



ROYAL SCHOOL OF BIO-SCIENCES

(RSBSC)

DEPARTMENT OF BIOTECHNOLOGY

COURSE STRUCTURE AND SYLLABUS

FOR

B.SC. IN BIOTECHNOLOGY

(4 YEARS SINGLE MAJOR)

W.E.F.

AY-2025-26

(BASED ON NATIONAL EDUCATION POLICY 2020)

Outline of the syllabus for B.Sc. in Biotechnology (Royal School of Bio-Sciences)

1 ST SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M101	Biochemistry	100	3	2-1-0
	BTC152M112	Practical on Biochemistry	100	3	0-0-6
Minor *	BTC152N101	Biotechnology and Human Welfare	100	3	3-0-0
Interdisciplinary (IDC)	IKS992K101	Indian Knowledge System – I	100	3	3-0-0
Ability Enhancement Course (AEC)	CEN982A101	Communicative English – I	100	1	1-0-0
	BHS982A102	BHS – I	100	1	1-0-0
Skill Enhancement Course (SEC)	BTC152S111	Compost Preparation and Applications	100	3	0-0-6
Value Added Course (VAC) **	VAC992V1---	To be chosen from a pool of courses	100	3	
SWAYAM				3/4	
TOTAL CREDIT FOR 1ST SEMESTER				20+3/4	
2 ND SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M201	Microbiology	100	2	2-0-0
	BTC152M211	Practical in Microbiology	100	1	0-0-2
Major (Core)	BTC152M202	Cell Biology	100	2	2-0-0
	BTC152M212	Practical in Cell Biology	100	1	0-0-2
Minor	BTC152N201	Basic Instrumentation in Biology	100	3	3-0-0
IDC	IKS992K201	Indian Knowledge System – II	100	3	3-0-0
AEC	CEN982A201	Communicative English – II	100	1	1-0-0
	BHS982A202	BHS – II	100	1	1-0-0
SEC	BTC152S211	Biochemical Analysis of Food	100	3	0-0-6
VAC	VAC992V2---	To be chosen from a pool of courses	100	3	
SWAYAM				3/4	
TOTAL CREDIT FOR 2ND SEMESTER				20+3/4	
Exit 1 – UG Certificate in Biotechnology (with 40 credits + a vocational course of 4 credits in summer break)					
3 RD SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M301	Genetics	200	3	2-1-0
	BTC152M311	Practical in Genetics	200	1	0-0-2
Major (Core)	BTC152M302	Biophysical Chemistry	200	4	3-1-0
Minor	BTC152N301	Introduction to IPR	200	4	3-1-0
IDC #	BTC152I301	Health and Hygiene	200	3	3-0-0
AEC	CEN982A301	Communicative English – III	200	1	1-0-0
	BHS982A302	BHS – III	200	1	1-0-0
SEC	BTC152S311	Clinical Biochemistry	200	3	0-0-6
SWAYAM				3/4	
TOTAL CREDIT 3RD SEMESTER				20+3/4	
4 TH SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M401	Molecular Biology	200	3	2-1-0
	BTC152M411	Practical in Molecular Biology	200	1	0-0-2
Major (Core)	BTC152M402	Immunology	200	3	2-1-0
	BTC152M412	Practical in Immunology	200	1	0-0-2

Outline of the syllabus for B.Sc. in Biotechnology (Royal School of Bio-Sciences)

Major (Core)	BTC152M403	Bioethics, Biosafety and IPR	200	4	3-1-0
Minor	BTC152N401	Biofertilizer and Its Application	200	3	3-0-0
	BTC152N402	Food Biotechnology	200	3	3-0-0
AEC	CEN982A401	Communicative English – IV	200	1	1-0-0
	BHS982A402	BHS – IV	200	1	1-0-0
SWAYAM				3/ 4	
TOTAL CREDIT 4TH SEMESTER				20+3/4	
Exit 2 – UG Diploma in Biotechnology (with 80 credits + a vocational course of 4 credits in summer break of 2nd year)					
5TH SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M501	Genomics and Proteomics	300	4	4-0-0
	BTC152M502	Plant and Animal Biotechnology	300	4	4-0-0
	BTC152M513	Practical – V ^φ	300	4	0-0-8
Minor	BTC152N501	Basics of Molecular Biology	300	4	4-0-0
INTERNSHIP			300	4	
TOTAL CREDIT FOR 5TH SEMESTER				20	
6TH SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M601	Genetic Engineering	300	4	4-0-0
	BTC152M602	Bioinformatics and Biostatistics	300	4	4-0-0
	BTC152M603	Bioprocess Engineering	300	4	4-0-0
	BTC152M614	Practical – VI ^ψ	300	4	0-0-8
Minor	BTC152N601	Entrepreneurship Development	300	4	4-0-0
TOTAL CREDIT FOR 6TH SEMESTER				20	
Course completion Option 1 – UG Degree (B.Sc.) in Biotechnology (with 120 credits)					
7TH SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M701	Environmental Biotechnology	400	4	3-1-0
	BTC152M702	Medical Biotechnology	400	4	3-1-0
	BTC152M703	Plant and Animal Physiology	400	4	3-1-0
	BTC152M714	Practical – VII ^ω	400	4	0-0-8
Minor	BTC152N701	Pharmaceutical Biotechnology	400	4	4-0-0
TOTAL CREDIT 7TH SEMESTER				20	
8TH SEMESTER					
COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	BTC152M801	Research Methodology & Scientific Writing	400	4	3-1-0
Minor	BTC152N801	Ecology & Environment Management	400	4	4-0-0
Project/Dissertation [§]	BTC152M821	Students with ≥ 75% till the 6th semester	400	12	
<i>(Major courses for the rest of the students in lieu of Project/ Dissertation)</i>					
Major (Core)	BTC152M802	Developmental Biology	400	4	3-1-0
	BTC152M803	Ecosystem Degradation and Intervention	400	4	3-1-0
	BTC152M804	Techniques in Molecular Biology	400	4	3-1-0
TOTAL CREDIT 8TH SEMESTER				20	
Course completion Option 2 – B.Sc. (Honours) in Biotechnology (with 160 credits)					
Course completion Option 3 – B.Sc. (Honours with Research) in Biotechnology (with 160 credits)					

SYLLABUS (1st SEMESTER)

Course Title: Biochemistry	Course Component: Major
Course code: BTC152M101	Credit: 3
Level of course: 100	L-T-P-C: 2-1-0-3
Scheme of Evaluation: Theory (T)	

Course Objectives: The main objective of the course is to provide basic foundation on biomolecules of life with reference to their properties, and biological functions.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Recall the structure of atoms, biomolecules and chemical bonds	BT 1
CO 2	Understand the concepts of enzyme kinetics, bio-polymers etc.	BT 2
CO 3	Develop the knowledge gained in solving practical experiments.	BT 3
CO 4	Analyze the metabolic processes.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	<p>Introduction to Biochemistry: A historical prospective.</p> <p>Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.</p> <p>Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions</p>	16
II.	<p>Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebroside, gangliosides, Prostaglandins, Cholesterol.</p> <p>Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, biologically important</p>	16

	nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.	
III.	Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyper thermophilic archaea and bacteria. Role of: NAD ⁺ , NADP ⁺ , FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions	16
IV	Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids, glyoxylate cycle.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (80 class hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Nelson, D.L., Cox, M.M., *Lehninger Principles of Biochemistry* 4th Edition, 2004, WH Freeman and Company, New York, USA

Reference Books

1. Berg, J. M., Tymoczko, J. L. and Stryer., *Biochemistry*, 6th Edition, 2006, W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R., *Biochemistry and Molecular Biology of Plants*, 2nd Edition, 2015, American Society of Plant Biologists, USA.

Course Title: Practical on Biochemistry	Course Component: Major
Course code: BTC152M112	Credit: 3
Level of course: 100	L-T-P-C: 0-0-6-3
Scheme of Evaluation: Practical (P)	

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Learn and remember about the process of preparation of buffers and calculate the same.	BT 1
CO 2	Understand about pH and its importance, enzyme kinetics.	BT 2
CO 3	Apply the knowledge of microscopy in identifying various stages of cell division.	BT 3
CO 4	Categorize the equipment's used and the underlying safety measures in a laboratory.	BT 4

Detailed Practical:

Module	Topics & Course Contents	Periods
I	<ul style="list-style-type: none"> • Safety measures in Biochemistry laboratory. • Effect of α-amylase on starch • Determination of K_m and V_{max} of α-amylase activity 	20
II	<ul style="list-style-type: none"> • pH meter and buffers • Preparation of phosphate buffer • Preparation citrate buffer 	20
III	<ul style="list-style-type: none"> • Principles of Colorimetry and Verification of Beer's law • Separation of Amino acids by paper chromatography. • Separation of various biomolecules by using TLC 	20
IV	<ul style="list-style-type: none"> • Estimation of carbohydrates (glucose, maltose, lactose) present in a sample solution by DNS method • Estimation of protein by Lowry's method • Extraction and estimation of cellular protein from animal tissue by ammonium salt precipitation method. 	20
TOTAL		80

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (80 lab hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books:

As suggested under the theory papers.

Course Title: Biotechnology and Human Welfare	Course Component: Minor
Course code: BTC152N101	Credit: 3
Level of course: 100	L-T-P-C: 3-0-0-3
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to provide a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on cell-cell communication and the importance of cell division.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various roles played by Biotechnology.	BT 1
CO 2	Understand the role of Biotechnology in solving environmental issues.	BT 2
CO 3	Employ the theoretical knowledge in future studies.	BT 3
CO 4	Analyze the role of the techniques learnt in development of society	BT 4

Detailed Syllabus

Modules	Topics & Course Contents	Periods
I.	Biotechnology in Industries: Development of protein products, development of recombinant proteins, modification and application of enzymes, antibiotic production, alcohol production. Biotechnology in Agriculture: Production of new crops, genetically modified crops, development of stress/flood/drought tolerant crops. Better	12

	production of resistant crops. Improvement of livestock.	
II.	Biotechnology in Environment: Development of products which can degrade organic and inorganic pollutant, degradation of hydrocarbons and agriculture wastes, development of biodegradable polymers.	12
III.	Biotechnology in Food: Development of better-quality food products, development of innovative food products, development of new microbial strains, new beverages, quality preservation in foods, development of nutraceuticals and their role in health.	12
IV	Biotechnology in Forensics: Biotechnological interventions in solving crimes, DNA fingerprinting-Principles and applications, serology tools and role in solving crimes, biological solutions to solving crimes. Biotechnology in Pharmaceutical and Health: Development of new therapeutic agents, vaccines, gene therapy techniques, new diagnostic techniques for detection of viral disease, e.g. Covid-19, HIV, etc. Role of Human Genome Project.	12
TOTAL		48
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (48 class hours + 42 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. S. M. Reddy, S. R. Reddy, G.N. Babu, Basic industrial Biotechnology, 2012, New Age Publishers.

Reference Books

1. Ratledge, C., Kristiansen, B., Basic Biotechnology, 3rd edition, 2006, Cambridge University Press;
2. Das, H. K., Text book of Biotechnology, 5th edition, 2017, Wiley Publishers.

Course Title: Introduction to Indian Knowledge System – I		Course component: IDC
Course Code: IKS992K101		Credits: 3
Course Level: 100		L-T-P-C: 3-0-0-3
Scheme of Evaluation: Theory (Summative Assessment - 70% + Formative Assessment -30%)		
Credit Distribution (NCH)		
Lecture/Tutorial (Hours)	Practical (Hours)	Experiential Learning (Hours)
60	0	30

Course objectives:

This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course students will be able to:

CO	Contents	BT Level
CO ₁	Recall the rich heritage of Indian knowledge systems	BT level 1
CO ₂	Describe the contribution of Indian knowledge systems to the world	BT level 2
CO ₃	Demonstrate knowledge of sociocultural and ethnolinguistic diversity that constitutes the soul of Bharatvarsha	BT level 2
CO ₄	Apply traditional knowledge and techniques in day-to-day life	BT level 3
CO ₅	Distinguish knowledge traditions that originated in the Indian subcontinent	BT level 3

Detailed syllabus

Module	Course Contents	Periods
I	<p>Introduction to Indian Knowledge Systems (IKS): About Indian Knowledge System; Definition of Indigenous/ Traditional Knowledge; Scope, and Importance of Traditional Knowledge.</p> <p>Ancient India- Bharat Varsha: People of Ancient Bharat Varsha; Our great natural heritage: The great Himalayas and the rivers; The civilizations of the Sindhu-Ganga valley, and the Brahmaputra valley; Our coastal plains; Our Nature: Forests and Minerals; Ancient Indian Traditional Knowledge and Wisdom about nature and climate.</p>	15

II	<p>Indian Heritage of Knowledge: Ancient Indian Knowledge: The <i>Vedas</i> and its components-the <i>Vedangas</i> Ancient Indian books and treaties: The <i>Sastras</i>.; The Great Indian Epics: The Ramayana and The Mahabharata Epics and religious treaties of ancient Assam: Introduction to Madhav Kandali's <i>Ramayan</i> and Srimanta Sankardev's <i>Dasam Skandha Bhagavat</i> of the Puranas; Ancient Traditional Knowledge-The <i>Agamas</i> ; The ancient Buddhist knowledge: <i>Tripitaka: Vinaya, Sutta</i> and <i>Abhidhamma Pitaka</i></p> <p>Languages and language studies in India: What is linguistics?; Script and Language; Alphabet of the Indian; languages <i>Varnamala</i>: Origin, Evolution, and phonetic features; Languages of India; Important texts of Indian languages: Skills <i>Siksha</i>, Expression/Pronunciation-<i>Nirukta</i>, Grammar-<i>Vyakarana</i>, Poetic rhythm- <i>Chandas</i>;Paninian Grammar: A Brief Introduction</p> <p>Introduction to Fine Arts and Performing Arts of India: Ancient Indian classical music and dance forms: The Science of Dramas-<i>Natyasastra</i> and the Science of Music-<i>Gandharva-Veda</i>; Aesthetics in Indian Art and Culture; Folk music and traditional dance forms of the Northeast.</p>	
III	<p>Indian Science & Technology: Ancient India's contribution to Mathematics - Number System. Algebra and Arithmetic, Geometry and Trigonometry; Origin of Decimal system in India; nomenclature of numbers in the Vedas. Zero and Infinity. Sulba-sutras. Contribution of Brahmagupta and Sridhar Acharya to Mathematics. Important texts of Indian mathematics.</p> <p>Indian Astronomy: Planetary System. Motion of the Planets; Velocity of Light; Eclipse. Astronomy. Navagrahas. Important works in Indian Astronomy. Aryabhata and Nilakantha: Contribution to Astronomical Studies</p> <p>Indian Metal Works: Mining Techniques. Types of Metals. Tools & Techniques for Metal Smelting with examples. Metalworks in pre- modern India: Special reference to NE India.</p>	15
IV	<p>Contribution of Ancient India to Health Sciences: Traditional Indigenous systems of medicines in India: - <i>Ayurveda</i> and <i>Yoga</i>; Elements of <i>Ayurveda: Gunas</i> and <i>Doshas</i>, <i>Pancha Mahabhuta</i> and <i>Sapta-dhatu</i>; Concept of disease in <i>Ayurveda</i>; Ayurvedic lifestyle practices: <i>Dinacharya</i> and <i>Ritucharya</i>; Important Ayurvedic Texts; Hospitals in Ancient India; <i>Ayurveda</i>: Gift of India to the modern world.</p>	15
Total		60

Text Books

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), *Introduction to Indian Knowledge System: Concepts and Applications*. PHI Learning Private Ltd.
2. Mukul Chandra Bora, *Foundations of Bharatiya Knowledge System*. Khanna Book Publishing

Reference Books

1. Baladev Upadhyaya, *Sanskṛta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna and Śārīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrottana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy, and Polity in Eighteenth-century Chengalpattu*, in J. K. Bajaj ed., *Indian Economy and Polity*, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

The experiential learning sessions may include:

- Field Visits: Organizing visits to historical sites, museums, traditional craft centers, and other places relevant to Indian knowledge systems.
- Interactive Sessions: Engaging students in discussions with experts and practitioners in various fields of Indian knowledge systems to gain insights and practical knowledge.
- Online Lecture Series: Providing the students with online lectures by distinguished experts in the field of the Indian Knowledge System.
- Hands-on Activities: Providing opportunities for students to participate in activities related to traditional arts, crafts, music, dance, agriculture, etc., to understand the practical aspects of Indian knowledge systems.
- Practical Demonstrations: Conducting workshops or sessions to demonstrate traditional practices, such as yoga, Ayurveda, Vastu Shastra, etc., for the students.

Course Title: CEN I: Introduction to Effective Communication	Course Component: AEC
Course code: CEN982A101	Credit: 1
Level of course: 100	L-T-P-C: 1-0-0-1
Scheme of Evaluation: Theory (T)	

Course Objective: To understand the four major aspects of communication by closely examining the processes and outlining the most effective ways to communicate with interactive activities.

Course Outcomes: On successful completion of the course the students will be able to

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	List the elements and processes that make for successful communication and recognize everyday activities that deserve closer attention in order to improve communication skills	BT 1
CO 2	Contrast situations that create barriers to effective communication and relate them to methods that are consciously devised to overcome such hindrance	BT 2
CO 3	Apply language, gestures, and para-language effectively to avoid miscommunication and articulate one's thoughts and build arguments more effectively	BT 3

Detailed Syllabus		
Units	Course Contents	Periods
I	Introduction to Effective Communication <ul style="list-style-type: none"> • Listening Skills <ul style="list-style-type: none"> ○ The Art of Listening ○ Factors that affect Listening ○ Characteristics of Effective Listening ○ Guidelines for improving Listening skills 	5
II	<ul style="list-style-type: none"> • Speaking Skills <ul style="list-style-type: none"> ○ The Art of Speaking ○ Styles of Speaking ○ Guidelines for improving Speaking skills ○ Oral Communication: importance, guidelines, and barriers 	5
III	<ul style="list-style-type: none"> • Reading Skills <ul style="list-style-type: none"> ○ The Art of Reading ○ Styles of Reading: skimming, surveying, scanning ○ Guidelines for developing Reading skills 	5

IV	<ul style="list-style-type: none"> • Writing Skills <ul style="list-style-type: none"> ○ The Art of Writing ○ Purpose and Clarity in Writing ○ Principles of Effective Writing 	5
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Credit Distribution		
Lecture/Tutorial	Practicum	Experiential Learning
15 hours	-	10 hours <ul style="list-style-type: none"> - Movie/ Documentary /Podcasts screening - Peer teaching

Text Books

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication*. Pearson.
3. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University Press.

Course Title: Behavioural Sciences - 1	Course Component: AEC
Course code: BHS982A102	Credit: 1
Level of course: 100	L-T-P-C: 1-0-0-1
Scheme of Evaluation: Theory (T)	

Course objectives: To increase one’s ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

Course Outcomes: On completion of the course the students will be able to –

- CO1: Understand self & process of self-exploration
 CO2: Learn about strategies for development of a healthy self esteem
 CO3: Apply the concepts to build emotional competencies.

Detailed syllabus

Module	Course Contents	Periods
I	Introduction to Behavioral Science Definition and need of Behavioral Science, Self: Definition components, Importance of knowing self, Identity Crisis, Gender and Identity, Peer Pressure, Self-image: Self Esteem, Johari Window, Erikson’s model.	4

II	Foundations of individual behavior Personality- structure, determinants, types of personalities. Perception: Attribution, Errors in perception. Learning- Theories of learning: Classical, Operant and Social	4
III	Behaviour and communication. Defining Communication, types of communication, barriers to communication, ways to overcome barriers to Communication, Importance of Non-Verbal Communication/Kinesics, Understanding Kinesics, Relation between behaviour and communication.	4
IV	Time and Stress Management Time management: Introduction-the 80:20, sense of time management, Secrets of time management, Effective scheduling. Stress management: effects of stress, kinds of stress-sources of stress, Coping Mechanisms. Relation between Time and Stress.	4
Total		16

Text Books

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer & Company
2. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.
3. K. Alex, Soft skills; S. Chand.

Course Title: Compost Preparation and Applications	Course Component: SEC
Course code: BTC152S111	Credit: 3
Level of course: 100	L-T-P-C: 0-0-6-3
Scheme of Evaluation: P	

Course Objective: The main objective of the course is to provide the graduates with the knowledge of biofertilizers and their applications in agriculture.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various techniques in production of biofertilizer	BT 1
CO 2	Understand the principles and applications biofertilizer	BT 2
CO 3	Apply the theoretical knowledge in practical applications.	BT 3

CO 4	Analyze the role of biofertilizers in agricultural production.	BT 4
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Detailed Syllabus

Modules	Topics & Course Contents	Periods
I.	Earthworms: Introduction, classification and types of earthworms. The behavior of earthworms as indicators of soil fertility, plant growth and promoters & soil health regulators. Role of Earthworms to protect Environment. Starter culture of compost. Its preparation.	15
II	Vermicomposting: Vermiculture and Vermicomposting, Advantages of Vermicomposting, Chemical composition of vermicompost. Vermicomposting in everyday life earthworms and vermicomposting at commercial scale. Vermicomposting and Sustainable agriculture, restoration of degraded soil systems, vermicomposting and its effect on the greenhouse effect. Vermicomposting and its economic viability.	15
III	Definition, science and classification of compost, role of microbes in composting, carbon-nitrogen balance, C:N ratio, Moisture content, availability of temperature and oxygen,	15
IV	Methods of composting: Indore method, activated compost, NADEP method, Coimbatore method, Windrows composting. Coir pith, fly ash, Sewage and sewage sludge, sugar cane waste, compost of animal waste, phosphorous compost, weed composting	15
TOTAL		60
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 20 Lab hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Book

1. Singh, K. A Textbook of Vermicompost: Vermiwash and Biopesticides, 2014, Biotech Books.

Reference Books

1. Sreenivasan, E. Handbook of Vermicomposting Technology, 2018, The Western India Plywoods Ltd.
2. M. K. Rai., Handbook of Microbial Biofertilizers, 2006, Food Products Press

List of Practical Experiments

Modules	Topics & Course Contents	Periods
I.	1. Evaluation of various microbial species used in preparation of compost. 2. Assessment of earthworm species used in preparation of vermicompost 3. Determination of constituents in preparation of compost and vermicompost	12
II	1. Preparation of the soil structure used in vermicompost. 2. Analysis of composition of vermicompost bed. 3. Preparation of vermicompost shed	12
III	1. Assessment on the methods of preparation of compost. 2. Estimation on the organic constituents of compost 3. Evaluation on the growth patterns of earthworms on different feeds.	12
IV	1. Assessment of the quality of compost and vermicompost. 2. Estimation of the NPK content. 3. Study of market potential of compost	12
TOTAL		48
Pedagogy: Lectures, Experiments, Laboratory sessions		

SYLLABUS (2nd SEMESTER)

Course Title: Microbiology	Course Component: Major
Course code: BTC152M201	Credit: 2
Level of course: 100	L-T-P-C: 2-0-0-2
Scheme of Evaluation: Theory (T)	

Course Objective: The course aims to give a holistic theoretical and practical knowledge in field of general microbiology, its core concepts, scopes, applications and future prospects.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Recall the various types of microorganism and the roles played by them.	BT 1
CO 2	Relate the microbial world, their diversity and utilization.	BT 2
CO 3	Apply the knowledge gained in understanding the causative agents of various diseases and maintenance of sterility.	BT 3
CO 4	Analyze and relate the co-evolutionary pattern and relationship between microbes and the environment.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	<p>An introduction to microbiology: History of microbiology, concepts of microbial diversity, scope and applications of microbiology.</p> <p>Microscopy and specimen preparation: Bright and dark field microscopy, TEM and SEM. Concepts of fixation and staining, Gram staining, acid fast staining, negative staining, capsule, flagellar and endospore staining.</p> <p>Prokaryotic cellular architecture: The cell wall and other constituents. Comparison between prokaryotic and eukaryotic organisms. Introduction to Eubacteria and Archaea, their major structural differences. General characteristics and classification of viruses, differences between bacteria and viruses. Bacteriophages; lytic and lysogenic cycles. Prions and virioids.</p>	12
II.	<p>Eukaryotic microbial diversity: Introduction to protists, bacteria, actinomycetes and fungi, Mycelia of fungi and Actinomycetes, cytoskeleton filament, heterocysts and akinets of Cyanobacteria.</p>	12

	Microbial growth and nutrition: Principles of growth and growth curve, methods of growth determination and factors affecting growth. Mode of nutrition, growth mediums and pure culture techniques; isolation, preservation and maintenance of cultures, sterilization techniques.	
III.	Microbial taxonomy: Concept of microbial species and strains, classification of bacteria based on-morphology (shape flagella), staining reaction, mutation and extreme environment. Microbial Reproduction and recombination: Transformation, conjugation (cointegrate Formation and Hfr Cells, F-Plasmid) and transduction (generalized and specialized).	12
IV	Microbial Metabolism: Bacterial Photosynthesis, photophosphorylation, assimilation of inorganic nitrogen, phosphorus and sulphur, ED Pathway Microorganisms and health: Basics of host pathogen interaction, commensalism, colonization, infection and disease. Infections caused by Enterobacteriaceae, Mycobacteriaceae, <i>Candida</i> , <i>Aspergillus</i> , <i>Variola</i> , <i>Varicella-Zoster</i> , <i>HPV</i> , <i>EBV</i> Plant microbe interactions: Plant microbe interaction in the rhizosphere. Carbon and Nitrogen cycle, biological nitrogen fixation – symbiotic and non-symbiotic Plant Growth Promoting Rhizobacteria (PGPR) - Mycorrhizae -Blue Green Algae (BGA)	12
TOTAL		48
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

2 credits: 2 × 30 = 60 Notional Credit Hours (48 class hours + 12 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Gupta P.K., *Genetics*, ISBN-10 8171339328, ISBN-13 978-8171339328, Rastogi Publications, Meerut.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R. *Molecular Biology of the Gene*, 6th edition, 2008. Cold Spring Harbour Lab. Press, Pearson Pub.

Reference Books

1. Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.
2. Tamarin, R.H. (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.

Course Title: Practical on Microbiology	Course Component: Major
Course code: BTC152M211	Credit: 1
Level of course: 100	L-T-P-C: 0-0-2-1
Scheme of Evaluation: Practical (P)	

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Learn and remember about the process of preparation of media and calculation of molarity and estimation of pH.	BT 1
CO 2	Understand the components of the various media and their roles in microbial culture	BT 2
CO 3	Apply the knowledge of microscopy in identifying the morphology of microbes	BT 3
CO 4	Analyze the equipment's used and the underlying safety measures in a laboratory.	BT 4

Detailed Practical

Module	Topics & Course Contents	Periods
I	<ul style="list-style-type: none">• To study the various instruments used in a microbiology laboratory• To study the safety protocols to be followed in a microbiology laboratory	15
II	<ul style="list-style-type: none">• To prepare media for growth of microorganisms• To isolate microbes from soil and water	15
III	<ul style="list-style-type: none">• To perform pure culture techniques for isolation of microbes• To perform Gram's staining of microbes	15
IV	<ul style="list-style-type: none">• To perform Growth curve analysis of microbes• To perform sliding motility test in bacteria	15
TOTAL		60

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books

As suggested under the theory papers.

Course Title: Cell Biology	Course Component: Major
Course code: BTC152M202	Credit: 2
Level of course: 100	L-T-P-C: 2-0-0-2
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to provide a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on cell-cell communication and the importance of cell division.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various components of the cell and their function.	BT 1
CO 2	Understand the function of the cells and their roles.	BT 2
CO 3	Apply the knowledge gained in solving of problems associated with the topic.	BT 3
CO 4	Analyze the components of the cellular structure in prokaryotes, eukaryotes and archaea.	BT 4

Detailed Syllabus

Module	Topics & Course Contents	Periods
I	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Extracellular matrix and its composition.	12

II	Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.	12
III	Lysosomes: Vacuoles and micro bodies: Structure and functions, Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure. Signal transduction.	12
IV	Structure and function of prokaryotic cell and its components. Cell wall of bacteria, outer membrane of Gram-negative bacteria. Overview of the cell-cycle, Intracellular and extracellular control of cell division. Programme cell death, Cell cycle and cancer.	12
	TOTAL	48
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

2 credits: 2 × 30 = 60 Notional Credit Hours (48 class hours + 12 Experiential learning)

Experiential learning activities may include

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Karp, G., *Cell and Molecular Biology: Concepts and Experiments*, 6th Edition, 2010 John Wiley & Sons Inc.

Reference Books

1. De Robertis, E.D.P. and De Robertis, E.M.F., *Cell and Molecular Biology*, 8th edition, 2006, Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. & Hausman, R.E. *The Cell: A Molecular Approach*, 5th edition. 2009, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Course Title: Practical on Cell Biology	Course Component: Major
Course code: BTC152M212	Credit: 1
Level of course: 100	L-T-P-C: 0-0-2-1
Scheme of Evaluation: Practical (P)	

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Learn and remember the different components of cells.	BT 1
CO 2	Understand the mechanism of cell division and differentiation.	BT 2
CO 3	Apply the knowledge identifying various mechanisms involved in cell growth and development	BT 3
CO 4	Analyze the equipment used and the underlying safety measures in a laboratory pertaining to cell biology.	BT 4

Detailed Practical

Module	Topics & Course Contents	Periods
I	<ul style="list-style-type: none"> Study the effect of temperature and organic solvents on semi permeable membrane. Demonstration of dialysis. 	15
II	<ul style="list-style-type: none"> Study of plasmolysis and de-plasmolysis. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source. 	15
III	<ul style="list-style-type: none"> Study of structure of any Prokaryotic and Eukaryotic cell. Study of cell counting and their viability 	15
IV	<ul style="list-style-type: none"> Cell division in onion root tip/ insect gonads. Identification of blood cells in human blood smear 	15
TOTAL		60

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research

- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books

As suggested under the theory papers.

Course Title: Basic Instrumentation in Biology	Course Component: Minor
Course code: BTC152N201	Credit: 3
Level of course: 100	L-T-P-C: 3-0-0-3
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to provide the graduates with a strong foundation in the area of instrumentation's used in Biology.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various instruments that play a major role in the study of biology.	BT 1
CO 2	Understand the principles and applications of the instruments.	BT 2
CO 3	Apply the theoretical knowledge in practical applications.	BT 3
CO 4	Analyze the results of practical carried out using the instruments	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Microscopy and Imaging techniques: Principles and applications of Light microscopy, Phase contrast microscopy, fluorescence microscopy, electron microscopy- Scanning electron microscopy and Transmission electron microscopy	12
II	pH and Centrifugation: pH meter: Principles and application, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation. Electrophoresis techniques: Gel electrophoresis, PAGE, Pulse field, 2DGE	12

III	Chromatography techniques: Principles and Application of Thin layer chromatography, Column chromatography, Gas Chromatography, High pressure liquid chromatography Preparation of Buffers, Molar solutions, Dilutions, Handling of chemicals, Good Laboratory Practices	12
IV	Spectroscopy and other techniques: UV-Vis spectroscopy, Infra-Red spectroscopy, Mass Spectroscopy, Lyophilizer, Sonication, Freeze Drying, Micropipettes	12
TOTAL		48
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (48 class hours + 42 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Bajpai, P.K., Biological Instrumentation and methodology, 2006, S. Chand & Co. Ltd.

Reference Books

1. K. Wilson and J. Walker Eds. Biochemistry and Molecular Biology, 2005, Cambridge University Press.
2. F. Partibhan and S. Felix, Biochemical Techniques and Instrumentation, 2020, Daya Publishing House.

Course Title: Introduction to Indian Knowledge System – I		Course component: IDC
Course Code: IKS992K201		Credits: 3
Course Level: 100		L-T-P-C: 3-0-0-3
Scheme of Evaluation: Theory (Summative Assessment - 70% + Formative Assessment -30%)		
Credit Distribution (NCH)		
Lecture/Tutorial (Hours)	Practical (Hours)	Experiential Learning (Hours)
60	0	30

Course objectives:

This Foundation course is designed to present an overall introduction to all the streams of IKS relevant to the UG program. It would enable students to explore the most fundamental ideas that have shaped Indian Knowledge Traditions over the centuries.

Course Outcomes:

On completion of this course, students will be expected to –

CO	Contents	BT Level
CO ₁	Recall traditional Indian knowledge traditions constituting Indian culture	BT level 1
CO ₂	Summarize differences between classical literature in Sanskrit and other Indian languages	BT level 2
CO ₃	Compare knowledge traditions originating in NE India	BT level 2
CO ₄	Appreciate the contribution of Indian Knowledge Systems to the world	BT level 3

Detailed Syllabus

Module	Course Contents	Periods
I	Indian Classical Literature Indian Classical Literature: A Brief Introduction; Ancient Indian Spiritual Poetics- <i>Kavya</i> : Contribution of Kalidasa Diversity and Indian Culture: Diversity and Indian Culture; Indigenous Faith and Religion; Preservation of culture and indigenous knowledge The Purpose of Knowledge: Understanding Self-Awareness and Spirituality; Indian concept and purpose of Knowledge and Education; Understanding Spirituality and Materialism: <i>Para</i> and <i>Apara Vidya</i>	15
II	Methodology of Indian Knowledge System: <i>Shruti</i> and <i>Smriti</i> traditions; Introduction to <i>Shastras</i> ; Manuscriptology: The art and science of documenting knowledge; Repositories of ancient manuscripts with special reference to the Northeast India. Indian Architecture and Town Planning: Introduction ancient Indian architecture; <i>Sthapatya-Veda</i> : An Introduction; Indigenous tools & techniques for town planning & Temple Architecture. Lothal, Mohan Jo Daro; Temple Art: Lepakshi Temple, Jagannath Puri Temple, Konark Sun Temple; Vernacular architecture of Assam: Special reference to Brahmaputra Valley	

III	<p>Indian Agriculture: Agriculture: Significance in Human Civilization; Sustainable Agriculture; Historical significance of agriculture and sustainable farming in India; Step Cultivation of India: Special reference to Northeast India; Wet rice cultivation of Assam.</p> <p>Indian Textiles: What is Textile? Tradition of cotton and silk textiles in India; The historical contribution of textile and weaving to the Indian economy; Varieties of textiles and dyes developed in different regions of India with special reference to Northeast India.</p>	15
IV	<p>Indian Polity and Economy: Understanding Kingdom and Chiefdom; Role of a king; The Indian idea of a well-organized polity and flourishing economy; The <i>Chakravarti</i> System: Administrative System of Ancient Bharatvarsha; Village administrative system: Northeast India; <i>Arthashastra</i>: Brief synopsis. The outreach of Indian Knowledge System across Geographical Boundaries: Indian Languages; Scripts; Linguistics; Ayurveda; Yoga and Meditation; Textile; Decimal value place system-based arithmetic, Algebra and Astronomy</p>	15
Total		60

Text Books

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavan RN. (2022), *Introduction to Indian Knowledge System: Concepts and Applications*. PHI Learning Private Ltd.
2. Mukul Chandra Bora, *Foundations of Bharatiya Knowledge System*. Khanna Book Publishing

Reference Books

1. Baladev Upadhyaya, *Sanskṛta Śāstrom ka Itihās*, Chowkhambha, Varanasi, 2010.
2. D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., *A Concise History of Science in India*, 2nd Ed., Universities Press, Hyderabad, 2010.
3. Astāngahrdaya, Vol. I, *Sūtrasthāna* and *Śārīrasthāna*, Translated by K. R. Srikantha Murthy, Vol. I, Krishnadas Academy, Varanasi, 1991.
4. Dharampal, *The Beautiful Tree: Indian Indigenous Education in the Eighteenth Century*, Dharampal Classics Series, Rashtrottana Sahitya, Bengaluru, 2021.
5. J. K. Bajaj and M. D. Srinivas, *Indian Economy, and Polity in Eighteenth-century Chengalpattu*, in J. K. Bajaj ed., *Indian Economy and Polity*, Centre for Policy Studies, Chennai, 1995, pp. 63-84.

Course Title: CEN II: Approaches to Verbal and Non-Verbal Communication	
Course Component: AEC	Course code: CEN982A201
Credit: 1	L-T-P-C: 1-0-0-1
Scheme of Evaluation: Theory (T)	Level of course: 100

Course Objectives

To introduce the students to the various forms of technical communication and enhance their knowledge in the application of both verbal and non-verbal skills in communicative processes.

Course Outcomes

On successful completion of the course the students will be able to:		
CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	List the different types of technical communication, their characteristics, their advantages and disadvantages.	BT 1
CO 2	Explain the barriers to communication and ways to overcome them.	BT 2
CO 3	Identify the means to enhance conversation skills.	BT 3
CO 4	Determine the different types of non-verbal communication and their significance.	BT 4

Detailed Syllabus

Modules	Topics (if applicable) & Course Contents	Periods
I	Technology Enabled Communication Communicating about technical or specialized topics, Different forms of technology-enabled communication tools used in organizations Telephone, Teleconferencing, Fax, Email, Instant messaging, Blog, Podcast, Videos, videoconferencing, social media	4
II	Communication Barriers Types of barriers: Semantic, Psychological, Organisational, Cultural, Physical, Physiological, Methods to overcome barriers to communication.	4
III	Conversation skills/Verbal Communication Conversation – Types of Conversation, Strategies for Effectiveness, Conversation Practice, Persuasive Functions in Conversation, Telephonic Conversation and Etiquette Dialogue Writing, Conversation Control.	4
IV	Non-verbal Communication Body language- Personal Appearance, Postures, Gestures, Eye Contact, Facial expressions Paralinguistic Features-Rate, Pause, Volume, Pitch/Intonation/ Voice/Modulation, Proxemics, Haptics, Artifacts, Chronemics,	4
	Total	16

Text Books

1. Rizvi, M. Ashraf. (2017). *Effective Technical Communication*. McGraw-Hill.
2. Chaturvedi, P. D. and Chaturvedi, Mukesh. (2014). *Business Communication*. Pearson.
3. Raman, Meenakshi and Sharma, Sangeeta. (2011). *Technical Communication: Principles and Practice* (2nd Edition): Oxford University Press.

Course Title: Behavioural Sciences - II	
Course Component: AEC	Course code: BHS982A202
Credit: 1	L-T-P-C: 1-0-0-1
Scheme of Evaluation: Theory (T)	Level of course: 100

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

Course outcomes: On completion of the course the students will be able to:

CO 1: Develop an elementary level of understanding of culture and its implications on personality of people.

CO2: Understand the concept of leadership spirit and to know its impact on performance of employees.

CO3: Understand and apply the concept of Motivation in real life.

Modules	Course Contents	Periods
I	Culture and Personality Culture: Definition, Effect, relation with Personality, Cultural Iceberg, Overview of Hofstede's Framework, Discussion of the four dimensions of Hofstede's Framework.	4
II	Attitudes and Values Attitude's definition: changing our own attitudes, Process of cognitive dissonance Types of Values, Value conflicts, Merging personal and Organizational values	4
III	Motivation Definition of motivation with example, Theories of Motivation (Maslow, McClelland's theory & Theory X and Y)	4
IV	Leadership Definition of leadership, Leadership continuum, types of leadership, Importance of Leadership, New age leaderships: Transformational & transactional Leadership, Leaders as role models.	4
Total		16

Text Books

- J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer & Company

- Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.
- Organizational Behaviour by Kavita Singh (Vikas publishers, 3rd Edition).

Course Title: Biochemical Analysis of Food	Course Component: SEC
Course code: BTC152S211	Credit: 3
Level of course: 100	L-T-P-C: 0-0-6-3
Scheme of Evaluation: Practical (P)	

Course Objective: The main objective of the course is to provide the graduates with a strong foundation in the area of instrumentation's used in Biology.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Recall the various theories taught and relate them to the analysis of food materials.	BT 1
CO 2	Understand the various theories and the practical in analysis of different food components.	BT 2
CO 3	Apply the knowledge of instruments in analysis of food products.	BT 3
CO 4	Analyze the components of food and relate them to health and wellness.	BT 4

Detailed List of Practical Experiments

Modules	Topics & Course Contents	Periods
I.	<ul style="list-style-type: none"> • Preparation of buffers and chemicals required in analysis of food. • Isolation and separation of food components by paper chromatography and TLC. • Extraction and estimation total sugar and reducing-sugar present in food. 	20
II	<ul style="list-style-type: none"> • Biochemical analysis of different food components. • Analysis of protein and fats of cereals. • Analysis of lipid and lactose from milk and milk products. • Estimation of casein from milk. 	20
III	<ul style="list-style-type: none"> • Assessment of microbial contamination in food products and water. • Estimation of sucrose and glucose in food products. • Estimation of starch in food samples. 	20
IV	<ul style="list-style-type: none"> • Estimation cholesterol from egg yolk. • Milk adulteration analysis • Analysis of synthetic colours present in food. 	20
Total		80
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: $3 \times 30 = 90$ Notional Credit Hours (80 lab hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Pearson, D. Chemical analysis of foods, 1970 (6th Edn), London: TA Churchill.

Reference Books

1. Plummer DT. Introduction to practical Biochemistry. Bombay: 1979, Tata McGraw Hill Pub. Co. Ltd.
2. Sadasivan S, and Manickam A. Biochemical Methods, 2ndEdn., 2003, New Age International (P) Ltd., Publishers.

SYLLABUS (3rd SEMESTER)

Course Title: Genetics	Course Component: Major
Course code: BTC152M301	Credit: 3
Level of course: 200	L-T-P-C: 2-1-0-3
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to understand the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Memorize the various laws of genetics	BT 1
CO 2	Understand the concepts of the core areas	BT 2
CO 3	Apply the knowledge gained in solving of genetic problems.	BT 3
CO 4	Analyze the theoretical knowledge gained in solving inheritance pattern.	BT 4

Detailed Syllabus

Modules	Topics & Course Contents	Periods
I.	<p>Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.</p> <p>Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance, and expressivity.</p>	12
II.	<p>Non-allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.</p> <p>Linkage & crossing over - Chromosome theory of Linkage, types of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over.</p>	12
III.	<p>Sex determination and sex linkage: Mechanisms of sex determination in human, Environmental factors and sex determination, sex differentiation, sex limited traits, sex linked inheritance.</p>	12

	Human Genetics: Concept, Human chromosomes and Mendelian pedigree pattern. Basic concept of Mutation and chromosome abnormalities.	
IV	Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, in breeding and out breeding, evolutionary genetics, natural selection.	12
TOTAL		48
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Gupta P.K., *Genetics*, ISBN-10 8171339328, ISBN-13 978-8171339328, Rastogi Publications, Meerut.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., *Molecular Biology of the Gene*, 6th edition, 2008. Cold Spring Harbour Lab. Press, Pearson Pub.

Reference Books

1. Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). *Principles of Genetics*, 8th Edition, John Wiley and Sons.
2. Tamarin, R.H. (2002). *Principles of Genetics*, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.

Course Title: Practical on Genetics	Course Component: Major
Course code: BTC152M311	Credit: 1
Level of course: 200	L-T-P-C: 0-0-2-1
Scheme of Evaluation: Practical (P)	

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Learn and remember the different components of cells.	BT 1
CO 2	Understand the mechanism of mitotic and meiotic cell division.	BT 2
CO 3	Apply the knowledge identifying chromosomes at various stages of cell division	BT 3
CO 4	Analyze the equipment used and the underlying safety measures in a laboratory pertaining to genetics.	BT 4

Detailed Practical

Module	Topics & Course Contents	Periods
I	<ul style="list-style-type: none"> • Calibration of Microscope • To prepare the media for culturing <i>Drosophila melanogaster</i> • To clean and sterilize the Drosophila culture bottle 	15
II	<ul style="list-style-type: none"> • Preparation of metaphase plate from mouse bone marrow. • Preparation of human karyotypes from well spread metaphase photographs 	15
III	<ul style="list-style-type: none"> • Temporary slide preparation of buccal smear to study Barr-body. • Introduction of chromosome abnormalities in mammalian chromosomes. 	15
IV	<ul style="list-style-type: none"> • Temporary slide preparation of Grasshopper testis to study the meiotic phases. • Temporary slide preparation of onion root tip to study the mitotic phases. 	15

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching

- classroom presentation *etc.*

Reference Books

As suggested under the theory papers.

Course Title: Biophysical Chemistry	Course Component: Major
Course Code: BTC152M302	Credit: 4
Level of course: 200	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objective: The course is designed to learn about the process of biophysical chemistry and understand the underlying phenomenon involved in protein structure and its composition.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the basics of biophysical chemistry	BT 1
CO 2	Understand the principles of and processes of biophysical chemistry and its application in solving protein structure	BT 2
CO 3	Apply the basics in understanding the role of bioenergetics.	BT 3
CO 4	Analyze the role of equilibrium and study the properties of protein folding and refolding.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Structure and Bonding: Structure of atoms, molecules and chemical bonds (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, Covalent bonding, etc.). Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).	16
II.	Conformation and configuration of proteins: Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds. Conformation of nucleic acids (A, B, Z-DNA forms), t-RNA structure, micro-RNA etc.)	16
III.	Bioenergetics: Concept of energy coupling in biological processors, Energy requirements in cell metabolism, high energy phosphate bond, energy currency of cell, biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis.	16
IV	Multiple equilibrium: Titration of proteins to evaluate total and net charge; Scatchard and hill plots; Protein stability, denaturation, unfolding equilibrium;	16

	Kinetics and thermodynamics of protein folding; Protein refolding and aggregation; Effect of solvent and temperatures on the protein stability and folding, Heat Shock Proteins	
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Text Books

1. Nelson, D.L., Cox, M.M. *Lehninger Principles of Biochemistry*, 4th Edition, 2004, W. H. Freeman and Co., New York, USA

Reference Books

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. *Biochemistry*, 6th Edition, 2006, W.H. Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. *Biochemistry and Molecular Biology of Plants*, 2nd Edition, 2015, American Society of Plant Biologists, USA.

Course Title: Introduction to IPR	Course Component: Minor
Course code: BTC152N301	Credit: 4
Level of course: 200	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives

This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues in the biological sciences and the laws pertaining to these in both the global and national context and also to aware the students with ethical practices appropriate for various scientific disciplines at all times and to adopt safe working practices relevant to the different biotech industries & fields of research.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level

CO 1	Remember intellectual property laws/principles (including copyright, patents, designs and trademarks) to real problems and to analyse the social impacts of intellectual property law and policy.	BT 1
CO 2	Understand , recognize, and distinguish an ethical issue from other issues	BT 2
CO 3	Apply the knowledge gained during the course in spreading IPR related awareness.	BT 3
CO 4	Analyze experimental results for their potential to file suitable IPR.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I	Concept of Property: Tangible and Intangible Property, Intellectual Property-Origin Development and Objectives, Classification of Intellectual Property-Patents, Copyright, Trademark, Industrial Design, Geographical Indications, <i>etc.</i>	12
II	Patent Rights and Copyrights- Origin, Meaning of Patent, Types, Patentability Criterion-Discovery and Invention, Patentable Subject Matters; Novelty, Utility (Industrial Applicability), Non-Obviousness (Inventive Step) and Written Description, Product Patents vis-à-vis Process Patents, Inventions which are not patentable. Copyright- Origin, Definition & Types of Copy Right, Registration procedure, Assignment & license, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.	12
III	Trademarks- Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties. Design- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.	12
IV	Protection of Plant Varieties and Traditional Knowledge, Relevance of Intellectual Property Rights for Science and Technology; Patentability of Biotechnology Inventions; Patent Laws in Indian and International Perspective; Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005); International Conventions relating to Intellectual Property; General Agreement on Trade and Tariff (GATT); Trade Related Aspects of Intellectual Property Rights (TRIPS)	12
TOTAL		48

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (60 class hours + 60 Experiential learning)

Text books

1. Cornish, W. R., Intellectual Property (Latest Edition)
2. Intellectual Property Rights by Paul Goldstein
3. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair

Reference Books

1. B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
2. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)

Course Title: Health and Hygiene	Course component: IDC
Course Code: BTC152I301	Credit: 3
Level of course: 200	L-T-P-C: 3-0-0-3
Scheme of Evaluation: Theory (T)	

Course objective: The main objective of the course is to familiarize the students with different aspects of health like nutrition, the role of microorganisms, and good practice to ensure hygiene in day-to-day life.

Course Outcome:

On successful completion of the course the students will be able to		
Sl. No.	Course Outcome	Blooms Taxonomy Level
CO1	Remembering the basics of health and hygiene	BT1
CO2	Understanding the role of microbes in health	BT2
CO3	Applying the knowledge to maintain a hygienic life style	BT3
CO4	Categorize commonly encountered health problems due to hygiene issues	BT4

Detailed Syllabus:

Module	Topics & Course Contents	Periods
I	Nutrition – definition, importance, nutrition and malnutrition; Balanced Diet: Basics of Meal Planning; Carbohydrates, Lipids, Proteins: Sources and Deficiency, Brief account of Vitamins- functions, food sources, effects of deficiency, Macro and micro minerals –functions, effects of deficiency; food	14

	sources of Calcium, Potassium and Sodium; food sources of Iron, Iodine and Zinc; Importance of water – functions, sources, requirement and effects of deficiency; Types, Symptoms and Diagnosis of nutritional deficiencies: Iron deficiencies (Anemia) and Vitamins (Night Blindness, Beriberi, Pellagra, birth defects, Osteoporosis)	
II	Microorganisms in health: Basic concept of bacteria and viruses, Cellular morphology of bacteria, fungi and viruses, microorganisms in human health; Microbial toxins; Mechanism of host-pathogen interaction. Host immunity against infectious diseases	10
III	Health hazards: Food poisoning: Introduction, Organism involved, source of food contamination Causes and symptoms in food poisoning by: Clostridium, water borne diseases: jaundice, cholera, diarrhoea and typhoid; Sexually transmitted infections – AIDS, Zoonotic diseases: Bacterial zoonoses (anthrax, plague); Viral zoonoses (rabies, influenza), Rickettsial zoonoses (scrub typhus, Q-fever), Fungal zoonoses (histoplasmosis)	16
IV	Hygiene – Hygiene: Definition, personal hygiene- body odour, oral hygiene, grooming, feminine hygiene, sleep hygiene, hand washing, toiletry. Social hygiene – clean living movements, occupational hygiene, food and cooking hygiene, medical hygiene, excessive hygiene. Rural Community Health: Village health sanitation & Nutritional committee (Roles & Responsibilities); Accredited Social Health Activist (ASHA). Public Awareness – Introduction to antibiotic and their resistance; Importance of vaccine, Introduction to Mobile Apps of Government of India: NHP, Swasth Bharat, No More Tension, Pradhan Mantri Surakshit Mantritva Abhiyan (PM Suman Yojana), My Hospital (Mera aspataal), India fights Dengue, JSK Helpline, Ayushman Bhava, Arogya Setu, Covid-19AP	8
	TOTAL	48

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (48 class hours + 42 Experiential learning)

Text Books

1. Adams MR and Moss MO (2008) Food Microbiology (3rd Edition) RSC publications, UK.
2. Geoffrey Campbell-Platt (Editor) (2009) Food Science and Technology, Willey and Blackwell Publication, UK.

Reference Books

1. Lightfoot NF and Maier EA (Editor) (2003) Microbiological analysis of food and water, Elsevier Publication, Netherland.
2. Ray B and Bhunia A (2008) Fundamental food Microbiology (4th Edition) CRC publication, UK

3. Jatin V. Modi and Renjith S. Chawan. Essentials of Public Health and Sanitation – Part I- IV.

Course Title: CEN III – Fundamentals of Business Communication	
Course Component: AEC	Course code: CEN982A301
Credit: 1	L-T-P-C: 1-0-0-1
Scheme of Evaluation: Theory (T)	Level of course: 200

Course Objective: The aim of the course is to develop essential business communication skills, including effective writing, speaking, and interpersonal communication, to enhance professional interactions, collaboration, and successful communication strategies within diverse corporate environments.

Course Outcomes: On successful completion of the course the students will be able to:

CO Level	Course Outcome	Blooms Taxonomy Level
CO 1	Define and list business documents using appropriate formats and styles, demonstrating proficiency in written communication for various business contexts.	BT 1
CO 2	Demonstrate confident verbal communication skills through persuasive presentations, active listening, and clear articulation to engage and influence diverse stakeholders.	BT 2
CO 3	Apply effective interpersonal communication strategies, including conflict resolution and active teamwork, to foster positive relationships and contribute to successful organizational communication dynamics	BT 3

Detailed Syllabus		
Units	Course Contents	Periods
I	Business Communication: Spoken and Written <ul style="list-style-type: none"> • The Role of Business Communication • Classification and Purpose of Business Communication • The Importance of Communication in Management • Communication Training for Managers • Communication Structures in Organizations • Information to be Communicated at the Workplace • Writing Business Letters, Notice, Agenda and Minutes 	5

II	Negotiation Skills in Business Communication <ul style="list-style-type: none"> • The Nature and Need for Negotiation <ul style="list-style-type: none"> ○ Situations requiring and not requiring negotiations • Factors Affecting Negotiation <ul style="list-style-type: none"> ○ Location, Timing, Subjective Factors • Stages in the Negotiation Process <ul style="list-style-type: none"> ○ Preparation, Negotiation, Implementation • Negotiation Strategies 	5
III	Ethics in Business Communication <ul style="list-style-type: none"> • Ethical Communication • Values, Ethics and Communication • Ethical Dilemmas Facing Managers • A Strategic Approach to Business Ethics • Ethical Communication on the Internet • Ethics in Advertising 	5
IV	Business Etiquettes and Professionalism <ul style="list-style-type: none"> • Introduction to Business Etiquette • Interview Etiquette • Social Etiquette • Workplace Etiquette • Netiquette 	5

Text Books

1. Business Communication by Shalini Verma
2. Business Communication by P.D. Chaturvedi and Mukesh Chaturvedi
3. Technical Communication by Meenakshi Raman and Sangeeta Sharma

Course Title: Behavioural Sciences - III	
Course Component: AEC	Course code: BHS982A302
Credit: 1	L-T-P-C: 1-0-0-1
Scheme of Evaluation: Theory (T)	Level of course: 200

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations. To enable the students to understand the process of problem solving and creative thinking.

Course outcomes: On completion of the course the students will be able to: CO1: Understand the process of problem solving and creative thinking. CO2: Develop and enhance of skills required for decision-making.

Modules	Course Contents	Periods
I	Problem Solving Process Defining problem, the process of problem solving, Barriers to problem Solving (Perception, Expression, Emotions, Intellect, surrounding environment)	4
II	Thinking as a tool for Problem Solving What is thinking: The Mind/Brain/Behaviour Critical Thinking and Learning: -Making Predictions and Reasoning. -Memory and Critical Thinking. - Emotions and Critical Thinking.	4
III	Creative Thinking - Definition and meaning of creativity, - The nature of creative thinking: Convergent and Divergent thinking, - Idea generation and evaluation (Brain Storming) - Image generation and evaluation. - The six-phase model of Creative Thinking: ICEDIP model	4
IV	Building Emotional Competence Emotional Intelligence – Meaning, components, Importance and Relevance Positive and Negative emotions Healthy and Unhealthy expression of emotions	4
Total		16

Text books

- J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer & Company
- Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.

Course Title: Clinical Biochemistry	Course Component: SEC
Course Code: BTC152S311	Credit: 3
Level of Course: 200	L-T-P-C: 0-0-6-3
Scheme of Evaluation: Practical (P)	

Course Objective: This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues and practices.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy

		Level
CO 1	Remember the principles of the experiments and apply them during their practical	BT 1
CO 2	Understand , the basic reaction mechanism of the chemical processes.	BT 2
CO 3	Apply the knowledge gained in carrying out experiments associated with the course of study.	BT 3
CO 4	Analyse the data and relate them with the experiments being conducted.	BT 4

Detailed List of Practical Experiments:

Modules	Topics & Course Contents	Periods
I.	1. Preparation of solutions of acid, base and buffers based on molarity and normality 2. Preparation of serial and simple dilutions of salt solutions 3. Measurement of pH of various solutions.	20
II.	1. Measurement of absorbance and transmittance 2. Determination of Beer-Lambert's equation 3. Estimation and separation of plasma proteins.	20
III.	1. Estimation of salivary amylase. 2. Estimation of glucose from blood sample. 3. Separation of amino acid using paper/ thin layer chromatography	20
IV	1. Estimation of cholesterol in blood. 2. Analysis of urine and its components 3. Determination of serum urea/ creatinine/ SGPT/SGOT/ALP/ALT	20
TOTAL		80
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (80 practical hours + 10 Experiential learning)

Text Books

1. Temple, V.J., Practical Manual in Biochemistry and Clinical Biochemistry, University of Papua New Guinea Press, 4th edition, 2013.

Reference Books

1. Mohanty, S. and Verma, A., Practical Clinical Biochemistry, Jaypee Publications, 5th edition, 2016.

SYLLABUS (4th SEMESTER)

Course Title: Molecular Biology	Course Component: Major
Course code: BTC152M401	Credit: 3
Level of course: 200	L-T-P-C: 2-1-0-3
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to allow the students to perceive the structure of the DNA molecule, understand the various mechanisms of molecular events and relate the role played in maintaining the biological system.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the basic concepts in molecular biology.	BT 1
CO 2	Demonstrate the concepts in understanding the formation of various	BT 2
CO 3	Apply the theoretical knowledge in carrying out the practical assigned.	BT 3
CO 4	Analyze and categorize the various molecular reactions involved in mutations and DNA repair	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Introduction to Molecular Biology, Types of genetic materials- Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and chase, Lederberg and Tatum, Central dogma of life. Replication of DNA, Models of DNA replication, Mechanism of DNA replication in prokaryotes and eukaryotes (initiation, elongation, replication fork, replication machinery, termination), Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSCP, topoisomerase, primase).	12
II.	Mechanism of transcription in prokaryotes and eukaryotes. Enzymes and proteins involved in transcription, post transcriptional modification. Inhibitors of transcription. Translation initiation and elongation.	12
III.	Genetic code - characteristics and properties, Wobble hypothesis. Post translational modification, protein degradation, Inhibitors of protein synthesis. Regulation of gene expression (lac and trp operons).	12

IV	Mutation and its types- spontaneous, induced, reverse, suppressor mutations; chemical mutagens- alkylating agent, nitrous acid, hydroxylamine; physical mutagen- radiation (X-Ray, Gamma Ray and UV). Concept of DNA repair.	12
TOTAL		48
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books

1. Watson, J.D., Molecular Biology of the Gene, Pearsons, 8th edition

Reference books

1. Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). Media Connected – W. H. Freeman and Company. 2009
2. Cell and Molecular Biology by De Robertis E.D.P and De Robertis E.M.F, 1987. Lea and Febiger International Edition, USA. 8th Ed. 2010.

Course Title: Practical on Molecular Biology	Course Component: Major
Course code: BTC152M411	Credit: 1
Level of course: 200	L-T-P-C: 0-0-2-1
Scheme of Evaluation: Practical (P)	

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy

		Level
CO 1	Learn and remember about the process of preparation of chemicals and calculate the same.	BT 1
CO 2	Understand about the various molecular mechanisms.	BT 2
CO 3	Apply the knowledge about the structure of DNA, its isolation and use of electrophoresis in isolation.	BT 3
CO 4	Analyse the role of bioinformatics and biostatistics in solving biological problems.	BT 4

Detailed Practical:

Module	Topics & Course Contents	Periods
I	1.Isolation of genomic DNA from plants/ microorganisms/ animal cells 2.Isolation of plasmid DNA by alkaline lysis method 3. Isolation of plasmid DNA by phenol method	15
II	1. To perform restriction digestion of DNA 2. Gel electrophoresis of DNA	15
III	1.To perform ligation of foreign DNA into cloning/ expression vector 2.Quantification and purity determination of isolated genomic DNA by UV-Spectrophotometry.	15
IV	1.To carry out polymerase chain reaction of genomic DNA 2. Gel electrophoresis of the PCR amplified product	15

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books: As suggested under the theory papers.

Course Title: Immunology	Course Component: Major
Course code: BTC152M402	Credit: 3
Level of course: 200	L-T-P-C: 2-1-0-3
Scheme of Evaluation: Theory (T)	

Course Objective: The course aims to provide knowledge in the field of immunology and demonstrate the various forms in relation to their purpose of defending the living system.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the basic forms of immune system present in the body.	BT 1
CO 2	Understand the mechanism of the immune system.	BT 2
CO 3	Apply the knowledge learnt in relating the same to the defence of the body during diseases.	BT 3
CO 4	Analyse the importance of the various molecules that play an important role in immune function.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Immunology - History & Milestones, Microbial infections and host resistance. Immune response: Innate & Adaptive responses, Humoral and cell mediated Immune Responses. Structures, composition and functions of cells and organs of immune system.	12
II.	Antigens & Immunogenicity. Antigens - Types, properties, Haptens, Adjuvants, Toxoids, Immunoglobulins- structure, types and properties, Theories of antibody formation, Structural and genetic basis of antibody formation. Antigen and antibody reactions, Immunodiagnostic methods - Agglutination, precipitations, complement fixation, RIA, ELISA and its types, Immunofluorescence, Production of Monoclonal Antibodies and Hybridoma technique.	12
III.	Cytokines & Chemokines - Classification, types and its functions, Complement system: structure, properties, functions of complement components and its pathways. Hypersensitivity reactions: Type I, II, III and IV, MHC - Structure and function of class I and class II MHC molecules	12
IV	Immunity and tumors: Types of tumors, tumor antigens, immune response to tumors. Immunodeficiency and auto immune diseases, Vaccines, Transplantation immunology - types and mechanisms involved.	12
TOTAL		48
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books:

1. Kuby, J., Immunology by (7th edition) W.H. Freeman and Company, New York, 2013

Reference books:

1. Khan. F.H. The Elements of Immunology, Pearson Education India, 2009

Course Title: Practical on Immunology	Course Component: Major
Course code: BTC152M412	Credit: 1
Level of course: 200	L-T-P-C: 0-0-2-1
Scheme of Evaluation: Practical (P)	

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Learn and remember about the process of preparation of chemicals and calculate the same.	BT 1
CO 2	Understand about the various immunological cells and tissues.	BT 2
CO 3	Apply the knowledge about the role of immune molecules in organism defence.	BT 3
CO 4	Analyse the role of the instruments and techniques used in immunology	BT 4

Detailed Practical:

Module	Topics & Course Contents	Periods
I	1. Isolation of lymphocytes from blood / spleen 2. Assays based on agglutination reactions - Blood typing (active) and passive	15

	Agglutination	
II	1. Blood film preparation and identification of cells 2. Demonstration of ELISA	15
III	1. Estimation of RBCs in blood 2. Estimation of WBCs in blood 3. Widal test for determination of typhoid	15
IV	1. Blood Grouping assay 2. Determination of coagulation time of blood	15

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books: As suggested under the theory papers.

Course Title: Bioethics, Biosafety and IPR	Course Component: Major
Course code: BTC152M403	Credit: 4
Level of course: 200	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objective: The course aims to provide knowledge in field of immunology and demonstrate the various forms in relation to their purpose of defending the living system.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the basics of Bioethics, biosafety and IPR	BT 1
CO 2	Understand the principles of bioethics and biosafety and the importance of IPR	BT 2
CO 3	Applying the knowledge of IPR in applying for patent, copyright etc.	BT 3
CO 4	Analyzing the rules and regulations involving biosafety, bioethics and	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Concept of Property: Intellectual Property Rights-Origin Development and Objectives, Classification of Intellectual Property-Patents, Copyright, Trademark, Industrial Design, Geographical Indications, Protection of Plant Varieties and Traditional Knowledge, Patentability Criterion, Product Patents vis-à-vis Process Patents	16
II.	Patentability of Biotechnology Inventions; Patent Laws in Indian and International Perspective; Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005); International Conventions relating to Intellectual Property; General Agreement on Trade and Tariff (GATT); Trade Related Aspects of Intellectual Property Rights (TRIPS)	16
III.	Biosafety: Definition and requirement; Important symbols and their meaning, Biosafety in relation to human health, environment, transgenic research and applications; International Legal Instruments on Biosafety Cartagena Protocol on Biosafety, Nagoya Protocol Laws relating to Biosafety in India: The Biological Diversity Act, 2002, Biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989;	16
IV	Nature, Concept and Relevance of Bioethics; Basic Principles of Bioethics; Legal, Social and Economic Impacts of the Products and Techniques in Biotechnology; Bioethics in Plants, Animals and Microbial Genetic Engineering; Ethical issues in Healthcare; Biopiracy and Bioethics, Institutional Bioethical Committees and Composition on Human and Animals.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books

1. Cornish, W. R., Intellectual Property (Latest Edition)
2. Intellectual Property Rights by Paul Goldstein
3. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair
4. Kilner, John, et.al, eds., Cutting-Edge Bioethics. Eerdmans 2002.

Reference Books

1. B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
2. S. Ignacimuthu, Bioethics, Alpha Science International, Limited (2009)
3. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)
4. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)

Course Title: Biofertilizer and Its Application	Course Component: Minor
Course code: BTC152N401	Credit: 3
Level of course: 200	L-T-P-C: 3-0-0-3
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to provide the graduates with the knowledge of biofertilizers and their applications in agriculture.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various techniques in production of biofertilizer	BT 1
CO 2	Understand the principles and applications biofertilizer	BT 2
CO 3	Apply the theoretical knowledge in practical applications.	BT 3
CO 4	Analyze the role of biofertilizers in agricultural production.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Soil Environment- microorganisms, soil structure, soil profile, physicochemical conditions, microbial composition, sampling techniques, role of microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins). Bio-geochemical cycles: Carbon cycle, Nitrogen cycle	12
II	Biofertilizers-Introduction, biofertilizers using nitrogen fixing microbes, phosphate solubilization- Rhizobium, Azotobacter, Azospirillum, Azolla- Anabaena Symbiosis, bluegreen algae and Ecto- and Endomycorizae. Cultivation, mass production and inoculation of Rhizobium, Azotobacter, Azospirillum, Azolla and cyanobacteria, Carrier-based inoculants, methods of application, quality control,	12

	agronomic importance. Application methods for different biofertilizers.	
III	Role of endophytic fungi in the production of biofertilizer: symbiotic and opportunistic associations, coevolution and loss of reproductive structures, Secondary metabolite production, toxins-importance, toxicity to herbivores and insects. Role of algae and lichens as biofertilizers.	12
IV	Solid wastes in the production of biofertilizers: Types and Concept of solid waste; solid waste management.	12
TOTAL		48
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Book

1. S. Kannaiyan, Biotechnology of Biofertilizers, 2002, Alpha Science International.

Reference Books

1. The Complete Technology Book on Bio-Fertilizer and Organic Farming. 2004, Niir Board.
2. M. K. Rai. Handbook of Microbial Biofertilizers, 2006, Food Products Press

Course Title: Food Biotechnology	Course Component: Minor
Course code: BTC152N402	Credit: 3
Level of course: 200	L-T-P-C: 3-0-0-3
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to provide the graduates with the knowledge of biofertilizers and their applications in agriculture.

Course Outcome:

On successful completion of the course the students will be able to:

SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various sources for production of food	BT 1
CO 2	Understand the principles and applications of enzymes and molecules	BT 2
CO 3	Apply the knowledge in practical applications for preparation of food	BT 3
CO 4	Analyze the role of biotechnology in food production.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Micro-organisms important in biotechnology processes, Strain improvement; mutation, recombination, protoplast fusion. Microbial growth kinetics; principles of batch, fed-batch and continuous fermentation, processes; sterilization of culture media; stirring, mixing and aeration of fermentation cultures.	12
II	Bacteria-based products; dairy, meat, fish and vegetable products, vinegar and additives. Yeast-based products; food yeasts, alcoholic beverages and bread. Other microbial based products; enzymes, microbial biomass protein (MBP), additives and “smart foods.”	12
III	Testing and analysis of genetically modified foods; protein-based methods to detect the transgene product and DNA-based methods to detect the transgene or associated marker or regulatory sequences. Safety evaluation of novel food products. Benefits and risks of GM foods.	12
IV	Plant cell and tissue culture, Genetic modification of agronomic traits in crops such as herbicide tolerance, pest and disease resistance, Laboratory generated meat, Animal nutrition and health. Generation of transgenic animals. Biotechnology in the animal feed industry, Regulations in production of GMO.	12
TOTAL		48
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Book

1. Ratledge, C. and Kristiansen, B. (Eds.) (2006) Basic Biotechnology. 3rd Edition. Cambridge University
2. Johnson-Green, P. (2002). Introduction to Food Biotechnology

Reference Books

1. Adams, M.R., and Moss, M.O. (2000). Food Microbiology. Second Edition. The Royal Society of Chemistry, UK.
2. Wood, B.J.B. (Editor) (1998). Microbiology of Fermented Foods, 2-Volumes, Second Edition. Blackie Academic & Professional, London.

Course Title: CEN IV – Business Communication: Concepts and Skills	
Course Component: AEC	Course code: CEN982A401
Credit: 1	L-T-P-C: 1-0-0-1
Scheme of Evaluation: Theory (T)	Level of course: 200

Course Objectives: This course is designed to enhance employability and maximize the students' potential by introducing them to the principles that determine personal and professional success, thereby helping them acquire the skills needed to apply these principles in their lives and careers.

Course Outcomes: After the successful completion of the course, the students will be able to

CO Level	Course Outcome	Blooms Taxonomy Level
CO 2	Demonstrate understanding the importance of verbal and non-verbal skills while delivering an effective presentation.	BT 2
CO 3	Develop professional documents to meet the objectives of the workplace	BT 3
CO 3	Identify different life skills and internet competencies required in personal and professional life.	BT 3

Detailed Syllabus		
Units	Course Contents	Periods
I	Presentation Skills Importance of presentation skills, Essential characteristics of a good presentation, Stages of a presentation, Visual aids in presentation, Effective delivery of a presentation	5

II	<p>Business Writing</p> <p>Report writing: Importance of reports, Types of reports, Format of reports, Structure of formal reports</p> <p>Proposal writing: Importance of proposal, Types of proposal, structure of formal proposals</p> <p>Technical articles: Types and structure</p>	5
III	<p>Preparing for jobs</p> <p>Employability and Unemployability, Bridging the Industry-Academia Gap Knowing the four- step employment process, writing resumes, Guidelines for a good resume, Writing cover letters</p> <p>Interviews: Types of interviews, what does a job interview assess, strategies of success at interviews, participating in group discussions.</p>	5
IV	<p>Digital Literacy and Life Skills</p> <p>Digital literacy: Digital skills for the '21st century', College students and technology, information management using Webspaces, Dropbox, directory, and folder renaming conventions. Social Media Technology and Safety, Web 2.0.</p> <p>Life Skills: Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem-solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion.</p> <p>Application of life skills: opening and operating bank accounts, applying for PAN, Passport, online bill payments, ticket booking, gas booking</p>	5

Text Books

1. *Business Communication* by Shalini Verma References:
2. *Technical Communication* by Meenakshi Raman and Sangeeta Sharma

Credit Distribution		
Lecture/Tutorial	Practicum	Experiential Learning
15 hours	-	10 hours <ul style="list-style-type: none"> - Movie/ Documentary screening - Field visits - Peer teaching - Seminars - Library visits

Course Title: Behavioural Sciences - IV	Course code: BHS982A402
Course Component: AEC	L-T-P-C: 1-0-0-1
Credit: 1	Level of course: 200
Scheme of Evaluation: Theory (T)	

Course objectives: To increase one's ability to draw conclusions and develop inferences about attitudes and behaviour, when confronted with different situations that are common in modern organizations.

Course outcomes: On completion of the course the students will be able to:

CO1: Understand the importance of individual differences

CO2: Develop a better understanding of self in relation to society and nation

CO3: Facilitation for a meaningful existence and adjustment in society

Module	Course Contents	Periods
I	Managing Personal Effectiveness Setting goals to maintain focus, Dimensions of personal effectiveness (self-disclosure, openness to feedback and perceptiveness), Integration of personal and organizational vision for effectiveness, A healthy balance of work and play, Defining Criticism: Types of Criticism, Destructive vs Constructive Criticism, Handling criticism and interruptions.	4
II	Positive Personal Growth Understanding & developing positive emotions, Positive approach towards future, Impact of positive thinking, Importance of discipline and hard work, Integrity and accountability, Importance of ethics in achieving personal growth.	4
III	Handling Diversity Defining Diversity, Affirmation Action and Managing Diversity, Increasing Diversity in Work Force, Barriers and Challenges in Managing Diversity.	4
IV	Developing Negotiation Skills Meaning and Negotiation approaches (Traditional and Contemporary) Process and strategies of negotiations. Negotiation and interpersonal communication. Rapport Building – NLP.	4
Total		16

Text Books

1. J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 3, Management; Pfeiffer & Company
2. Blair J. Kolasa, Introduction to Behavioural Science for Business, John Wiley & Sons Inc.

SYLLABUS (5th SEMESTER)

Course Title: Genomics and Proteomics	Course Component: Major
Course code: BTC152M501	Credit: 4
Level of course: 300	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objective: The course is designed to apprise the students to the vital concepts of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various techniques involved in the study of genomics and proteomics.	BT 1
CO 2	Understand the basic principle of all the techniques associated with genomics and proteomics study.	BT 2
CO 3	Apply the knowledge in the study of genomics and proteomics of a cell under specific conditions.	BT 3
CO 4	Analyze the effect of various intrinsic and extrinsic factors on the genome and proteome of a cell under certain conditions	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Importance of genome projects, human genome project, Sequence component of eukaryotic genome, satellite, microsatellite and minisatellite DNA; physical mapping by building clone contigs, genomic libraries, YAC, BAC libraries. General organization of human genome. Introduction to functional genomics	16
II.	Genomics and Transcriptomics: Microarray, RNA sequencing, methods to study differential gene expression: differential display PCR Tools for genome analysis- PCR and automated DNA sequencing, RFLP, DNA foot printing, DNA finger printing, RAPD, AFLP, SNP detection techniques, Applications of DNA markers	16

III.	Introduction to Proteome Concept and nature of proteome, overview of the tools to study proteome, and categories of current proteomic studies, Application of Proteomic studies in (Gene Expression, Protein, Biomarker discovery in disease diagnosis and drug designing); Proteomic interactions (Y2H approaches, Co-IP); Sequencing of proteins, Concepts of protein engineering, protein microarray.	16
IV	Proteomic tools: SDS-PAGE, Native PAGE, western blotting and immune-detection, 2D-gel electrophoresis., in gel digestion, Purification of proteins using various chromatographic techniques. Mass spectrometry: Principle and practices.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Campbell AM & Heyer LJ, Benjamin Cummings 2007; CSH Press, NY. ISBN-10: 8131715590
2. Principles of Proteomics. R.M Twyman (2004) (BIOS Scientific publishers). ISBN-10: 1859962734
3. Genome III – T.A. Brown Garland Science Publ. June 08, 2006. ISBN-10: 0815341385

Reference Books

1. Principles of Gene Manipulation and Genomics- Primrose S & Twyman R, 7th Edition, Blackwell, 2006. ISBN-10: 1405135441
2. Principles of Genome Analysis and Genomics. Primrose SB & Twyman RM. 2007. Blackwell. ISBN-10: 1405101202

Course Title: Plant and Animal Biotechnology	Course Component: Major
Course Code: BTC152M502	Credit: 4
Level of Course: 300	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objective: The course is designed to understand the various processes involved in plants tissue culture and how the techniques learnt can help in the creation of tissue cultured plants.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember about the process of tissue culture, callus culture, suspension cell culture of plant tissues and the basic theories of animal cell culture.	BT 1
CO 2	Understand the processes and techniques of creation of tissue cultured plants and animal cells and new hybrids	BT 2
CO 3	Apply the knowledge of in conservation of plants and animals and production of high yield animals.	BT 3
CO 4	Analyse the theoretical knowledge in the generation of new plants and animal cell lines for experimental purpose	BT 4

Detailed Syllabus:

Modul es	Topics & Course Contents	Periods
I.	Plant tissue cultures: callus, meristem culture etc., secondary metabolites in plant tissue cultures; protoplast culture and somatic hybridization; haploid plants and soma-clonal variation. Methods for Plant Conservation: Germplasm conservation- in situ, ex situ conservations and in vitro conservation; cryopreservation, Transgenic crop plants - Review of transgenic plants (Bt-cotton and other Bt- plants, Golden rice etc.), development of pathogen resistant cultivars using resistant lines.	16
II.	Genetic engineering of crop plants: Agrobacterium-mediated gene transfer, direct gene transfer; Biolistic gene transfer, alternative approaches of gene transfer – micro injection and electroporation. Bioreactors- Stirred tank, Bubble column, Air lift, Rotating drum and immobilized plant cell reactor.	16
III.	Animal Cell Culture: History of animal cell culture; Basic requirement for animal cell culture; Cell culture media and reagents; Animal cell; Tissue and organ cultures; Primary culture and established cell lines; Basic technique of mammalian cell culture, cell synchronization, Scaling of animal cell culture, Transfection and	16

	transformation of cells, Application of animal cell culture for in vitro testing of drugs; Testing of toxicity for environmental pollutants in cell culture; Stem cells and their application, in-vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer; embryo splitting	
IV	Animal health Biotechnology: History of development of vaccines; Introduction to the concept of vaccines; Conventional methods and Recombinant approaches to vaccine production; Hybridoma technology; Application of cell culture technology in vaccine production and pharmaceutical proteins. Introduction of DNA fingerprinting. Scope and application of DNA forensics: animal species identification; detection of adulteration of meat by DNA based techniques.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30= 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books

1. Satyanarayana, U. Biotechnology (Books and Allied (P) Ltd.2005).
2. Slater, A., Scott, N. W., Fowler, M. R Plant Biotechnology: The Genetic Manipulation of Plants (Oxford University Press, USA; 2NDedition, 2008).
3. Animal cell biotechnology Portner, 2nd edition, Humana Press,2007.
4. Pinkert, Transgenic animal technology, Academic Press,2006.

Reference Books

1. Adrian, S. Plant Biotechnology: The Genetic Manipulation Of Plants (Oxford University Press,2008)
2. Bohnert, H. J. et al Bioengineering and Molecular Biology of Plant Pathways, Volume 1 (Elsevier, USA,2008)
3. Davey, M.R. Plant Cell Culture: Essential Methods (Wiley-Blackwell Publishing, 2010)
4. Gordon, Reproductive technologies in farm animals, CAB Intl,2005.
5. Ed. John R.W. Masters, Animal cell culture- Practical approach, 3rd edition, Oxford University Press, 2000.

Course Title: Practical – V
Course Code: BTC152M513
Level of Course: 300
Scheme of Evaluation: Practical (P)

Course Component: Major
Credit: 4
L-T-P-C: 0-0-8-4

Course Objective: The course is designed to learn about the various experiments used in plant and animal tissue culture and their role in the generation of new plants, animals and their products.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember about the procedures of tissue culture and maintenance of plant culture laboratory. The students will also be aware of the process of fermentation and preparation of various fermented food products.	BT 1
CO 2	Understand the role of various instruments and setups in the tissue culture laboratory and in bioprocess industry.	BT 2
CO 3	Apply the knowledge of plant tissue culture in conservation and fermentation in food preservation and processing.	BT 3
CO 4	Analyze the theoretical knowledge in the generation of new plants and innovative food products	BT 4

Detailed Syllabus:

Module	Topics & Course Contents	Periods
I.	1. Overview of setup in a plant tissue culture laboratory 2. Preparation of media for plant tissue culture. 3. Micropropagation using apical/nodal explants. 4. Isolation of protoplasts.	24
II.	1. Study of equipment's and materials for animal cell culture. 2. Demonstration of the process and techniques of animal cell culture. 3. Isolation of human lymphocytes from the blood. 4. Culture of human blood lymphocytes	24
III.	1. G-banding of human chromosomes and physical mapping of human genome. 2. Design of PCR primers from Genomic DNA. 3. DNA isolation and single nucleotide genotyping.	24
IV	1. Extraction and quantification of proteins 2. Digests proteins into peptides, which are then separated and analysed by mass spectrometry 3. Native and SDS-PAGE. 4. Compare protein expression in biological samples.	24
TOTAL		96

Credit distribution:**4 credits: 4 × 30= 120 Notional Credit Hours (96 lab hours + 24 Experiential learning)****Experiential learning activities may include:**

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books

1. Ed. John R.W. Masters, Animal cell culture- Practical approach, 3rd edition, Oxford University Press, 2000.

Reference books: As suggested under the theory courses.

Course Title: Basics of Molecular Biology	Course Component: Minor
Course Code: BTC152N501	Credit: 4
Level of Course: 300	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objective: The main objective of the course is to provide basic foundation on biomolecules and molecular events of life with reference to their properties, and biological functions.

Course outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the basic concepts of cellular organelles biomolecules and molecular biology.	BT 1
CO 2	Demonstrate the concepts in understanding the formation of various molecular events in life forms.	BT 2
CO 3	Develop the knowledge gained in solving practical experiments.	BT 3
CO 4	Analyze and categorize the various molecular reactions involved in various molecular events	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Basics of cell structure: Introduction and classification of organisms by cell structure, Structure and function of prokaryotic cell and its components. Cell	14

	wall of bacteria, outer membrane of Gram-negative bacteria, Compartmentalization of eukaryotic cells, cytosol, Cell Membrane, Chemical components of biological membranes, organization and Fluid Mosaic Model, Cell organelles: Structure and functions of various cell organelles like Endoplasmic reticulum: Golgi complex, Mitochondria, Chloroplasts, Overview of the cell-cycle and cell division.	
II.	Biological macromolecules: Amino acids and Proteins: structure, classification of amino acids, concept of zwitterionic structure, physical and chemical properties. classification of proteins on the basis of composition, conformation and function, different level of structural organization of proteins (primary, secondary, tertiary & quaternary) Nucleic acids: Ribonucleic and deoxyribonucleic acids, purines and pyrimidines, nucleosides and nucleotides. Carbohydrate: Structure, function and properties of Carbohydrates. Lipids: Definition and classification of lipids, structure and function of fatty acids, storage lipids, structural lipids.	12
III.	DNA Replication: Models of DNA replication, Mechanism of DNA replication in prokaryotes and eukaryotes (initiation, elongation, replication fork, replication machinery, termination), Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSCP, topoisomerase, primase).	12
IV	Protein synthesis: Central dogma of life, transcription in prokaryotes and eukaryotes, Enzymes and proteins involved in transcription, post transcriptional modification, Genetic code - characteristics and properties, Wobble hypothesis, Translation initiation and elongation.	10
TOTAL		48

Credit distribution:

3 credits: 4 × 30 = 120 Notional Credit Hours (60 class hours + 60 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books

1. Nelson, D.L., Cox, M.M., *Lehninger Principles of Biochemistry* 4th Edition, 2004, WH Freeman and Company, New York, USA

2. Watson, J.D., Molecular Biology of the Gene, Pearsons, 8th edition

Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer., *Biochemistry*, 6th Edition, 2006, W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R., *Biochemistry and Molecular Biology of Plants*, 2nd Edition, 2015, American Society of Plant Biologists, USA.
3. Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. *Molecular Cell Biology (Fourth Edition)*. Media Connected – W. H. Freeman and Company. 2009
4. Cell and Molecular Biology by De Robertis E.D.P and De Robertis E.M.F, 1987. Laea Febiger International Edition, USA. 8th ed 2010.

Course Title: Internship	Course Component: Major
Code: BTC152M524	Credit: 4
Scheme of Evaluation: Project and Viva-voce	Level of Course: 300

Course Objective: In this course the students shall carry out a period of training in the form of an internship at a well-established laboratory/ industry/ factory or University. The student will train himself/ herself in the core areas of biotechnology and shall present a report.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the basic concepts taught to be incorporated in the training	BT 1
CO 2	Understand the role of various instruments required in biology and their use in training process.	BT 2
CO 3	Apply the knowledge of working with the instruments/ equipment during the internship period.	BT 3
CO 4	Analyze the results obtained based upon the concept and training received	BT 4

SYLLABUS (6th SEMESTER)

Course Title: Genetic Engineering	Course Component: Major
Course code: BTC152M601	Credit: 4
Level of course: 300	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The main objective of the course is to provide basic foundation on Genetic Engineering with reference to their practical applications in biological systems.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Recall the structure of various vectors used in Genetic Engineering	BT1
CO2	Understand the concepts of gene manipulation and the techniques involved.	BT2
CO3	Develop the knowledge gained in solving practical experiments.	BT3
CO4	Analyze the practical outcome of the gene manipulation techniques.	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Basics Concepts: DNA modifying enzymes, classification and nomenclature; Cohesive and blunt end ligation; Linkers; Adaptors; Radioactive and non-radioactive probes; Selectable and Scorable marker genes. Cloning Vectors: Plasmids; Phagemids, M13 vectors; pUC19, Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Plant based vectors: Ti and Ri as vectors; Expression vectors.	12
II	Cloning Methodologies: Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Hybridization techniques: Southwestern, Northern and Western hybridization; DNA-Protein Interactions Electromobility shift assay; DNase I foot printing.	17
III	PCR and Its Applications: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis;	17

IV	Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Transfection techniques; Introduction to siRNA technology and MicroRNA; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; DNA microarray techniques.	18
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Brown, T. A., Gene Cloning and DNA Analysis: An Introduction, 8th Edition, John Wiley & Sons Ltd., 2021
2. Nicholl D. S. T., An Introduction to Genetic Engineering, 4th Edition, Cambridge University Press, 2023

Reference Books:

1. Sambrook, J., and Russel, D.W., Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
2. Primrose, S. B., Twyman, R.M., and Old, R.W. Principles of Gene Manipulation. 6th Edition, S. B. University Press, 2001.
3. Selected papers from scientific journals.

Course Title: Bioinformatics and Biostatistics	Course Component: Major
Course code: BTC152M602	Credit: 4
Level of course: 300	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objective: The course aims to give a holistic theoretical and practical knowledge in field of bioinformatics and biostatistics to relate the role of computational biology and statistics in biotechnology.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the various software and biological databases and their application in the analysis of various biological experiments.	BT 1
CO 2	Understand the various software and their use in the analysis of various biological results.	BT 2
CO 3	Apply the knowledge to analyse the results of biological experiments statistically using various computational tools.	BT 3
CO 4	Analyse the various biological events and their probable outcome using computational tools.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	<p>Basics of bioinformatics: Definition, Scope and Goal, Application in Computational Biology, Limitations;</p> <p>Biological Database: Types of databases, biological database: GenBank, EMBL, DDBJ, Uniprot-KB: SWISS-PROT, PDB, AceDBs, literature databases, PubMed; Webtools: ExpASy server</p> <p>Sequence Analysis and Sequence Alignment: Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues and paralogues, Basic concepts of sequence alignment, Uses of Sequence Alignment, Pairwise, multiple, Database Similarity search,</p> <p>Scoring matrices: Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles</p> <p>Sequence similarity search: BLAST and FASTA</p> <p>Structural bioinformatics: proteins and its structure, Determination of protein 3-Dimensional structure, Protein structure visualization, comparison, Secondary and tertiary structure prediction</p>	16

II.	Molecular Phylogenetics: Basic concepts, Methods in evaluation of phylogeny and steps in constructing alignments and phylogenetic Trees, Types of phylogenetic tree. Protein Structure Prediction and Molecular Interaction studies: Methods of protein structure prediction, validation by Ramachandran Plot, Docking and Molecular Dynamic Simulation (MDS). Chemoinformatic and Computer Aided Drug Designing (CADD): Introduction to cheminformatics, Use of cheminformatics, Prospectus of cheminformatics,	16
III.	Statistical tools: Measures of central tendencies and dispersion, concept of probability and theoretical distributions (Binomial, Poisson and normal distribution), Correlation and Regression; Random numbers, sampling methods, random plot design. Basics of testing of hypothesis. Analysis of variance (one way and two way), Students t test, Chi-square test, F-test and Z-test.	16
IV	Statistical Science and biological assays: Importance, nature and planning of bioassays; Direct and indirect bioassays; Design of experiments by Analysis of variance and Dose-response analysis. Analysis of biochemical data: Application of multiple regressions in epidemiologic and clinical data; Study of association between disease and risk factors. Application of odds ratio, Logistic regression with dichotomous response variable.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Lesk, A. (2019). Introduction to bioinformatics. Oxford university press.
2. Xiong, J. (2006). Essential bioinformatics. Cambridge University Press.

Reference Books:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, Published CSHL Press.
2. Des Higgins, Willie R. Taylor. Bioinformatics: Sequence, Structure and Databanks: A Practical, Approach, Oxford University Press.

Course Title: Bioprocess Engineering	Course Component: Major
Course code: BTC152M603	Credit: 4
Level of course: 300	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The main objective of the course is to provide comprehensive understanding on the principles underlying various techniques used in bioprocess engineering and technology for the development of fermented product.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Recall the structure of various types of fermenters and bioreactors	BT1
CO2	Understand the concepts of fermented product development	BT2
CO3	Develop the knowledge to implement modern biotechnology in the food and pharmaceutical industries	BT3
CO4	Analyze the practical outcome of bioprocess engineering	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Basic principle of Biochemical engineering: Isolation screening and maintenance of industrially important microbes, microbial growth and death kinetics (particularly with reference to industrially useful microorganisms), strain improvement for increased yield and other desirable characteristics.	16
II	Detailed study of the design and operation of different types of fermenters, Mode of fermentation processes: Bioreactor designs, types of fermentations and fermenters: Upstream processing: scale up and scale down process. thermal death of micro-organisms, enzyme inhibition, Downstream processing: Bioseparation: drying, crystallization, storage and packaging, treatment of effluent and its disposal.	16
III	Applications of enzymes in industry and food processing: enzymatic bioconversions e.g. starch and sugar conversion processes, High-Fructose Corn Syrup, and their downstream processing, backing by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases; application of enzymes in detergents. Fermentated foods: microbes and their use in	16

	pickling, producing colours and flavours, and process of wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins: production and applications.	
IV	Biodegradation of xenobiotic compounds and toxic wastes, removal of spilled oil & grease deposits, Biosurfactants, Bioremediation of soil & water, solid waste & waste water treatment, use of microorganism for the production of energy: Biogas (production of methane and hydrogen), fuel alcohol production & hydrocarbon production.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Fermentation and Biochemical Engineering Handbook, Principles, Process Design, and Equipment; Edited by Henry C. Vogel; Noyes Publications, New Jersey, U.S.A. ISBN: 0-8155-1407-7. 2.
2. Biotechnology- Volume 3- Bioprocessing; VCH VerlagsgesellschaftmbH. Weinheim, ISBN 3-527-28313-7 (Weinheim); ISBN 1-56081-153-6 (New York).

Reference Books:

1. Principles of Fermentation Technology, P. E. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heinemann, ISBN: 07506 45016.
2. Practical Fermentation Technology, B. Mcneil and L. M. Harvey, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, ISBN 978-0470-0143492.
3. Buchanan, B., Gruissem, W. and Jones, R., Biochemistry and Molecular Biology of Plants, 2nd Edition, 2015, American Society of Plant Biologists, USA.

Course Title: Practical – VI	Course Component: Major
Course code: BTC152M614	Credit: 4
Level of course: 300	L-T-P-C: 0-0-8-4
Scheme of Evaluation: Practical (P)	

Course Objectives: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Learn and remember about the process of preparation of consumables for various experiments	BT1
CO2	Understand about the principles involved in Genetic Engineering, Bioprocess Technology and Bioinformatics	BT2
CO3	Apply the knowledge of bioprocess technology in developing various products	BT3
CO4	Categorize the equipment's used and the underlying safety measures in a laboratory	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	<ul style="list-style-type: none"> Isolation of genomic DNA from bacteria, plants and blood. Isolation of plasmid DNA from bacteria Quantification of DNA through Spectrophotometric analysis 	20
II	<ul style="list-style-type: none"> Agarose gel electrophoresis PCR (Polymerase Chain Reaction), Setting up a PCR reaction, Optimization of PCR conditions, gel documentation 	24
III	<ul style="list-style-type: none"> Designing of stirred tank bioreactor Production of wine from fruit juice Isolation of protoplast from plant Fusion of protoplast Preparation of synthetic seeds 	24
IV	<ul style="list-style-type: none"> Introduction to bioinformatics software Database search and sequence download Sequence retrieval and analysis BLAST, FASTA: Search and analysis of data Sequence alignment: algorithms for global and local alignments, pairwise alignment and multiple sequence alignment Phylogenetic analysis and tree building 	28

	<ul style="list-style-type: none"> Protein structure download and structural analysis ADMET – drug properties analysis and toxicology study 	
TOTAL		96

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (96 lab hours + 24 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation etc.

Text Books:

As suggested under the theory papers.

Course Title: Entrepreneurship Development Course code: BTC152N601 Level of course: 300 Scheme of Evaluation: Theory (T)	Course Component: Minor Credit: 4 L-T-P-C: 4-0-0-4
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Course Objective: The main objective of the course is to provide the basic understanding in entrepreneurship and its importance in daily life.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the role of entrepreneurship in daily life.	BT 1
CO 2	Understand the role of development of entrepreneurship and its activities in sustaining a life.	BT 2
CO 3	Interpret the knowledge in generating entrepreneurship avenues.	BT 3
CO 4	Outline the role of entrepreneurship in solving unemployment problem.	BT 4

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	Entrepreneurship: Meaning and its needs and importance. Promotion of entrepreneurship, factors influencing entrepreneurship, Features of successful entrepreneurship	12
II.	Establishment of enterprise: Forms of business organization, project identification, formulation and feasibility, selection of product. Entrepreneurship and International Business: Meaning of International business, selection of product and market, financing in business and export, institutional support for exports.	12
III.	Enterprise financing: Importance of finance/loans and repayments, characteristics of business finance, sources of fixed capital, working capital and its sources, application for loans. Inventories, raw materials and its management.	12
IV	Marketing Management: Meaning and importance, marketing mix, product management, marketing research, survey and its importance, physical distribution and stock management.	12
TOTAL		48
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (60 class hours + 60 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, 2017, Sultan Chandand Sons.

Reference Books

1. D.H. Holt, Entrepreneurship: New Venture Creation. 2016, Pearson Education India.

SYLLABUS (7th SEMESTER)

Course Title: Environmental Biotechnology	Course Component: Major
Course code: BTC152M701	Credit: 4
Level of course: 400	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The main objective of the course is to provide comprehensive understanding on the use of biotechnology to protect and improve the environment. The course covers topics such as the role of microorganisms in environmental processes, and how they can be used to remediate polluted soil and water.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Recall the environmental problems and their sources	BT1
CO2	Understand the concepts of various global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of life including native biodiversity	BT2
CO3	Develop the knowledge on the applications of environmental biotechnology in various fields	BT3
CO4	Analyze the examples of different types of environmental pollution and their impacts	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Limiting factors, energy transfer and biogeochemical cycling in ecological systems; Response of microbes, plant and animals to environmental stresses; Concept of ecosystems and ecosystem management, Environmental problems- ozone depletion, green house effect, water, air and soil pollution, land degradation.	16
II	GEMs in environment; Role of environmental biotechnology in management of environmental problems, Bioremediation, advantages and disadvantages; In situ and ex-situ bioremediation; slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals; microbiology of degradation of xenobiotics	16
III	Sewage and waste water treatment and solid waste management, chemical measure of water pollution, conventional biological treatment, role of	16

	microphyte and macrophytes in water treatment; Recent approaches to biological waste water treatment, composting process and techniques, use of composted materials	
IV	Biofuels, plant derived fuels, biofuel from algae, biogas, landfill gas, bioethanol, biohydrogen; use of biological techniques in controlling air pollution; Removal of chlorinated hydrocarbons from air.	16
Total		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Wang, L. et al. (2010). Environmental Biotechnology, Humana Press. (available at UTS Library, either in hard copy or electronic version)
2. Wang, L. et al. (2010). Environmental Engineering, Humana Press. (available at UTS Library, either in hard copy or electronic version)

Reference Books:

1. Vallero, D. A. (2010). Environmental Biotechnology: A Biosystems Approach, Elsevier. (available at UTS Library)
2. Evans, G. M. and Furlong, J. C. (2011). Environmental Biotechnology: Theory and Application, Wiley-Blackwell. (available at UTS Library)
3. Jördening, H. J. and Winter, J. (2005). Environmental Biotechnology: Concepts and Applications, Wiley-VCH. (available at UTS Library E-book)

Course Title: Medical Biotechnology	Course Component: Major
Course code: BTC152M702	Credit: 4
Level of course: 400	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The objective of a Medical Biotechnology course is to teach students how to apply biotechnology to medicine and healthcare. Students learn about molecular biology, genetic engineering, and other areas to address medical challenges.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Recall the cellular and molecular the cause and development of diseases or abnormal conditions	BT1
CO2	Understand the concepts of human oncogenesis	BT2
CO3	Develop the knowledge on the applications of biotechnology in various medical fields	BT3
CO4	Analyze the examples of different types of recombinant and immunotherapeutic techniques	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Introduction: History and scope of medical biotechnology, current status and future prospects. Classification of genetic diseases: Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.	16
II	Molecular basis of human diseases: - Pathogenic mutations Gain of function mutations: Oncogenes, Huntington’s Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases	16
III	Gene therapy: Ex-vivo, In vivo, In situ gene therapy, Strategies of gene therapy: gene augmentation Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, ADA, AIDS, Cystic Fibrosis, Solid tumors. epigenetic inheritance, problems & ethics. Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases, & Auto-immune diseases. SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), and HPV	16
IV	Recombinant & Immunotherapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes;	16

	Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors, Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosuppressors in organ transplants; Role of cytokine therapy in cancers	
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books

1. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000)

Reference Books

1. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl
2. Human Molecular Genetics by T. Strachan, Andrew Read Amazon Sales Rank

Course Title: Plant and Animal Physiology	Course Component: Major
Course code: BTC152M703	Credit: 4
Level of course: 400	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The objective is to teach the students the structure and function of plants and animals so that they learn about the structure of organs, organ systems, and cells, and how they function.

Course Outcome:

On successful completion of the course the students will be able to:

SI No	Course outcome	Blooms Taxonomy Level
CO1	Remember about the various organs, organ structures and cell types in plants and animals.	BT1
CO2	Understand the functions of the organs and organ systems in growth and development.	BT2
CO3	Utilize fundamental understanding to analyze the diverse life processes, including the operations of the nervous system, respiratory system, cardiovascular system, excretory system, and digestive system.	BT3
CO4	Compare and contrast between different biological system.	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing, factors affecting stomatal movement. Role of micro and macro nutrients in plants and their mechanism of transport.	16
II	Photosynthesis and its importance: Photosynthetic pigments and photosystems, C3, C4 and CAM photosynthesis. Plant growth regulators and its role, Movement in plants, Physiology of flowering, seed dormancy and germination, photoperiodism and vernalization.	16
III	Digestive system: Comparative account of physiology of digestive system in herbivores and carnivores. Digestion and absorption of various nutrients; Hormonal control of secretion of enzymes in Gastrointestinal tract in humans. Disorders of the digestive system. Excretory system: Comparative account of physiology of excretory system; Structure of kidney and its functional unit; Micturition; Urine formation; Disorders of the excretory system. Cardiovascular System: Comparative account of circulation; Lymphatic system; Components of blood and their functions; Haemopoiesis; Structure of mammalian heart; Origin and conduction of cardiac impulses; ECG – its principle and significance. Disorders of the cardiovascular system.	16
IV	Nervous System: Comparative account of nervous system; Structure of neuron; Types of neurons, Resting membrane potential, Origin of action potential and its propagation; Synaptic transmission; Reflex action and its types. Disorders of nervous system.	16

	Respiratory system: Structural components of respiratory system; Mechanism of respiration, Gaseous exchange: CO ₂ and O ₂ transport, Disassociation curve, respiratory volumes; Comparative account of respiratory systems in animals; Disorders of nervous system. High altitude respiratory adaptations.	
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*

Text Books

1. Guyton, A.C. & Hall, J.E. (2015). Textbook of Medical Physiology. XIII Edition. Hecourt Asia PTE Ltd. W.B. Saunders Company. 51 | Page
2. Tortora, G.J. & Grabowski, S. (2017). Principles of Anatomy & Physiology. XI Edition John Wiley & Sons
3. Marieb E.N & Hoehn K.N (2022). Human Anatomy & Physiology. 12th Ed, Pearson Education.
4. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd. 1991, Latest edition.
5. Taiz, L. and Zeiger, E. Plant Physiology, 4 th edition, Sinauer Associates Inc .MA, USA, 2006, Latest edition.

Reference Books

1. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills
2. Dr Ian Kay (1998). Introduction to Animal Physiology. 1st Ed, Garland Science.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.

Course Title: Practical – VII	Course Component: Major
Course code: BTC152M714	Credit: 4
Level of course: 400	L-T-P-C: 0-0-8-4
Scheme of Evaluation: Practical (P)	

Course Objectives: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Learn and remember about the process of preparation of consumables for various experiments	BT1
CO2	Understand the principles involved in Environmental, Medical Biotechnology and Plant and Animal Physiology	BT2
CO3	Apply the knowledge in developing solutions to environmental issues	BT3
CO4	Categorize the equipment's used and the underlying safety measures in a laboratory	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	<ul style="list-style-type: none"> • Isolation and screening of fecal coliforms from contaminated water. • Determination of BOD of contaminated water. • Determination of COD of contaminated water 	20
II	<ul style="list-style-type: none"> • To learn the principle and procedure of ELISA • Determination of human blood grouping • VDRL test • WIDAL test • SGPT and SGOT test for liver functioning 	28
III	<ul style="list-style-type: none"> • Histological staining of tissues 	20
IV	<ul style="list-style-type: none"> • Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf. • Demonstration of plasmolysis by <i>Tradescantia</i> leaf peel. • Demonstration of opening & closing of stomata • Separation of photosynthetic pigments by paper chromatography. • Demonstration of aerobic respiration. • Preparation of root nodules from a leguminous plant. 	28
TOTAL		96

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (96 lab hours + 24 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*

Text Books:

As suggested under the theory papers.

Course Title: Pharmaceutical Biotechnology	Course Component: Minor
Course code: BTC152N701	Credit: 4
Level of course: 400	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The objective of this course is to make Students understand the basic concepts involved in pharmaceutical industry.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Recall the scientific principles involved in drug development	BT1
CO2	Understand the strategies and various steps of new drug discovery process	BT2
CO3	Develop the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones	BT3
CO4	Analyze available drug formulations for suitability of usage	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
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I	Definition and scope of Pharmaceutical Biotechnology, sources of drugs, classification of pharmacological agents (based on chemistry, mode of action, dosage forms), route of administration, absorption and bioavailability of drugs, distribution and liver detoxification metabolism and drug excretion.	16
II	General classes and properties of phytopharmaceuticals, Extraction of phytochemicals, Phytochemical screening of medicinal plants. Bioassay guided fractionation methods TLC, HPTLC, GC, and HPLC, Role of NMR and Mass spectrometry in drug discovery.	16
III	Antimicrobial agents, Antibiotics -source, classification, mode of action, Antimicrobial resistance, and Antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activity). Pharmacological Assays - In-vitro assays - chemical (anti-oxidant), Biological (anticancerous and assay system based on enzymes and cells), and immunological (RIA and ELISA) - In vivo assays (Anti-inflammatory and Anti-analgesic). Basic concept of computer aided drug designing, ADMET of drugs	16
IV	Vaccines: concept, production and types - Inactivated, Attenuated, toxoid, Recombinant vaccines, Peptide and DNA vaccines, Edible vaccines, nanodrugs. Recombinant proteins, approved rDNA drugs in market, Probiotics, Nutraceuticals, Economic and legal considerations in Pharmaceutical Biotechnology	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Satoskar R.S, Nirmala N. Rege, and Bhandarkar S. D, Pharmacology and Pharmacotherapeutics (Revised 23rd Edition), Popular Prakashan, Mumbai.
2. Tripathy K. D, Essentials of Medical Pharmacology (6th edition), Jaypee publishers
3. Shoba rani R Hiremath, Text book of industrial pharmacy, Orient Longman Pvt ltd 2008.
4. Crommelin Daan J. A., Sindelar D. Robert (3rd edition) Pharmaceutical Biotechnology: Fundamentals and Applications, CRC Press, 2007.

Reference Books:

1. Trease, G. E. and Evans, W.C., 2011, Pharmacognosy (12th edition), Bailliere Tindall Eastbourne, U.K
2. Mukherje P. K., Quality Control Herbal Drugs–An approach to evaluation of botanicals. Business Horizons Pharmaceutical Publishers, 2005
3. Sambamurthy K., Pharmaceutical Biotechnology (1st edition) New Age International

SYLLABUS (8th SEMESTER)

Course Title: Research Methodology & Scientific Writing	Course Component: Major
Course code: BTC152M801	Credit: 4
Level of course: 400	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The course aims to build scientific perspective, attitude and skills for systematic enquiry by developing understanding of philosophical foundations of research, various elements of research design and methods and tools for data collection and analysis. The course will enable comprehension of principles and elements of research methodology, to formulate research problem, objectives and questions. It will introduce students to various methods, tools and techniques related to research. The course has a strong practical component. The students will write research proposal and submit a full-length review article based on secondary data.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Recall the scientific principles involved in research methodology	BT1
CO2	Understand the strategies and various steps involved in defining research problems	BT2
CO3	Develop the knowledge of various tools and techniques involved in for data collection and fieldwork	BT3
CO4	Analyze the effectiveness of literature survey in drafting quality manuscripts	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of	16

	investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	
II	Types of Researches Survey, historical, philosophical, experimental, case study, genetic Design of Experiments. Need and purpose, importance, characteristics of good experimental design, basic principles, types of basic experimental design. Questionnaire, schedule, rating scale, tests Collection of Data Need, meaning, nature; constants, variables, variate; characteristics of quantitative data, types of data, data collection, organization of data.	16
III	Tools of Research Questionnaire, schedule, rating scale, tests Collection of Data Need, meaning, nature; constants, variables, variate; characteristics of quantitative data, types of data, data collection, organization of data.	16
IV	Research Report & Proposal Writing Need of research report, format of research report (preliminary section, main section & reference section), Journal matrices: citation index, h-index, impact factor of journals, mechanics of writing Reports, Research Abstract, and Research Paper, Need of research proposal for dissertation and for obtaining funds from various sources. Effective literature study approaches, analysis Plagiarism, Research ethics.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Kothari R.C. (2005): Research Methodology, 2nd Edition, New Age International Publisher Ltd., New Delhi.

Course Title: Ecology & Environment Management	Course Component: Minor
Course code: BTC152N801	Credit: 4
Level of course: 400	L-T-P-C: 4-0-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The main objective is to learn and understand the various components of ecology and environment. It focuses on understanding the causes of environmental problems and learns about the various policies for environment conservation, and the modern strategies for environment management.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Remember the various components of ecology and environment.	BT1
CO2	Understand the interaction of various components of ecosystem	BT2
CO3	Apply ecological knowledge to solve real-world environmental problems.	BT3
CO4	Analyze critical thinking and problem-solving skills in the context of environmental sustainability.	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Basic concepts: Components of Environment; Key concepts: ecosystems, biomes, and biodiversity; Levels of ecological organization (individuals, populations, communities, ecosystems); Ecological succession and stability; Energy flow and nutrient cycling; Biogeochemical cycles (carbon, nitrogen, water, etc.)	16
II	Human Impact on Ecosystems: Importance of biodiversity; Threats to biodiversity (habitat loss, invasive species, climate change); Pollution: air, water, and soil; Consequences of pollution; Climate change and its ecological consequences; Overexploitation of natural resources; Anthropogenic substances and endocrine disrupting compounds.	16
III	Environmental Policy and Governance: Definition and scope of environmental policy; Historical development of environmental policy; The Role of governments, NGOs, and international organizations in environment conservation; The importance of Environmental impact assessment (EIA), its objectives and implementation; National and international environmental policies.	16
IV	Tools and Techniques in Environmental Management: Principles of sustainable development; Circular economy and waste management; AI tools and applications for monitoring environmental quality; Geographic Information Systems (GIS) and remote sensing; Environmental modelling and simulation; Life cycle assessment (LCA); understanding the role of social media in	16

	environment conservation; Biotechnological intervention for environment management; Carbon foot printing and mitigation <i>etc.</i>	
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: $4 \times 30 = 120$ Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books

1. Ecology: Concepts and Applications by Manuel C. Molles
2. *Ecology and Environment* by P. D. Sharma, Rastogi Publications
3. Environmental Management: Principles and Practice by Christopher J. Barrow
4. Principles of Environmental Science by William P. Cunningham and Mary Ann Cunningham.

Reference Books

1. Fundamentals of Ecology, M. C. Dash, Tata McGraw-Hill Education
2. Environmental Management, S. K. Agarwal, APH Publishing Corporation

Course Title: Project/ Dissertation***	Course Component: Major
Course code: BTC152M821	Credit: 12
Level of course: 400	
Scheme of Evaluation: Project presentation and Viva voce	

***** Only for students with an overall percentage $\geq 75\%$ till the 6th semester**

***Major courses for the rest of the students in lieu of Project/ Dissertation**

Course Title: Developmental Biology	Course Component: Major
Course code: BTC152M802	Credit: 4
Level of course: 400	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The main objective is to teach the processes of development, the genetic and molecular basis of development, and the evolutionary history of life forms.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Remember the various principles of developmental biology.	BT1
CO2	Understand the functions of cellular organelles and how a cell carries out and regulates cellular functions	BT2
CO3	Apply the acquired knowledge to solve real-world medical issues.	BT3
CO4	Analyze critically to solve theoretical questions in the topic.	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division	16
II	Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastulae; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizer	16
III	Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	16
IV	Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories; Teratogenesis: Teratogenic agents and their effects on embryonic development; Amniocentesis	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: $4 \times 30 = 120$ Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press

Reference Books

1. Carlson, R. F. Patten's Foundations of Embryology
2. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
3. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.

Course Title: Ecosystem Degradation and Intervention	Course Component: Major
Course code: BTC152M803	Credit: 4
Level of course: 400	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objectives: The main objective of the course is to provide the knowledge of functioning of ecosystem, their degradation and the interventions required.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course outcome	Blooms Taxonomy Level
CO1	Remember the concepts of ecosystem and ecology.	BT1
CO2	Understand the role of ecosystem and ecology in degradation of environment.	BT2
CO3	Apply the theoretical knowledge of ecosystem in understanding environmental issues.	BT3
CO4	Analyze the impact of ecosystem degradation upon environment.	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Environment: Definitions, Components and Inter-relationships, Parts of the environment, Ecology and Ecosystems, examples of interconnections in nature. Ecology and ecosystem: Structure and boundaries of ecosystem, evolution of an ecosystem, value of ecosystem and ecosystem services. Biogeochemical cycles: Cycling elements, water cycle, carbon cycle, nitrogen cycle, phosphorus cycle, sulphur cycle. Impact of human activity on the cycling elements.	16
II	Environmental degradation: Impact of anthropogenic activities on biotic and abiotic components of ecosystem. Causes of biodiversity loss. Ecological balance and footprint; United Nations Millennium ecosystem assessment. Environmental toxicology: Toxic chemicals in the environment (air and water) – their effects and biochemical interactions; Pesticides, Heavy metals, etc.	16
III	Global environmental issues: Ozone layer depletion (Montreal protocol), El Nino, Acid rain - causes and effects, Green House Gases(GHG) and greenhouse effect, global climate change, global warming – effect on oceans, coastline and marine ecosystem, impact of global warming on India. Response to global warming – Kyoto protocol and its outcome. Environmental laws: The Environment Protection Act, 1986; The Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Forest Conservation Act, 1980, Cartagena protocol, COP27,	16
IV	Biotechnological interventions for pollution control: Biofilters, Bioremediation, Biotransformation, Biodegradation, and Phytoremediation: In situ and Ex situ bioremediation; Evaluating Bioremediation; Bioremediation of VOCs. Factors affecting process of biodegradation; Contaminant availability for biodegradation; Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation; Phytoremediation: Waste water treatment using aquatic plants, sustainable agriculture, waste to energy and waste management.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team

- Completion of an internship
- Student teaching
- Classroom presentation *etc*

Text Books:

1. Kumar H. D., Modern Concepts Of Ecology, 2018, 8th edition, Vikas Publishing House
2. Tyler Miller, G. Living in the Environment: Principles, Connections, and Solution, 16th edition, 2009, Cengage Publications

Reference Books

1. Nebel, B.J. & Wright, R. Environmental Science: Toward a Sustainable Future. Pearsons, Latest edition.
2. Cunningham, W.P., Cunningham, M.A. & Saigo, B. Environmental Science, a Global Concern. (16th edition). 2021, McGraw-Hill (Boston)

Course Title: Techniques in Molecular Biology	Course Component: Major
Course code: BTC152M804	Credit: 4
Level of course: 400	L-T-P-C: 3-1-0-4
Scheme of Evaluation: Theory (T)	

Course Objective: The course is designed to learn about the various molecular biology techniques and their use in the various molecular biology experiments/tests in different biotech/biomedical laboratories/industries

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	Course Outcome	Blooms Taxonomy Level
CO 1	Remember the procedures of various molecular techniques to perform molecular biology experiments/tests in different biotech/biomedical	BT 1
CO 2	Understand the role of various instruments and setups in the Molecular Biology laboratory and in biotech/biomedical industry.	BT 2
CO 3	Apply the knowledge of molecular biology in biotech/biomedical industry	BT 3
CO 4	Analyze the theoretical knowledge in the implementation of proper molecular techniques in biotech/biomedical industry	BT 4

Detailed Syllabus:

Module s	Topics & Course Contents	Periods
I.	Extraction methods of nucleic acids, basic extraction steps, and nucleic acid analysis, Polymerase chain reaction (PCR), Agarose gel electrophoresis, Restriction enzymes, Restriction Digestion, RFLP, AFLP, RAPD, DNA fingerprinting, qPCR, DNA microarray	16
II.	Extraction methods of proteins, SDS-PAGE, 2D-gel Gel electrophoresis, Radioimmunoassay, Enzyme Linked Immunosorbent Assay (ELISA) and its types, ELISPOT, CLIA, Immunoprecipitation and Co-immunoprecipitation, Immunoelectrophoresis	16
III.	Preparation of antigens and antibodies, purification of antibodies, analysis of antibodies and antigens, Types of immunodiffusion methods, immune histochemistry, Immuno-flow cytometry, Immunofluorescence.	16
IV.	Principles of cloning, vectors and cloning strategies, Selection, screening and analysis of recombinants by genetic, immunological and nucleic acid hybridization methods, Expression in bacterial, yeast, insect and mammalian cells.	16
TOTAL		64
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text books

1. Wilson and Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, 2008, Cambridge University Press, New York, USA.
2. Owen JA, Punt J and Stranford SA (2013) Kuby Immunology, 7th Edition, WH Freeman and Company, NY.

Reference books

1. Principles of Gene Manipulation and Genomics- Primrose S & Twyman R, 7th Edition, Blackwell, 2006. ISBN-10: 1405135441
2. Male D., Brostoff J., Roitt I and Roth D (2012) Immunology, WB Saunders Co. USA