis and Mitosis	K4	1,2

2. A Syllabus

Experiment List

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'sTaxonomic 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**

High – H **Medium- M** **Low- L**

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	Experiment
CO1	Explain various types of microscopy and staining techniques.	K2	6,7
CO2	Identify the different stages of bacterial growth curve.	K2	4
CO3	Examine the composition of bacterial cell wall	K2	7
CO4	Distinguish the detailed bacterial structures by different staining methods.	K4	5,7
CO5	Choose the appropriate staining techniques.	K4	6
CO6	Prepare media and develop pure cultures .	K3	2

2. A Syllabus

Experiment List

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

8. Antibiotic sensitivity testing: Disc diffusion test – Quality control with standards strains
9. Biochemical characteristics: IMViC test

10. Isolation of *Rhizobium* sp.
11. Isolation of Cellulolytic organisms
12. Isolation of *Lactobacillus* sp.
13. 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'sTaxonomic 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

5. Course Assessment Methods

Direct

5. Periodical Assessment
6. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
7. Model Practical Examination
8. 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	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%2Dsurface%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. References

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.Spcific Learning Outcomes (SLO)

Unit	Course Content	Learning outcomes	Highest Bloom'sTaxonomic Level of Transaction
1	**Chemistry of Biomolecules**		
1.1	Chemistry of Biomolecules 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	Explain the attributes of	K2

	(strong & 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	Carbohydrates 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	K3

		importance in 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 & Proteins** 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		Find the importance of proteins in cellular structure andsignalling	K1

	Proteins: classification and Biological importance	Demonstrate clear knowledge of protein classification based on structure-function aspects	K2
		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	K2

	Denaturation, precipitation, separation by solubility differences- isoelectric pH	purification	
		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	Lipids and Vitamins 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	K2

4.3	Vitamins- Source, structure, biological role	Find the composition and sources of vitamins-fat soluble and water soluble	K1
		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	K2
5	**Nucleic acids and Enzymes**		
5.1	Nucleic acids & Enzymes 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		Define the structure of DNA and RNA based on organism type and chemical composition	K2
		Classify nucleotides and genetic material based on structure	K2

	Composition and structure - their biological importance	Identify methods used to study nucleic acid structure	K3
		Describe the mechanisms of nucleic acid function based on base composition	K4
		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
		Identify the mechanism of enzyme catalysis based on theories of enzyme action-lock and key and induced	K1

	Enzyme activity; Factors affecting activity	fit theory	
		Explain theories of enzyme action	K2
		Illustrate thermodynamics of enzyme action	K3
		Diescribe 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4
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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

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 Wileyand 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'sTaxonomic 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 environment	Identify the role of microbes in environment	K1
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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

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
CO1	Observe and examine how theory can be translated into practice (K1)	K1	1
CO2	Learn to estimate the concentration of biomolecules and to report findings. (K1)	K1	3,4
CO3	Familiar with calculations pertaining to preparation of reagents and buffers (K2)	K2	1
CO4	Inculcate ability to devise experiments and to correlate the results with underlying mechanisms (K2)	K2	6
CO5	Summarize their findings in the form of lab reports (K2)	K2	6
CO6	Formulate methodologies to purify and estimate biomolecules (K4)	K4	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'sTaxonomic 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 buffers and their applications	K2
		Contrast buffers based on pKa	K2
		Measure the pH of buffers and solutions	K5
Ex 3	Colorimetry –	Define Beer-Lambert's law	K2

	Preparation of standard curve and estimation of the concentration of solute in an unknown sample	Illustrate the importance of Beer-Lambert's law in analytical biochemistry and spectroscop	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 4	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 5	Chromatography –Paper Chromatography - Determining the Rf value of aminoacids and its separation- Thin layer Chromatography- Separation of Plant pigments	Recall and define the principles of chromatography	K1
		Explain the importance of solvents	K2
		Compare the effect of hydrophilic and hydrophobic solvents on solute separation	K2

		Apply chromatography techniquesto analyse Biomolecules amd other samples	K4
		Measure the R_f value of separated solutes	K5
6.	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

9. Periodical Assessment
10. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
11. Model Practical Examination
12. 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'sTaxonomic 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). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum).	Describe the different types of data found at the NCBI and EBI resources.	K2
2.2			
2.3			
2.4		Differentiate the various Level of protein database based on their structure.	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. Recognize main difference between nucleotide and protein sequences Retrieve relvant protein structures	K2 K4 K6

		from from the Biological databases.	
4.2	Protein structure visualization tools – Rasmol, SPDBv, PyMol,.	Explain the application of predicting protein structures	K2
		Describe the different types of protein structures. Recognize main difference between nucleotide and protein sequences Retrieve relevant protein structures from the Biological databases.	K2 K4 K4
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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

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
CO1	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, pleotropy, 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 - 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, 3rd edition, 2008
2	Heterosis and hybrid vigour	Genetics: A conceptual approach, Benjamin A.Pierce, W.H.Freeman and Company, Newyork, 3rd edition, 2008
3	Genetic symbol	Genetics: A conceptual approach, Benjamin A.Pierce, W.H.Freeman and Company, Newyork, 3rd edition, 2008
4	Homeostasis	Genetics: A conceptual approach, Benjamin A.Pierce, W.H.Freeman and Company, Newyork, 3rd 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'sTaxonomic 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 versus expected) using	K3

		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**		
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, pleotropy, 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	K2

		determination	
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 – 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	K2

		chromosomes	
4.2	Changes in chromosome structure - Deletion, duplications, inversions, translocations	Analyze the effects of changes in chromosome structure	K4
		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 sequences	K5
		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 probility in familial genetic disorders	K4

2. 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

5. Course Assessment Methods

Direct

1. Continuous Assessment Test I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER : III **COURSE CODE : U16BT3P3**

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
CO2	Test the capability of the chemical to cause mutation	K6	2
CO3	Analyze the polyploidy in onion root	K2	3
CO4	Create Models based on the Mendel law	K	4
CO5	Analyse the human karyotype	K4	5
CO6	Identify sex chromatin in buccal smear	K3	6

2. A Syllabus

Experiment List

1. Drosophila – Morphology, Section culture and maintenance.
2. Identification of Mutants—Physical and Chemical Methods.
3. Study of polyploidy in onion root tip.
4. Experiments to determine Mendel’s law.
5. Human karyotype - demonstration.
6. 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'sTaxonomic Level of Transaction
Ex 1	Drosophila – Morphology, Section culture and maintenance	Design culture media to culture drosophila	K6
Ex 2	Identification of Mutants—Physical and Chemical Methods	Test the chemical and physical mutagen	K6
Ex 3	Study of polyploidy in onion root tip.	Analyse polyploidy in onion root tip	K4
Ex 4	Experiments to determine Mendel's law	Illustrate Mendel's law	K2
Ex 5	Human karyotype - demonstration	Analyze the karyogram	K4
Ex 6	Sex chromatin (buccal smear) identification	Identify the presence of Barr Body	K3

4.Mapping Scheme:

U16BT3P1	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**

High – H **Medium- M** **Low- L**

5. Course Assessment Methods

Direct

13. Periodical Assessment
14. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
15. Model Practical Examination
16. End Semester Practical Examination

Indirect

1. Course-end survey

SEMESTER: III **COURSE CODE : U19BTC33**
CREDITS : 3 **HOURS/WEEK. : 4**

ALLIED:III: ALLIED CHEMISTRY-I

Course Outcomes:

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

S.No.	Course Outcomes	Level	Unit
1	Distinguish the geometry and shape of molecules using VSEPR theory	K4	I
2	Illustrate the mechanism for different basic organic reactions	K3	II
3	Compare the different concepts of acids and bases	K2	III
4	Explain the kinetics of chemical reactions	K3	IV
5	Summarize the applications of catalytic reactions	K2	IV
6	Identify different applications of colloids in day-to-day life	K2	V

Unit – I **Chemical Bonding** **12 Hours**

1.1 Ionic bond- Nature of Ionic bond–structure of NaCl, KCl & CsCl- Factors influencing the formation of ionic bond.

1.2. Covalent bond- nature of covalent bond–VSEPR theory - shapes of $BeCl_2$, BF_3, CH_4, PCl_5, IF_7,NH_3& H_2O.

1.3 Coordinate Bond–Nature of coordinate bond, Werner's theory and structure of some complexes - $Ni(CO)_4$, $[Co(NH_3)_6]Cl_3$, $K_4[Fe(CN)_6]$.

1.4. Hydrogen bonding-Theory of Hydrogen bonding - Inter and Intra molecularhydrogen bonding- consequences of hydrogen bonding, van der Waals and London Dispersive forces in simple molecules.

Unit- II **Types of Reactions**

12 Hours

2.1- Types of chemical reactions,Types of intermediates- Electrophiles – nucleophiles – free radicals.

2.2 – Substitution Reactions: Nucleophilic and electrophilic substitution with mechanism (one example for each), Addition Reactions (Addition of HBr on alkenes) – Elimination Reactions (Dehalogenation of alkyl halides) – Condensation Reactions (formation of ester).

2.3 – Polymerization Reactions (Formation of Poly vinyl Chloride) – Reduction reactions (Hydrogenation of oil)- Oxidation Reactions (Conversion of benzaldehyde to benzoic acid) .

UNIT- III **Solutions**

12Hours

3.1 Types of Solutions – Homogeneous and Heterogeneous, saturated and unsaturated,Mole Concept, Normality, Molarity, Molality and Parts per Million**–Problems.**

3.2 Primary and secondary standards and preparation of standard solutions -**Problems.**
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

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

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)**

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

Recommended Reference Books

1. J.D. Lee, "Concise Inorganic Chemistry", Oxford University Press, New Delhi, 2008.
2. Morrison and Boyd "Organic Chemistry" Pearson Education, 2016.
3. 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 Walls 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 solutionsSaturated 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 thehalf 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-MentonEquation .	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 **COURSE CODE: U19BTCP2**
CREDITS: 3 **HOURS/WEEK.:3**

ALLIED PRAC:III VOLUMETRIC AND ORGANIC ANALYSIS

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 complexationconcept to check water quality	**K3**
CO5	**I**dentify 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 oforganic 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	PSO1	PSO2	PSO3	PS04
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	K4	I

	immunity based on mechanism.		
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 medicated-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, 6th edition, 2007
2	Antigen presentation	Immunology, Kuby, W.H.Freeman and Company, Newyork, 6th edition, 2007

3	Early vaccination study	Immunology, Kuby, W.H.Freeman and Company, Newyork, 6th edition, 2007
4	Anti-inflammatory agents	Immunology, Kuby, W.H.Freeman and Company, Newyork, 6th 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'sTaxonomic 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 K3
		Illustrate the structure of MHC molecules	

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 drugs	K1
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 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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

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	1,2
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	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

Experiment List

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'sImmunobiology, 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'sTaxonomic 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

17. Periodical Assessment
18. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
19. Model Practical Examination
20. End Semester Practical Examination

Indirect

1. Course-end survey

SEMESTER 5

SEMESTER : V **COURSE CODE : U20BT505**

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 transposons.	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	Summarize the various types post transcriptional and post translational modification process.	K5	V

2. A Syllabus

UNIT-I **18Hrs**

Structure of DNA and RNA- Composition, Types and Functions, 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 ofDNA 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 -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- Post translational modifications-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'sTaxonomic 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	Summarize the Enzymes involved in	K5

	replication-DNA polymerases, DNA ligase, Primase, helicase, topoisomerase.	replication and its significance.	
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.	Evaluate how the DNA damage are detected at molecular level	K5
		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	K2

		of DNA repair mechanisms.	
		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 transposition.	K2
		Summarize the applications of transposable elements.	K5
3.3	Transcription and RNA processing: Transcription in Prokaryotes and Eukaryotes -Post transcriptional modifications. mRNA Capping-splicing-Polyadenylation	Describe the various steps involved in transcription .	K2
		Distinguish the prokaryotic and Eukaryotic transcription.	K4
		Explain the mechanism of mRNA capping.	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	Summarize the characteristics of genetic code.	K2

	genetic code - Deciphering of the codon-wobble hypothesis.	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	Describe gene expression and regulation mechanism of prokaryotes	K4
		Explain the steps involved in eukaryotic translation.	K4
		Differentiate eukaryotic and prokaryotic translation.	K4
4.3	Post translation modifications- Protein targeting.	Summarize the various types post translational modification process.	K5
		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	K4

		Summarize about different Operon models such as Lac,Tryp,Arb.	K5
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:

U20BT505	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

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 : U20BT506**

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- Restriction endonucleases Type I & II, DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, T4 DNA ligase, Terminal deoxynucleotidy1 transferase, Reverse transcriptase. Enzymes in Molecular Biology: Nucleases, T4polynucleotide kinase, linker, adaptors and homopolymerase.

Unit-II **18Hrs**

Vector: Different kinds of vector- Cloning and expression vectors. Cloning vectors for E. coli-Bacterial artificial chromosome.Cloning vectors for Eukaryotes: Yeast shuttle vector,

Yeast artificial chromosome, HAC, Phage life cycle- Viral vector, phage vector-Phage M13, phagemids, cosmids.

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.

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.

Unit –V **18Hrs**

Polymerase chain Reaction and DNA sequencing: Polymerase chain reaction (PCR): key concepts, Applications of PCR: Ligase chain reaction. Molecular Techniques: DNA Finger printing, RFLP and RAPD. Sequencing (chemical degradation; chain termination and automated sequence).Next generation 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 Sninskey J.J., 1995. PCR Strategies, Academic Press, San Diego.

4. Persing D.H., Smith K.T.F., Teower F.C., and While 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'sTaxonomic Level of Transaction
1	**Enzymes in Recombinant Technology**		
1.1	Enzymes in ecombinant Technology: Enzymes in Genetic engineering- Restriction endonucleases Type I & II, DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, T4 DNA ligase,	Explainthe role of enzymes in Gene cloning methods	K2
1.2		List out the enzymes involved in genetic engineering	K1
		Enumerate the role of enzymes in molecular cloning	K2

	Terminal deoxynucleotidy1 transferase, Reverse transcriptase.		
2	**Vectors**		
2.1	Vector: Different kinds of vector-Cloning and expression vectors. Cloning vectors for E. coli-Bacterial artificial chromosome.	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 vector, phage vector-Phage M13, phagemids, cosmids.	Illustrate the components of different cloning vectors.	K2
		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	Apply the different types of methods involved in gene transfer.	K3
		Restate the specific methods in accordance to their properties and mechanisms	K2

	methods- Agrobacterium mediated gene transfer.		
3.3	Expression system Prokaryotes- Bacteria Eukaryotes- Yeast, mammalian and insect cell lines	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.	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. Molecular Techniques: DNA Finger printing, RFLP and RAPD. Sequencing	Explainthe principles of molecular techniques	K2
		Relate the definite techniques to specific experiments	K2

	(chemical degradation; chain termination and automated sequence). Next generation sequencing		

4.Mapping

U20BT506	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 Assesement Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect

1. Course-end survey

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	Experiments
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	6,10
CO4	Describe the uses of biotechnology in medicine and agriculture	K1	7
CO5	Identify the purpose of screening and selection of gene transformation	K2	10
CO6	Explain the genetic engineering techniques at a molecular level	K2	9

2. A Syllabus

Experiment List

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'sTaxonomic 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	Experiment the skill of	K4

	of DNA. - Single and double digestion*	of DNA fragmentation using specific enzymes	
		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

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

21. Periodical Assessment
22. Record of results, Punctuality, Observation note maintenance, Regular Submission of results, Discussion of results obtained
23. Model Practical Examination
24. End Semester Practical Examination

Indirect

1. Course-end survey

SEMESTER : V **COURSE CODE : U16BT5:1**

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	Unit Covered
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	K4	IV

	distance transport in plants		
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; CO_2 fixation-C 3, C 4 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 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; 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. HopkinsAnd Norman P. A. Huner, Introduction to Plant Physiology, 4th 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; NewDelhi, 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 arvesting 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 C3, C4 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. Evaluate the significance of nitrate and ammonium assimilation	K2 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	Predict the responses of	K5

	biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses;	plants to biotic and abiotic factors.	
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

U16BT5:1	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 : U16BT5:2**

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: Introduction, types and characteristic features of the Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystem: Pond ecosystem, Ocean ecosystems.

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 (CO^2, SO_2, NOx , O_3 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 : Environmental Impact Assessment, Environmental planning and National Environment Policy :Objectives, principles, strategies and actions.

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'sTaxonomic Level of Transaction
1	**Concept of an Ecosystem**		

1.1	**Concept of an Ecosystem** 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**		
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
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	K1

		and age	
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),		K4
		Analyse the different types of pollutant based on its effect on human beings	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**		
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

4.Mapping Scheme

U16BT5:2	**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**
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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER : V **COURSE CODE : U19BT5:3**

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	K1	I

	the life cycle.		
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 of development - life cycles, Developmental patterns and evolution of differentiation, Experimental embryology, Role of genes in development, Amniocentesis.

UNIT-II **15Hrs**

Early Embryonic Development: Gametogenesis- Spermatogenesis and oogenesis, Types of eggs, Fertilization changes in gametes, mono and polyspermy; the early development of C. elegans -The early development of Xenopous cleavage, Gastrulation, Embryonic induction and organizers; the early development of chick cleavage, Gastrulation.

UNIT-III **15Hrs**

Later Embryonic Development: 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: Metamorphosis changes and hormonal regulation of metamorphosis in insects and amphibians, Regeneration modes of regeneration epimorphosis, Morphallaxis and compensatory regeneration (with one example), Ageing3 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;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.Specfic Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom'sTaxonomic 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 lifecycle	Outline the principles of development with its life cycle.	K1
1.4	History and anatomy	Interpret the development pattern and evolution of organisms	K1
1.5	Principles of lifecycle	Substantiate the origination of organisms and their specific developmental pattern with experimental proof.	K4
1.6	Genes in development &Aminocentesis	Recognize the role of genes involved in development & aminocentesis	K1
2	**Early embryonic development**		
2.1	Define early embryonic development	Enumerate Early embryonic development.	K1
2.2	Gametogenesis	Define Gametogenisis	K2
		Infer the various phases of Gametogenisis.	K2

2.3	Spermatogenesis	Define spermatogenesis.	K1
		Explain spermatogensis and its process.	K2
2.4	Oogenesis	Define oogenisis.	K1
		Explain the mechanism of oogenisis.	K2
		Interpret the control of oogenisis.	K2
2.5	Types of eggs, fertilization changes in gamates	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 spermy in fertilization and zygote formation	K4
2.7	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
2.8	Early development of Xenopus Cleavage, Gastrulation	Recognize the cleavage pattern of xenopus	K1
		Elaborate the process of fertilization in xenopus.	K2
2.9	Induction &organizers, early development of chick cleavage, gastrualtion	Interpret the model of organization in chick embryo.	K2
		Explain on chick cleavage and gastrulation on chick	K2
3	**Later Embryonic development**		

3.1	Later embryonic development, differentiation of germ layers, formation of neural tube	Restate the neural induction and establishment of neural cells.	K2
3.2	Skin, notochord, somites, coelom and digestive tubes	Illustrate on embryonic development with appropriate diagram.	K3
3.3	Extra embroyonic membranes in birds and humans	List out extra embroyonic membranes in birds and humans.	K1
3.4	Implantation of embryo	Define implantation	K1
		Illustrate the process of embryonic implantation	K2
3.5	Placentation-structure, types & physiology of placenta	Elucidate the structure of placenta. Classify the types of placenta.	K1
4	**Post embroyonic development**		
4.1	Post embroyonic development metamorphosis changes	Discuss on post embryonic development and metamorphic changes.	K2
4.2	Hormonal regulation of metamorphosis in insects and amphibians	Elaborate on metamorphosis in amphibian, and insects	K1
4.3	mode of regeneration epimorphosis	Define epimorphosis	K1
		Describe the mode of epimorphosis	K3
4.4	morphallaxis & compensatory regeneration	Interpret on morphallaxis regeneration in hydra.	K2
4.5	ageing 3 concepts	Define ageing	K1

	and model	Analyze on 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	Tetratogenesis-teratogenic agents and effects of teratogenic development.	Define Tetragenesis.	K1
		Relate the environmental assaults on human development in Tetrogenesis.	K2
5.5	embroyonic stem cells new generation stem cells in biomedical field.	Define embroyonic stem cells.	K1
		Distinguish stem cells	K4

4.Mapping

U19BT5:3	**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	-	-	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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER : V **COURSE CODE : U16BT5:4**

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).

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 ofMigration 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'sTaxonomic 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	1Product 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

U16BT5:4	**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

High – H **Medium- M** **Low- L**

5. Course Assessment Methods

Direct
1. Continuous Assessment Test I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER : V **COURSE CODE : U16BT5S2**

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.

UNIT-II **6 Hrs**

Collection of data primary and secondary -types and methods of data collection procedures -merits and demerits. Classification -tabulation and presentation of data -sampling methods.

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 -simple hypothesis -student't' test -chi square test, ANOVA,SPSS.

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

C. Web Links

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

3.Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Cognitive Level

1	**Biostatistics -definition -statistical methods**		
1.1	Biostatistics -definition - tatistical methods-basic principles. Variables-measurements, functions, limitations and uses of statistics.	Define the Basic Concepts of Biostatistics	K1
		Expalin the different Statistical Methods	K2
2	**Collection of data**		
2.1	Collection of data primary and secondary -types and methods of data collection procedures - merits and demerits.	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
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	Classify the concepts	K2

	dissimilarities of correlation and regression.	and theory between correlation and regression.	
5	**Statistical inference**		
5.1	Statistical inference - 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

4.Mapping

U16BT5S2	**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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER : V **COURSE CODE : U16BT5S3**

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.

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.

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.

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.

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. McGram-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'sTaxonomic Level of Transaction**
1	**Food -Uses and Nutrition**		
1.1	1.1 Brief introduction on Food and its uses	Define food.	K1
		List out the functions of food.	K1
1.2	1.2 Nutrition and its types	Define nutrition.	K1
		Classify the types of nutrition with example and nutritive value	K2
1.3	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

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 organoliptic properties of food	K2
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
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
4	**Food preservation**		
4.1	Introduction on Food preservation	Describe Food preservation.	K1
		Interpret the methods of preservation.	K2
4.2	High temperature-sterlization, 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 the quality	K2
4.5	Irradiation preservation of food	Discuss on food irradiation .	K2
5	**Manufacture of food products**		
5.1	Introduction on manufacturer of food	Explain the manufacturer of	K1

	products	various food products.	
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

U16BT5S3	**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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER 6

SEMESTER : VI **COURSE CODE : U20BT607**

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	Diagramatically 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, strain development strategies, immobilization methods, fermentation media, raw material used in media production, antifoaming agents, buffers, downstream processing

UNIT-II **18Hrs**

Fermentation equipment and its uses: fermentor design, Types of fermentors and fermentations- single, batch, continuous, multiple, surface, submerged and solid state.

UNIT-III **18Hrs**

Industrial products from microorganisms: antibiotics: production of penicillin, streptomycin. Interferons, vaccines, hormones, vitamins.

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. DubeyR.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	Diagramatically represent the fermentor design and its types	K4
2.2	Types of fermentors – Air Lift, Tower, Bubble Column, Anaerobic	Explain the working principle and applications of different	K4

		types of fermentors	
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 and vitamins.	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

U20BT607	**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 : U19BT608**

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: Cell lines- types and isolation, culture media-types and supplements, cell fusion, cell differentiation, maintenance and preservation of cell lines. Stem cells-types, preparation and applications

UNIT-II **18Hrs**

Gene transfer: Gene transfer methods-mechanical, chemical, 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 . Molecular genetics.

UNIT-IV **18Hrs**

Applications: Development of recombinant vaccines, 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.inmod/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

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	Cognitive Level
1	**Basic techniques in animal cell culture and organ culture**		
1.1	Basic techniques in animal cell culture and organ culture: Cell lines- types and isolation, culture media-types and supplements, cell fusion, cell differentiation, maintenance and preservation of cell lines.	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, 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 agriculture and medicine,	Employ transgenic technology in animal rearing	K3
3.3	Molecular genetics	Devise methods used in producing transgenic livestock	K4
4	**Applications**		
4.1	Applications:	Assess the	K5

	Development of recombinant vaccines, monoclonal antibody their applications,	possibility of producing novel products	
4.2	human genome project and gene therapy.	Extend the applications of recombinant technology	K2
4.3	Role of Biotechnology in treating animal diseases	Recomend 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

U19BT608	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	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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination

Indirect
1. Course-end survey

SEMESTER : VI **COURSE CODE : U19BT609**

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, Cytokininis 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. Invitro 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 tumifaciens 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.

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.
3. Near Stewart, C., Plant Biotechnology and Genetics: Principles, Techniques and Applications. Wiley India Private Limited. 2013.
4. Singh, B.D. Plant Biotechnology. Kalyani Publishers, India 2010.
5. 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'sTaxonomic Level of Transaction

1	**Lab Organization and Sterilization**		
1.1	Introduction - history - boratory 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'sMedia.	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, Cytokininis 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 embryogenesis.	K2
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	K2

		importance of various embryo culture and rescue in agricultural and horticultural crops .	
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..	Comparevarious methods of isolation of Protoplast.	K2
		Interpret the concept of Terminator seed concept .	K2
		Differentiate cybrid and hybrid.	K2
3.2	Gene transfer techniquesin plants: Agrobacterium tumifaciens mediated gene transfer- Features of TiPlasmid,molecular mechanism of T-DNA transfer. Physical gene transfer methods – ParticleBombardment, Electroporation and Microinjection	Distinguish the importance of transposable elements.	K2
		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

4.Mapping

2. Mapping Scheme

U16BT609	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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

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
CO1	Knowledge of techniques used in milk quality analysis	K1	2
CO2	Report the significance of extra cellular enzyme producers	K2	5
CO3	Describe basic working processes of fermentor	K2	6
CO4	Practice the preparation of plant and animal culture media	K4	7,11
CO5	Differentiate viable and non- viable cells	K5	13
CO6	Develop practical skills in plant and animal tissue culture techniques	K5	8,12

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'sTaxonomic 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 7	Aseptic seed germination	Execute the preparation of MS medium from the basic chemicals.	K3
		Explain the concept of aseptic seed germination.	K3
Ex 8	Direct organogenesis – shoot and root induction	Illustrate the technique of micropropagation	K3
Ex 9	indirect organogenesis – callus induction	Employ the technique of callus induction	K3
Ex 10	Synthetic seeds	Prepare synthetic seeds	K2
Animal Biotechnology			
Ex 11	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 12	Demonstration of primary cell culture.	Demonstrate the protocol of isolating cells from organs	K4
Ex 13	Viability and cell counting by trypan blue.	Assess the live and dead cells by trypan blue method	K3

4.Mapping

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 : U20BT6:1**

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. Digestion and absorption of carbohydrates, Lipids and proteins. Digestive system associated diseases and disorders.

UNIT-II **15Hrs**

Circulation, Musculoskeletal System: Structure of Heart and blood vessels, Functions of heart. Organs of circulatory system. Circulatory system associated diseases and disorders. Musculoskeletal 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. Respiratory diseases and disorders. Plasma, Lymph & Blood. Blood- cells, Hemoglobin, blood coagulation.

UNIT-IV **15Hrs**

Excretory system: Structure and functions of kidney. Organs of excretory system. Urine-composition and formation. Renal regulation of acid-base balance. Excretory system associated diseases and disorders

UNIT-V **15Hrs**

Central nervous system: General organization. Conduction of nerve impulse. Synaptic transmission. Brain chemical composition, neurotransmitters and Camp. Biochemical aspects of learning and memory. Central nervous system associated diseases and disorders

B. Topic for Self Study

S.No	Topics	Weblinks
1	LOX plays a number of key roles in promoting skin and organ fibrosis in scleroderma	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

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
5. 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/-
2.https://onlinecourses.nptel.ac.in/noc20_ch18/preview

3.Specific Learning Outcomes (SLO)

Units	Course Contents	Learning Outcomes	Highest Bloom'sTaxonomic 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	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 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. Circulatory diseases and disorders.	Compare the organs of circulatory system	K2
		Analyze diseases and disorders of	K4

		circulatory system.	
2.3	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. Respiratory diseases and disorders.	Reproduce the organs of respiratory system	K1
		Indicate the diseases and disorders of respiratory system.	K2
3.3	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	4.1 Structure and functions of kidney.	Recall the excretory system	K1
		Reproduce the structure of kidney	K1
		Explain the significance of kidney.	K2
4.2	4.2 Organs of excretory system.	Label the parts of excretory system	K1
4.3	4.3 Urine-composition and	Distinguish the components of urine-	K4

	formation. Renal regulation of acid-base balance.	Summarize the mechanism involved in urine synthesis	K2
		Explain the renal regulation of acid-base balance.	K2
4.4	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. 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	Appraise the diseases and disorders of central nervous system.	K4

4.Mapping

U20BT6:1	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	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
1. Continuous Assessment Test I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER : VI **COURSE CODE : U16BT6:2**

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.

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.

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. Patent and copyright Infringement, Patent and copyright misappropriation, and enforcement. Trade secret.

Unit – IV **15Hrs**

Bioethics: Introduction to ethics/bioethics – framework for ethical decision making; purpose and principles of bioethics, Bioethics in medical – drug testing, Informed consent and human cloning, Bioethics on religious rules and guidelines

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.Trayror 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	Cognitive Level
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
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	Discuss about patent	K2

	schemes Patent licensing and agreement Patent infringement-meaning, scope.	license agreement paid to the patent owner.	
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
		Explain the procedures and processing of Patents for products	**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
		Define the guidelines of bioethics	K1
5	**Biotechnology and ethics**		
5.1	Biotechnology and ethics: Benefits and risks of genetic	State the principal mechanisms of Genetic engineering.	K1

5.2	engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and bio warfare;	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
	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:

U16BT6:2	**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**
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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

NMEC COURSES

SEMESTER : III **COURSE CODE : U16BT3E1**

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
CO1	Outline the basic idea of Biotechnology and how it evolved into a new branch	K2	I
CO2	Describe the information regarding the various tools and techniques involved in making a recombinant DNA molecule	K2	II
CO3	Interpret the construction of recombinant DNA using vectors	K3	III
CO4	Indicate the various gene transfer methods that are in existence	K2	IV
CO5	Verify the properties of the transformed DNA molecule by screening methods	K2	V
CO6	Debate how to apply these acquired ideas in Biotechnology and put them into practice.	K4	V

2. A Syllabus

UNIT-I **6 Hrs**

Scope of Biotechnology. History of Biotechnology. Biotechnology Tree – Roots and Branches. Strategies of gene cloning.

UNIT-II **6 Hrs**

Tools used in gene cloning – Restriction endonucleases – Types – Features. Ligases – Linkers & adaptors. Modifying enzymes – Nucleotide kinase, Alkaline phosphates. Gene amplification by PCR.

UNIT-III **6 Hrs**

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

UNIT-IV **6 Hrs**

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

UNIT-V **6 Hrs**

Properties of *E.coli*as good hosts. Selection of recombinants – Reporter genes, Colony hybridization.

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
4. Brown T.A., Gene Cloning and DNA Analysis, Blackwell Science, Osney Mead, Oxford, 2010
5. Singh B. D., Biotechnology, Kalyani Publishers, New Delhi, 2015

E. Web Links

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

3.Specific Learning Outcomes (SLO)

Units	**Course Contents**	**Learning Outcomes**	**Highest Bloom'sTaxonomic Level of Transaction**
1	**Scope of Biotechnology**		
1.1	Scope of Biotechnology. History of Biotechnology. Biotechnology Tree – Roots and Branches.	Describe the importance of Biotechnology subject	K2
1.2	Strategies of gene cloning.	Explain the basic steps involved in creating a	K2

		recombinant molecule.	
2	**Tools used in gene cloning**		
2.1	Tools used in gene cloning – Restriction endonucleases – Types – Features. Ligases – Linkers & adaptors. Modifying enzymes – Nucleotide kinase, Alkaline phosphates.	Relate the role of basic molecular tools in creating a recombinant molecule	K2
2.2	Gene amplification by PCR.	Contrast the alternate method for gene cloning	K2
3	**Vectors**		
3.1	Vectors – Properties of good Vector .Constructed plasmids- pBR322. Cosmid vectors, Animal vectors- SV40. Plant vectors- Ti derivatives.	Compare and distinguish the various types of vectors	K2
4	**Introduction of genes**		
4.1	Introduction of genes – Vector mode – transformation and transfection. Vector less mode –Biolistics, Electroporation, Microinjection	Interpret examples of many kinds of both vector based and vector less ways of transferring the genes	K3
5	**Selection of recombinants**		
5.1	Properties of *E.coli* as good hosts.	Judge the frequent use of *E.coli* for recombinant experiments	K5
5.2	Selection of recombinants – Reporter genes, Colony hybridization.	Point out the important selection methods used in screening	K4

4.Mapping

U16BT3E1	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	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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey

SEMESTER : IV **COURSE CODE : U16BT4E2**

CREDITS : 2 **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. A 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'sTaxonomic Level of Transaction**
1	**Plant biotechnology**		
1.1	Plant biotechnology-Role of tissue culture in agriculture, horticulture and	Describe the importance of biotechnology in plant science	K2

	forestry,		
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 animal Cells,	Relate the methods of vaccine production among different animals.	K3
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	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	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 I,II 2. Open book test; Cooperative learning report, Assignment; Journal paper review, Group Presentation, Poster preparation, Prototype or Product Demonstration etc. 3. End Semester Examination
Indirect
1. Course-end survey