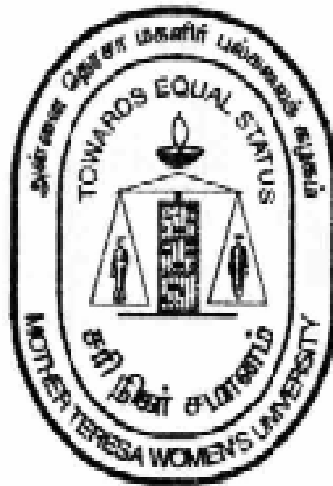


MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL - 624 102
Tamil Nadu.



UGC-Non-SAP, DST-CURIE and DST-FIST Assisted

DEPARTMENT OF BIOTECHNOLOGY

Curriculum Framework and Syllabi for

M.SC. BIOTECHNOLOGY (FIVE YEAR INTEGRATED PROGRAMME)

(For the candidates to be admitted from the academic year 2020-2021 onwards)

(UNDER CHOICE BASED CREDIT SYSTEM- CBCS)

PREAMBLE

Mother Teresa Women's University, whose foundation stone was laid by St. Mother Teresa herself, stands as an epitome of Women empowerment. The University stands as the first and the only Women's University in the State, and the third University in the Nation. With emphasis on research, supported by strong postgraduate programs in various disciplines, the University fosters high quality research activities in various disciplines at M.Phil. and Ph.D. levels.

Department of Biotechnology was started in 2002 with a vision to make an impact through research and technology based training. It is DST Curie, DST-FIST and UGC-Non-SAP sponsored Department. The Department is equipped with sophisticated instruments like GC-MS, HPLC, Multiplex PCR, Fluorescence Microscope, FTIR, XRD and many more. Skill and Employability based curriculum is the specialty of M.Sc Biotechnology (Integrated).

VISION

- ❖ To emerge into a top-notch International Women's University by creating empowered and socially responsible woman achievers through excellence in teaching, research and extension and enabling them to attain gender equity.

MISSION

- ✚ Striving for excellence in the tripartite goal of teaching, research and extension
- ✚ Promoting the educational standard of women at all levels
- ✚ Identifying and addressing the emerging trends and needs
- ✚ Providing community based learning experience
- ✚ Promoting community issues-based research activities with global standards
- ✚ Developing intellectual professionals with ethics for the benefit of mankind and environment.
- ✚ Extending collaborative and innovative research work for National Development.
- ✚ Equipping the learners with employability skills and groom them as Capacity Builders.
- ✚ Promoting global entrepreneurs addressing the market challenges.

M.SC. BIOTECHNOLOGY (FIVE YEAR INTEGRATED)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- PEO1:** To train the graduates to be the best practitioners of their chosen field
PEO2: To enable the learners to be socially responsible and accountable professionals
PEO3: To motivate the graduates to contribute to the economic growth of the country
PEO4: To encourage the students to pursue higher studies in their chosen field
PEO5: To enable them to be sustainable citizens and professionals in their chosen fields

PROGRAMME SPECIFIC OUTCOMES (PSOs):

On completion of M.Sc Biotechnology (5yr. Integrated) programme, graduates will be able to

- PSO1:** Gain and apply knowledge to plan, analyze and find innovative solutions in the field of biological sciences.
PSO2: Explore problems and provide valid solutions through the industry-academia interactions.
PSO3: Acquire interdisciplinary knowledge in the areas of biological, chemical, environmental and technical sciences for the benefit of society.
PSO4: Use modern software tools for sequence alignment and structure prediction, molecular

modeling and data acquisition for genome and proteome analysis.

PSO5: Realize personal and social responsibilities related to modern biotechnological research, environmental safety, ethical issues and intellectual property and develop entrepreneurial skills.

PROGRAMME OUTCOMES (POs):

On completion of M.Sc Biotechnology (5yr. Integrated) programme, graduates will be able to

PO1: demonstrate knowledge of basic concepts, principles and application of the specific science discipline.

PO2: cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.

PO3: ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures and safety measures.

PO4: demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data and provide solutions.

PO5: exhibit the potential to effectively accomplish tasks in diverse teams

PO6: communicate effectively to ascertain their professional acumen

PO7: analyze the impact of scientific and technological advances on the environment and society, and contribute towards sustainable development.

PO8: emerge as professionally, ethically strong and integral personalities

Regulations:

1. Qualification for Admission:

- i. Candidate should have passed a Higher Secondary Examination conducted by the Board of Higher Secondary Education, Government of Tamil Nadu/CBCS/ICS within the following science subject group Physics, Chemistry, Botany/Zoology or relevant subjects.
- ii. Candidates sponsored by industries/hospitals/Clinical laboratories may be considered for admission.

2. Duration of the course:

The students will undergo the prescribed course of study for a period of not less than five academic years (Ten semesters).

3. Medium of Instruction: English

4. Subject of Study: As given in Appendix A

5. PASSING MINIMUM

THEORY

University Semester Examination (ESE) - 75 marks

Continuous Internal Assessment (CIA) - 25 marks

Classification of Internal Assessment Structure

Marks

3 internals each 10 marks - 30 Marks

Seminar - 10 Marks

Assignment - 10 Marks

Average - 50/2 Marks

Total = 25 Marks

Passing minimum (CIA) 50% - 13 Marks

Passing minimum (ESE) 50% - 37 Marks

Total Passing minimum = 50 Marks

PRACTICAL

University Semester Examination (ESE) - **75 Marks**

Continuous Internal Assessment (CIA) - **25 Marks**

6. Eligibility of the degree:

Candidates will be eligible if they complete the course with the required credits and pass in the prescribed examinations.

7. The candidate requires 75% of attendance to attend the semester exam.
8. The passing minimum is 50 % (both in internal and external separately) in each paper.
9. The candidate has to undergo projects individually.
10. Extra credit courses are all compulsory.

Extra credit courses:

1. **Online Courses:** UGC Approved courses like NPTEL, MOOC, etc., relevant to the Programme can be selected. It should be minimum 8 weeks course. When the online course completion certificate is produced within the stipulated time, extra credits will be included in the mark statement.
2. **Intenships:** Authorization letter from the Institution/ company/Laboratory etc.. where internship for minimum 25 day was carried out should be submitted along with a report of work to the department to get extra credits.

11. Continuous Assessment- Project

Internal (25 marks)

- | | |
|--|----------|
| • 1 st presentation (Title, Abstract, guide) (1 st week) | 10 marks |
| • 2 nd presentation (Procedure, budget) (2 nd week) | 10 marks |
| • Continuous assessment | 60 marks |
| • 3 rd presentation(before submission) | 20 marks |

External (75 marks)

- | | |
|----------|----------|
| • Report | 50 marks |
| • Viva | 25 marks |

12. Question pattern

Part A	10x1 marks=10 marks (Objective type/Multiple Choice) 2 question from each unit	10
Part B	5x4 marks=20 marks (Either/ or Choice – Two questions from each unit)	20
Part C	3x15 marks = 45 (Open Choice – 3 out of 5 questions)	50
	Total	75

The Internal assessment for Practical :25

The External assessment for Practical :75

MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL
IPG-MBT- M.Sc INTEGRATED BIOTECHNOLOGY
SYLLABUS 2020-2021

Appendix A

Course Code	COURSE TITLE	Hours/Week		Credits	MARKS		
		L	P		CIA	ESE	Total
Semester -I							
ITAM11	Language : Tamil-1/other lanaguage-1	4		3	25	75	100
IENG11	Language :English-1	4		3	25	75	100
IBTT11	Core 1 : Professional English	4		4	25	75	100
IBTT12	Core 2 : Cell biology	5		4	25	75	100
IBTT13	Core 3: Biodiversity	5		4	25	75	100
IBTA11	Allied Theory 1: Chemistry	5		4	25	75	100
IVAE11	Value Education	3		3	25	75	100
Total Credits		30		25			
Semester -II							
ITAM22	Language :Tamil-2/ other lanaguage-2	4		3	25	75	100
IENG22	Language : English-2	4		3	25	75	100
IBTT21	Core 4 : Professional English	5		4	25	75	100
IBTT22	Core 5 : Basic microbiology and genetics	5		4	25	75	100
IBTP21	Core practical -I: Cell biology and microbiology		5	4	25	75	100
IBTA22	Allied practical -I: Chemistry		5	4	25	75	100
IEVS21	Environmental Studies	2		2			
Total Credits		30		24			
Semester -III							
ITAM33	Language :Tamil-3 / other lanaguage-3	6		3	25	75	100
IENG33	Language: English-3	6		3	25	75	100
IBTT31	Core 6 : Fundamental Biochemistry	5		4	25	75	100
IBTA31	Allied Theory 2: Plant and Animal physiology	5		4	25	75	100
***	Departmental Elective I	4		3	25	75	100
**	Non Major Elective I	2		2	25	75	100
IBTS31	Skilled based studies- I: Herbal technology	2		2	25	75	100
IBTI31	Internship-1	-		1*			
IBTO31	Online course-1	-		2*			
Total Credits		30		21+3*			
Semester -IV							
ITAM44	Language : Tamil-4/ other lanaguage-4	6		3	25	75	100
IENG44	Language : English-4	6		3	25	75	100
IBTT41	Core 7 : Principles of molecular	4		4	25	75	100

	biology						
IBTP41	Core practical- II: Biochemistry and molecular biology		4	4	25	75	100
IBTA42	Allied practical –II: Plant and animal physiology	3		4	25	75	100
***	Departmental Elective –II	3		3	25	75	100
**	Non Major Elective- II	2		2	25	75	100
IBTS42	Skilled based studies- II : Medical Laboratory technology	2		2	25	75	100
Total Credits		30		25			
Semester -V							
IBTT51	Core 8 : Biostatistics	5		4	25	75	100
IBTT52	Core 9 : Immunology	5		4	25	75	100
IBTT53	Core 10 : Developmental Biology	5		4	25	75	100
IBTT54	Core 11: Basic Bioinformatics	5		4	25	75	100
IBTT55	Core 12: Recombinant DNA technology	5		4	25	75	100
***	Departmental Elective- III	3		3	25	75	100
IBTS53	Skilled based studies –III: Patent and paper/project writing	2		2	25	75	100
Total Credits		30		25			
Semester -VI							
IBTT61	Core 13: Cell and tissue culture	5		4	25	75	100
IBTT62	Core 14: Enzyme technology	5		4	25	75	100
IBTT63	Core 15: Environmental Biotechnology	5		4	25	75	100
IBTP61	Core practical –III: Immunology and Recombinant DNA technology		5	4	25	75	100
IBTP62	Core practical –IV: Environmental Biotechnology and bioinformatics		5	4	25	75	100
***	Departmental Elective- IV	3		3	25	75	100
IBTS64	Skilled based studies –IV: Effective communication and personality development	2		2	25	75	100
IBTEX	Extension activity NCC, NSS, YRC, YWF, RRC	-		3	25	75	100
Total Credits		30		28			
Semester I-VI Total Credits				148+3*			

Course Code	COURSE TITLE	Hours/ Week		Credits	MARKS		
		L	P		CIA	ESE	Total
Semester -VII							
IBTT71	Core 16: Advanced biochemistry	6		5	25	75	100
IBTT72	Core17: Applied microbiology	6		5	25	75	100

IBTT73	Core 18: Molecular biology and genetics	6		5	25	75	100
IBTP71	Core Practical-V: Advanced biochemistry, microbiology and molecular biology		6	5	25	75	100
***	Departmental Elective V	6		5	25	75	100
IBTI72	Internship-2	-	1*				
Total Credits		30		25+1*			
Semester -VIII							
IBTT81	Core 19: Immunology and Immunotechnology	6		5	25	75	100
IBTT82	Core 20:Pharmaceutical Biotechnology	6		5	25	75	100
IBTT83	Core 21: Animal biotechnology	6		5	25	75	100
IBTP81	Core Practical-VI: Immuno technology and Animal Biotechnology		6	5	25	75	100
***	Departmental Elective VI	6		5	25	75	100
Total Credits		30		25			
Semester -IX							
IBTT91	Core 22: Plant biotechnology	6		5	25	75	100
IBTT92	Core 23: Bioinstrumentation and biostatistics	6		5	25	75	100
IBTT93	Core 24: Omics and Genome Editing	6		5	25	75	100
IBTP91	Core practical-VII: Plant Biotechnology & Genome Editing		6	5	25	75	100
***	Departmental Elective VII	6		5	25	75	100
Total Credits		30		25			
Semester -X							
IBTT101	Core 25 :Bioethics, Biosafety and IPR	6		5	25	75	100
IBTT102	Core 26:Bioprocess technology	6		5	25	75	100
IBTPROJ	Dissertation/Project	18		5			
IBTO102	Online course-2	-	2*				
Total Credits		30		15+ 2*			
Semester VII-X Total Credits						90 + 3*	
Semester I-X Total Credits						238+6*	

*Extra credits

****Non Major Elective:**

IBTNFC-Choice 1: Forest conservation

*****Departmental Elective:**

IBTNSB-Choice 1: Stem cell biology

IBTNPC-Choice 2: Phytochemistry

IBTNMM-Choice 3: Molecular Modeling and drug designing

IBTNNC-Choice 4: Nanotechnology and cancer biology

IBTNED- Choice 5: Entrepreneur Development

IBTNBB-Choice 6: Biobusiness

IBTNID-Choice 7: Industrial Fermentation and Distillation products

IBTNFP-Choice 8: Food processing Technology

IBTNWL-Option 9 : Wild life conservation

IBTNIM-Choice 10: Industrial waste management

IBTNHP-Choice 11: Human pathology

IBTNPM-Choice 12: Public health and management

IBTNDM-Choice 13: Drug metabolism

IBTNSB-Choice 14: System biology

Average percentage of Courses Having Focus on Skills

S.No	Core Theory	Courses	Employability	Skill	Entrepreneurship	Knowledge
1	Core 1 (theory)	Professional English		Y		
2	Core 2 (theory)	Cell biology				Y
3	Core 3 (theory)	Biodiversity	Y			
4	Core 4 (theory)	Professional English		Y		
5	Core 5 (theory)	Basic microbiology and genetics				Y
6	Core 6 (theory)	Funtamental biochemistry				Y
7	Core 7 (theory)	Principles of molecular biology				Y
8	Core 8 (theory)	Bioinformatics				Y
9	Core 9 (theory)	Immunology	Y			
10	Core 10 (theory)	Developmental biology				Y
11	Core 11	Basic bioinformatics				Y

	(theory)					
12	Core 12 (theory)	Recombinant DNA technology	Y			
13	Core13 (theory)	Cell and tissue culture	Y			
14	Core 14 (theory)	Enzyme technology	Y			
15	Core 15 (theory)	Environmental biotechnology	Y			
16	Core 16 (theory)	Advanced biochemistry	Y			
17	Core 17 (theory)	Applied microbiology	Y			
18	Core 18 (theory)	Molecular biology and genetics	Y			
19	Core 19 (theory)	Immunology and immunotechnology	Y			
20	Core 20 (theory)	Pharmaceutical biotechnology	Y			
21	Core 21 (theory)	Animal biotechnology			Y	
22	Core 22 (theory)	Plant biotechnology			Y	
23	Core 23 (theory)	Bioinstrumentation and biostatistics	Y			
24	Core 24 (theory)	Omics and Genome editing	Y			
	Total		13	2	2	7

S.No	Major Practicals	Courses	Employability	Skill	Entrepreneurship	Knowledge
25	Major practical I	Cell biology and microbiology			Y	
26	Major practical II	Biochemistry and molecular biology			Y	
27	Major practical III	Immunology, biostatistics and bioinformatics			Y	
28	Major practical-IV	Environmental Biotechnology and Bioinformatics		Y		
29	Major	Advanced			Y	

	practical-V	biochemistry, Microbiology and Molecular biology				
30	Major Practical-VI	Immuno technology and Animal biotechnology		Y		
31	Major Practical-VII	Plant biotechnology & Genome Editing		Y		
	Total			3	4	

S.No	Allied Theory	Courses	Employability	Skill	Entrepreneurship	Knowledge
32	Allied theory - I	Chemistry				Y
33	Allied theory-II	Plant and Animal physiology	Y			
	Total		1			1

S.No	Allied Practicals	Courses	Employability	Skill	Entrepreneurship	Knowledge
34	Allied practical – I	Chemistry		Y		
35	Allied practical – II	Plant and animal physiology		Y		
	Total			2		

S.No	Skill Based Studies	Courses	Employability	Skill	Entrepreneurship	Knowledge
36	Skilled based studies I	Herbal technology		Y		
37	Skilled based studies II	Medical laboratory technology		Y		
38	Skilled based studies III	Patent and paper/project writing		Y		

39	Soft skill	Effective communication and personality development		Y		
	Total			4		

S.No	Non Major Elective	Courses	Employability	Skill	Entrepreneurship	Knowledge
40	Elective VIII IBTNFC	Choice 1: Forest conservation	Y			
	Total		1			

S.No	Electives	Courses	Employability	Skill	Entrepreneurship	Knowledge
41	Elective I IBTNSB	Choice 1: stem cell biology		Y		
42	Elective II IBTNPC	Choice 2: phytochemistry	Y			
43	Elective III IBTNM M	Choice 3: Molecular Modeling and drug designing		Y		
44	Elective IV IBTNNC	Choice 4: nanotechnology and cancer biology		Y		
45	Elective V IBTNED	Choice 5: Entrepreneur Development			Y	
46	Elective VI IBTNBB	Choice 6: Biobusiness			Y	
47	Elective VII IBTNID	Choice 7: Industrial Fermentation and Distillation	Y			

		products				
48	Elective – IBTNFP	Choice 8:food processing technology	Y			
49	Elective-IBTNWL	Choice 9 : Wild life conservation	Y			
50	Elective-IBTNIM	Choice 10: Industrial waste management		Y		
51	Elective-IBTNHP	Choice 11: Human pathology				Y
52	Elective-IBTNPM	Choice 12: Public health and management				Y
53	Elective-IBTNDM	Choice 13: Drug metabolism				Y
54	Elective-IBTNSB	Choice 14: System biology	Y			
	Total		5	4	2	3

ABSTRACT

Courses	Employability	Skill	Entrepreneurship	Knowledge
Core Theory	13	2	2	7
Major Practical		3	4	
Allied Theory	1			1
Allied Practical		2		
Skill Based Studies		4		
Non Major Elective	1			
Elective	5	4	2	3
PERCENTAGE	20	15	8	11
	37	28	15	20
TOTAL PERCENTAGE	100			

SEMESTER I

Course Title & Code	CORE 1 (Theory) –PROFESSIONAL ENGLISH– IBTT11		
Semester	Semester-I	Credits:4	Hours/weeks: 4
Learning Objective	<ul style="list-style-type: none"> • To develop the language skills of students by offering adequate practice in professional contexts. • To enhance the lexical, grammatical and socio-linguistic and communicative competence of first year physical sciences students • To focus on developing students’ knowledge of domain specific registers and the required language skills. • To develop strategic competence that will help in efficient communication • To sharpen students’ critical thinking skills and make students culturally aware of the target situation. 		
Course Outcomes	<p>Upon completion of this course, the students will be able to</p> <ul style="list-style-type: none"> • Recognise their own ability to improve their own competence in using the language • Use language for speaking with confidence in an intelligible and acceptable manner • Understand the importance of reading for life • Read independently unfamiliar texts with comprehension • Understand the importance of writing in academic life • Write simple sentences without committing error of spelling or grammar 		
Unit I	<p>COMMUNICATION: Listening: Listening to audio text and answering questions - Listening to Instructions Speaking: Pair work and small group work. Reading: Comprehension passages –Differentiate between facts and opinion Writing: Developing a story with pictures. Vocabulary: Register specific - Incorporated into the LSRW tasks</p>		
Unit II	<p>DESCRIPTION: Listening: Listening to process description-Drawing a flow chart. Speaking: Role play (formal context) Reading: Skimming/Scanning- Reading passages on products, equipment and gadgets. Writing: Process Description –Compare and Contrast, Paragraph-Sentence Definition and Extended definition-Free Writing. Vocabulary: Register specific -Incorporated into the LSRW tasks.</p>		

Unit III	<p>NEGOTIATION STRATEGIES: Listening: Listening to interviews of specialists / Inventors in fields (Subject specific) Speaking: Brainstorming. (Mind mapping). Small group discussions (Subject- Specific) Reading: Longer Reading text. Writing: Essay Writing (250 words) Vocabulary: Register specific - Incorporated into the LSRW tasks</p>
Unit IV	<p>PRESENTATION SKILLS: Listening: Listening to lectures. Speaking: Short talks. Reading: Reading Comprehension passages Writing: Writing Recommendations Interpreting Visuals inputs Vocabulary: Register specific -Incorporated into the LSRW tasks</p>
Unit V	<p>CRITICAL THINKING SKILLS: Listening: Listening comprehension- Listening for information. Speaking: Making presentations (with PPT- practice). Reading: Comprehension passages –Note making. Comprehension: Motivational article on Professional Competence, Professional Ethics and Life Skills) Writing: Problem and Solution essay– Creative writing –Summary writing Vocabulary: Register specific - Incorporated into the LSRW tasks</p>

Course Title & Code	CORE 2 (Theory) – CELL BIOLOGY – IBTT12		
Semester	Semester-I	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To acquaint students with the concepts in Cell Biology. • To understand the structure and function of cell organelles • To learn the cell-cell interactions, transport mechanism and signaling pathways of cell 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Acquire Knowledge on cell structure and function of cellular organelles and components K1	
	CO2:	Analyze the behavior of cells in their microenvironment as multicellular structures K4	
	CO3:	Illustrate specific processes and components involved in membrane transport K4	
	CO4:	Understand receptor subclasses and their possible uses in cell signaling K2	
	CO5:	Understand the Mode of action and regulation of signaling molecules for signal transduction K2	

Unit I	Basics of Cells- Origin of life, history of cell and Cell Theory. Structure of prokaryotes and eukaryotic cell. Comparison between plant and animal cells; Cytoplasm; Chemical components of cells. Structure and function of Cell wall; Ultra Structure of Plasma membrane; Molecular organization-lipids and membrane proteins, Molecular models of plasma membrane. Cytoskeleton.
Unit II	Structure and functions of Cell Organelles - Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, peroxisome, endosome and microbodies, glyoxisome, lysosome, centriole, cilia and flagella. Ultra structure of Chromosome, Specialized Chromosomes
Unit III	Cell transport and traffic -Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting. Transport in prokaryotic cells, entry of viruses and toxins into the cell. Cell junction, Cell adhesion, Extra Cellular Matrix
Unit IV	Cell division and cell cycle -Cell cycle and molecules that control cell cycle, Regulation of cell cycle. Cell division: Mitosis and meiosis and their regulation, Apoptosis, Neoplasia and cell death.
Unit V	Cell Signaling molecules and their receptors -Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. Cytosolic, nuclear and membrane bound receptors: G-protein coupled receptor, protein tyrosine kinases receptor and cytokine receptors for cell signaling. Different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction, phosphorylation and regulation in signaling: serine – threonine kinases in signaling. Role of Inositol triphosphate (IP3) in signal transduction, calcium ion flux and its role in cell signaling.
References	<ol style="list-style-type: none"> 1. Bruce Alberts <i>et al.</i>, Essential Cell Biology, Taylor and Francis Group, 2014. 2. John K. Young, Introduction to Cell Biology, World Scientific, 2010. 3. George Plopper, Principles Cell Biology, Jones & Bartlett Publishers, 2016 4. Aubrey Stimola, Cell Biology, The Rosen Publishing Group, 2011. 5. G. Cooper, G. M. The Cell - A Molecular Approach.5th edition. ASM and Sinauer Press, Washington. 2009 . 6. De Robertis & De Robertis, Cell Biology, 4th Edition, 2010. 7. Lodish, H. and D. Baltimore, Cell Biology, W.H. Freeman publishers, 2012. 8. Gerald Karp, Cell and Molecular Biology, John Wiley and sons Inc, 2013.
E-reference links:	<ol style="list-style-type: none"> 1. https://www.mysciencework.com/publication/download/lecture-notes-cell-biology-1636c320/adc18b1228577d5353c56fdf7b69b6de 2. https://gurukpo.com/Content/Bsc-biotech/Cell_Biology.pdf 3. https://www.microscopemaster.com/cell-biology.html 4. https://microbenotes.com/category/cell-biology/

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	M
CO5	S	S	S	S	S	S	M	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks

Moderately Correlating	(M)	- 2 marks
Weakly Correlating	(W)	- 1 mark
No Correlation	(N)	- 0 mark

Course Title & Code	CORE 3 (Theory) – BIODIVERSITY – IBTT13		
Semester	Semester-I	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To understand the components and to learn the tools of biodiversity. To have an insight on impacts on biodiversity. To impart knowledge for biodiversity conservation. 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Acquire knowledge on the concepts and values of biodiversity and its conservation K1	
	CO2:	Understand the global patterns of biodiversity K2	
	CO3:	Assess the impacts on biodiversity K4	
	CO4:	Analyze the ethics and social responsibilities K4	
	CO5:	Formulate scientific intervention tools for conservation K3	
Unit I	Introduction to Biodiversity- Biodiversity-Definition- Biodiversity and kingdom of living organisms -Types-Diversity of Genes (genetic diversity) species (species diversity) and ecosystems (ecosystem diversity). Importance of biodiversity. Global distribution of richness, Centres of species diversity, Mega diversity centres , Hot spots and biodiversity in India.		
Unit II	Studies of Biodiversity- Assessment of mapping of biodiversity; GIS/Remote sensing; Species diversity- Measurement , Hot spot analysis . Representative type (one each) studies from Cryptogams, Phanerogams ; Sacred flora and fauna, Endemic plants and animals. Cataloging and Discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species), GAP Analysis		
Unit III	Impacts on Biodiversity- Bio-prospecting, Biopiracy, Hybridized plants, GM crops Bio-prospecting Botanicals for Biocontrol and Health, Threats to biodiversity predator control, exotic introductions, parasites and diseases. Overexploitation threatening living species, Animals threatened by International trade, Common patterns of over exploitation. Link between microbial diversity and ecosystem processes		
Unit IV	In situ Conservation of biodiversity- (Biosphere reserves, National parks, Sanctuaries), Botanical Gardens; Wildlife Sanctuaries, Preservation of wet lands; protection measures taken at global level. Social movement for biodiversity conservation- Chipko movement and Appiko movement. CITES, WWF, NBPGR, IUCN; ICZN rules and their role. Loss of biodiversity and restoration		

Unit V	Ex situ Conservation of biodiversity - (Cryopreservation, Germplasm banks, Gene banks, Sperm banks, DNA banks, Tissue culture and Biotechnological strategies). Environmental and biodiversity laws.
Reference	<ol style="list-style-type: none"> 1. Aber, J.D. and Melillo J.M., Terrestrial Ecosystems: W.B. Saunders, 2011. 2. Ingrowille, M Diversity and Evolution of land plants Chapman and Hall, 2002. 3. Gaston KJ, Spicer JI. Biodiversity – an introduction 4th edition, Blackwell, 2014. 4. Wilson EO, The diversity of life, Harvard University Press, 2010. 5. Krishnamurthy KV, Textbook of biodiversity, Taylor and Francis, 2017 6. Richard BP, Principles of Conservation Biology, 4th edition, Sinauer Associates, Inc.. 2016.
E-referenc e links:	<ol style="list-style-type: none"> 1. https://www.amnh.org/research/center-for-biodiversity-conservation/about-the-cbc/what-is-biodiversity 2. https://www.researchgate.net/publication/294876262_Biodiversity_Concept_Threats_and_Conservation 3. https://ncert.nic.in/ncerts/l/lebo115.pdf 4. https://www.unesco.pl/fileadmin/user_upload/pdf/BIODIVERSITY_FACTSHEET.pdf 5. https://www.biodiversitya-z.org/content/biodiversity.pdf 6. http://www.oecd.org/env/resources/OECD-work-on-biodiversity-and-ecosystems.pdf

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	M	S	S	S
CO2	S	M	M	S	S	S	S	S	S	M	S	S	S
CO3	S	M	S	M	S	S	S	S	S	M	S	S	S
CO4	S	M	S	M	S	S	S	S	S	M	S	S	S
CO5	S	S	S	S	S	S	S	M	S	M	S	S	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	ALLIED THEORY-I - CHEMISTRY – IBTA11		
Semester	Semester-I	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand		
Learning Objective	<ul style="list-style-type: none"> • To make non-chemistry students to get exposed to day to day Chemistry related materials and science. • To learn the terms and definitions in general chemistry and use of popularly used chemicals. • To understand the basics of thermodynamics, Nuclear chemistry and electrochemistry 		
Course Outcomes	At the end of the course, the student will be able to		
	CO1:	Able to understand the bonding of orbitals. K1	
	CO2:	Ability to understand the concepts in Nuclear Chemistry and Electrochemistry. K2	
	CO3:	Ability to understand the role of fertilizers in plant growth. K2	
	CO4:	Get exposed the chemistry related materials and science K2	
	CO5:	Able to understand the basics of Thermodynamics K2	
Unit I	Concepts of Chemical Bonding: Chemical Bonding - Molecular orbital theory - Bonding, Anti bonding and Non – bonding molecular orbitals - Energy order of MO's - Diamagnetism and Para magnetism - Bond order – Molecular orbital configuration of H ₂ , N ₂ , O ₂ and F ₂ . Interhalogen compounds: ICl, BrF ₃ , IF ₅ - Preparation, properties, hybridization and structure, shape.		
Unit II	Thermodynamics : Basic concepts - scope and limitations - Thermodynamic terms - intensive and extensive properties - state, equilibrium -isothermal reversible and irreversible expansion works of an ideal gas - Zeroth law of thermodynamics - Internal Energy and First law of thermodynamics – Second law of thermodynamics- Entropy and its significance-Carnot cycle- bomb calorimeter		
Unit III	Electrochemistry: Electrode potential – Nernst equation – derivation and problems based on single electrode potential calculation, reference electrodes – standard hydrogen electrode – calomel electrode– glass electrode – measurement of pH, electrochemical series – significance, electrolytic and electrochemical cells – reversible and irreversible cells, EMF- measurement of emf – Potentiometric Titrations (Redox – Fe ²⁺ Vs. dichromate), Conductometric titrations (acid-base – HCl Vs. NaOH).		
Unit IV	Nuclear Chemistry : Nuclear fission – controlled nuclear fission – nuclear fusion – differences between nuclear fission and fusion – nuclear chain reactions – nuclear energy – light water nuclear power plant – breeder reactor.		

Unit V	Industrial Chemistry: Synthesis, properties and Uses of Silicones. Fuel Gases, Natural gas, Water gas, Semi water gas, Carbureted water, producer gas and oil gas. Fertilizers: Urea, Ammonium Sulphate, Ammonium nitrate, Potassium Nitrate, NPK fertilizer, Triple super phosphate.
Reference	1. Dr. Veeraiyan, Chemistry –Paper I, High Mount Publishing House, Chennai, 2nd edition, 2005 2. R. D. Madan, Modern Inorganic Chemistry, Third Revised Edition, S.Chand and Co., 2011. 3. B. R. Puri, L.R. Sharma and M.S. Pathania, <i>Principles of Physical Chemistry</i> , 4th ed. New Delhi: Vishal Publishing Co., 2018. 4. P.L. Soni, O. P. Dharmarha and U.N. Dash, <i>Textbook of Physical Chemistry</i> , Revised Edition, New Delhi: S Chand & Sons, 2016. 5. P.C. Jain and Monika Jain, <i>Engineering Chemistry</i> , 16th ed. New Delhi: Dhanpat Rai Publishing Co., 2006. 6. Puri, Sharma and Kalia, <i>Principles of Inorganic Chemistry</i> , 33rd ed. Jalandhar: Vishal Publishing Co., 2017.

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	M	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	VALUE BASED EDUCATION- IVAE11		
Semester	Semester-I	Credits:3	Hours/weeks: 3
Cognitive Level	K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To enable the students to understand meaning and concept of values To orient about the society, social life, integrity in personal and public life. To learn the concepts of human values and respect for others To provide in-depth understanding about moral awareness To inculcate a sense of socially responsible citizens. 		
Course	Upon completion of this course, the students will be able to		

Outcome	CO1: Develop a sense of self-respect and respect for others K2 CO2: Occupy one's own social space and help others live peacefully K3 CO3: Understand the need for practicing positive values K2 CO4: Develop scientific temper and logical reasoning and to apply in day to day life K3 CO5: Know about gender equity, ethics and human rights. K4
Unit I	Values – definition – value crisis – need for practicing positive values for good life – values erosion – its impact on individual, societal – cultural level – way out.
Unit II	Family, material, human values – good health – individual and intellectual freedom – human progress – production and distribution – prosperity and peace – Aesthetic values – sense of beauty – moral ethical value – conscience – integrity – fairness.
Unit III	Societal values – cooperative living – healthy behaviors – justice – social responsibility – free from bribery and corruption – good citizen – good society – pursuit of excellence – Psychological values - self-esteem and acceptance – emotional intelligence – spiritual values – devotion and self-fulfillment
Unit IV	Bioethics – definition – goals and objectives – love of life – animal use and ethics – medical ethics – negligence and wrong judgments – issues genomes on organ transplantation – donors – drugs – mortality – social ethics – child labour and bonded labor
Unit V	Women – and development – sex versus gender – women's rights – factors affecting development – violence against women – right to privacy – abortion and reproductive rights – social stigma – women empowerment – social, economic and political – government program and policies.
References	1. Mani Jacob (Ed). 'Resource Book for Value Education', Institute for Value Education, New Delhi. 2002. 2. NCERT. "Value Education". Dharma Bharti National Institute of Peace and Value Education, Secunderabad, 2002. 3. Daniel and Selvamony. "Value Education Today - Madras Christian College, Tambaram and ALACHE, New Delhi, 1990. 4. Ignacimuthu S. "Values for Life". Better Yourself Books, Mumbai, 1991. 5. M.M.M.Mascaronhas. Centre for Research Education Science and Training for Family Life Promotion - Family Life Education, Bangalore, 1993.

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	S	S	S	M	S	M	S
CO2	S	M	M	M	S	S	S	S	S	S	S	M	S
CO3	M	M	M	S	S	S	S	S	S	S	S	M	S
CO4	S	M	M	S	S	S	S	S	S	S	S	M	S
CO5	S	M	M	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

SEMESTER II

Course Title & Code	CORE 5 (Theory) – BASIC MICROBIOLOGY AND GENETICS – IBTT22		
Semester	Semester-II	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand		
Learning Objective	<ul style="list-style-type: none"> • To make the students to understand the basic concepts of the biology of microorganisms and its mechanism of action in host cells. • To learn the microbiological techniques used for the classification of microorganisms • To know the important role of microbes in various field of microbiology • To understand the microbe-host interaction and their metabolic activities 		
Course Outcome	Upon completion of this course, the students will be		
	CO1:	Acquire knowledge on microbial physiology and culture methods K1	
	CO2:	Able to know the basics of Microscopy	
	CO3:	Able to understand the structure and multiplication of viruses and fungi K1	
	CO4:	Able to understand the concepts of mendelian genetics K1	
	CO5:	Able to understand the metabolism of the various microbes K2	
Unit I	Introduction to Microbiology: An overview of microbiology including a historical perspective of microbiology-classification, and nomenclature of microorganisms-Basics of Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM)- principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining, spore staining		
Unit II	Microbial Structure and Multiplication: Morphology, Structure and Functions of Prokaryotic- and Eukaryotic Cells, Multiplication of bacteria, viruses, algae, protozoa, fungi, yeast with appropriate examples, Life history of actinomycetes and bacteriophage		
Unit III	Microbial Nutrition and Metabolism: Nutritional requirements of bacteria: Growth curve and Different methods to quantitative bacterial growth, Mathematics of growth generation time and growth rate constant, factors affecting growth. Aerobic and Anaerobic respiration, Microbial metabolism- Entner– Doudoroff and Phosphoketolase pathway		
Unit IV	Mendelian principles- segregation and independent assortment. Incomplete dominance. Trihybrid ratio. Epistasis. Pedegree analysis. Chromosome abnormalities, quantitative inheritance, Hardy-Weinberg equilibrium, genetic drift and speciation.		
Unit V	Sex determination and Linkage: (Drosophila, Mammals). Environmental factor and Sex determination, Sex differentiation. Sex linkage in diploids crossing over. Genetic disorders.		
References	<ol style="list-style-type: none"> 1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007 2. Prasad B.N., “A Text Book of Biotechnology”, Budha Academic Enterprises, G.P.O., Box 20195, Kathmandu, Nepal. 2003. 3. Talaron K, Talaron A, Casida, Pelczar and Reid. Foundations in Microbiology, W.C.Brown Publishers, 2001. 4. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001. 		

	5. Lim D, "Microbiology", Second Edition, WCB-Mc Graw Hill, 2001.
E-reference links	<ol style="list-style-type: none"> https://www.nature.com/subjects/microbiology#:~:text=Microbiology%20is%20the%20study%20of,host%20response%20to%20these%20agents. https://www.moscmm.org/pdf/Ananthanarayan%20microbio.pdf https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/lecture1.pdf https://samples.jblearning.com/076371075X/Wheelis_CH01_001%20copy.pdf http://www.grsmu.by/files/file/university/cafedry/microbiologii-virysologii-immynologii/files/essential_microbiology.pdf

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	M	S	S	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	CORE PRACTICAL I- CELL BIOLOGY AND MICROBIOLOGY-IBTP21		
Semester	Semester-II	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		

Learning Objective	<ul style="list-style-type: none"> To know about the basic techniques in cell biology and microbiology Understand the organization and function of different cell organelles
Course Outcomes	At the end of the course, the student will be able to
	CO1: Perform experiment on understanding of cells CO2: Understand the sub-cellular organelles of the cell CO3: Perform an experiment to understand the various stages of mitosis CO4: Identify and examine bacterial cell by different staining methods CO5: Understand the basic microbiological techniques
Experiments in Cell Biology	<ol style="list-style-type: none"> Differentiating plant cells from animal cells using a basic, acidic, and a combination stain. Growing root tips of different plants and comparing the chromosome number by fixing at the metaphase stage. Differentiation of Blood Cells Using Giemsa Staining Osmosis and Tonicity Studies Staining for Various Stages of Mitosis in <i>Allium cepa</i> root tip (Onion)
Experiments in microbiology	<ol style="list-style-type: none"> Lab safety method and Regulations, Principles and methods of sterilization and Study of instruments: Compound microscope, Autoclave, Hot air oven, Laminar Airflow Media preparation- Nutrient broth, Nutrient agar, slants, soft agar Culturing of microorganisms– in broth and in plates (pour plates, streak plates) Enumeration of microorganisms from Soil Enumeration of microorganisms from Water Staining Techniques (Simple, Gram staining, and spore staining) Staining of fungus – Lacto phenol cotton blue staining

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	M	S	M	S
CO2	S	M	S	S	S	S	S	S	S	M	S	M	S
CO3	S	M	S	S	S	S	S	S	S	M	S	M	S
CO4	S	M	S	S	S	S	S	S	S	M	S	M	S
CO5	S	M	S	S	S	S	S	S	S	M	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	ALLIED PRACTICAL -I – CHEMISTRY – IBTA22		
Semester	Semester-II	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		

Learning Objective	<ul style="list-style-type: none"> To know the principles and theory of various analysis and chemical reactions
Course Outcomes	At the end of the course, the student will be able to
	<p>CO1: To create interest in application side of chemistry K1</p> <p>CO2: Ability to perform experiments, analyzes data, interpret results and observe in scientific aspects. K3</p> <p>CO3: Ability to work effectively in diverse teams in laboratory. K3</p> <p>CO4: Ability to understand the concepts in volumetric analysis K2</p> <p>CO5: Able to know the principles of chemical reactions K2</p>
Experiments	<p>VOLUMETRIC ANALYSIS</p> <ol style="list-style-type: none"> 1. Estimation of Sodium hydroxide using Standard Carbonate. 2. Estimation of Hydrochloric acid using Standard Oxalic acid. 3. Estimation of Oxalic acid using Standard Sulphuric acid. 4. Estimation of Ferrous Sulphate using Standard Mohr's salt solution. 5. Estimation of Oxalic acid using Standard Ferrous Sulphate. 6. Estimation of Potassium permanganate using Standard Sodium Hydroxide.
Reference	<ol style="list-style-type: none"> 1. Venkateswaran. V, Veeraswamy. R, Kulandaivelu. A.R., Basic Principles of Practical Chemistry, 2nd ed. New Delhi: Chand and Sons, 2015. 2. Radha and Rekha, Chemistry Laboratory Manual, 1st ed. Chennai: Elshadai Publishers, 2011. 3. O.P. Pandey, N.Bajpai and S. Giri, Practical chemistry, 1st ed. New Delhi: Nirja Publishers and Printers Pvt. Ltd., 2014.

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	ENVIRONMENTAL STUDIES – IEVS21		
Semester	Semester-II	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand		

	K3: Apply K4: Analyze
Learning Objective	<ul style="list-style-type: none"> ▪ To understand the Scope and importance, need for public awareness ▪ To be acquainted with about Natural Resources: Renewable and non – renewable resources ▪ To comprehend the Concept and structure and function of an ecosystem and to conquer knowledge on Biodiversity and its conservation ▪ Expand knowledge about the environment and its importance for survival of living organisms
Course Outcomes	At the end of the course, the student will be able to
	CO1 : Understand the natural resources and sustainable utilization K1 CO2 : Apprehend the utilization of land and water K3 CO3: Understand the biological resources and forests K2 CO4: Understand the renewable and non-renewable sources of energy K2 CO5: Describe the contemporary practices in resource management K4
Unit I	The multidisciplinary nature of environmental studies. Definition, Scope and importance. Need for public awareness
Unit II	<p>Natural Resources: Renewable and non – renewable resources: Natural resources and associated problems</p> <p>a) Forest resources: Use and over – exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.</p> <p>b) Water resources: Use and over utilization of surface and ground water, floods, drought, conflicts over water, dams – benefits and problems.</p> <p>c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.</p> <p>d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer – pesticide problems, water logging, salinity, case studies.</p> <p>e) Energy resources: Growing energy needs, renewable and non – renewable energy sources, use of alternate energy sources, case studies.</p> <p>f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.</p> <ul style="list-style-type: none"> • Role of an individual in conservation of natural resources. • Equitable of resources for sustainable lifestyles.
Unit III	<p>Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids.</p> <p>Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)</p>
Unit IV	<p>Biodiversity and its conservation</p> <ul style="list-style-type: none"> • Introduction – definition: generic, species and ecosystem diversity. • Biogeographical classification of India. • Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega – diversity nation, Hot – spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wild life, man – wildlife conflicts. • Endangered and endemic species of India. • Conservation of biodiversity: In – situ and Ex-situ conservation of biodiversity.

Unit V	<p>Environmental Pollution</p> <ul style="list-style-type: none"> • Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards • Solid waste Management: causes, effects and control measures of urban and industrial wastes. • Role of an individual in prevention of pollution. • Pollution case studies. • Disaster management: floods, earthquakes, cyclone and landslides.
Unit VI	<p>Social issues and the Environment</p> <ul style="list-style-type: none"> • From Unsustainable to Sustainable development • Urban problems related to energy • Water conservation. Rain water harvesting, watershed management • Resettlement and rehabilitation of people; its problems and concerns. Case studies. • Environmental ethics: Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. • Wasteland reclamation. • Consumerism and waste products. • Environment Protection Act. • Air (Prevention and Control of Pollution) Act. • Water (Prevention and control of Pollution) Act. • Wildlife Protection Act. • Forest Conservation Act. • Issues involved in enforcement of environmental legislation. • Public awareness.
Unit VII	<p>Human population and the Environment</p> <p>Population growth, variation among nations., Population explosion – family Welfare Programme, Environment and human health, Human Rights, Value Education, HIV / AIDS, Women and child welfare, Role of Information Technology in Environment and human health, Case studies.</p>
Unit VIII	<p>Field work</p> <ul style="list-style-type: none"> • Visit to a local area to document environment assets – river / forest/ grassland/ hill/ mountain. • Visit to a local polluted site – Urban/ Rural/ Industrial/ Agricultural. • Study of common plants, insects, birds. • Study of simple ecosystems – pond, river, hill slopes, etc.
Reference	<ol style="list-style-type: none"> 1. Agarwal, K.C 2001 Environmental Biology, Nidi Publishing Ltd, Bikaner 2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt Ltd. (R) 3. Brunner R.C 1989, Hazardous Waste Incineration, McGraw Hill Inc 480p 4. Clark R.S marine Pollution, Claderson Press Oxford (TB) 5. Cunningham, W.P Cooper, T.H Gorhani, E & Hepworth, M.T 2001, Environmental Encyclopedia, Jaico Publ House, Mumbai 1196p. 6. De A.K Environmental Chemistry, Wiley Eastern Ltd., 7. Down to Earth, Centre for Science and Environment (R) 8. Gleick, H.P 1993 Water in crisis, Pacific Institute for Studies in Dev., Environmental & Security. Stockholm Env. Institute. Oxford Univ Press 473p.

	<p>9. Hawkins R.E Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R).</p> <p>10. Heywood, V.H & Watson R.T 1995 Global Biodiversity Assessment. Cambridge Univ Press 1140p.</p> <p>11. Jadhav, H & Bhosale, V.M 1995 Environmental Protection and Laws. Himalaya Pub House, Delhi 248p.</p> <p>12. McKinney M.L & Schoch R.M 1996 Environmental Science systems & Solutions, Web enhanced edition 639p.</p> <p>13. Miller T.G Jr Environmental Science, Wadsworth Publishing Co (TB).</p> <p>14. Odum, E.P 1971 Fundamentals of Ecology, W.B Saunders Co USA, 574p.</p> <p>15. Rao M.N & Datta A.K 1987. Waste Water treatment. Oxford & IBH Publ Co Pvt Ltd. 345p.</p> <p>16. Sharma B.K 2001 Environmental Chemistry Goel Publ House, Meerut.</p> <p>17. Trivedi R.K Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol I and II, Enciro Media (R).</p> <p>18. Trivedi R.K and P.K Goel, Introduction to air pollution, Techno Science Publications (TB).</p>
E-reference links:	<p>1. https://study.com/academy/lesson/what-is-environmental-studies-definition-topics.html</p> <p>2. https://www.researchgate.net/publication/328783669_ELEMENTS_OF_ENVIRONMENTAL_STUDIES</p> <p>3. http://intranet.bhu.ac.in/unit2.pdf</p> <p>4. https://www.researchgate.net/publication/323944189_Environmental_Pollution_Causes_and_Consequences_A_Study</p> <p>5. https://www.ugc.ac.in/oldpdf/modelcurriculum/Chapter5.pdf</p>

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	S	S	S	M	S	S	S
CO2	S	M	S	S	S	S	S	S	S	M	S	M	S
CO3	S	M	M	S	S	S	S	S	S	M	S	S	S
CO4	S	M	S	M	S	S	S	S	S	S	S	M	S
CO5	S	M	S	M	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

SEMESTER III

Course Title & Code	CORE 6 (Theory) – FUNDAMENTAL BIOCHEMISTRY-IBTT31		
Semester	Semester-III	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		

	K5: Evaluate
Learning Objective	<ul style="list-style-type: none"> To learn biochemical principles with specific emphasis on different biomolecules. To introduce the biomolecules which are involved in metabolic pathways To ensure students to have strong foundation in structure, properties and function of various biomolecules.
Course Outcomes	Upon completion of this course, the students will be
	<p>CO1: Able to understand the fundamental aspects in biochemical phenomenon. K1</p> <p>CO2: Apply their knowledge of biochemistry to correlate the structure and functional relationships of biomolecules in living organisms. K3</p> <p>CO3: Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids, proteins, vitamins, hormones and minerals which help them to understand the significance of biomolecules in bioprocesses and biotechnology K2</p> <p>CO4: Able to explain the classification criteria and nomenclature of the different types of simple and complex biomolecules, according to their structural characteristics. K5</p> <p>CO5: Able to understand the concept of chemical and regulatory interrelationship between major cellular synthetic and catabolic pathways. K2</p>
Unit I	Atom, Molecules & chemical bonds properties of H ₂ O, acid and buffer. Carbohydrates - Classification, Structure and Function, Occurrence, chemical properties, stereo and optical isomerism, Biological significance, Glycosylation of biomolecules – glycoproteins and glycolipids.
Unit II	Amino acids- structure, classification and chemical properties. Peptides – synthesis, peptide linkage- Proteins – Classification – Structure and color reactions of protein- Organization - primary (Insulin), secondary structure (alpha helix and beta structure), tertiary and quaternary structure. Significant natural and artificial peptides. Enzymes- Classification and IUB nomenclature, Holo and apo enzyme, coenzymes and cofactors.
Unit III	Lipids-Nomenclature and Classification, structure and functions: occurrence, chemical properties.; Lipoproteins: Structure and functions of lipoproteins; Role of lipids in biomembranes, Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid-fat and wax, Compound lipid-Phospholipid, Triglycerides, Steroids, Cholesterol, Terpenes, sphingolipid and glycolipid.
Unit IV	Nucleic acids –Structure of purine and pyrimidine bases, Structure of double stranded DNA (A, B and Z-DNA). Chargaff's rule on DNA base composition, Physical properties of double stranded DNA. Types of RNAs- r RNA, t RNA and m RNA and their biological significance. Purines and pyrimidines biosynthesis.
Unit V	Vitamins, minerals & Hormone. Introduction, Functions and deficiency -Fat - soluble vitamins - A, D, E & K –, Water - soluble vitamins, B Complex (Riboflavin, Niacin, Pyridoxine, Folic acid, Cyanocobalamine, Pantothenic acid) Vitamin C (Ascorbic acid). Daily requirement Types and Functions of hormones. Minerals - Calcium, Phosphorus, Iodine, Fluorine, Manganese, Iron, Magnesium, Potassium
References	<ol style="list-style-type: none"> Lehninger, A. L., "Principles of Biochemistry", 6th edition, New York., 2012 Stryer, L., "Biochemistry", 8th edition, New York: Freeman, 2015. Voet, D., & Voet, J. G., "Biochemistry", Hoboken, NJ: J. Wiley & Sons, 5th edition, 2016.

	<p>4. Jain and Jain “Biochemistry”, Chand publication, 2008.</p> <p>5. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2008</p>
E-reference links:	<p>1. http://people.uleth.ca/~steven.mosimann/bchm2000a.html</p> <p>2. https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_(Jakubowski)</p> <p>3. https://www.researchgate.net/publication/200787272_Carbohydrates</p> <p>4. file:///C:/Users/Thamarai/Downloads/Ch-4Protein.pdf</p> <p>5. https://www.researchgate.net/publication/331701677_UNIT-II_Lipid_metabolism</p>

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	S	S	S	S	M	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	ALLIED THEORY 2 -PLANT AND ANIMAL PHYSIOLOGY-IBTA31		
Semester	Semester-III	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K4: Analyze		

Learning Objective	<ul style="list-style-type: none"> To acquire the basic knowledge needed for proper understanding of plant and animal functioning. Students should gain the knowledge of photosynthesis and photo respiration Students should identify and describe the different types of plant and animal cells and tissues, their structure and function. Students should able to determine the role and function of specific vegetative parts of the plant and the role and function of the reproductive parts of the plant. Students should able to know the animal physiology system
Course Outcome	<p>Upon completion of this course, the students will be able to</p> <p>CO1: Have a brief knowledge on macro and micro nutrients and transpiration K1</p> <p>CO2: Exhibit a brief and concise knowledge on photosynthesis and electron transport system K1</p> <p>CO3: Acquire knowledge on nitrogen fixation and plant growth regulators K2</p> <p>CO4: Able to understand the Physiology of Cardiovascular system, reproduction and Endocrine Glands K2</p> <p>CO5: Gain knowledge on muscle contraction and nerves K4</p>
Unit I	<p>Plant Physiology (Importance of Plant Physiology); Plant cells -leaves, stem, roots, xylem & phloem. Water transport, water potential and transpiration through leaf, Osmosis. Photosynthesis-Structure and function of chloroplast, light and dark reactions, Cyclic and non-cyclic electron transfer, C3, C4 and CAM pathways (Crassulacean acid metabolism). Respiration & Photo respiration: Respiration types, RQ- Glycolysis, Citric acid cycle, electron transport chain and ATP synthesis. Nitrate & Ammonium assimilation. Nitrogen fixer and Nitrogen fixation.</p>
Unit II	<p>Plant Hormones-Types & roles- mode of action: Auxin, Gibberellins & Cytokinins, Ethylene, Abscissic Acid. Biosynthesis, Storage, breakdown & transport; Physiological effects& Mechanisms of action. Sensory Photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; Transpiration; mechanisms of loading and unloading of photo assimilates. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles</p>
Unit III	<p>Digestion: Physiology of digestion in the alimentary canal; Absorption of carbohydrates, lipids, Proteins, gastric ulcers, BMR. Blood Circulation - Structure & Function of Haemoglobin. Blood corpuscles, haemopoiesis, plasma function, blood volume, blood pH regulation, blood groups, haemostasis., Bohr and Haldane effect, Chloride shift. Cardiovascular System: Structure of Heart; Origin and conduction of the heart impulse, heart as a pump, Cardiac cycle, Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance. Respiration: anatomy, pulmonary ventilation, Respiratory volume and capacities. Transport of O₂ and CO₂ in blood. Pulmonary diseases, neural and chemical regulation of respiration</p>
Unit IV	<p>Physiology of excretion- Structure of Kidney & Nephron, physiology of urine formation, urea cycle, nitrogenous wastes -ammonia, urea, uric acid, creatinine. Counter current mechanism, Types of dialysis, ARF & CRF. Anatomy of the brain and spinal cord, central and peripheral nervous system. Structure and types of Neurons, Resting membrane potential, Graded potential, synaptic nerve impulse, Neuro transmitters, Orgin of graded potential and its propagation in myelinated and non myelinated nerve fibre. Molecular and chemical basis of muscle contraction.</p>

Unit V	Sensory organs- Ultra structure and function of human eye, ear, tongue, nose and skin. Pigmentation. Sensory process (Vision, auditory, touch, taste, vestibular and kinesthesia); Perception; Cognition (Concepts, language and thought, problemsolving and decision – making); Intelligence (Characteristics, assessment, the role of creativity).Reproduction and Endocrine Glands: Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle; Structure and function of Pituitary, Thyroid, parathyroid, adrenal and pancreas, neuroendocrine regulation.
References	<ol style="list-style-type: none"> 1. Rajiv Kumar Sinha, Modern Plant Physiology, Alpha Science International Ltd, 2004. 2. Hans Mohr, Peter Schopfer, Plant Physiology, Springer, 2012. 3. P.C.Trivedi, Advances in Plt.Physiology, I.K. Int. Publishing House P. Ltd. 2006. 4. Salisbury, F.B. and Ross, C.W. 1986- Plant Physiology, CBS Publishers and Printers, New Delhi. 5. Pandey, S.N.1991 – Plant Physiology, Tata McGraw Hill Publishers, New Delhi. 6. Fundamentals of Plant Physiology- V. K.Jain 7. S. C. Rastogi, Essentials of Animal Physiology, New Age International Publishers, 2007. 8. Knut Schmidt-Nielsen, Animal Physiology: Adaptation and Environment, Fifth Edition, Cambridge University Press, 1997. 9. Lauralee Sherwood, Hillar Klandorf, Paul Yancey, Animal Physiology: From Genes to Organisms, Cengage Learning Pvt Ltd. 2012.
E-reference links:	<ol style="list-style-type: none"> 1. http://www.plantphysiol.org/ 2. https://www.nature.com/subjects/plant-physiology 3. https://bio.libretexts.org/Bookshelves/Microbiology/Book%3AMicrobiology(Boundless)/5%3AMicrobialMetabolism/5.11%3APhototrophy/5.11C%3ATheTwoPartsofPhotosynthesis 4. https://www.livescience.com/51720-photosynthesis.html 5. https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookPS.html 6. https://nptel.ac.in/courses/ 7. https://www.researchgate.net/publication/286456096 8. https://www.pdfdrive.com/animal-physiology-d58162507.html 9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2660586/

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	S	S	S	M	S	M	S
CO2	S	M	M	S	S	S	S	S	S	M	S	M	S
CO3	S	M	M	S	S	S	S	S	S	S	S	M	S
CO4	S	M	M	S	S	S	S	S	S	S	S	M	S
CO5	S	M	M	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks , Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark , No Correlation (N) - 0 mark

Course Title & Code	SKILLED BASED STUDIES I – HERBAL TECHNOLOGY-IBTS31
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Semester	Semester-III	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> Understands the concepts of Pharmacognosy To be able to identify, classify, collect and process medicinal plants Acquire knowledge about the uses of various medicinal plants in the treatment of illness. To learn the methods of processing and packaging of medicinal plants for commercial use. 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Understand the concepts of pharmacognosy K1	
	CO2:	Know about the classification of medicinal plants. K1	
	CO3:	Able to understand the preparation and development of herbal formulations K2	
	CO4:	Understanding the basics of Herbal medicines for Human ailments K2	
	CO5:	Learn the methods of processing and packaging of medicinal plants for commercial use K3	
Unit I	Introduction To Herbal Biotechnology And Methods For Processing Of Herbs: Introduction to herbal biotechnology: Herbal versus conventional drugs, safety in herbal medicine, importance of herbal therapy, efficacy of herbal medicinal products, validation of herbal therapies. Methods for processing of herbs: Collection, harvesting, garbling, packing, and storage conditions. Methods of drying - natural and artificial drying methods -merits and demerits.		
Unit II	Methods For Preparation of Extracts: Methods for preparation of extracts: Types of herbal extracts, principles of extraction and selection of suitable extraction method. Different methods of extraction - infusion, decoction, digestion, maceration, percolation, successive solvent extraction, soxhlet extraction, supercritical fluid extraction, steam distillation, microwave assisted extraction, headspace techniques, sepbox, hot continuous extraction, pilot scale extraction with example.		
Unit III	Modern Techniques In Herbal Drug Identification And Characterization : Modern technique in herbal drug identification and characterization: Ultraviolet-visible spectrometry, FTIR, TLC, capillary electrophoresis, HPLC, HPTLC, GC-MS, LC-MS, Super critical fluid chromatography, XRD, NIR, and NMR.		
Unit IV	Herbal Formulation: Herbal formulation: Types and forms, WHO Guidelines for standardization of quality herbal formulations, standardization of herbal formulations, parameter used for formulation, standardization for single drugs and compound formulations, quality assessment of herbal formulation, certification for formulations.		
Unit V	Toxicity – Regulations And Herbal Products: Toxicity and regulations: Adverse reactions in herbal medicine, toxicity in herbals and their interactions, factors affecting safety of herbal formulation, detoxification of formulation, quality control of herbal drugs, policies and regulation. Herbal products: Herbal syrups, herbal cosmetics, herbal creams, herbal lotions, herbals used in dentifrice, herbals as immunity boosters, herbal oil, colors, perfumes, preservatives.		
References	<ol style="list-style-type: none"> S. S. Agrawal and M. Paridhavi (2013).Herbal Drug Technology, Orient Blackswan. Herbal Drug Technology (English, Paperback, Mohan Lal Kori, Santram Lodhi, Tushar A Deshmukh, Rageeb Md. Usman, Vaibhav M Darvhekar). 		

	3. Shanti bhushan Mishra (2019) Essentials of herbal drug technology: A guide of standardization quality control education publishing. 4. EiRi Board. Herbal Cosmetics and Beauty Products Formulations Book. Engineers India Research Instt.
E-reference link	1. https://www.youtube.com/user/cecedusat 2. https://www.slideshare.net/mostafam7moud/herbal-medicine-intro 3. https://agris.fao.org/agris-search/search.do?recordID=MY2012050079 4. https://www.slideshare.net/Sindhukuberappa/phytochemical-extraction 5. https://www.slideshare.net/Sindhukuberappa/phytochemical-extraction 6. https://www.slideshare.net/LavanyaSA/drlavanyasa-standardization-of-herbal-drugs 7. https://www.slideshare.net/priyankagoswami/herbal-formulations 8. https://www.slideshare.net/parth241989/who-certification-112070804014 9. https://www.slideshare.net/jatinsingla16/regulation-of-herbal-products 10. https://www.slideshare.net/binnz/herbal-regulations-92992268

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

SEMESTER IV

Course Title & Code	CORE 7 (Theory)- PRINCIPLES OF MOLECULAR BIOLOGY-IBTT41		
Semester	Semester-IV	Credits:4	Hours/weeks: 4

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning Objective	<ul style="list-style-type: none"> To understand the basic principles of molecular biology from DNA as genetic material to protein synthesis and regulation. To know the fundamental aspects in biological phenomenon. To learn the basics of DNA replication
Course Outcomes	Upon completion of this course, the students will be able
	<p>CO1: Understand the various biological processes and molecular structure and functions of cells and molecules such as DNA, RNA and proteins K1</p> <p>CO2: Understand storage of genetic information and its translation at molecular level in prokaryotic and eukaryotic systems. K2</p> <p>CO3: Understand the fundamental aspects in biological phenomenon. K2</p> <p>CO4: Know the properties of genetic materials and processing of genetic information. K3</p> <p>CO5: Understand the Prokaryotic and Eukaryotic DNA replication K3</p>
Unit I	Genome organization -Molecular Biology – An Overview – Structure of DNA - denaturation, and renaturation of DNA -Genome organization in prokaryotes and eukaryotes - DNA packaging in nucleosome – chromatin and chromosome.
Unit II	Genetic Material / Replication enzymes DNA as genetic material. Central dogma concept. Methods of replication. Enzymes in DNA replication. Replication in prokaryotes-origin of replication, replication fork, leading and lagging strand replication. Okazaki fragments. Elongation, termination of replication. Eukaryotic DNA replication. Inhibitors of replication. Genetic Code. triplet code and its feature, wobble hypothesis, DNA Repair mechanism.
Unit III	RNA and Transcription - RNA structure, types of RNA, RNA polymerases, transcription in prokaryotes-initiation and elongation, promoters, termination of transcription. Eukaryotic promoters. Post Transcriptional processing and modifications. Reverse transcription.
Unit IV	Translation- Translation initiation, elongation, and termination in prokaryotes. Translation in eukaryotes. Post translational processing and modifications. Antibiotics-inhibitors of protein synthesis. Protein structure-folding of the polypeptide chain, alpha-helix and secondary beta structures.
Unit V	Gene Regulations - Principles of regulation - Cis-acting sites, and transacting molecules - feedback inhibition and allosteric regulation - The lac operon - trp operon, regulation of mRNA stability – Eukaryotic regulation.
References	<ol style="list-style-type: none"> Freifelder D and Malcinski GM Essential of Molecular Biology, 2nd Edition, Jones Barlett Publishers, 1993. Watson JD, Molecular Biology of the Gene, 4th edition, Benjamin and Cummings Publishers, 1987. Gerald Karp, Cell and Molecular Biology, John Wiley, 1996. Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, and Walter P (2014) Molecular Biology of the Cell. 6th edition. Garland Science, USA. Cooper G M and Hausman R E (2013) The Cell: A Molecular Approach. 6th edition. Sinauer Associates, Inc. The USA.

E-reference links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/ 2. https://psychiatryonline.org/ 3. http://textbookofbacteriology.net/regulation_5.html 4. https://molbiomadeeasy.files.wordpress.com/2013/09/fundamental_molecular_biology.pdf
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Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S
CO3	S	M	S	S	S	S	S	S	S	S	S	S	S
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE PRACTICAL II - BIOCHEMISTRY AND MOLECULAR BIOLOGY- IBTP41		
Semester	Semester-IV		Credits:4 Hours/weeks: 4
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To know the fundamental aspects in biological phenomenon. • To develop the skills in identifying the various biomolecules • To develop the skills of quantifying the various biomolecules 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1: CO2: CO3: CO4: CO5:	Know the basic units, calculations and different measurements tools used in biomolecule analysis K3 Understand the basic principles of biochemical technique. K1 Able to perform the contemporary techniques in molecular biology K2 Perform basic biochemical test K4 Apply the knowledge gained to address various technical problems K3	
Experiments in Biochemistry	<ol style="list-style-type: none"> 1. Preparation of solutions – Molar, Normal, Percentage, Stock, Working etc. 2. Determination of pH 3. Preparation of buffers – PBS, Tris and Acetate buffer. 4. Qualitative analysis of carbohydrate, protein, and lipid 5. Estimation of protein by Lowry's method 6. Estimation of nucleic acids by UV method 		

	<ol style="list-style-type: none"> 7. Estimation of lipids –cholesterol 8. Estimation of glucose (DNS method)
Experiments in Molecular Biology	<ol style="list-style-type: none"> 1. Bacterial Transformation. 2. Study of mutation by Ames test. 3. Induced mutagenesis (UV, NTG) 4. Bacteriophage titration – plaque forming cells. (DEMO) 5. Isolation of Genomic DNA 6. Agarose Gell Electrophoresis apparatus, principle.
References	<ol style="list-style-type: none"> 1. Mathews C K, van Holde K E, Appling D R, Anthony-Cahill S J (2012) Biochemistry, 4th Edition. Prentice-Hall Bench Marked with 1. 2. Cooper G M and Hausman R E (2013) The Cell: A Molecular Approach. 6th edition. Sinauer Associates, Inc. The USA. 3. Wilson K and Walker J (2016) Principles and Techniques of Biochemistry and Molecular Biology 8th Ed. Cambridge University Press. 4. Shad Arif Mohammed & Hawnaz Othman Najmalddin , Molecular biology Lab Manual , 2017

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	M	S	S	S
CO2	S	M	S	S	S	S	M	S	S	M	S	S	S
CO3	S	M	S	S	S	S	M	S	S	S	S	S	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	ALLIED PRACTICAL -II - PLANT AND ANIMAL PHYSIOLOGY- IBTA42		
Semester	Semester-IV	Credits:4	Hours/weeks: 3
Cognitive Level	K1: Recall K2: Understand K3: Apply		

Learning Objective	<ul style="list-style-type: none"> To equip the mind with the entire systems viz., digestion, cardiovascular system, excretion, nerve and muscles and endocrine glands with a view to gain a thorough input.
Course Outcomes	<p>Upon completion of this course, the students will be able to</p> <p>CO1: Understand the isolation of blood cells K2 CO2: Have knowledge on blood pressure and sugar level determination K1 CO3: Understand the Cardiac cycle and BMR determination K2 CO4: Acquire the knowledge on preparation of herbarium K3 CO5: Elaborate understanding of sectioning of Dicot stem, Dicot root, Monocot Stem and Monocot root. K2</p>
Experiments in Plant Physiology	<ol style="list-style-type: none"> Systematic study of locally available plants belonging to the families prescribed in theory syllabus. Demonstration of herbarium techniques Structure of pollen grains using whole mounts Demonstration of Pollen viability test using in- vitro germination Section the parts of plants & Structure of endosperm (nuclear and cellular); Developmental stages of dicot and monocot Embryos using permanent slides / Photographs Demonstration of Hydroponics System Isolation and mounting of embryo Estimation of Chlorophyll from leaves Sectioning of Dicot/Monocot stem and root
Experiments in Animal Physiology	<ol style="list-style-type: none"> Blood cells isolation (centrifuge), staining, examine under microscope. Blood pressure determination, blood sugar level examination. Sperm structure observation, egg structure observation. Dialysis process, methods, application. (Demo). Skeletal muscle mechanics, and the electromyogram (EMG). Cardiac cycle and the electrocardiogram (ECG). BMR determination
References	<ol style="list-style-type: none"> Sambasivaiah, Kamalakara Rao and Augustine Chellappa, 1990. A text book of Animal Physiology and Ecology, S.Chand &Co., Ltd., New Delhi-110 055 Parameswaran, Anantskrishnan and Ananta Subramaniam, 1975. Outlines of Animal Physiology, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Pandey, S.N.1991 – Plant Physiology,Tata McGraw Hill Publishers, New Delhi. Verma,V.,1991-A Text Book of Plant Physiology, Emkay Publications, NewDelhi. Malik, C.P. 1999 – Plant Physiology, Kalyani Publishers, Ludhiyana. Gill, D.S.2000 –Plant Physiology, S.Chand and co., New Delhi. Salisbury, F.B. and Ross, C.W. 1986- Plant Physiology, CBS Publishers and Printers, New Delhi. Jayaraman, J. 1992 – Techniques in Biology. A College level Study, Higginbotham’s (Private) Ltd, Chennai. Winchester, A.M. (1958) : Genetics(3rd Edition) Oxford & IBH Publishing House, Calcutta, Bombay, New Delhi

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	SKILLED BASED STUDIES II - MEDICAL LABORATORY TECHNOLOGY- IBTS42		
Semester	Semester-IV	Credits:2	Hours/weeks: 2
Cognitive Level	K2:Understand K3:Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To understand the basic concepts of laboratory techniques To learn the techniques required for clinical diagnosis Have a knowledge on histopathology 		
Course Outcomes	On Successful completion of the course, the students will be able to		
	CO1:	Perform the basic haematology techniques and undertake biochemical analysis of clinical samples K2	
	CO2:	Understand the tests performed in clinical microbiology lab K2	
	CO3:	Analyse the histological samples. K3	
	CO4:	Apply their knowledge for the clinical Diagnosis K3	
	CO5:	Know about quality control, lab accreditation and automation. K2	
Unit I	Basic Hematology - Specimen collection and handling, transportation of specimens, disposal of specimen after laboratory use. Specimen preservation. Composition of blood. Methods of estimation of Haemoglobin, PCV, total and differential count of WBC, platelet count, clotting, bleeding and prothrombin time. Blood Group - methods of grouping and Rh factor.		
Unit II	Biochemical test- Tests for specific amino acids, determination of proteins in serum and plasma. Determination of glucose, glucose tolerance test, ketone bodies, glycated hemoglobin, triglycerides, cholesterol, lipoproteins. Examination of body fluids - ascitic fluid, pleural fluid, synovial fluid, pericardial fluid, CSF and amniotic fluid. Urine analysis, abnormal constituents. Faecal specimen - Macroscopic and microscopic examinations - detection of occult blood, Semen analysis. Laboratory analysis of throat swab, sputum specimens, purulent exudates – Tuberculosis		
Unit III	Histopathology - Tissue reception, labeling, fixation and section cutting, Preparation of paraffin blocks (Dehydration, clearing, embedding, blocking). Handling and care of microtome, types of microtome, sharpening of knives, and		

CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

SEMESTER V

Course Title & Code	CORE 8 (THEORY)- BIostatistics – IBTT51
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Semester	Semester-V	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> To acquire knowledge on applications of statistics in research. To gain knowledge in experimental design and data collection techniques. To develop the technical art of writing research report and presentations. To learn the concepts of probability, probability laws, probability distributions and apply them in solving biological problems and statistical analysis. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Understand the fundamentals of statistics and its methodology K1	
	CO2:	Know the theory of statistics and their application for solving the problems in the field of life sciences. K2	
	CO3:	Understand the various types of data and apply basic statistical concepts skill development in the aspects of collection and presentation of biological data through biostatistics K3	
	CO4:	Learn the methods in statistics to solve the biological problems with accuracy K2	
CO5:	Carry out effective research K3		
Unit I	Introduction to Basis of statistics – Definition – Statistical methods – kinds of Biological Data. Classification of Data, Meaning and definition, objectives of Classification of Data.		
Unit II	Collection, Organization and Representation of Data- Collection of Data, Types of Data- Primary Data and Secondary Data, methods of collecting Data. Sampling and sampling Designs – Meaning and Definition – Random and Non – Random sampling. Tabulation and representation of data – diagrammatic and graphical.		
Unit III	Measures of central Tendency. Definition, Types of averages- Arithmetic mean, Median, Mode, Problems related to ungrouped data, simple grouped data – Continuous and discrete series.		
Unit IV	Measures of Dispersion, Definition, Types of dispersion – Range, Mean deviation, Standard deviation and variance, problems related to measures of dispersion.		
Unit V	Correlation analysis (Karl Pearson's and Spearman's Rank), Regression analysis – simple, linear. Tests of significance – 't'-test, Chi-square and goodness of fit, 'F' test, Analysis of variance (ANOVA): One-way & Two-way.		
References	<ol style="list-style-type: none"> Sokal, R.R. and F.J. Rohlf. 1969. Biometry: The Principles and Practice of Statistics in Biological Research. W.H. Freeman and Company, USA. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi. Jerrold H. Zar, "Biostatistical analysis", Prentice Hall International, Inc. Press, 1999. Bernard Rosner, Fundamentals of Biostatistics, Seventh Edition, Cengage Learning, 2010. Lisa Marie Sullivan, Essentials of Biostatistics, Jones and Bartlett Publishers, 2008. 3. Veer Bala Rastogi, Fundamentals of Biostatistics, Second Edition, Ane Books. Pvt. Ltd. 2010. 		
E-reference	1) https://www.pdfdrive.com/biostatistical-methods-biostatistical-methods-		

links:	e15213717.html 2) https://www.pdfdrive.com/biostatistics-e42988735.html 3) https://www.pdfdrive.com/introductory-biostatistics-e15112721.html 4) https://www.pdfdrive.com/introductory-biostatistics-e176105301.html 5) https://www.pdfdrive.com/bioinstrumentation-instructional-resources-technology-austin-e15581883.html
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Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	M	S	S	S	S	S	S
CO5	S	M	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE 9 (THEORY) – IMMUNOLOGY-IBTT52		
Semester	Semester-V	Credits:4	Hours/weeks: 5
Cognitive Level	K2: Understand K3: Apply K4: Analyze		

	K5: Evaluate
Learning Objective	<ul style="list-style-type: none"> To gain comprehensive knowledge on cells and organs of the immune system Understand the immune types of response Immune mechanisms of protection and types of available Know about the availability of new vaccines.
Course Outcomes	Upon completion of this course the students will be able to
	<p>CO1 : Specify the lymphoid organs, cells of the immune system and their functions K2</p> <p>CO2 : Apprehend the definition, properties and role of antigens and antibody and comprehend the role of complement system K2</p> <p>CO3: Understand the genetic mechanism for antibody diversity and know in detail about classical and newer vaccines K5</p> <p>CO4: Understand the immune mechanisms, hypersensitivity and tissue transplantation K3</p> <p>CO5: Acquire the knowledge on the principle and applications of various immunological techniques K4</p>
Unit 1	History of Immunology, Types of immunity - innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Cells of the immune system - lymphocytes, mononuclear phagocytes-dendritic cells, granulocytes, NK cells and mast cells. Antigens - antigenicity, epitopes, haptens. Immunoglobulins - structure, classification and functions.
Unit II	T-cell, B-cell receptors, Antigen recognition - processing and presentation to T-cells. Immunological memory. Effector mechanisms - macrophage activation. Complement activation. Organization and expression of immunoglobulin genes. Generation of antibody diversity.
Unit III	Transplantation types. MHC antigens in transplantation. Immunodeficiency disorders - AIDS: The HIV genome and life cycle. Autoimmunity and elementary details of autoimmune disorders (systemic lupus erythematosus).
Unit IV	Immunization practices - active and passive immunization. Vaccines - killed, and attenuated. Recombinant vaccines - DNA vaccines, synthetic peptide vaccines. Production of applications of polyclonal and monoclonal antibodies.
Unit V	Agglutination and precipitation techniques. Immunoelectrophoresis, RIA, Immunoblotting, Avidinbiotin mediated immunoassay. Immunohistochemistry, immunofluorescence. ELISA - principle and applications.
References	<ol style="list-style-type: none"> Jenni Punt, Sharon Stranford et al. Kuby Immunology. WH Freeman & Co. 8th ed. 2018. Abbas et al. Cellular and Molecular Immunology. Elsevier. 9th ed. 2018. Janeway, C. (Ed), Travers. Immunobiology. Garland Publ. 9th ed. 2017. Coico and Sunshine. Immunology: A short course. Wiley-Liss. 7th ed. 2015. Roitt et al. Roitt's Essential Immunology. Wiley-Blackwell Sci.13th ed. 2017.
E-reference links	<ol style="list-style-type: none"> https://nptel.ac.in/ http://www.nptelvideos.in/2012/11/essentials-in-immunology.html http://www.sacema.org/uploads/Introduction-to-Medical-Immunology.pdf http://dl.mehrsys.ir/pdfbooks/Roitt_s%20Essential%20Immunology%20Thirteenth%20Edition(www.myuptodate.com).pdf http://med-mu.com/wp-content/uploads/2018/06/Essentials-of-Clinical-Immunology-6E-Chapel-Haeney-Misbah-Snowden.pdf

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	M	S	S	S	S	M	S
CO2	S	M	M	S	S	S	M	S	S	S	S	M	S
CO3	S	M	S	M	S	S	M	S	S	S	S	M	S
CO4	S	M	S	M	S	S	M	S	S	S	S	M	S
CO5	S	M	S	M	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	CORE 10 Theory – DEVELOPMENTAL BIOLOGY-IBTT53		
Semester	Semester-V	Credits:4	Hours/weeks: 5
Cognitive Level	K1:Recall K2:Understand K3:Apply		

Learning Objective	<ul style="list-style-type: none"> • Students should be able to understand the different phases of the embryo development and associated medical implications. • Students will acquire knowledge to analyze and interpret the principles of early and late embryonic development . • To compare and comprehend the development of model organisms like C. elegans, amphibians, Aves . • To demonstrate the medical implications of developmental biology.
Course Outcomes	<p>On Successful completion of the course, the students will be able to</p> <p>CO1 : Understand the basics of embryo development in vertebrates and invertebrates.K1</p> <p>CO2 : Learn the events in the early embryonic development.K1</p> <p>CO3: Understand the development of organs and developmental pattern K2</p> <p>CO4: Understand the events taking place during post - embryonic development.K2</p> <p>CO5: Understand the cell to cell communication.K3</p>
Unit I	Basic concepts of developmental biology - cell theory, mosaic and regulative development, discovery of induction. Cell division, cell differentiation, signaling, patterning. Hormones involved in reproduction, Internal fertilization in mammals
Unit II	Early embryonic development of vertebrates and invertebrates: structure and development of the gametes - the sperm, the egg; cleavage and gastrulation; axes and germ layers; morphogenesis - cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation, cell migration
Unit III	Origin of anteriorposterior and dorsal - ventral patterning- role of maternal genes, patterning of early embryo by zygotic genes; segmentation genes - the gap genes, the pair - rule genes, the segment polarity genes, the homeotic selector genes - bithorax and antennapedia complex.Organogenesis- development of central nervous system in vertebrates, Sex Determination, genetic errors of human development, teratogenesis
Unit-IV	Angiosperm –Life cycle, Plant growth and development, Embryonic and post-embryonic development, Characteristics of plant development. Molecular Genetics of Plant Development: Generation and characterization of developmental mutants, studying temporal and spatial expression pattern of developmental regulators.
Unit-V	Microsporangium:Structure and development; Megasporangium:Structure, types and development, Development of male and female gametophyte; Double fertilization;Endosperm – types, dicot embryo- Structure, Floral organ patterning and determinacy, Cell-to-cell communication during development. senescence
References	<ol style="list-style-type: none"> 1. Jonathan Slack. Essential Developmental Biology. Wiley-Blackwell. 3rd ed. 2012 2. Lewis Wolpert. Principles of Development. Oxford University Press.4th ed. 2012 3. Scott F. Gilbert. Developmental Biology. Sinauer Associates Inc., 10th ed. 2013 4. Lewis Wolpert & Cheryll Tickle. Principles of Development.Oxford University Press, 4th ed. 2011. 5.Klaus Kalthoff. Analysis of Biological Development. McGraw-Hill. 2nd ed. 2000
E-reference links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/ 2. https://www.pdfdrive.com/developmental-biology-eighth-edition-d161981415.html 3. https://www.pdfdrive.com/embryology-e15928581.html

	4. www.gutenberg.net
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Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	M	S	S	M	S	S	M	S	M	S
CO2	S	M	M	M	S	S	M	S	S	M	S	M	S
CO3	S	M	M	M	S	S	M	S	S	S	S	M	S
CO4	S	M	M	M	S	S	M	S	S	S	S	M	S
CO5	S	M	M	M	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	CORE 11 (Theory) – BASIC BIOINFORMATICS- IBTT54		
Semester	Semester-V	Credits:4	Hours/weeks: 5
Cognitive Level	K1:Recall K2:Understand K3:Apply K4: Analyze		

	K6: Create	
Learning Objective	<ul style="list-style-type: none"> • The objectives of this course are to provide students with the theory and practical experience of the use of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts. • Develop an understanding of the basic theory of these computational tools. • Students should gain working knowledge of these computational tools and methods. • Students gain knowledge to relevance for investigating specific contemporary biological questions and critically analyse and interpret the results of their study. 	
Course Outcomes	Upon completion of this course the students will be able to	
	CO1:	Understand the basic bioinformatics information's such as data types, data storage, retrieval, sequence alignments and gene expression patterns in pro and eukaryotes. K1
	CO2:	Understand the computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts. K2
	CO3:	Apply structural bioinformatics tools to predict and elucidate protein structures and map protein interactions. K3
	CO4:	Evaluate the protein structure from structural database K4
	CO5:	Construct the phylogenetic tree of different sequences and apply database information for molecular modelling. K6
Unit I	Introduction- History of Bioinformatics– challenges and opportunities- applications of Bioinformatics, Biological databases- Literature databases: PubMed, Nucleic acid sequence databases: GenBank, EMBL. Protein sequence databases: UniProt, PDB. Sequence submission databases – BankIt, Structure databases -CATH, SCOP, and PDB	
Unit II	Sequence analysis- Various file formats for bio-molecular sequences: genbank, FASTA, GCG, nbrf-piretc-Basic concepts of sequence similarity, identity and homology- Sequence-based Database Searches- BLAST and FASTA algorithms	
Unit III	Sequence Alignment- Dot plot and Dynamic Programming - Local alignment smith waterman algorithm - and Global alignment - Needleman-Wunsch - (algorithm and example) –sequence formats and Pair wise alignment and its tools	
Unit IV	Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results– Clustal W algorithm - Feng Doolittle algorithm. Definition and description of phylogenetic trees and various types of trees	
Unit V	Structural Bioinformatics - 3D structure prediction – Homology modeling – folds recognition & Ab-initio methods. Visualization of structures using SPDBViewer or PyMol. Bioinformatics in the Pharmaceutical Industry- Drug discovery	
References	<ol style="list-style-type: none"> 1. Claverie, Jean-Michel and Cedric Notredame, Bioinformatics for Dummies, 2nd Edition, 2007. 2. Wiley (required text) Westhead, D.R., J.H. Parish and R.M. Twyman, Instant Notes: Bioinformatics, 2002. 3. BIOS Scientific Publishers Ltd. Xiong, Jin, Essential Bioinformatics, 2006, 	

	Cambridge University Press. 4. Campbell, A. Malcolm and Laurie J. Heyer, Discovering Genomics, Proteomics & Bioinformatics, 2nd edition, 2007, Pearson Benjamin Cummings. 5. Lesk A Introduction to Bioinformatics. Oxford Univ Press. 4th ed. 2014. 6. Hodgman et al. Instant Notes in Bioinformatics. Taylor and Francis. 2nd ed. 2010.
E-reference links	1. https://www.pdfdrive.com/bioinformatics-books.html 2. http://www.ru.ac.bd/ 3. https://nptel.ac.in/

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	M	S	S	S	M	S	S	S	S	S	M
CO2	S	S	M	S	S	S	M	S	S	S	S	S	M
CO3	S	S	M	S	S	S	M	S	S	S	S	S	M
CO4	S	S	M	S	S	S	M	S	S	S	S	S	M
CO5	S	S	M	S	S	S	M	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE 12 (THEORY)- RECOMBINANT DNA TECHNOLOGY- IBTT55		
Semester	Semester-V	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand		

	K3: Apply
Learning Objective	<ul style="list-style-type: none"> To expose students to application of rDNA technology to various fields of biotechnology (medicine and research areas). The student a thorough knowledge in principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms and gene therapy. To learn about techniques employed are carved as self-study. To get information on the latest advances in recombinant DNA technology, principles, techniques for genetic engineering new organism to solve the social problems. which is a powerful tool needed for modern biotechnology research.
Course Outcomes	<p>Upon completion of this course the students will be able to</p> <p>CO1: Study and know the tools and advanced current techniques of genetic engineering K2</p> <p>CO2: Understand the difference between hosts and its suitable vectors for gene cloning K2</p> <p>CO3: Learn the procedure for gene transformation techniques K1</p> <p>CO4: Well versed in PCR techniques and primer design using bioinformatics tools K3</p> <p>CO5: Know advanced techniques, identification of any organisms using DNA barcoding, DNA based nanostructure and applications K2</p>
Unit I	Restriction enzymes, DNA ligase, Klenow fragment, DNA polymerase I, T4/T7 DNA polymerase, Taq polymerase linkers, adaptors, Homopolymeric tailing, Alkaline phosphatase, Reverse transcriptase, Radioactive and non radioactive probes, hybridization, Microarray, blotting- southern, northern, western
Unit II	Host cells – Prokaryotic & Eukaryotic, Vectors – plasmids, Lamda phage, M13, PUC 18, Cosmids, artificial chromosomal vectors (YAC,BAC), Animal virus derived-SV40, Vaccinia, retroviral, Expression vectors-pET based yeast vectors and Shuttle vectors, Ti and R vectors.Intein – based vectors, inclusion bodies.
Unit III	Insertion of foreign DNA into host- Transformation, Electroporation, Lipofection, Microinjection, Construction of Genomic DNA and cDNA libraries, cDNA and genomic cloning, Expression cloning, protein-protein interactive cloning. Yeast two hybrid system, principles to maximize gene expression.
Unit IV	Primer design, PCR- Multiplex, nested, reverse transcriptase, realtime, Touchdown, Hot start and colony. Cloning of PCR products. PCR in molecular diagnostics, Viral & Bacterial detections, mutation & polymorphism detection – RFLP, SSCP, Oligo ligation assay, Allele specific amplification, DNA fingerprinting, site directed mutagenesis.
Unit V	DNA sequencing –chemical, enzymatic, Automated & Pyro Human genome project, DNA barcoding, DNA based nanostructure and applications. Chemical synthesis of oligonucleotides. Gene knockout and gene therapy, suicide gene therapy and transgenics.
References	<ol style="list-style-type: none"> Gene Cloning and DNA Analysis. An introduction (2006) by T.A Brown, Blackwell Scientific Publications. Principle of Gene Manipulation and Genomics (2006) by S.B. Primrose and R.M Twyman, Blackwell Scientific Publications. Molecular Biology of the Gene, 6th edition (2008) by James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine and Richard Losick, Benjamin Cummings.

	<p>4. From Genes to Clones: Introduction to gene technology (1987) by Winnacker, E.L.</p> <p>5. Next generation sequencing (2008) by Michael Janitz, Wiley-Blackwell Publications.</p>
E-reference links:	<p>1) https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-4th-edition-e162050162.html</p> <p>2) https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-e156918014.html</p> <p>3) https://www.pdfdrive.com/recombinant-dna-technology-molecular-biology-and-paradigms-e11385991.html</p> <p>4) https://www.pdfdrive.com/recombinant-dna-principles-and-methodologies-e185941491.html</p>

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	S	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S
CO5	S	S	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	SKILLED BASED STUDIES III -PATENT AND PAPER/PROJECT WRITING- IBTS53		
Semester	Semester-V	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objectiv	<ul style="list-style-type: none"> Estimate the possibilities of IP rights and the various ways of securing national and international protection 		

e	<ul style="list-style-type: none"> Have critical thinking and innovative skills
Course Outcomes	Upon completion of this course the students will be able to
	CO1: Perceive the role of Scientific writing K1 CO2: Utilize IP rights in business effectively K2 CO3: Decide on patenting procedures, types and filing K2 CO4: Perform Prior Art search and Draft Patents K3 CO5: Acquire knowledge in develop skills required in writing reports and dissertation K3
Unit I	Traditional Knowledge – Petty patents, Patenting of biological materials –Patentable and non patentable inventions. Patentability of living organisms and genetic material, Pharmaceutical Patent, Patentability of diagnostic methods. Priority Search, paid and free tools for priority search. Forms and Procedures for filing patent. Technology transfer, IP Policy of University
Unit II	Choosing the problem for research, literature collection – Primary, secondary and tertiary sources – Bibliography – indexing and abstracting – Reporting the results of research in conferences – Oral and Poster presentation . Thesis writing – Research journals – SCI, National and International –monographs – reprints – proof correction – Full paper – Short Communication – Review paper. Shodhganga, infliibnet, online portals for free and paid access to journals and books
Unit III	Proposal Writing. National and International funding agencies. Applying for research funding and their Importance, Assumptions and strategies when writing proposals, hypothesis and preliminary works, Writing review: Introduction, Literature survey, Source of literature, compilation.
Unit IV	Preparing Manuscripts: Main contents of a scientific paper, Procedure to submit a paper, Reviewing procedure, Advices in responding to reviewer, Examples-An example on abstract & an example on responses to reviewers, Online literature databases; Literature management tools. Journal Metrics, Author Metrics. Referencing and citation. Plagiarism: Introduction; Tools for the detection of plagiarism; avoiding plagiarism
Unit V	Activity: Preparation of Departmental Magazine: Collection of events including Festival celebrations, Club Activities, Departmental Activities and achievements and compilation. Monthly magazine.
References	1. Intellectual Property Rights (2008) Prabuddha Ganguly, Tata McGraw Hill Publishing Company, India. ISBN: 9780070077171 2. Patents (2003), N.Subbaram, Pharma Book Syndicate, Hyderabad. 3. Ethics and Biotechnology by Anthony Oakley Dyson, John Harris. Routledge. 1994.
E-referenc e links	1. http://www.ipindia.nic.in/ 2. https://www.epo.org/learning/materials/inventors-handbook/novelty/searching.html 3. https://www.uspto.gov/patent/initiatives/prior-art-search 4. https://www.wipo.int/edocs/mdocs/aspac/en/wipo_ip_cm_09/wipo_ip_cm_09_topic7_01.pdf

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	M	S	S	M	S	S	S	M	M	S

CO2	S	M	M	M	S	S	M	S	S	S	M	M	S
CO3	S	M	M	M	S	S	M	S	S	S	M	M	S
CO4	S	M	M	M	S	S	M	S	S	S	M	M	S
CO5	S	M	M	M	S	S	M	S	S	S	M	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

SEMESTER VI

Course Title & Code	CORE 13 (Theory) – CELL AND TISSUE CULTURE –IBTT61		
Semester	Semester-V1	Credits:4	Hours/weeks: 5
Cognitive Level	K2: Understand K3: Apply K4: Analyze		
Learning	<ul style="list-style-type: none"> To learn the fundamentals of cell and tissue culture, 		

Objective	<ul style="list-style-type: none"> To know about the media preparation To understand the commercial applications of tissue culture.
Course Outcomes	<p>Upon completion of this course the students will be able to</p> <p>CO1 : Acquire knowledge on organization of cell and tissue culture lab and methods of aseptic maintenance and nutritional requirements. K3</p> <p>CO2 : Understand the culture methods of bacteria, fungi and virus</p> <p>CO3 : Know the techniques of algal culture. K2</p> <p>CO4 : Understand the methods of animal cell culture. K2</p> <p>CO5 : Analyze the techniques employed for plant tissue culture including single cell, protoplast and callus culture. K4</p>
Unit I	Bacterial and Actinomycetes cell culture - culture media and its types, preparation of culture media- Media optimization: pH & temperature, techniques of aseptic transfer and observation of culture. Culture methods- spread plate, streak plate, test tube culture Pure culture- sub culture – cryopreservation Storage and Maintenance. Culture repositories.
Unit II	Fungal and viral cultures – different types of media, optimization of media, inoculation methods -fungi and mushrooms. Spore culture, maintaining of culture and specimen, identification and observation of culture, Culture repositories. Cultivation and purification of viruses, Assay of viruses. Bacteriophage – isolation and identification.
Unit III	Algal cell culture: Laboratory and Mass culture of Algae, Mass production of blue green algae. Method of production of unicellular algal food, Single Cell Protein, Sea weeds Cultivation, Algal food in the field of Aquaculture. Planktons (Phyto plankton & Zoo plankton) - production and measurement, Methods of collection and preservation.
Unit IV	Animal cell culture: Culture media preparation, Synthetic and Artificial, Serum and glutamine in cell culture, Serum and Protein free defined media and their applications. Biology of Cultured cells: Characteristics, Measurement of growth, Cell synchronization, Senescence and Apoptosis. Primary and established cell cultures. Cell lines, Subculture: Monolayer, Suspension culture. Stem cell cultures- Organ culture and Histotypic culture. Assays for cell viability and Cytotoxicity.
Unit V	Plant Cell Culture- Growth and development of plant cells and tissues in vitro. Laboratory requirements, aseptic techniques. Nutrient media. Plant growth regulators: mode and mechanism of action. Callus culture, cell suspension culture, organ culture, protoplast culture. In-vitro Germplasm conservation (Cryopreservation).
References	<ol style="list-style-type: none"> Martin BM. Tissue Culture Techniques- An Introduction. Birkhauser. 1994. Smith RH. Plant tissue culture. Elsevier. 3rd ed. 2013. Singh B.D. Biotechnology. Expanding horizons. Kalyani Publ. 4th ed. 2012 Mather JP and Barnes D. Animal Cell Culture Methods. Vol 57. Elsevier Freshney RI. Culture of Animal Cells: A manual of basic technique. Wiley-Liss. 6th ed. 2010.
E-reference links:	<ol style="list-style-type: none"> https://nptel.ac.in/ https://www.pdfdrive.com/culture-of-animal-cells-a-manual-of-basic-technique-and-specialized-applications-d157211461.html https://www.pdfdrive.com/animal-cell-biotechnology-d22743665.html https://www.pdfdrive.com/plant-cell-and-tissue-culture-a-tool-in-biotechnology-d20389188.html

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	S	S	S	S	M	S	S	S	S	M	S
CO3	S	M	S	S	S	S	M	S	S	S	S	M	S
CO4	S	M	S	S	S	S	M	S	S	S	S	M	S
CO5	S	M	S	S	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

Course Title & Code	CORE 14 (Theory) – ENZYME TECHNOLOGY-IBTT62		
Semester	Semester-V1	Credits:4	Hours/weeks: 5
Cognitive Level	K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To understand the mechanism of enzyme action and its kinetics To study the downstream processing of enzymes To gain knowledge of enzyme techniques for industrial application 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1 :	Understand the basic concepts and the kinetics and regulatory role of enzymes. K2	
	CO2 :	Comprehend the methods for enzyme production and immobilization K2	
	CO3 :	Design the strategies of enzyme engineering K3	
	CO4 :	Apply the methods for large scale isolation, purification and downstream processing of Enzymes K3	
CO5:	Apprehend the applications of enzymes as tools in industry and as therapeutics in medicine. K4		
Unit I	Brief introduction to enzymes, mechanisms of enzyme action, specificity of enzyme action, the structure–functionality relationships, concept and determination of enzyme activity, Effect of physical and chemical factors on enzyme activity, applications in food, pharmaceutical and other industries		
Unit II	Kinetics of enzyme catalysed reactions. Importance and estimation of kinetic constants, Kinetics of bi substrate enzymes, Enzyme inhibition types and models- Competitive, Non-competitive and Un-competitive inhibitions. Inhibition kinetics- substrate, product and toxic compound.		
Unit III	Extraction and purification of enzymes from plant, animal and microbial sources, Extraction of soluble and membrane bound enzymes. Nature of		

	extraction medium. Purification of enzymes. Criteria of purity. Determination of molecular weight of enzymes.
Unit IV	Immobilization of enzymes: Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, Encapsulation, cross-linking, covalent binding, advantages and disadvantages of Different immobilization techniques. Design of immobilized enzyme reactors – Packed bed, Fluidized bed and Membrane bioreactors
Unit IV	Analytical and Industrial Applications of enzymes: Enzyme electrodes. Biosensors: components, types, (calorimetric, potentiometric, amperometric). Enzymes of industrial significance: use of enzymes in detergents, textiles, and leather industry, production of glucose syrup, cheese production. Therapeutic uses of enzymes: Enzymes as diagnostic aids. Therapeutic uses of enzymes: enzymes as thrombolytic agents and digestive aids.
References	<ol style="list-style-type: none"> 1. Palmer T. Understanding Enzymes. Printice Hall. 2004. 2. Buchholz et al Biocatalysts and Enzyme Technology. Wiley-Blackwell. 2nd ed. 2012. 3. Pandey et al. Enzyme Technology. Springer. 2010. 4. Nelson, Cox. Lehninger Biochemistry. Freeman. 7th ed. 2017. 5. Balasubramanian et al. Concepts in Biotechnology. Univ Press. 2007. 6. Dixon and Webb. Enzymes. Elsevier. 2nd ed. 2014 7. John E. Smith. Biotechnology. Cambridge university press,5th ed. 2009
E-reference links:	<ol style="list-style-type: none"> 1. https://nptel.ac.in/ 2. https://www.pdfdrive.com/enzyme-kinetics-enzymes-e5167787.html 3. http://www1.lsbu.ac.uk/water/enztech/ 4. https://www.pdfdrive.com/enzymes-biochemistry-biotechnology-clinical-chemistry-e183694351.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	M	S	S	S	S	M	M
CO2	S	M	S	S	S	S	M	S	S	S	S	M	M
CO3	S	M	M	S	S	S	M	S	S	S	S	M	M
CO4	S	M	M	S	S	S	M	S	S	S	S	M	M
CO5	S	M	S	S	S	S	M	S	S	S	S	M	

Strongly Correlating (S) - 3 marks

Moderately Correlating	(M)	- 2 marks
Weakly Correlating	(W)	- 1 mark
No Correlation	(N)	- 0 mark

Course Title & Code	CORE 15 (THEORY)- ENVIRONMENTAL BIOTECHNOLOGY- IBTT63		
Semester	Semester-VI	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To understand the concept of natural resources, environmental pollution and remediation using biotechnology. Students will get an idea about the hazards to our environment, solutions to protect and for sustainable development. To learn remediation of contaminated environments (land, air, water), and for environment-friendly processes such as green manufacturing technologies and sustainable development. Student can identify the environmental problems such as global warming, ozone depletion and waste disposal and acquire skills to solve the environmental problems through biotechnological approach and become environmental conscious. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Identify and conserve the diversity both plants and animals resources. K1	
	CO2:	Understand and identify the environmental issues and gaining the problem solving ability K2	
	CO3:	Apply the knowledge of water chemistry to prevent the water pollution K3	
	CO4:	Gain knowledge about solid wastes management K2	
	CO5:	Analyse the eco friendly products and apply methods for environmental protection K4	
Unit I	Environment components- Biotic and Abiotic factors, Natural resources and fuels: Role of Biotechnology in Environmental protection, Classification of natural resources – Inexhaustible, Exhaustible- resources. Conservation of natural resources – water, forest, energy and soil resources. Production of biogas, Hydrogen gas and biofuel (alcohol), environmental act.		
Unit II	Pollution: Types of environmental pollution. Bioindicators and biosensors for detection of pollution. Biochemical methods for control of pollution. Green house effect and global warming. Ozone depletion and acid rain, Bhopal disaster, London smog.		
Unit III	Water chemistry – physical-chemical and biological parameters – sources and effect of water pollution, oil pollution-super bug, waste water treatment, water borne		

	diseases, Treatment of effluent from distillery and sugar industry. Minamata disease, GAP, Eutrophication, Oil disaster.
Unit IV	Types of solid wastes, sources and its impact on environment, solid waste disposal-land filling, composting, incineration, 3R concepts, Vermicomposting, Radioactive wastes sources, Disposal Sources effects and control measures - Deino coccus, Love canal disaster.
Unit V	Biopesticides and Biofertilizers, Single cell protein, Biomineralisation, Mechanism of Biomineralization. Biomining. Xenobiotics – Pesticides degradation, Degradative plasmids for hydrocarbons and Persistent organic pollutants, Biological detoxification of PAH, Eco – mark, Biodegradable plastics.
References	<ol style="list-style-type: none"> Jordening HJ and Winter J. 2005. Environmental Biotechnology: Concepts and Applications. Wiley. Dwivedi S.K, Kalita M.C, and Dwivedi P. 2007. Biodiversity and Environmental Biotechnology. 1st edition. Scientific Publishers, India, New Delhi. Sharma P.D. 1994. Environmental Biology. Rastogi Publishers, New Delhi. Chatterjee A.K. 2002. Introduction to Environmental Biotechnology. Printice Hall, India. B.K Sharma – 2000. Environmental Chemistry, Krishna Prakashan Media
E-reference links	<ol style="list-style-type: none"> https://www.pdfdrive.com/environmental-biology-the-conditions-of-life-environmental-selection-extinction-creation-e116415545.html https://www.pdfdrive.com/environmental-biotechnology-biodegradation-bioremediation-and-bioconversion-of-xenobiotics-for-sustainable-development-e158141796.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	CORE PRACTICAL-III -IMMUNOLOGY AND RECOMBINANT DNA TECHNOLOGY - IBTP61		
Semester	Semester-VI	Credits:4	Hours/weeks: 5
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To introduce students to different techniques that are commercially used in molecular diagnosis of diseases and give an account of different diseases that are routinely diagnosed using molecular testing. To give a broad overview of molecular theory and exposure to molecular and immunology techniques, a forum to understand clinical applications of various molecular tests. To introduce students to different techniques that are commercially used in molecular and immunology diagnosis of diseases and give an account of different diseases that are routinely diagnosed using molecular and immunology testing. To get information on the latest advances in recombinant DNA technology, which is a powerful tool needed for modern biotechnology research. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Gain practical knowledge about immunological techniques K1	
	CO2:	Understand the ABO blood grouping easily K2	
	CO3:	Learn procedure of various blotting techniques K3	
	CO4:	Analyze the immunological problems, find solution using immunology testing. K4	
	CO5:	Gain knowledge about latest advances in recombinant DNA technology K2	
Experiments in Immuno and Recombinant DNA Technology	<ol style="list-style-type: none"> Antigen-anti body reactions Immuno diffusion (Single radial, double and rocket) Blood grouping Preparation of serum from blood ELISA- Demonstration Restriction digestion, ligation Preparation of competent <i>E.coli</i> cells & transformation of <i>E.Coli</i> using recombinant DNA Primer designing and PCR 		

References	<ol style="list-style-type: none"> 1. Roitt et al. Roitt's Essential Immunology. Wiley-Blackwell Sci. 13th ed. 2017. 2. James D. Watson et al. Recombinant DNA: Genes and Genomes- A Short Course. Freeman.3rd ed. 2006. 3. Glick and Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press. 4th ed. 2010. 4. H.N. Thatoi , Supriya, Dash, Swagat Kumar Das. Practical Biotechnology: Principles and Protocols. 2017. 5. Thankur IS (2011) Environmental biotechnology: Basic concepts and applications. Second Edition (revised), I.K. International.
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Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	M	M	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	M	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE PRACTICAL-IV –ENVIRONMENTAL BIOTECHNOLOGY AND BIOINFORMATICS – IBTP62		
Semester	Semester-VI	Credits:4	Hours/weeks: 5
Cognitive Level	K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To practice remediation of contaminated environments (land, air, water), and for environment-friendly processes such as green manufacturing technologies and sustainable development. 		
Course	Upon completion of this course the students will be able to		

Outcomes	CO1: Gain practical knowledge about Environmental Biotechniques K2 CO2: Understand and identify physico-chemical characterization of water sample K4 CO3: Gain knowledge about analysis of water quality and solve the problem to the society K3 CO4: Understand the basics of Biological databases K2 CO5: Apply their knowledge of bioinformatics tools to interpret the finding K3
Experiments in Environmental Biotechnology	<ol style="list-style-type: none"> 1. Sampling techniques of water 2. Determination of colour, pH and temperature 3. Estimation of total alkalinity 5. Estimation of chloride 6. Estimation of total hardness 7. Estimation of Calcium 8. Estimation of DO, BOD and COD in drinking water 9. Estimation of DO, BOD and COD in sewage sample 10. Estimation of phosphate in drinking water 11. Estimation of nitrate in drinking water 12. Estimation of chromium and ferrous ion 13. Quick field soil test 14. Isolation of micro-organism from environmental sample 15. MPN- Water portability Test
Experiments in bioinformatics	<ol style="list-style-type: none"> 1. Database searching against a query sequence and selection of orthologous sequences using BLAST & database searching 2. Multiple Sequence Alignment using Clustal W. 3. Prediction of Open Reading Frames using ORF Finder 4. 3 Dimensional Structure of protein using Deep View, UCSC Genome Browser. 5. NCBI databases, Databases at EBI: EMBL-Bank, UniProt, ArrayExpress, InterPro Ensembl- genome browser.

Course Title & Code	SKILLED BASED STUDIES IV- EFFECTIVE COMMUNICATION AND PERSONALITY DEVELOPMENT-IBTS64		
Semester	Semester-VI	Credits:2	Hours/weeks: 2
Cognitive Level			
Learning Objective	<ul style="list-style-type: none"> • To develop the students to understand the importance of personality development 		

	<ul style="list-style-type: none"> • To know about self-awareness and self-monitoring • To create an effective team and know the importance of team building
Course Objectives	
Unit I	PERSONALITY - Definition – Determinants – Personality Traits –Theories of Personality –Importance of Personality Development. SELF AWARENESS – Meaning – Benefits of Self –Awareness – Developing Self – Awareness. SWOT – Meaning – Importance- Application –Components. GOAL SETTING Meaning- Importance – Effective goal setting – Principles of goal setting – Goal setting at the Right level.
Unit II	SELF MONITORING – Meaning – High self – monitor versus low self monitor – Advantages and Disadvantages self monitor- Self –monitoring and job performance. PERCEPTION Definition- Factor influencing perception- Perception process –Errors in perception – Avoiding perceptual errors. ATTITUDE – Meaning- Formation of attitude – Types of attitude - Measurement of Attitudes – Barriers to attitude change – Methods to attitude change. ASSERTIVENESS - Meaning – Assertiveness in Communication – Assertiveness Techniques – Benefits of being Assertive – Improving Assertiveness.
Unit III	TEAM BUILDING –Types of teams – Importance of Team building- Creating Effective Team. LEADERSHIP – Definition – Leadership style-Qualities of an Effect leader. NEGOTIATION SKILLS – Meaning – Principles of Negotiation–Types of Negotiation – The Negotiation Process – Common mistakes in Negotiation process. CONFLICT MANAGEMENT – Definition- Types of Conflict- Levels of Conflict – Conflict Resolution – Conflict management
Unit IV	Communication network – Barriers in communication – Overcoming Communication Barriers. TRANSACTIONAL ANALYSIS –Meaning – EGO States – Types of Transactions - Life Positions. EMOTIONAL INTELLIGENCE- Meaning – Components of Emotional Intelligence Significance of managing Emotional intelligence – How to develop Emotional Quotient. STRESS MANAGEMENT – Meaning – Sources of Stress – Symptoms of Stress – Consequences of Stress – Managing Stress
Unit V	SOCIAL GRACES – Meaning – Social Grace at Work – Acquiring Social Graces. TABLE MANNERS – Meaning – Table Etiquettes in Multicultural Environment- Do’s and Don’ts of Table Etiquettes. DRESS CODE – Meaning- Dress Code for selected Occasions – Dress Code for an Interview. GROUP DISCUSSION – Meaning – Personality traits required for Group Discussion- Process of Group Discussion- Group Discusson Topics. INTERVIEW – DefinitionTypes of skills – Employer Expectations –Planning for the Interview – Interview QuestionsCritical Interview Questions.
References	<ol style="list-style-type: none"> 1. Stephan P.Robbins, Organisational Behaviour, Tenth Edition, Prentice Hall of India Private Limited, New Delhi, 2008 2. Jit S. Chandan, Oragnisational Behaviour, Third Edition, Vikas Publishing House Private Limited, 2008 3. Dr.K.K. Ramachandran and Dr.K.K. Karthick, From Campus to Corporate,

Macmillan Publishers India Limited, New Delhi, 2010.

SEMESTER VII

Course Title & Code	CORE 16 (THEORY)-ADVANCED BIOCHEMISTRY-IBTT71		
Semester	Semester-VII	Credits:4	Hours/weeks: 4
Cognitive Level	K1: Recall K2: Understand		
Learning Objective	<ul style="list-style-type: none"> • Students will get knowledge about the structure and functions of biomolecules, enzyme kinetics, bio polymers and metabolic reactions in a living system. • To introduce them to the basic structure of biomolecules which are involved in metabolic pathways • To determining how they are metabolized in organisms, and elucidating their role in the operation of the organism. • On the successful completion of the course the students will get an overall understanding of Biomolecules, their structure and classifications, enzyme kinetics and metabolic reactions in a living system. • To understand the industrial-market value and significance of these biomolecules and to apply these in the fundamentals of biotechnology 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Understand the metabolic pathway of biomolecules K1	
	CO2:	Gain knowledge on the structure of protein and its disorder K2	
	CO3:	Know about nucleotide structure, biosynthesis, its regulation & degradation of Biomolecules K2	
	CO4:	Know the molecules, metabolisms of biochemical pathways and apply the knowledge in clinical lab and industries K3	
	CO5:	Learn the basic concept of Enzymes – Nomenclature and Classification, factors influencing enzyme activity K2	
Unit I	Atom, Molecules & chemical bonds, Introduction to metabolism – anabolism and catabolism. Carbohydrates – Occurrence, chemical properties, stereo and optical isomerism, structure and classification. Metabolism and its regulation – Glycolysis, TCA cycle, Oxidative phosphorylation, pentose phosphate pathway and gluconeogenesis, ATP synthesis, Photosynthesis, Glycolysis. Disorders of carbohydrate metabolism.		
Unit II	Lipids – occurrence, chemical properties and classification-biosynthesis of fatty acids triglycerides, phospholipids and cholesterol – Oxidation of fatty acids, lipid storage and membrane lipids and their organization, Lipoproteins. Disorders of lipid metabolism. Vitamins – classifications, derivatives, hormones, secondary metabolites – Types functions & disorders.		
Unit III	Amino acids and Proteins – Amino acids: structure, classification and chemical properties, structure of peptide bond – protein: classification, amino acid		

	composition. Protein structure – Primary structure, secondary structure – alpha helix and beta pleated structure, tertiary and quaternary structure. Protein metabolism and degradation: A.A oxidation & Urea cycle. Ramachandran plot. Model proteins myoglobin, hemoglobin and chymotrypsin. Disorders of aminoacid metabolism.
Unit IV	Nucleic acids – DNA & RNA – structure of purine and pyrimidine bases, nucleotides and nucleotide biosynthesis, its regulation & degradation of purine and pyrimidine nucleotides – Biosynthesis of deoxyribonucleotides. Sequencing of nucleotides. Disorders of nucleic acid metabolism.
Unit V	Enzymes – Nomenclature and Classification – protein enzymes, coenzymes, prosthetic groups, cofactors, isoenzymes, ribozymes, abzymes: chemical properties of enzymes: types of specificity – absolute, group, stereochemical and geometrical; factors influencing enzyme activity – temperature, pH, concentration of enzyme, substrate and effect of ions; enzyme kinetics, types of enzyme inhibition – reversible, competitive, non-competitive, uncompetitive, irreversible inhibition; allosteric enzymes. Single substrate and multi substrate enzymes. Relevance of enzymes in metabolic regulation.
References	<ol style="list-style-type: none"> 1. Nelson D.L and Cox M.M. 2006. Lehninger Principles of Biochemistry, 4th edition, Macmillan worth Publishers. 2. Murray R.K, Granner D.K and Rodwell V.M. 2006. Harper's Illustrated Biochemistry, 27th Edition, The McGraw-Hill companies, Inc. 3. Berg J.M, Tymoczke J.L and Stryer W.H. 2007. Biochemistry, Freeman and Company, USA 4. Principles of Biochemistry Third Edition International Student Version Chapter 13 Biochemical Signaling Copyright © 2008 by John Wiley & Sons, Inc. Donald Voet • Judith G. Voet • Charlotte W. Pratt 5. U. Satyanarayana, Biochemistry, Books and Allied (P) Ltd., Calcutta, Latest Edition. 2017
E-reference links:	<ol style="list-style-type: none"> 1. https://doi.org/10.1002/cbf.1216 2. https://www.pdfdrive.com/biochemistry-biochemistry-e19576202.html 3. https://www.pdfdrive.com/textbook-of-biochemistry-e14983388.html 4. https://www.pdfdrive.com/biochemistry-genetics-molecular-biology-e18198970.html 5. https://www.pdfdrive.com/lehninger-principles-of-biochemistry-5th-edition-e164892141.html

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	M	S	S	S	M	S	S	S	M	M	S
CO3	S	M	M	S	S	S	M	S	S	S	S	M	S
CO4	S	M	M	M	S	S	M	S	S	S	S	S	S
CO5	S	M	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating	(S)	- 3 marks
Moderately Correlating	(M)	- 2 marks
Weakly Correlating	(W)	- 1 mark
No Correlation	(N)	- 0 mark

Course Title & Code	CORE17 (THEORY)- APPLIED MICROBIOLOGY- IBTT72		
Semester	Semester-VII	Credits:4	Hours/weeks: 4
Cognitive Level	K1: Recall K2: Understand K3: Analyze K4: Apply		
Learning Objective	<ul style="list-style-type: none"> To learn about the basic applications of microorganisms. To understand the identification of microorganisms using advanced microbiological methods To identify any microorganisms, predict the intermediate metabolism of any microbe used in industrial production processes, To understand the pathogenesis of micro organisms 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Know the Applications of various field of microbiology K1	
	CO2:	Understand the causative agent, epidemiology, Pathogenesis of microbes	
	CO3:	K2	
	CO4:	Have a knowledge on food spoilage micobes and its preservation techniques K3	
	CO5:	Know about the beneficial micro organism in agriculture and Environment K4	
		Evaluate the role of micro-organisms in specific biotechnological processes K3	
Unit I	Medical Microbiology: Introduction to Infectious diseases - Methods of transmission. Host parasite relationship. Causative agent, Epidemiology, Pathogenesis, Prophylaxis and Treatment - Staphylococcosis, Salmonellosis Aspergillosis, Cadidiasis, Giardiasis, Malaria, Rickettsiosis, AIDS, Influenza , Mycoplasmosis, flu (H1N1) and Covid-19. Importance of nosocomial infections (hospital borne), mode of transmission of airborne pathogens.		
Unit II	Food Microbiology - Production of distilled beverage alcohol, wine, brandy and beer. Single cell protein and Baker's yeast. Food industry enzymes -source and application. Contamination and spoilage of meat, fish, milk, vegetables and fruits. - Principle of food preservation methods, Food quality and control. Determination of microorganisms in food -culture, microscopy and sampling methods		
Unit III	Agriculture Microbiology: Microbial flora of soil – bacteria, fungi, algae and protozoa. Microbial interactions among soil microorganisms. Plant growth promoting bacteria. Introduction to Nitrogen fixing bacteria-Rhizobium. Phosphorus solubilizing bacteria –VAM, <i>Anabaena</i> –importance in agriculture.		

Strongly Correlating	(S)	- 3 marks
Moderately Correlating	(M)	- 2 marks
Weakly Correlating	(W)	- 1 mark
No Correlation	(N)	- 0 mark

Course Title & Code	CORE 18 (THEORY) - MOLECULAR BIOLOGY AND GENETICS- IBTT73		
Semester	Semester-VII	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> Outline the regulation of gene expression Explain the importance of mutations Illustrate chromosome inheritance pattern To Understanding the structural and functional aspects of the cell provides the student with a strong foundation in the molecular mechanisms underlying cellular function. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Recall key concepts about the organization of genes and the process of replication K1	
	CO2:	Gain knowledge in genome organization of organisms. K2	
	CO3:	Understanding the structural and functional aspects of the genes provides the student with a strong foundation in the molecular mechanisms K2	
	CO4:	Understand the basis of mutations and gene arrangements K2	
	CO5:	Compare and analyze the different methods of gene transfer and their related mechanisms K3	
Unit I	Genetic Material / Replication enzymes: DNA as genetic material. Central dogma concept. Semi-conservative replication. Enzymes in DNA replication - prokaryotic and eukaryotic DNA polymerases, fidelity, and processivity of polymerases. Genetic code: commaless, non-ambiguous, degenerate, triplet code and its feature, wobble hypothesis, universality of genetic code.		
Unit II	DNA Replication : Replication in prokaryotes-origin of replication, replication fork, leading and lagging strand replication. Okazaki fragments. Elongation, termination of replication. Eukaryotic DNA replication. Inhibitors of replication.		
Unit III	RNA and Transcriptional process: RNA structure, types of RNA, RNA polymerases, transcription in prokaryotes-initiation and elongation, promoters, termination of transcription. Eukaryotic promoters. Post transcriptional processing and modifications of RNA		
Unit IV	Gene Transfer Mechanism: Lateral and Horizontal gene transfer. Conjugation, Transformation, and Transduction (Generalized transduction and specialized transduction) Transformation and & its mechanism. Griffith experiment. DNA repair - DNA damage and causative agents. The mechanism that reverse, excise, or tolerate DNA repair.		
Unit V	Mutation and Gene arrangement: Classes of mutations, spontaneous and induced mutation, mutagens, Reversion and suppression mutations, Ames test. Genetic characterization of mutants. Transposition -Transposons, structure, types and mechanism. Genetic Recombination - Homologous Recombination,		

	enzymes, and models (Double-stranded invasion model and Meselson and Radding model). Site-specific recombination (Bacteriophage lambda). Short sequence recombination
References	<ol style="list-style-type: none"> 1. Chaudhuri K (2012) Microbial Genetics The Energy and Resources Institute, TERI 2. Snyder L, Peters JE, Henkin TM, Champness W (2013) Molecular Genetics of bacteria, 4th Edition ASM press 3. Krebs JE Lewin B, Goldstein ES and Kilpatrick ST (2014) Lewin's GENES XI Jones & Bartlett Publishers 4. De Robertis and De Robertis. 2005. 8th Eds. Cell and Molecular Biology. Lippincott Williams & Wilkins. 5. Brown T.A, 2002. Genomes. 2nd Edition. Wiley-Liss, New York. 6. Molecular Biology of the Cell (2014), 6th Edition, B. Alberts, A. Johnson Lewis, M. Raff, K. Roberts and P Walter, Garland Publishing (Taylor & Fran Group), New York & London (ISBN: 9780815344322). 7. Molecular Cell Biology (2014), Harvey Lodish, 7th Edition, W.H.Freeman Company, New York. 8. Primrose S.B, Twyman R.M., Old R.W. 2002. Principles of Gene Manipulation and genomics. 7th Edition. Blackwell Science.
E-reference links:	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/cell-division-genetics-and-molecular-biology-cell-division-genetics-and-molecular-biology-e22406140.html 2. https://www.pdfdrive.com/cell-biology-genetics-molecular-biology-evolution-and-ecology-e132225829.html 3. https://www.pdfdrive.com/molecular-cell-biology-molecular-cell-biology-e7302545.html 4. https://www.pdfdrive.com/biochemistry-genetics-molecular-biology-e18198970.html 5. https://www.pdfdrive.com/molecular-cell-biology-lodish-5th-ed-e15674865.html 6. https://www.pdfdrive.com/karps-cell-and-molecular-biology-e176035175.html

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	S	M
CO2	S	M	M	S	S	S	S	S	S	S	S	S	M
CO3	S	M	M	M	S	S	S	S	S	S	S	S	M
CO4	S	M	S	M	S	S	S	S	S	S	S	S	M
CO5	S	M	S	M	S	S	S	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE PRACTICAL-V - ADVANCED BIOCHEMISTRY, MICROBIOLOGY AND MOLECULAR BIOLOGY- IBTP71		
Semester	Semester-VII	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> To learn the technique about identification of microorganism from biological samples. To know the isolation and purification of actinomycetes and fungi and biochemical characterization of selected bacteria. To know the technique about spontaneous mutation by gradient plate technique, induced mutagenesis (UV, NTG) and replica plate technique. To learn technique about molecular mechanisms underlying cellular function, isolation of plasmid DNA and genomic DNA and DNA repair mechanism. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Gain practical knowledge about biomolecules K1	
	CO2:	Develop skill and do different chromatography techniques K2	
	CO3:	Gain hands on isolation and identification of microbes in the laboratory K3	
	CO4:		
	CO5:	Gain knowledge about analysis of mutation studies K2	
		Train on isolation of nucleic acids K2	
Experiments in Biochemistry	<ol style="list-style-type: none"> 1. Estimation of DNA by diphenylamine 2. Estimation of RNA by orcinol method. 3. Extraction and Estimation of starch from potato/ tapioca 4. Estimation of protein by lowry's method 5. Enzyme assay: Estimation of salivary amylase from saliva & phosphatase from potato 6. Separation of amino acids by Paper chromatography 7. Separation of amino acids by Thin layer chromatography 8. Separation of pigments by column chromatography 		
Experiments in microbiology and molecularbiology	<ol style="list-style-type: none"> 1) Isolation of microbes from different sources-food, effluent, soil 2) Measurement of microbial Size – Micrometry 3) Biochemical Characterization of Bacteria-. IMViC test, Catalase, Casein and Starch Hydrolysis 4) Anaerobic Cultivation- Fluid Thioglycolate broth 5) Antibiotic sensitivity assay- Disc and Well diffusion 6) SDS –PAGE 7) PCR principles, reaction 8) Isolation of Plasmid DNA 9) Isolation and purification of protein (Dialysis). 10) DNA damage and repair 		
References	<ol style="list-style-type: none"> 1. Okafor N (2016) Modern Industrial Microbiology and Biotechnology, SP publishers. 2. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman. 7th ed. 2017 		

	<p>3. Alberts et al Molecular Biology of the Cell. Garland Sci. 6th ed. 2014.</p> <p>4. Andreas Hofmann and Samuel Clokie. Wilson and Walker's Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press. 8th ed. 2018.</p>
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Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	S	S	S	S	S	M
CO3	S	S	S	S	S	S	M	S	S	S	S	S	M
CO4	S	S	S	M	S	S	S	S	S	S	S	S	M
CO5	S	S	S	M	S	S	M	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

SEMESTER VIII

Course Title & Code	CORE 19 (THEORY)- IMMUNOLOGY AND IMMUNOTECHNOLOGY- IBTT81		
Semester	Semester-VIII	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand		

	K4 Analyze
Learning Objective	<ul style="list-style-type: none"> To understand the definition of immunity, how it discriminates self and non-self and its regulation To understand the concepts of immune system and the structure, functions and properties of different cell types and organs that comprise the immune system. To comprehend the range of immunological agents and the strategies that may be used to prevent and combat infectious diseases
Course Outcomes	Upon completion of this course the students will be
	<p>CO1: Able to acquire the knowledge about immune system and its components K1</p> <p>CO2: Able to understand the complement system, MHC and the mechanism of immunity K2</p> <p>CO3: Able to classify the immune response related to immunodeficiency, allergy and hypersensitivity K2</p> <p>CO4: Able to know about organ transplantation and immunological anomalies related to autoimmune disorders K2</p> <p>CO5: Analyze the production of monoclonal antibodies, different types of vaccines and antibodies K4</p>
Unit I	Introduction - Overview of the immune system, Milestones of Immunology. Structure, classification, functions, Isotypes, allotypes and idiotypes. Complement system components, nomenclature, pathways of complement activation, classical pathway and alternate pathway. Biological functions of complement. Types of immunity.
Unit II	Innate and adaptive immunity - Lymphoid organs and cells of immune system. Complement classical and alternate pathways. T-cells and B-cell receptors. Maturation of T and B-cells. Antigen recognition, Antigen presentation, Immunological memory, Immuno tolerance. phagocytosis, cell mediated immunity- antibody-dependent cellular cytotoxicity (ADCC), MHC proteins – Antigen processing and presentation. Inflammatory response to infection. Transplantation types. Graft vs host reaction.
Unit III	Major Histocompatibility Complex, Hypersensitivity and Transplantation: Major histocompatibility complex- gene organisation - HLA genes class I and II antigens. Structure and function histocompatibility testing, cross matching. MHC & disease association. Hypersensitivity- definition and classification - type I to type V (brief account only). Transplantation-types: autograft, syngraft, allograft, xenograft.
Unit IV	Immunization practices and Immune Disorders: Immunization practices - active and passive immunization. Vaccines - killed, attenuated- toxoids. Recombinant vector vaccines - DNA vaccines, synthetic peptide vaccines. Production and applications of polyclonal and monoclonal antibodies. Genetically engineered antibodies. AIDS - pathogenesis. Tumor immunology - tumor antigens, cancer immunotherapy. Elementary details of anti-immunodisorder-SLE
Unit V	Immunotechniques: Agglutination and precipitation techniques. Immunodiffusion techniques, immunoelectrophoresis, RIA, Immunoblotting, Avidin - biotin mediated immunoassay. Immunohistochemistry, immunofluorescence. Complement fixation test. HLA typing. Hybridoma technology, ELISA - principle and applications. Western blotting and Flow cytometry.

References	<ol style="list-style-type: none"> 1. Kuby J. <i>et al.</i>, Immunology, 6th Edition. W.H. Freeman and Company, New York. 2006. 2. Chakravarthy A, Immunology and Immunotechnology, Oxford University Press, India. 2009. 3. C. V. Rao, An introduction to Immunology, Narosa Publishing House, Chennai. 2002. 4. Khan, Fahim Halim. The elements of Immunology, Pearson Education (India) Pvt. Ltd. 2009. 5. R. Tizard, Immunology: An Introduction. 4th Edition. Saunder's College Publishing, NY. 1995. 6. Roitt, Essential Immunology. Blackwell Science, Singapore. 1994.
E-Reference links:	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/microbiology-and-immunology-textbook-of-2nd-edition-e33405391.html 2. https://www.pdfdrive.com/cellular-molecular-immunology-7th-edition-e157242744.html 3. https://www.pdfdrive.com/basic-immunology-e21670961.html 4. https://www.pdfdrive.com/medical-microbiology-virology-immunology-e43491517.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	M	M	S
CO2	S	M	S	S	S	S	M	S	S	S	S	S	S
CO3	S	M	S	S	S	S	M	S	S	S	S	S	S
CO4	S	M	M	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE 20 (THEORY) - PHARMACEUTICAL BIOTECHNOLOGY – IBTT82		
Semester	Semester-VIII	Credits:5	Hours/weeks: 6
Cognitive Level	K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To know the basic concepts in pharmaceutical industry • To understand drug development, approval process and manufacturing of biopharmaceuticals. • To know the steps involved in drug discovery process 		

Course Outcomes	At the end of the course, the student will be able to	
	CO1 :	Understand the scope of pharmaceutical biotechnology. K2
	CO2 :	Understand pharmacokinetics, metabolism, dynamics of drugs and steps involved in drug discovery process K2
	CO3:	Apply the manufacturing principles in formulation of drugs and biopharmaceuticals. K3
	CO4:	Comprehend the production of recombinant proteins, enzymes and carbohydrate and nucleic acid based biopharmaceuticals. K4
	CO5:	Explain the regulatory aspects in drug development and drug approval K2
Unit 1	Introduction: Pharmaceutical Biotechnology and biopharmaceuticals. Sources of biopharmaceuticals - yeast, animal cell cultures, bacteria, fungi, plants, animals, transgenic plants. Drug isolation and evaluation. Formulation of biopharmaceutical products. Shelf life of protein based pharmaceuticals. Site specific delivery of protein drugs.	
Unit II	Pharmacokinetics and Dynamics: Routes of drug administration. Absorption of drugs. Bioavailability - factors influencing absorption and bioavailability. Drug distribution - plasma protein binding, placental transfer, blood-brain barrier. Mechanism of drug action, receptor theory, adverse effects of drugs, drug interactions.	
Unit III	Drug Metabolism and Manufacturing: Chemical reactions (proteolysis, deamidation, oxidation, disulfide exchange), reduction, hydrogenation, dehydrogenation. Excretion Manufacturing principles - compressed tablets, controlled and sustained release dosage forms enteric coated tablets and capsules.	
Unit IV	Biopharmaceuticals: Vaccines, modern vaccine technologies, pharmaceutical aspects. Recombinant proteins as pharmaceutical drugs. Protein engineering, peptide chemistry and peptidomimetics. Catalytic antibodies. Monoclonal antibody based pharmaceuticals. Hematopoietic growth factors. Nucleic acid therapy in development. Pharmaceutical enzymes. Development of adhesion molecules. Glycoprotein and carbohydrate based pharmaceuticals (Elementary details only).	
Unit V	Drug development and approval: Strategies for new drug discovery, lead compound, combinatorial approaches to drug discovery, pre-clinical and clinical trials. Phase I, II and III. Regulatory authorities - Food and Drug Administration (USA), European regulations- National security authorities, European medicine agency and new EU drug approval system. Current Streams of Thought The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.	
References	<ol style="list-style-type: none"> 1. Gilman et al. Goodman and Gilman's The Pharmacological Basis of Therapeutics. McGraw Hill. 12th ed. 2011. 2. Satoskar, Bhardarkar and Rege. Pharmacology and Pharmacotherapeutics. Poular Prakashan. 24th ed. 2015 3. Kayser O, Muller RH. Pharmaceutical Biotechnology- Drug Discovery and Clinical Applications. Wiley-VCH. 2004. 4. Klefenz H. Industrial Pharmaceutical Biotechnology. Wiley-VCH. 2002. 5. Shargel L, Yu ABC, Wu-Pong S. Applied Biopharmaceuticals and Pharmacokinetics. McGraw-Hill. 6th ed. 2012. 6. Spada S, Walsh G. Directory of Approved Biopharmaceuticals CRC Press. 2004 	
E-Reference Links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/pharmaceutical-biotechnology-fundamentals-and-applications-e164753639.html 2. https://www.kobo.com/us/en/ebook/pharmaceutical-biotechnology-2 	

3. <https://www.pdfdrive.com/pharmaceutical-biotechnology-concepts-and-applications-d38535075.html>

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	S	S
CO2	S	M	S	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	S	S	S	S	S	S	S	S	S
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	S	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

Course Title & Code	CORE 21 (THEORY)- ANIMAL BIOTECHNOLOGY- IBTT83		
Semester	Semester-VIII	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> To gain knowledge on animal cell culture, gene manipulation, principles of cloning and transgenic animal technology and safety. To know the ethical principles underlying biotechnology research and develop entrepreneurship skills. 		
Course Outcomes	Upon completion of this course , the students will be able to		
	CO1 :	Understand the fundamental principles that underlie cell culture and carryout cell based assays. K1	
	CO2 :	Comprehend the steps in manipulation of reproduction and acquire knowledge in animal cloning. K2	
	CO3 :	Understand the methods of gene transfer in animals. K2	
	CO4 :	Comprehend the methods of producing transgenic animals and benefits of transgenesis and related issues. K2	
CO5:	Recognize the importance of biosafety practices, ethical guidelines for research and entrepreneurship skill development. K3		
Unit I	Structure and organization of animal cell. History of animal cell culture technique. Constituents of culture medium; serum and supplements; Facilities for animal cell culture-infrastructure, equipment, culture vessels. Biology and characterization of cultured cells-cell adhesion, proliferation, differentiation, morphology of cells and identification. Animal cell culture-merits and demerits.		

Unit II	Primary cell culture techniques - aggregation, Cell growth & viability determination. Measurement of cell death, Transformation and Cytotoxicity assays. chromosome analysis and antigenic markers, selectable markers for animal cells. Mass culture of cells - manipulation of cell line selection - types of cell lines - maintenance of cell lines - immobilization of cells and its application - synchronization of cell - cryopreservation - germplasm conservation and establishment of gene banks. Hazards and safety aspects of cell culture techniques.
Unit III	Sources of contamination, Monitoring and eradication – suspension, monolayer, organ culture. Knock out and Knock in, Suicide gene therapy Gene silencing. Transgenic animals and Molecular pharming: Animal Biotechnology for the production of regulatory proteins, blood products, cell culture based vaccines and hormones and other therapeutic proteins. Embryonic preservation and its uses in endangered animals.
Unit IV	Gene therapy – IVF & Embryo transfer, Gene transfer techniques, Tissue engineering, Organ transplant. Synthetic viral vectors in gene transfer. Biotechnological applications for HIV. diagnostics and therapy. DNA based diagnosis of genetic diseases, DNA barcoding. Oncogenes and anti oncogenes. Genetic engineering approaches for genetic disorder correction. Transgenic animals as models for human disease
Unit V	Stem cells: types – Hematopoietic stem cells, Mesenchymal stem cells, embryonic stem cells, fetal stem cells, Adult stem cells- characterization, isolation, cultures. Stem cells as vector for cancer therapy. Collection, processing, preservation and banking of Umbilical cord blood stem cells. 3D culture, human cloning, ethical limits and mapping of human genome. Commercial application of animal cell culture
References	<ol style="list-style-type: none"> 1. Ralf Pörtner. 2007. Animal Cell Biotechnology: Methods and Protocols (Methods in Biotechnology). 2nd Edition. Humana Press. USA. 2. R.Spier and J.Griffiths. 1994. Animal Cell Biotechnology. Academic Press. London. 3. D.C. Darling and S.J. Morgan. 1994. Animal Cells Culture and media, BIOS Scientific Publishers Limited. Oxford. UK. 4. Jennie P. Mather and David Barnes. 1998. Methods in Cell Biology. Volume 57: Animal Cell Culture Methods. Academic Press. New York. 5. Ann Harris. 1996. Epithelial Cell Culture, Cambridge University Press. USA. 6. M .M. Ranga. 2000. Animal Biotechnology, Agrobios, India. 7. R Ian Freshney.2005. Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): Wiley-Liss, New York. 8. John R W Masters. 2000. Animal Cell Culture – Practical Approach, Ed. Oxford Univ Press. 9. JD Watson, M. Gilamn, J. Witkowski. 1992. Recombinant DNA technology. Scientific American books, New York. 10. Bhernard R Glick and Jack J. Pasterna, 2009, Molecular Biotechnology II edition, 4th edition, ASM press. USA.
E-Reference links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/animal-cell-biotechnology-e22743665.html 2. https://www.pdfdrive.com/animal-biotechnology-1-reproductive-biotechnologies-e187110512.html 3. https://www.pdfdrive.com/animal-cell-biotechnology-e177857548.html 4. https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-4th-edition-e162050162.html

.Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	S	S
CO3	S	M	S	S	S	S	S	S	S	S	S	S	S
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	S	M	S	M	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

Course Title & Code	CORE PRACTICAL-VI –IMMUNO TECHNOLOGY & ANIMAL BIOTECHNOLOGY- IBTP06		
Semester	Semester-VIII	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> To know the basic principles and techniques involved in plant cell culture and to understand the concepts of transformation and achievements of biotechnology in Plant systems. To know practical knowledge about the basics of animal cell culture, transgenic animals, pest & animal management, Molecular markers and regulations about the use of Biotechnology. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Able to apply immune techniques K1	
	CO2:	Gain practical knowledge about animal cell culture techniques requirements K1	
	CO3:	Learn culture media preparation and cell culture procedure K1	
	CO4:	Acquire skill in culture techniques in animal cells K3	
	CO5:	Gain knowledge about Virus inoculation methods K2	
Experiments in Immuno Technology	1. Preparation of plasma and serum, Blood cell analysis – total count, differential count. 2. ELISA 3. FACS 4. Blotting techniques (Southern Blotting, Western Blotting, Northern Blotting). 5. Immune diffusion methods (Radial immunodiffusion) (double immunodiffusion) , (single immunodiffusion), Rocket electrophoresis, Immuno electrophoresis		
Experiments in Animal	1. Introduction to the laboratory and general safety practices for animal cell culture.		

Biotechnology	<ol style="list-style-type: none"> 2. Balanced salt solutions 3. Animal cell culture media preparation 4. Filter sterilization of cultural media 5. Cell disaggregation 6. Handling of animals 7. Isolation of fibroblast from chick embryo 8. Virus inoculation methods 9. Isolation of genomic DNA from Animal cells 10. Quantification of DNA by spectroscopic method 11. Cell growth analysis 12. Cell viability test – MTT 13. Resuscitation of frozen cell lines 14. Sub culture of Adherence cell lines
References	<ol style="list-style-type: none"> 1. Abbas et al. Cellular and Molecular Immunology. Elsevier. 9th ed. 2018. 2. Roitt et al. Roitt's Essential Immunology. Wiley-Blackwell Sci.13th ed. 2017. 3. Hay FC, Westwood OMR. Practical Immunology 4th edition, Wiley, New Jersey, USA. 2008 4. Joseph Sambrook, David William Russell. Molecular cloning: A laboratory manual. 3rd ed.CSHL Press. New York. 2001. 5. John R.W Masters. Animal Cell Culture: a practical approach. 3rd ed. 2000.

SEMESTER IX

Course Title & Code	CORE 22 (THEORY)- PLANT BIOTECHNOLOGY- IBTT91		
Semester	Semester-IX	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply K5: Evaluate K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To learn laboratory set up for plant tissue culture • To gain the knowledge in plant tissue culture methods and gene transfer techniques • To create a plant bioreactor for social benefits • Analyze biotechnological tools for engineering plants in agriculture and industry 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Understand the tissue culture lab set up and learn the various techniques for plant tissue culture K1	
	CO2:	Know about the gene transfer methods and molecular marker assisted selection. K2	
	CO3:	To produce a new technology for agricultural improvement and become an entrepreneur K6	
	CO4:	Apply rDNA technology for crop improvement. K3	

Strongly Correlating	(S)	- 3 marks
Moderately Correlating	(M)	- 2 marks
Weakly Correlating	(W)	- 1 mark
No Correlation	(N)	- 0 mark

Course Title & Code	CORE 22 (THEORY)- BIOINSTRUMENTATION AND BIOSTATISTICS – IBTT92		
Semester	Semester-IX	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply		
Learning Objective	<ul style="list-style-type: none"> To develop knowledge handle the instruments for biological research and interrupt the data. To acquire knowledge on applications of statistics in research. To gain knowledge in experimental design and data collection techniques. To develop the technical art of writing research report and presentations. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Know about types of instruments and its principles, working procedure and sample preparation techniques K1	
	CO2:	Understand the importance of instruments and techniques in research aspects K2	
	CO3:	Know the advanced methods to detect and study any biomolecules using advanced instruments K3	
	CO4:	Skill development in the aspects of collection and presentation of biological data through biostatistics K3	
	CO5:	Learn the methods in statistics to solve the biological problems with accuracy K3	
Unit I	Microscopy-Principle and applications of light, phase contrast, fluorescence, inverted, scanning and transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, confocal microscopy, field emission scanning electron microscope, cytophotometry and flow cytometry. Micrometry, lyophilizer, Preparation of microbial, animal and plant samples for microscopy. Principles of colorimetry and spectroscopy.		
Unit II	Centrifugation: Basic principle and applications: Differential, density and Ultracentrifugation-velocity and buoyant density , Principle methodology and applications of gel – filtration, ion –exchange and affinity chromatography; Thin layer, liquid and gas chromatography; High performance liquid chromatography, ultra sonicator, pH meter, FT-IR.		
Unit III	Principle of biophysical method and used for analysis of biopolymer structure; X ray diffraction, fluorescence, UV, visible, IR. Atomic absorption and plasma emission spectroscopy, NMR, MS, ELISA reader, Electrophoresis: Principle and applications of Native, SDS,2D, Agarose gel, isoelectric focusing, isotachopheresis, MADI-TOF, thermocycler, microarray.		
Unit IV	Collection and presentation of experimental data. Brief description and tabulation of data and its graphical representation. Measures of central tendency: arithmetic		

	mean, median, mode, geometric mean, Harmonic mean. Uncertainties in estimation of mean. Measures of dispersion: range, interquartile range, standard deviation.
Unit V	Hypothesis testing - Idea of two types of errors and level of significance. Tests of significance: Parametric (F & t test); Non parametric: Chi square tests. Simple linear regression and correlation. Analysis of variance. Statistical treatment to proportion data and count data. Poisson distribution, standard error, confidence limits of count.
References	<ol style="list-style-type: none"> 1. John G Webster. 2004. Bioinstrumentation .Student edition, John Wiley & sons, Ltd. New York. 2. Edward Batschelet. 1992. <i>Introduction to Mathematics for Life Scientists</i>, 3rd ed., Springer. New York. 3. M Becker, G A Caldwell and E A Zachgo. 1996. <i>Biotechnology: A laboratory course (Second Edition)</i> Academic Press, USA. 4. Sokal, R.R. and F.J. Rohlf. 1969. <i>Biometry: The Principles and Practice of Statistics in Biological Research</i>. W.H. Freeman and Company, USA. 5. Zar, J.H. 1996. <i>Biostatistical analysis</i>. Prentice Hall, USA.
E-Reference links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/biostatistical-methods-biostatistical-methods-e15213717.html 2. https://www.pdfdrive.com/biostatistics-e42988735.html 3. https://www.pdfdrive.com/introductory-biostatistics-e15112721.html 4. https://www.pdfdrive.com/introductory-biostatistics-e176105301.html 5. https://www.pdfdrive.com/bioinstrumentation-instructional-resources-technology-austin-e15581883.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	M	S	S	S	S	S	S
CO5	S	M	S	S	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE 24 (THEORY)-OMICS AND GENOME EDITING – IBTT93		
Semester	Semester-IX	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply		

Learning Objective	<ul style="list-style-type: none"> To study prokaryotic and eukaryotic genomes , general methods of genome sequencing techniques, genome analysis and annotations, genome mapping techniques and applications of genomics. To understand the proteins enclosed by the genes with respect to structure, function, protein – protein interactions, techniques for separation and analysis, database and applications.
Course Outcomes	<p>After completion of this course, student would be able to</p> <p>CO1: Know the current genomic and proteomic perspective of model organisms. K1</p> <p>CO2: Gain the knowledge on the computational methods for gene expression analysis. K1</p> <p>CO3: Understand the constraint-based metabolic modelling and metabolic simulation. K2</p> <p>CO4: Use the proteome tools for protein identification from experimental data and Interaction databases.K3</p> <p>CO5: Use the knowledge on comparative genomics and its applications and also know the transcriptome analysis and its applications. K3</p>
Unit I	Genome and Genome sequencing: Genome structure and organization – Eukaryotic genome - Organelle genome- Genomics of Microbes and Microbiomes – Genome sequencing technologies –Comparative genomics and its applications
Unit II	Functional genomics - Large scale gene expression analysis –Experimental methods - Computational tools for expression analysis-Hierarchical clustering – Gene expression analysis– STS-EST-GSS-Assessing levels of gene expression using ESTs - cDNA databases – Transcriptome analysis and applications
Unit III	Molecular systems biology – Introduction – methodologies – constraint and kinetic modeling – Biomass objective function - metabolic simulation - biotechnological applications – Molecular network biology – Medical and clinical genomics - Pharmacogenomics and drug discovery – Agriculture genomics and its applications
Unit IV	Proteome – structural and functional features – Qualitative proteome technology (Gel-based and Gel-free) – Quantitative proteome technology – Functional proteome technology – Methods, algorithms and tools in computational proteomics - Proteome databases – Protein engineering resources
Unit V	Interactomics - Techniques to study protein-protein interactions - Modelling of proteomic networks – Interactome databases - Label-free nanotechnologies in proteomics – Modificomics – Proteomics applications in clinical and biomedicine - Application of proteomics in agricultural biotechnology – Industrial proteomics and its applications
References	<ol style="list-style-type: none"> Baxevanis D and Ouellette BFF, Bioinformatics: A practical guide to the analysis of genes and proteins (3rd Ed), John Wiley & Sons,Inc. 2005. Baxevanis D and Ouellette BFF, Bioinformatics: A practical guide to the analysis of genes and proteins (2nd Ed), John Wiley & Sons,Inc. 2002. Brown TA, Genomes (2nd Ed), BIOS Scientific Publishers, Oxford,UK, 2002. Sensen CW, Essentials of Genomics and Bioinformatics, Wiley-VCH, 2002. Sensen CW, Hand book of Genome Research, Wiley-VCH Verlag GmBh & Co, Weinheim, 2005. Pennigton SR and Dunn MJ, Proteomics, Viva Books Pvt. Ltd, NewDelhi, 2002. Sándor Suhai, Genomics and Proteomics: Functional and Computational

	Aspects, Kluwer Academic Publishers, 2002.
E-Reference Links	<ol style="list-style-type: none"> www.genomic.org.uk/ https://www.britannica.com/science/genomics https://www.sciencedirect.com/journal/genomics

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	M	S	S
CO2	S	M	S	S	S	S	S	S	S	S	S	S	M
CO3	S	M	S	S	S	S	M	S	S	S	M	S	S
CO4	S	M	S	S	S	S	S	S	S	S	M	S	S
CO5	S	M	S	S	S	S	M	S	S	S	S	S	M

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE PRACTICAL-VII -PLANT BIOTECHNOLOGY & GENOME EDITING- IBTP91		
Semester	Semester-IX	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply		

CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

SEMESTER X

Course Title & Code	CORE 25 (THEORY)- BIOETHICS, BIOSAFETY AND IPR – IBTT101		
Semester	Semester-X	Credits:5	Hours/weeks: 6
Cognitive Level	K2: Understand K3: Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> • To get knowledge on Bioethics, Biosafety and IPR. • To learn about procedures on IPR filings • To improve knowledge towards ethical clearances and Biosafety regulations • Student will acquire knowledge in bioethics, biohazard and bio-safety level and Intellectual property rights. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Become aware on bioethical issues and Analyze it K4	
	CO2:	Understand the various biosafety regulations in biotechnology K2	
	CO3:	Gain knowledge to handle living organisms K3	
	CO4:	Get familiarized with IPR and patent procedures K3	
	CO5:	Gain knowledge about various committees, regulations on bioethics, biosafe and IPR K2	
Unit I	Introduction to bioethics, concepts, ethical terms, issues on genetic modification and recombinant DNA technologies, ethics in agriculture and Environment benefits, risks, transhumanism and bioweapons. GM crops, Release of GMO to the environment. Special procedures for r-DNA based product production. Risk of genetic engineering, Ecocide-Eco terrorism. Emerging issues of biotechnology's impact on society.		
Unit II	Animal rights, ethics of human cloning, Reproductive cloning, Ethical legal and Socio economic aspects of Gene therapy, Somatic, Embryonic and Adult stem cell research, ELSI of human genome project. Transgenic plants and animals. Challenges to public policy and regulations. CCAC Guidelines on Transgenic Animals (1997), CCAC Guidelines on Animal Welfare, Laboratory Animal Management, The Need for Ethical Review		
Unit III	Primary containments for biohazards, Biosafety levels, recommended biosafety levels for specific microorganism, infectious agents and Infected animals. Environmental release of GMO and risk assessment. Biosafety regulations, r-DNA guidelines- National and international, levels of containment., Role of Intuitional		

CO4	S	S	M	S	S	S	M	S	S	S	S	S	S
CO5	S	S	M	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	CORE 26 (THEORY)- BIOPROCESS TECHNOLOGY- IBTT102		
Semester	Semester-X	Credits:5	Hours/weeks: 6
Cognitive Level	K1: Recall K2: Understand K3: Apply K6 : Create		
Learning Objective	<ul style="list-style-type: none"> To understanding the knowledge about food production, pest control, and the development of new drug and for other related biotechnological applications. To exploiting knowledge about microbes and to study the downstream processes for product recovery in fermentation. To learn about commercially valuable biochemical and genetic resources in plants, animals and microorganisms. Student will understand basics of industrial Biotechnology and requirements for large scale productions. 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Identify the industrially important organisms and create new designs on application K6	
	CO2:	Know about principles and techniques in Designing and types of fermentor K1	
	CO3:	Gain knowledge and aware bioreactor usage and fermentation process K2	
	CO4:	Understand and apply knowledge on the fermentation product purification and characterization K3	
CO5:	Know about Industrial production of bioproducts K2		
Unit I	Milestones of fermentation technology. Identification of industrially important microorganism, primary and secondary screening, strain development and improvement for increase yield, product assays. Microbial growth and death kinetics, mathematical expression of bacterial growth.		
Unit II	Designing and types of fermentor – liquid, solid state and immobilized, Media and ingredients for industrial fermentation, industrial sterilization of fermentor media and air. Types of heat exchangers, immobilization techniques, Bioreactor for cell cultures. Diauxic growth and factors affecting microbial growth.		
Unit III	Instrumentation for monitoring bioreactor and fermentation process – PH, temperature pressure dissolved O ₂ , air flow rate, shaft speed, foaming, viscosity and controlling. Batch, fed and continuous fermentation, large scale cultivation of plant and animal cells. Up-streaming process in product production.		
Unit IV	Downstream processing – recovery and purification of fermentation products –		

	filtration, flocculation, centrifugation, cell disruption, liquid- liquid extraction, Solvent and super critical extraction, precipitation, chromatography, ultra filtration, drying, crystallization, lyophilization. Storage and packing of products.
Unit V	The production of primary metabolites such as organic acids like citric acid, glucamic acid, Lysine. Protease, Alcohols: Beer and Wine production. Production of Bioethanol. Secondary metabolites - Antibiotics: Penicillin V, Streptomycin and Ampicillin sodium salt. flavoring and colour production.
References	<ol style="list-style-type: none"> 1. Stanbury, RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997. 2. Shuler, M.L. and Kargi,F. “ Bioprocess Engineering - Basic concepts” Prentice Hall of India Pvt. Ltd.,2nd edition, 2005. 3. Kalaichelvan and Arulpandi, Bioprocess Technology. MJP. Publishers 2008. 4. Biotechnology: The Biological Principles (1990) Edited by M D Trevan, S Boffey, K H Goulding, and P Stanbury, Tata McGraw-Hill Publishing company Ltd, New Delhi, India. 5. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, “Principles of Fermentation Technology”, Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005. <p>Pauline M. Doran, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, May 1995</p>
E-Reference links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/bioprocess-technology-d27110100.html 2. https://www.pdfdrive.com/advances-in-bioprocess-technology-d186651074.html 3. https://www.pdfdrive.com/biotechnology-bioprocessing-d158764194.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	S	S	S	S	M	S	S	S	S	M	S
CO3	S	M	S	M	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	M	S	S	S	S	M	S
CO5	S	M	S	M	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

DEPARTMENTAL ELECTIVES

Course Title & Code	ELECTIVE - STEM CELL BIOLOGY- IBTNSB		
	CHOICE 1	Credits:2	Hours/weeks: 2

Cognitive Level	K1: Recall K2: Understand K3: Apply
Learning Objective	<ul style="list-style-type: none"> Recall the fundamental concepts of stem cells Dissect mechanistic details about stem cells and regeneration (horizontal and vertical integration) Extend these concepts in the industrial and academic sectors
Course Outcomes	Upon completion of this course the students will be able to
	<p>CO1: Relate the fundamental aspects of stem cell technology K1</p> <p>CO2: Illustrate the principles and methodologies about the mechanistic aspects K2</p> <p>CO3: K2</p> <p>CO4: Apply the knowledge gained in regenerative aspects and therapeutic potential K3</p> <p>CO5: Having a clear understanding of professional and ethical responsibility K2</p> <p>Determine the commonalities and distinguish between embryonic and adult stem cells K2</p>
Unit I	Introduction- Embryonic stem cells, Blastula, Inner cell mass, Totipotent, pluripotent, multipotent and Induced pluripotent stem cells characterization, potency, self-renewal, cell division, and differentiation
Unit II	Pathways involved in stem cell proliferation, differentiation, and dedifferentiation - Signal transduction pathways and signaling molecules involved cellular proliferation, differentiation, and dedifferentiation. Relationship between cellular proliferation and differentiation concerning stem cells
Unit III	Embryonic stem cells - How embryonic stem cells are obtained, in vitro multiplication: embryonic stem cells gene manipulation and nuclear transfer technology. Adult stem cells - Methods to obtain stem cells from adults (Amniotic fluid, cord blood cells, Mesenchymal stem cells, etc). Induced pluripotent technology (IPS), genes, and their mode of action in inducing stemness in adult cells. Advantages and disadvantages of IPS technology
Unit IV	Organ regeneration using Stem cells - Heart regeneration, angiogenesis, kidney regeneration, a neurodegenerative disorder, spinal cord injury, tissue engineering. Ethics in using Embryonic stem cells - Human stem cell research: Ethical consideration; Stem cell religion consideration; Stem cell-based theories: Preclinical regulatory consideration, and Patient advocacy.
Unit V	Application of stem Cells- Overview of embryonic and adult stem cells for therapy in Neurodegenerative diseases; Parkinson's, Alzheimer's, Spinal Cord Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia, etc.
References	<ol style="list-style-type: none"> Cherian E (2011) Stem cells JP brothers medical publishers Atala A (2012) Progenitor and Stem Cell Technologies and Therapies Woodhead publishing Phinney DG (2011) Adult stem cells: Biology and methods of analysis Humana press
E-Reference links:	<ol style="list-style-type: none"> https://www.law.berkeley.edu/files/stem_cell_day1_part2_shelanski.pdf https://www.bjcancer.org/Sites/OldFiles/Library/UserFiles/pdf/stem_cell_handbook.pdf https://go.openathens.net/redirector/tulane.edu?url=http://www.sciencedirect.com/science/book/9780123815354

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	M	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	S	M
CO3	S	M	S	S	S	S	M	S	S	S	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	M
CO5	S	M	S	S	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE - PHYTOCHEMISTRY- IBTNPC		
	CHOICE 2	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K4: Apply		
Learning Objective	<ul style="list-style-type: none"> Learn to extract and purify the bioactive compounds Understand the structural analysis of bioactive compounds Gain a knowledge on herbal medicine and phytopharmaceuticals 		
Course Outcomes	Upon completion of this course the students will be able to		
	CO1:	Understand the extraction and purification of the bioactive compounds K2 Able to perform various chromatographic techniques K2	
	CO2:	Understand the structural analysis of bioactive compounds using spectroscopy K2	
	CO3:	Apply the knowledge on purifying bioactive compounds K4	
	CO4:	Know the basics of phytopharmaceuticals K1	
	CO5:		
Unit 1	Polar and Non-polar solvents for extraction. Extraction – purification of bio-active compounds from plants - cold & hot extract. Soxhlet extraction - crude extracts purification by various solvents.		
Unit II	Isolation of bioactive compounds- chromatographic techniques - thin layer chromatography- liquid chromatography - HPLC and UPLC.		
Unit III	Structural analysis of bioactive compounds - IR spectroscopy - Mass spectroscopy – NMR spectroscopy.		
Unit IV	Herbal medicine - History of herbal medicine - different types of herbal medicine - Ayurveda, Siddha and Unani - Pharmacological action - clinical research and traditional uses of Indian medicinal plants - <i>Eclipta alba</i> , <i>Gymnema sylvestre</i> , <i>Ocimum sanctum</i> , <i>Curcuma longa</i> .		
Unit V	Phytopharmaceuticals and their health benefits - anthocyanins, carotenoids, lycopene,		

	isoflavones, polyphenols, omega 3 - fatty acids, biological effects of resveratrol.
References	<ol style="list-style-type: none"> 1. Harbone, J.B. Phytochemical Methods: A guide to modern techniques of plant analysis, 3rd ed. Springer (India) Private Limited, New Delhi. 1998. 2. R. M. Silverstein, F. X. Wester- Spectroscopic identification of organic compounds. John-Wiley. 1998. 3. H.H. Willard, L. L. Merrit, J. A. Dean. Instrumental Methods of Analysis, 1987. 4. V. M. Godte. Ayurvedic pharmacology and therapeutic uses of medicinal plants. Bharathiya Vidya Bhavan, Mumbai. 2000. 5. R.C. Grewal. Medicinal Plants. Campus Books International, New Delhi. 2000.
E-Reference links	<ol style="list-style-type: none"> 1. https://www.pdfdrive.com/textbook-of-pharmacognosy-and-phytochemistry-d184620437.html 2. https://books.google.co.in/books?id=satDwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0 3. https://www.pdfdrive.com/trease-and-evans-pharmacognosy-e58233029.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	M	S	S	S	M	S	S	S	S	M	M
CO2	S	M	S	S	S	S	M	S	S	S	S	M	S
CO3	S	M	S	S	S	S	M	S	S	S	S	S	M
CO4	S	M	M	S	S	S	S	S	S	S	S	S	M
CO5	S	M	S	M	S	S	M	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE - MOLECULAR MODELLING AND DRUG DESIGNING – IBTNMM		
	CHOICE 3	Credits:2	Hours/weeks: 2
Cognitive Level	K2: Understand K3: Apply K4: Analyze		

Learning Objective	<ul style="list-style-type: none"> Outline preliminary concepts in molecular modeling using molecular dynamics Utilize basic modeling techniques to explore biological phenomena at the molecular level Perceive knowledge in protein-ligand interaction study by docking and visualization tools for molecular dynamics.
Course Outcomes	<p>Upon completion of this course the students will be able to</p> <p>CO1: Illustrate the concepts of Molecular modeling using Molecular Dynamics K2</p> <p>CO2: Experiment with protein-ligand interaction study by docking. K3</p> <p>CO3: Translate the understanding of visualization tools for molecular dynamics K3</p> <p>CO4: Apply the information gained in various chemistry and biochemistry courses toward solving problems pertinent to drug designing K3</p> <p>CO5: Demonstrate the relative importance of molecular modeling and drug designing K4</p>
Unit I	Quantum mechanics & concepts in molecular modeling: Coordinate systems, potential energy surfaces. Introduction to quantum mechanics. Force Fields - Bond stretching; angle bending. torsional terms; non-bonded interactions; electrostatic interactions; Vander Waals interactions
Unit II	Molecular Dynamics and Monte Carlo simulation: Design constraints, Potentials in MD simulation, Molecular dynamics algorithms.
Unit III	Analysis and Properties - Geometry optimization, Vibrational frequencies: potential energy surface, harmonic vs. fundamental frequencies, zero-point vibrational energies.
Unit IV	Modeling :Homology modeling, Ab initio, Protein Threading. Drug design - Structure-based methods to identify lead compounds: finding lead compounds by searching 3D databases; de novo ligand design.
Unit V	Molecular Docking : Docking - molecular modeling in drug design – structure-based drug design – pharmacophores -QSAR.
References	<ol style="list-style-type: none"> Leach AR (2010) Molecular Modeling, Principles & Applications, (Dorling Kindersley(India) (P)Ltd with Pearson education Ltd, UK. Arjun S (2103) Drug Discovery, Design & Development Lambert Academic publishing. Clark T, Thurston DE, and Banting L (2012) Drug Design Strategies: Computational Techniques & Applications Royal society of chemistry
E-Reference links	<ol style="list-style-type: none"> https://www.mdpi.com/books/pdfview/book/1187 https://www.kobo.com/us/en/ebook/molecular-modelling-and-drug-design https://faculty.psau.edu.sa/filedownload/doc-3-pdf/e1490523b8cd2c130b29656613850cf8-original.pdf

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	S	M	S	S	S	M	S	S	S	S	S	S
CO2	S	S	S	S	S	S	M	S	S	S	S	S	S
CO3	S	S	M	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	S	S	S	S	S

CO5	S	S	S	S	S	S	S	S	S	S	S	S	S
Strongly Correlating	(S)	- 3 marks											
Moderately Correlating	(M)	- 2 marks											
Weakly Correlating	(W)	- 1 mark											
No Correlation	(N)	- 0 mark											

Course Title & Code	ELECTIVE - NANOTECHNOLOGY AND CANCER BIOLOGY- IBTNNC												
	CHOICE 4					Credits:2			Hours/weeks: 2				
Cognitive Level	K1: Recall K2: Understand												
Learning Objective	<ul style="list-style-type: none"> To provide the students with knowledge and the basic understanding of nanotechnology and cancer. The properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials. To give an idea about Synthesis of nanomaterials, characterisation and their application To give students an historical perspective on the most commonly studied topics in cancer biology. To link specific cancer biology subjects with clinical aspects of the disease. Students can understand the nanomaterials, its synthesis and application for almost all the field to the benefit of humankind. Students will also acquire knowledge on cancer biology. 												
Course Outcomes	Upon completion of this course the students will be able to												
	CO1:	Know basic about nanomaterial and Nanoparticles K1											
	CO2:	Learn the Application of nanotechnology in different field and problem solving solution K2											
	CO3:	Learn update research in Nanotechnology for cancer research & therapy K2											
	CO4:	Gain knowledge about Epidemiology of cancer, cancer types, characteristics of cancer cells in molecular aspects K2											
CO5:	Find out and acquire knowledge about chemotherapy and chemoprevention in Tumor immunology K2												
Unit I	Nanotechnology – definition – Quantum dots, Nanowires & properties, 2D films. Nano scale materials. Nanopores . Characterization of Nanoparticles and Nanomaterials.												
Unit II	Application of nanotechnology; Nano sensors-types & its applications, Nano carriers for drug delivery-polymeric NP, Micelles, Micro emulsions, Lipoproteins as pharmaceutical carriers. Solid lipid NP as drug carriers. Nanocapsules-Preparation, Characterization & therapeutic applications. Nano medicine-Biopharmaceuticals. Implantable materials, Devices, Surgical aids, diagnostic tools, Genetic testing, Imaging.												
Unit III	Nanotechnology for cancer research & therapy. Environmental nano remediation technology. Thermal, physico-chemical and Biological methods. Nano filtration for the treatment wastes, removal of organics, Inorganics and pathogens. Nanotechnology for water purification.												

Strongly Correlating	(S)	- 3 marks
Moderately Correlating	(M)	- 2 marks
Weakly Correlating	(W)	- 1 mark
No Correlation	(N)	- 0 mark

Course Title & Code	ELECTIVE -ENTREPRENEUR DEVELOPMENT- IBTNED		
	CHOICE 5	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3: Apply K6: Create		
Learning Objective	<ul style="list-style-type: none"> To train students in different aspects of management pertaining to biotechnology industry in addition to principles of economics and accountancy. To know the ethical principles underlying biotechnology research and develop entrepreneurship skills. 		
Course Outcome	On Successful completion of the course, the students will be able to		
	CO1:	Develop an understanding of the fundamental topics on management. K1	
	CO2:	Gain knowledge on business economics and project management. K2	
	CO3:	Get a strong foundation on commercialization of biotechnology products. K3	
	CO4:	Get the required knowledge to lead and administer biotechnology companies. K2	
	CO5:	Undertake entrepreneurship ventures. K6	
Unit I	Entrepreneurship - definition, needs and importance. Factors necessary for entrepreneurship. Promoting bio-entrepreneurship. Bio-entrepreneurship in India. Entrepreneurial traits, self appraisals, sources of funds. Business planning in Biotech.		
Unit II	Principles of management, management process, functions of organization. Functions of managers - delegation, decentralization and leadership. Motivation - management control, MIS process of design and management. Use of flow sheets in the design of a process.		
Unit III	Entrepreneurship development - theory of entrepreneurship. Process techniques, raw material preparation, product recovery and purification, formulation packaging and quality control. Economic considerations - cost estimation, total product cost, capital investment and profitability. Manufacturing cost estimates, capital investment and resources, cost benefit analysis.		
Unit IV	Legal and ethical issues, biosafety legal issues concerning genetic engineering, biological containment, ethical and professional problems, risk assessment and prevention. Patents and exploitation of inventions. Intellectual Property Rights (IPR), Farmer's/ breeder's rights, geographic appellation.		
Unit V	Bio industry and prospects - recent trends in the development of bioindustry, selection, transfer and adaptation of technologies. Training of qualified personnel, new relationship between industries and universities. International cooperation. Scope and status of biotechnology industry in India.		
References	1. Harpum P. Portfolio, Program and Project Management in the pharmaceutical		

and biotechnology industries. 2010. 2. M.J. Roy. Biotechnology operations: Principles & Practices. CRC Press. 2011. 3. Biren N Shah, Bhavesh S Nayak, Vineet C Jain; Textbook Of Pharmaceutical Industrial Management; 2010; 1st edition; Elsevier India
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Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	M	M	S	M	S	S	S	S	M	S	S	M	S
CO2	M	M	S	S	S	S	S	S	M	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	M	S	S	S	S	S	M	S	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE - BIOBUSINESS- IBTNBB		
	CHOICE 6	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3: Apply K4: Evaluate		
Learning Objective	<ul style="list-style-type: none"> To introduce students in different aspects of biobusiness. 		
Course outcomes	On Successful completion of the course, the students will be able to		
	CO1:	Identify the origin of bio business and the current scenario K1	
	CO2:	Evaluate the various sectors of bio business K4	
	CO3:	Determine different types of business models viz. product, subscription and integrated K2	
	CO4:	Adopt international standards and certifications for cGMP and Cglp K3 Perceive the role of IPR in bio business K2	
CO5:	Analyse the prons and cons of biobusiness K4		
Unit I	Fundamentals of Bio business : History of evolution of Bio Business, Importance of Finance for Bio business –Sectorial support by Government of India - policies, and frameworks.		
Unit II	Overview of Bio business in various sectors : Healthcare, Industrial life-Sciences, Agriculture and Agri-biotechnology, Environment and Environmental Biotechnology.		
Unit III	Business Models in Bio business: Product Based-Service Based-Subscription Based-Integrated Models.		
Unit IV	Best Practices: Current Good Manufacturing Practices (cGMP), Current Good		

	Laboratory Practices (cGLP).
Unit V	IPR: Determining "patentability"; Industry-wise implications; use of patents – relevant case studies highlighting its importance. Importance of IPR in the Pharmaceutical Industry- Drug development-Product/Process Patenting-Marketing. Technology transfer, Licensing
References	<ol style="list-style-type: none"> 1. Shahi, G. BioBusiness in Asia: How Asian Countries Can Capitalize on the Life Science Revolution. Pearson Prentice Hall. 2004. 2. Hirsch RD & Peters MP, "Entrepreneurship," Tata McGraw Hill Publishers, New Delhi, 2002. 3. Holt DH, "Entrepreneurship – New Venture Creation," Prentice Hall of India, 1999.

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	M	M	S	M	S	S	S	S	M	S	S	M	S
CO2	M	M	S	M	S	S	S	S	M	S	S	M	S
CO3	M	M	S	M	S	S	S	S	M	S	S	M	S
CO4	M	M	S	M	S	S	S	S	S	S	S	M	S
CO5	M	M	S	M	S	S	S	S	S	S	S	M	S

Strongly Correlating (S)- 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation(N) - 0 mark

Course Title & Code	ELECTIVE - INDUSTRIAL FERMENTATION PRODUCTS-IBTNID		
	CHOICE 7	Credits:2	Hours/weeks: 2
Cognitive Level	K3: Apply K4: Analyze K5: Evaluate K6: Create		
Learning Objective	<ul style="list-style-type: none"> • To equip the mind with the modern techniques such as fermentation technology and manufacture of various bioproducts • To design appropriate bioreactor configurations and operation modes based upon the nature of bioproducts 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Evaluate model required for the microbial growth and can design own batch thermal Sterilization K5	
	CO2:	Formulate medium using various kinetics for maximum production of metabolites and biocatalyst for commercial applications K6	
	CO3:	Model the kinetics of living cells and to develop a strategy to solve the issues emerging during fermentation processes K6	
	CO4:	Choose better yield using gene manipulation of microorganisms and integrate research lab and industry K3	
	CO5:	Identify problems and seek practical solutions for large scale implementation of biotechnology K4	
Unit I	Definition and importance of fermented products; Organisms used for production of		

CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks

Moderately Correlating (M) - 2 marks

Weakly Correlating (W) - 1 mark

No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE - FOREST CONSERVATION - IBTNFC		
	CHOICE 8	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand		
Learning Objective	<ul style="list-style-type: none"> Acquire knowledge on composition and structure of forest. To know the techniques in establishment, growth and quality of forest vegetation. Understand the role of forests in environmental sustenance. Learn about the manipulations in management and establishment of forest vegetation. 		
Course Outcomes	At the end of the course, the student will be able to		
	CO1 :	Understand the objectives and scope of forest conservation K2	
	CO2 :	Understand the composition and structure of forest K1	
	CO3 :	Understand the role of forests in environmental sustenance K2	
	CO4 :	Understand the concepts of Injuries to forest K2	
	CO5:	Understand the fundamentals of Forest Management and its Management Systems K2	
Unit I	Definition, objectives and scope of Silviculture. Status of forests in India and their role. General Silvicultural Principles : methods of propagation, grafting techniques; site factors; nursery and planting techniques-nursery beds, polybags and maintenance, water budgeting, grading and hardening of seedlings; special approaches; establishment and tending.		
Unit II	Introduction to trees and their general classification under different forest types. Important tree families and their peculiar characters. Types of trees and canopy structure. Coniferous and broad leaved tree species. Trees in tropical, sub-tropica, temperate and alpine regions.		
Unit III	Forests Soils, classification, factors affecting soil formation; physical, chemical and biological properties. Soil conservation - definition, causes for erosion; types - wind and water erosion; conservation and management of eroded soils/areas, wind breaks, shelter belts; sand dunes; Role of forests in conserving soils.		
Unit IV	Forest Management and Management Systems : Objective and principles; techniques; stand structure and dynamics, sustained yield relation; rotation, normal forest, growing stock; regulation of yield; management of forest		

	plantations, commercial forests, forest cover monitoring. Approaches viz., (i) site-specific planning, (ii) strategic planning, (iii) Approval, sanction and expenditure, (iv) Monitoring (v) Reporting and governance.
Unit V	Injuries to forest - abiotic and biotic, destructive agencies, insect-pests and disease. Role of afforestation and forest regeneration in absorption of CO ₂ . effect of wild animals on forest regeneration, human impacts; encroachment, poaching, grazing, live fencing, shifting cultivation and control.
References	<ol style="list-style-type: none"> 1. Dwivedi, A. P. 1992. Principles and Practice of Indian Silviculture, Surya Publication, 420p. 2. Shiva, M.P. A Handbook of Systematic Botany, 1986.IBD Publisher, Dehradun. 3. Sagreiya, K.P. Forests and Forestry, 1997. National Book Trust India. 4. Khanna, L. S. 1984.Principles and Practice of Silviculture, Khanna Bhandu, Dehra Dun. P. 476. 5. Ram Prakash and L.S. Khanna. 1991. Theory and Practice of Silvicultural systems. International Book Distributors, Dehra Dun. 298p. 6. Dwivedi, A.P. 1993. A Text Book of Silviculture, International Book Distributors, Dehradun.
E-Reference book links	<ol style="list-style-type: none"> 6. https://www.pdfdrive.com/forestryagro-forestry-indian-council-of-agricultural-research-e10418465.html 7. https://www.pdfdrive.com/tropical-forest-ecology-the-basis-for-conservation-and-management-tropical-forestry-e168566994.html 8. https://www.pdfdrive.com/forest-ecology-and-conservation-a-handbook-of-techniques-techniques-in-ecology-conservation-e185085454.html

Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	M	S	S	S	S	S	S	M	S
CO2	S	M	S	M	S	S	M	S	S	S	S	M	S
CO3	S	M	S	M	S	S	M	S	S	S	S	M	S
CO4	S	M	S	M	S	S	M	S	S	S	S	M	S
CO5	S	M	S	M	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE - WILD LIFE CONSERVATION - IBTNWL		
	CHOICE 9	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand		
Learning Objective	<ul style="list-style-type: none"> To understand about habitat analysis, human-wildlife interactions To know about the concepts of management and sustainable wildlife management 		
Course Outcomes	At the end of the course, the student will be able to		
	CO1 :	Understand the ethics of wildlife conservation K2	
	CO2 :	Understand the salient features of habitat analysis K2	
	CO3 :	Describe the basics of human-wildlife interactions K1	
	CO4 :	Understand the concepts of management K2	
	CO5:	Understand the fundamentals of sustainable wildlife management K2	
Unit I	Introduction: Values and ethics of wildlife conservation; importance of conservation. Conservation Vs protection Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions		
Unit II	Habitat analysis: Types of Habitats & their major ecological factors Ecological Succession & climax ecosystems (e.g. Sholas) Maximizing usage of Habitat resources by populations Insular habitats & insular flora & fauna Extreme Habitats and their flora & fauna (Dark Caves, deep sea etc.) Evaluation and management of wild life - Physical parameters and Biological Parameters; Standard evaluation procedures: Faecal analysis of ungulates and carnivores. Geographical Information System (GIS), Global Positioning System (GPS), and Remote Sensing (RS).		
Unit III	Human-wildlife interactions: Poaching, illegal trading, conflict management and shifting from extraction to preservation; effect of extinction of a species on ecosystem; Forest landscape restoration. Conservation Vs protection Concept of Buffer zones, Wildlife corridors Strategies to reduce human-wildlife interactions Role of Government and NGOs in controlling human-wildlife interactions Socio-economic issues related to human-wildlife interaction		
Unit IV	Concepts of management: Protected Area Network (PAN), WWFN, IUCN, and CITES. Wild life Legislation – Wild life Protection act (1972), its amendments and implementation. IUCN Red data book and red list categories (only names), Protected areas National parks & sanctuaries, Community reserve; Important features of protected areas in India; Project Tiger and Project Elephant.		
Unit V	Sustainable wildlife management: Natural resource management. Eco tourism / wild life tourism in forests; various Environmental movements in India: Bishnoi movement, Chipko movement, Narmada bachao andolan, Silent valley movement, Baliyapal movement.		
References	<ol style="list-style-type: none"> Caughley, G., and A.R.E. Sinclair Wildlife Ecology and Management, Blackwell Science. 2004 Woodroffe R., S. Thirgood and A. Rabinowitz. People and Wildlife, Conflict or Coexistence? Cambridge University Press, 2011 Bookhout, T.A. Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press. 2006 Sutherland, W.J. The Conservation Handbook: Research, Management and 		

	Policy. Blackwell Sciences 2010 5. Hunter M.L., J.B. Gibbs and E.J. Sterling. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing. 2009
E-Reference book links	<ol style="list-style-type: none"> https://www.pdfdrive.com/wildlife-ecology-conservation-and-management-2nd-edition-d184311905.html https://www.pdfdrive.com/comprehensive-wildlife-conservation-strategy-e38430632.html https://www.pdfdrive.com/wildlife-ecology-and-management-wildlife-producers-association-e9899184.html

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	M	S	S	S	S	S	S	M	S
CO2	S	M	S	M	S	S	M	S	S	S	S	M	S
CO3	S	M	S	M	S	S	M	S	S	S	S	M	S
CO4	S	M	S	M	S	S	M	S	S	S	S	M	S
CO5	S	M	S	M	S	S	M	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE – INDUSTRIAL WASTE MANAGEMENT - IBTNM		
	CHOICE 10	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3-Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To impart knowledge on effluent characteristics and effects on environment To understand the importance of industries for development To develop skill for designing ETP for industries 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Acquire Knowledge on effect of industries waste on environment and environmental legislation K1	
	CO2:	Understand the basic of common waste water treatment K2	
	CO3:	Gain the knowledge effluent characteristic and treatment process of various industrial effluent K1	
	CO4:	Analyse the characteristics of effluent and student can able to design treatment	

CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE – HUMAN PATHOLOGY- IBTNHP		
	CHOICE 11	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3-Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> The student should acquire a theoretical knowledge in General pathology. To gain knowledge about systemic pathology Gastrointestinal system, Respiratory tract and Breast Tumours To understand and skill on Transfusion Medicine, Clinical pathology 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Understand the basics of pathological disorders K2	
	CO2:	Gain knowledge on morphology and reproduction of fungi K1	
	CO3:	Acquire knowledge on Systemic Pathology K2	
	CO4:	Apply their skill in the clinical laboratory K3	
	CO5:	Analyze the Blood grouping and blood transfusion K4	
Unit I	General Pathology – Introduction, History of pathology, Cell injury and cell death, Cellular accumulations, Inflammation and repair, Circulatory disturbances, Immunological disorders, Infections, Neoplasia		
Unit II	Mycology - Human Fungi - morphology and reproduction. Classification of fungi . Opportunistic fungi. Superficial mycotic infection. Fungi causing subcutaneous mycoses. Fungi causing systemic infections. Laboratory diagnosis of fungal infections.		
Unit III	Systemic Pathology - Gastrointestinal system. Disorders of mouth, salivary glands , esophagus, stomach , intestines, rectum and anal canal. Respiratory tract – infections, inflammations, environmental, immunological and neoplastic disorders and their identification. Breast - Tumors and tumor like conditions. Pathogenesis pathology and diagnosis.		
Unit IV	Haematology - Development and morphology of blood cells, bone marrow, general alterations in diseases. Anaemia – deficiency, hemolysis and other causes. Disorders of hemostasis and coagulation. Disorders of leucocytes and platelets – quantitative, qualitative and in neoplastic proliferations. Paraproteinemia and		

	plasma cell disorders.
Unit V	Transfusion Medicine. Essentials of blood bank serology and transfusion medicine. Clinical Pathology - Basic principles and methods employed in tissue processing, paraffin and frozen sections and staining procedures including tissue microarrays.
References	1.Husain A. Sattar,2017.Fundamentals of Pathology. Published by PathomaLLC. 2.Balaram Jana.2005. Human Pathology.B.Jain Publishers 3. David T. Rowlands.1986. Human Pathology: An Introduction to the Study of Disease. Macmillan Pub Co publisher 4. Harsh Mohan. 2014.Textbook of Pathology, 7th Edition. Jaypee Brothers,Medical Publishers Pvt. Limited 5. Vinay Kumar Abul Abbas Jon Aster. 2014.Pathologic Basis of Disease 9th Edition. Elsevier.
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Mapping of COs with POs &PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE – PUBLIC HEALTH AND MANAGEMENT- IBTNPM
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	CHOICE 12	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3-Apply K4: Analyze		
Learning Objective	To gain a knowledge on pollution, types of pollutants and global warming To understand the waste management and its hazards To understand the risk factors, symptoms and treatment of communicable and non-communicable diseases.		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Discuss the sources and causes of environmental hazards K1	
	CO2:	Know the types, causes, sources and prevention of pollution K1	
	CO3:	Describe the types and characteristics of wastes and disposal K2	
	CO4:	Understand the social and economic factors of communicable diseases K2	
	CO5:	Understand the risk factors, symptoms and treatment of non-communicable Diseases K2	
Unit I	Introduction: Sources and causes of Environmental hazards, identification and accounting of hazards, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure assessment and tests.		
Unit II	Pollution: Air pollution: definitions, types of pollutants, causes, sources, effects and prevention. Water pollution: , definitions, types of pollutants, causes, sources, effects and prevention, noise pollution sources and effects. Global warming.		
Unit III	Waste Management and hazards: Types and characteristics of wastes, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants. Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.		
Unit IV	Communicable Diseases: Social and economic factors of disease including role of health services and other organizations: Infectious (Bacterial-Tuberculosis, Typhoid; Viral- AIDS, Poliomyelitis, Protozoan- Leishmaniasis, Malaria)		
Unit V	Non-communicable Diseases: Lifestyle and Inherited/genetic diseases, brief account of immunological diseases; Risk factors, symptoms, diagnosis and treatment of cancer, diabetes and cardiovascular diseases		
References	1. Cutter, S.L. (2009). Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi. 2. Kolluru R., Bartell S., Pitblado R. and Stricoff, S. (2006). Risk Assessment and Management Handbook. McGraw Hill Inc., New York. 3. Kofi, A.D. (2012). Risk Assessment in Environmental management, John Wiley and sons, Singapore. 4. Joseph, F. L. and Louver, B.D. (2007). Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey		
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	3. https://www.pdfdrive.com/principles-of-epidemiology-in-public-health-practice-d23834453.html 4. https://www.pdfdrive.com/risk-management-handbook-for-health-care-organizations-student-edition-j-b-public-health-health-services-text-d185548651.html
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Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
 Moderately Correlating (M) - 2 marks
 Weakly Correlating (W) - 1 mark
 No Correlation (N) - 0 mark

Course Title & Code	ELECTIVE – DRUG METABOLISM- IBTNM		
	CHOICE 13	Credits:2	Hours/weeks: 2
Cognitive Level	K1: Recall K2: Understand K3-Apply K4: Analyze		
Learning Objective	<ul style="list-style-type: none"> To understand the classification and mechanism of action of drugs To gain knowledge on Pharmacokinetics To know about the Drugs for metabolic disorders and its toxicity 		
Course Outcomes	Upon completion of this course, the students will be able to		
	CO1:	Know the identity, distribution and regulation of major drug-metabolizing enzymes and transporters K1	
	CO2:	Evaluate the appropriate application of experimental models and protocols to drug metabolism K3	
	CO3:	Interpret the relative importance of various metabolic pathways K4	
	CO4:	Acquire knowledge on clinical toxicology K2	
	CO5:	Understand the biochemical mode of action of antibiotics K2	

CO2	S	M	S	S	S	S	S	S	S	S	S	M	S
CO3	S	M	S	S	S	S	S	S	S	S	S	M	S
CO4	S	M	S	S	S	S	S	S	S	S	S	M	S
CO5	S	M	S	S	S	S	S	S	S	S	S	M	S

Strongly Correlating (S) - 3 marks
Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark
No Correlation (N) - 0 mark