Mahatma Education Society's

Pillai College of Arts, Commerce & Science (Autonomous)

Affiliated to University of Mumbai

'NAAC Accredited 'A' grade (3 cycles)'
'Best College Award' by University of Mumbai
ISO 9001:2015 Certified

SYLLABUS

Program: Bachelors of Science (B. Sc.) in Biotechnology

S.Y.B.Sc.Biotechnology

PCACS/BSCBT/SYL/2024-25/TY

As per National Education Policy
Choice Based Credit & Grading System
Academic Year 2024-25

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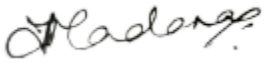
Board of Studies of Department of Biotechnology

1	Mrs. Suparna Deepak Assistant Professor, PCACS	Chairperson (Head of Department of Biotechnology)	
2	Mrs. Meenakshi Johri Assistant Professor, PCACS	Member	
3	Mr. Gopakumar Pillai Assistant Professor, PCACS	Member	
4	Mrs. Bindu Rajaguru Assistant Professor, PCACS	Member	
5	Dr. C. K. Prashant Assistant Professor, PCACS	Member	
6.	Mrs Suprita Rao Assistant Professor, PCACS	Member	
7	Dr. D.B. Thakare Former Chairman,BOS of Microbiology,University of Mumbai	Vice Chancellor Nominee	
8	Dr. Mansee Thakur Director,MGM School of Biomedical Sciences,Kamothe,Navi Mumbai	Subject Expert From outside Parent University	
9	Dr.Usha Padmanabhan Senior Scientific Officer&Head,Cell Biology	Industry Representative (Industry/Corporate/Allied sector)	

	Department,Haffkine Institute of Testing,Training,Research,Parel,Mumbai		
10	Dr. Thakamani Marar Dean,Faculty of Science and Technology,Professor,School of Biotechnology, D.Y Patil University,Navi Mumbai	Subject Expert From outside Parent University	
11	Dr. Pankaj Mundada Asistant Production Head, Agri Division Warkem Biotech Pvt Ltd,Mumbai	Post Graduate Meritorious Alumni	
12	Dr. P. S. Goyal Dean, R&D, Pillai College of Engineering	Faculty Specialist	
13	Dr. Gajanan Wader	Principal, PCACS	
14.	Mrs Deepika Sharma	Vice Principal PCACS	

1. Introduction to B. Sc Biotechnology

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and their studies from molecular biology to cell biology, from biochemistry to biophysics, from genetic engineering to stem cell research, from bioinformatics to genomics-proteomics, from environmental biology to biodiversity, from microbiology to bioprocess engineering, from bioremediation to material transformation and so on. The relevance and application of these studies on living organisms and their bioprocesses is extensively covered in the syllabus B.Sc. Biotechnology program.

The B.Sc. Biotechnology program is a three-year degree. In these three years, students will tackle core subjects to ensure that they receive a solid grounding in fundamentals. In the final year, students can make their choice from a wide range of options and research projects.

Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders.

2. Programme Outcomes for B. Sc. Biotechnology Programme

Sr. No.	PO Title	POs in brief
PO 1	Theoretical Knowledge	Demonstrate strong theoretical background which they would be able to use in Biotech industry, hospitals, community and institutes or any other profession they would like to pursue.
PO 2	Practical skills	Demonstrate the knowledge to manipulate living cells to create and manufacture various products that will help in diagnosis and treatment of diseases as well as in areas like food, agriculture and environment.
PO 3	Planning Experiments	Ability to design and conduct experiments, as well as to analyse and interpret scientific data.
PO 4	Biosafety	Demonstrate competency in laboratory safety and in routine and specialized biotechnological laboratory skills applicable to biotechnology research or clinical methods, including accurately reporting observations and analysis.
PO 5	Communication	Communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing and also ability to present their work through written, oral, and visual presentations, including an original research proposal
PO 6	Ethics	Awareness of the impact of biosolutions in a global, economic, environmental, and societal context and understanding of professional and ethical responsibilities.
PO 7	Innovation	Inculcate an attitude of enquiry towards developing innovative ability and enhancing entrepreneurship skills.
PO 8	Life-long learning	Interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments, recognition of the need for, being a better human being and an ability to engage in life-long learning.

3. Programme Specific Outcomes for B. Sc.Biotechnology Programme.

Sr. No	PSO Brief
PSO-1	Apply biotechnology skills (including molecular & micro biology, immunology & genetic engineering, bioprocess & fermentation, enzyme & food technology and bioinformatics) and its applications in core and allied fields.
PSO-2	Exhibit in-depth practical oriented knowledge to students in various thrust areas of biotechnology, so as to meet the demands of industry and academia.
PSO-3	Identify and formulate healthcare, textile, cosmetics, agriculture, marine products for commercialization.
PSO-4	Develop concepts and research approaches for higher career in the field of biotechnology and develop scientific interest required for research.

Course Structure

Semester V

Course Code	Course Type	Course Title	Theory/ Practical	Marks	Credits	Lectures/ Week
PUSBT501	Core	Cell biology	Theory	100	3	3
PUSBT502	Core	Medical Biotechnology	Theory	100	3	3
PUSBT503	Discipline related Course	QA/QC +Practicals	Theory	100	2	3
PUSBT504	Discipline related Course	Marine Biotechnology + Practicals	Theory	100	2	3
PUSBT505	Skilled Enhancement Course	Computational Biotechnology	Theory	100	2	3
PUSBT506 (a)	Skilled Enhancement Elective	Pharmacology and Neurochemistry	Theory	100	2	3
PUSBT506 (b)	Skilled Enhancement Elective	Research Methodology and Scientific Writing				
PUSBT507		INTERNSHIP		100	2	
PUSBT508P	Core Practicals	Cell biology + Medical Biotechnology Practicals	Practical	100	2	6
PUSBT509P	Core Practicals	QA/QC + Marine Biotechnology Practicals	Practical	100	2	6
Total				900	20	30

All Subjects having Field Project as part of Continuous Assessment-2

Course Structure

Semester VI

Course Code	Course Type	Course Title	Theory/ Practical	Mark s	Credits	Lectures/ Week
PUSBT601	Core	RDNA technology and Genomics	Theory	100	3	3
PUSBT602	Core	Industrial Microbiology	Theory	100	3	3
PUSBT603	Discipline related Course	Agribiotechnology	Theory	100	2	3
PUSBT604	Discipline related Course	Environmental Biotechnology	Theory	100	2	3
PUSBT605	Skilled Enhancement Course	Nutrition and Endocrinology	Theory	100	2	3
PUSBT606 (a)	Skilled Enhancement Elective	Clinical Data Management	Theory	100	2	3
PUSBT606 (b)	Skilled Enhancement Elective	Entrepreneurial Avenues in Biotech	Theory	100	2	3
PUSBT607		Emotional Intelligence	Theory	100	2	3
PUSBT608P	Core Practicals	RDNA technology and Genomics + Industrial Microbiology Practicals	Practical	100	2	6
PUSBT609P	Core Practicals	Agribiotechnology + Environmental Biotechnology Practicals	Practical	100	2	6
Total				900	20	30
All Subjects having Field Project as part of Continuous Assessment-2						

Evaluation Pattern

Marking Code	Marking Scheme
A	60 Marks Final Exam, 20 Marks Internal Exam, 20 Marks Project.
B	50 Marks Continuous Exam, 50 Marks Practical Exam.
C	100 marks distributed within report /case study/ project/ presentation etc.
D	100 Marks Practical Examination.

Semester V

Course Code	Course Type	Course Title	Evaluation
PUSBT501	Core	Cell biology	A
PUSBT502	Core	Medical Biotechnology	A
PUSBT503	Discipline related Course	QA/QC +Practicals	A
PUSBT504	Discipline related Course	Marine Biotechnology + Practicals	A
PUSBT505	Skilled Enhancement Course	Computational Biotechnology	C
PUSBT506 (a)	Skilled Enhancement Elective	Pharmacology and Neurochemistry	C
PUSBT506 (b)	Skilled Enhancement Elective	Research Methodology and Scientific Writing	
PUSBT507		INTERNSHIP	C
PUSBT508P	Core Practicals	Cell biology + Medical Biotechnology Practicals	D
PUSBT509P	Core Practicals	QA/QC + Marine Biotechnology Practicals	D

Semester

Semester IV

Course Code	Course Type	Course Title	Evaluation
PUSBT601	Core	RDNA technology and Genomics	A
PUSBT602	Core	Industrial Microbiology	A
PUSBT603	Discipline related Course	Agribiotechnology	A
PUSBT604	Discipline related Course	Environmental Biotechnology	A
PUSBT605	Skilled Enhancement Course	Nutrition and Endocrinology	A
PUSBT606 (a)	Skilled Enhancement Elective	Clinical Data Management	C
PUSBT606 (b)	Skilled Enhancement Elective	Entrepreneurial Avenues in Biotech	
PUSBT607		Emotional Intelligence	C
PUSBT608P	Core Practicals	RDNA technology and Genomics + Industrial Microbiology Practicals	D
PUSBT609P	Core Practicals	Agribiotechnology + Environmental Biotechnology Practicals	D

Theory:

Continuous Assessment- 40 Marks

- Continuous assessment I would be a written exam for 20 marks consisting of objective type questions of 10 Marks and subjective type questions of 10 marks with internal options.
- Continuous assessment II would be 15 marks assignments, projects or presentations as per the requirement of the course.
- 5 marks would be for active participation and attendance.

Semester end Exam- 60 Marks

- The question paper for the Term End Exam would be of 60 marks consisting of 4 Questions (15M each), of which one question would be common for all units in the syllabus.
- The question paper would be set for 120 marks including internal options.
- There shall be no internal exam for any paper.

This evaluation pattern will be followed for all the Core and Skilled Enhancement Elective Courses.

Emotional Intelligence

Sr. No	Particulars	Marks
1.	7 Quizzes x 5marks each (5 questions-1mark each)	35
2.	Presentation, Podcasting, Short videos, Posters, Articles for Newsletters (Any 2 for 15 marks each)	30
3.	Situational Awareness test (Quiz in Google form – 2 test of 15 marks each (15 questions of one marks each 15 marks)	30
4.	Active Participation	05
	TOTAL	100

Entrepreneurial Avenues in Biotechnology

Sr. No	Particulars	Marks
1.	1 Quiz on Biotech start up Ecosystem	30
2.	Practical Project on Mushroom Cultivation and Probiotic Formulation	35
3.	Practical Project on Hydroponics and aquaponic	35
	TOTAL	100

Practical Examinations:

- Would be conducted over a period of 3 days; 100M each paper.
- Each student performs 2 major and 2 minor practicals for each practical paper.
- Identification, spots or problem based questions would be included depending upon the requirement of the course.
- Viva would be conducted during the practical examination.
- Journals should be completed and checked by the concerned faculty and certified by the Coordinator.

SEMESTER V

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	V
Course Name	Cell biology
Course Code	PUSBT501
Type of Course	Core
Level of the Course	Medium
Total Credits for the Course	3

Course objectives:

1. Create a firm foundation in the fundamentals of Cell Biology and Cytogenetics.
2. Understanding the structural and functional aspects of the cell provides the student with a strong foundation in the molecular mechanisms underlying cellular function.

Unit No.	Name of Unit	Topic No.	Name of the topic	Hours
I	Cytoskeleton	1.1	Overview of the Major Functions of Cytoskeleton.	15
		1.2	Microtubules: Structure and Composition. MAPs: Functions- Role in Mitosis, Structural Support and Cytoskeleton Intracellular Motility. Motor Proteins: Kinesins, Dynein; MTOCs. Dynamic Properties of Microtubules. Microtubules in Cilia and Flagella.	
		1.3	Microfilaments: Structure, Composition, Assembly and Disassembly. Motor Protein: Myosin. Muscle Contractility: Sliding Filament Model. Actin Binding Proteins: Examples of Non- Muscle Motility.	
		1.4	Intermediate Filaments: Structure and Composition; Assembly and Disassembly; Types and Functions. Drugs targeting cytoskeleton.	

II	Cell Membrane	2.1	Introduction and overview of functions: Fluid Mosaic Model, Chemical composition; Membrane Lipids- Phosphoglycerides, Sphingolipids, Cholesterol. Membrane Carbohydrates- Sugars, Oligosaccharides. Membrane Proteins- Integral, Peripheral, Lipid anchored. Membrane lipids and fluidity- Importance, Maintenance & Asymmetry. Dynamic nature- Flip flop and lateral movement.	15
		2.2	Cell Permeability. Principles of Membrane Transport- Transporters and Channels; Active Transport, Passive Transport; Types of Transporters; Types of ATP Driven Pumps Na^{+}, K^{+}, Ca^{2+}Pump	
		2.3	Cell Junctions; Cell Adhesion and Extracellular Material- Microvilli; Tight Junctions, Gap Junctions; Cell Coat and Cell Recognition. Cellular Interactions.	
III	Cell Signaling	3.1	Cell signalling and signal transduction: Introduction, General Principles of Cell Signaling**.**	15
		3.2	Signaling via G-Protein-linked Cell-Surface Receptors**;** Signaling via Enzyme-linked Cell-Surface Receptors**;**	
		3.3	Target-Cell Adaptation, The role of calcium and NO as intracellular messengers.	
			Total Lectures	**45**

Course outcomes: By the end of the course the student will be able to:

1. Describe structure and function of cell membrane and cytoskeleton.
2. Discuss the principles of membrane transport and dynamic properties of cytoskeleton and plasma membrane.
3. Determine the cellular responses to environmental or physiological changes, or alterations of cell function

4. Outline the principles and general steps in a cell signalling process
5. Summarise the intricate relationship between various cellular structures and their corresponding functions
6. Elaborate how lipids, receptors, ion channels and signalling molecules interplay in generating cell responses to stimuli. Carry out and interpret experiments in cell biology.

References:

1. Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., K Reiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
2. Molecular Biology of the Cell, 5th Edition (2007) Bruce Alberts, Alexander Johnson,Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Garland Science, USA
3. Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
4. The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
5. Developmental Biology; Scott Gilbert; 9th Edition
6. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins
7. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International

	CASE STUDY:
1	In a study conducted by Dr. Anita and her team, a novel mechanism of target adaptation was identified involving cross-talk between GPCR signaling and calcium signaling pathways. Specifically, they found that prolonged activation of GPCRs led to the modulation of calcium signaling dynamics, resulting in downstream cellular responses such as gene expression changes and cytoskeletal rearrangements. This groundbreaking discovery shed new light on the interconnectedness of signaling pathways within cells and provided valuable insights into the regulation of cellular responses to extracellular stimuli. Also, they observed that prolonged activation of GPCRs led to the downregulation of receptor expression on the cell surface, accompanied by alterations in downstream signaling pathways. Moreover, it highlighted the potential therapeutic implications for diseases characterized by dysregulated GPCR and calcium signaling, paving the way for targeted intervention strategies in the field of cellular physiology and pathology
2	Through a series of experiments using advanced imaging techniques, Mr. Patel discovered a direct correlation between the activity of calcium pumps and microtubule dynamics. Specifically, they observed that alterations in calcium pump activity led to dysregulated calcium signaling, resulting in aberrant microtubule organization and function. This finding shed new light on the intricate regulatory networks governing calcium dynamics within cells. Moreover, it underscored the pivotal role of microtubules in mediating calcium signaling events and highlighted the

	potential implications for diseases characterized by calcium dysregulation, paving the way for future research in the field of cellular physiology and pathology.

PRACTICALS	
1	Osmotic fragility of RBCs
2	Effect of Colchicine on microtubules
3	Microscopic visualization of stomata
4	Effect of temperature on cell permeability
5	Effect of chemicals on the permeability of cell membrane.

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	V
Course Name	Medical Biotechnology
Course Code	PUSBT502
Type of Course	Major
Level of the Course	Medium
Total Credits for the Course	3

Course objectives:

1. To gain insight into Disease Factors and Processes and Diseases Caused by microorganisms.
2. To provide knowledge on the students handling, isolating and identifying various pathogens.

Unit No.	Name of Unit	Topic No.	Name of the topic	Hours
I	Infectious Diseases	1.1	Host Parasite Relationship: Normal Flora; Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors.	15
		1.2	Infection: Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers.	
		1.3	Diseases: Origin of Pathogens; Reservoir of infection; Acquisition of Infection; Koch's Postulates.	
II	Infectious Diseases	**Study of a few diseases with emphasis on cultural characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, prevention and treatment.**		15
		2.1	**Skin infections:** *S. aureus* *S. pyogenes* *Fungal Thrush*	
		2.2	**Respiratory Tract Infections :** *M. tuberculosis,* *S. pneumoniae*	

			SARS CoV-2	
		2.3	**Urinary Tract Infections :** *E.coli* infection *Proteus* infection	
III	Medical Microbiology - Causative Organisms- II	3.1	**Gastrointestinal tract infections :** Enteric fever- Salmonella Shigellosis Rotavirus diarrhea Dysentery due to *Entamoeba histolytica*	15
		3.2	**Sexually Transmitted Diseases :** HIV infection	
		3.3	**Nosocomial Infections :** *Ps. aeruginosa*	
			Total Lectures	45

Course Outcomes: By the end of the course the student will be able to:

1. Describe the importance of Host Parasite relationship, patterns and types of infection and mechanisms of infectious disease transmission.
2. Explain the virulence factors and other features of the pathogen and correlate these virulence factors with the pathogenesis and clinical features of the disease.
3. Articulate understanding on the reservoir of infection, mode of transmission, and therefore modes of prophylaxis of these diseases.
4. Identify the importance of pathogenic bacteria in human disease with respect to infections of the respiratory tract, gastrointestinal tract, urinary tract, skin and nosocomial infection
5. Summarise the principle of epidemiological sciences in studying the underlying mechanisms of spread of disease and controls required thereof to combat the spread of pathogens
6. Develop diagnostic skills, including the use and interpretation of laboratory tests in the diagnosis of infectious diseases.

References:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Bacterial Pathogenesis –A molecular approach Abigail Salyer And Dixie Whitt 2nd Ed ASM

press
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
5. Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Enginering, USA

	CASE STUDY:
1	A 44-year-old man presented to the doctor with symptoms of progressive shortness of breath and cough with greenish sputum production. He complained of subjective fever, night sweats, weight loss, shortness of breath on exertion and chest pain during his follow-up. The patient was a smoker, alcoholic and on physical examination, the patient was febrile and poorly nourished.The Chest X-ray showed progressive deterioration. The bronchial aspiration was found positive with the acid fast bacilli.
2	Mary J. is a 21 year old medical student. About 3 months ago she completed her obligatory internship at the University Hospital. Unfortunately, she had a small accident injecting the patient with insulin—while discarding the used needle she accidentally pricked her finger. As she was ashamed of her clumsiness, she did not tell anybody about it, trying initially to ignore the incident and its possible after-effects. Nevertheless, the more she thought about the situation the more she was afraid of getting infected. Finally, in order to calm down, she decided to perform the HIV test

PRACTICALS	
1	Identification of *S.aureus*-Isolation, Catalase, Coagulase Test
2	Identification of *E.coli*-Isolation, Sugar Fermentations,IMViC
3	Identification of *Salmonella*- Isolation, Sugar Fermentations, TSI Slant.
4	Identification of *Shigella*- Isolation, Sugar Fermentations, TSI Slant
5	Identification of *Proteus*- Isolation, Sugar Fermentations, IMViC.
6	Identification of *Pseudomonas* - Isolation, Urease test, Oxidase Test, TSI Slant.
7	Acid fast staining
8	Germ tube for *Candida* sp
9	Detection of Virulence factors – (a) Lecithinase, (b) Hemolysin, (c) Coagulase, (d) Streptokinase

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	V
Course Name	Quality assurance (QA) and Quality control (QC)
Course Code	PUBT503
Type of Course	Discipline related Course
Level of the Course	Moderate
Total Credits for the Course	2

Course Objectives:

1. The Regulations and various guidelines, and how these regulations apply to the manufacturing and distribution of pharmaceutical and biological products.
2. Quality control and quality assurance aspects of industries.
3. Principles of GLP/GMP and their practical applications.

Unit No.	Name of Unit		Contents	Hours
I	QA & QC	1.1	Introduction: Concept and evolution and scopes of Quality Control and Quality Assurance, Overview of ICH Guidelines – QSEM, with special emphasis on Qseries guidelines. Protocol for conduct of non- clinical testing, control on animal house, report preparation and documentation. CPCSEA guidelines. Indian Pharmacopia and British Pharmacopia.	15
		1.2	Quality assurance unit, QA concepts, Requirements for implementing. Total Quality Management (TQM): Definition, elements	
		1.3	Introduction to Quality control and Total Quality Control: Concept of QC; Requirements for implementing QC, Instrumental chemical and microbial quality control Sensory evaluation, Quality control point in different stages of production including raw materials and processing materials in pharma industry. Quality control including the HACCP system (Critical quality control points in different stages of production including	

			raw materials and processing materials)	
II	GLP & GMP	2.1	Introduction to GLP: Good laboratory practices-Introduction, WHO guidelines on GLP, History of Good Laboratory Practices, Quality assurances in Good Laboratory Practices, General Provisions, Organization and Personnel, Facilities, Equipment, Testing Facilities Operation.	15
		2.2	Preparation of SOPs, Documentation of Laboratory work, Calibration records, Disqualification of Testing Facilities. Validation of methods, Documentation of results, Audits & Audit reports.	
		2.3	Concept of cGMP; Requirements of GMP implementation. Documentation of GMP practices, Regulatory certification of GMP, Types of validation in Pharma industry Scope and importance of Validation, Limitations, Organization and Elements of validation (Q, OQ, PQ and DQ) Cleaning Validation, Validation of Analytical Procedures as per ICH Guidelines	
III	Detection and testing of contaminants	3.1	Microbial spoilage, infection risk: spoilage-chemical physicochemical deterioration of pharmaceuticals, pharmaceutical ingredients susceptible to microbial attack, observable effects of microbial attack on pharmaceutical product	15
		3.2	factors affecting microbial spoilage of pharmaceutical products Microbial Contamination in food and pharma products. Some common microbial contaminants.	
		3.3	Microbial assay for pharmaceutical products.: Measurement of pyrogens, measurement of bacterial endotoxins; Microbial testing in pharmaceutical: The test for sterility, parametric release,pyrogens, Physiological effects of pyrogens	
Total Lectures				**45**

Course outcomes:

By the end of the course the student will be able to:

1. Gain the skills and knowledge necessary to understand and work in a GLP/GMP compliant environment
2. Explain the goal and relations of quality assurance and quality control and investigate the accuracy and defects of the pharmaceutical drugs and
3. Describe the requirements required for implementing total quality management Understand QA-GMP-QC relationship.
4. Align the SOPs and modules to be followed in case of pathogen handling or in bioproduction setups.
5. Analyse the influence of environmental parameters on microbial spoilage of pharmaceutical products.
6. Perform Microbial assay for pharmaceutical products

References:

1. Biosafety in Microbiological and Biomedical Laboratories - 5th Edition, L. Casey Chosewood, Deborah E. Wilson, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention National Institutes of Health.
2. Quality Assurance Guide by organization of Pharmaceutical Procedures of India, 3rd revised edition, Volume I & II, Mumbai, 1996.
3. Good Laboratory Practice Regulations, 2nd Edition, Sandy Weinberg Vol. 69, Marcel Dekker Series, 1995.
4. Quality Assurance of Pharmaceuticals- A compedium of Guide lines and Related materials Vol I & II, 2nd edition, WHO Publications, 1999.
5. How to Practice GMP's – P P Sharma, Vandana Publications, Agra, 1991.
6. The International Pharmacopoeia – vol I, II, III, IV & V – General Methods of Analysis and Quality specification for Pharmaceutical Substances, Excepients and Dosage forms, 3rd edition, WHO, Geneva, 2005.

	CASE STUDY
1	Pharmaceutical Company ABC, a global player in drug development, aims to align its processes with the International Conference on Harmonisation (ICH) guidelines to ensure the safety, efficacy, and quality of its pharmaceutical products. The company recognizes the importance of standardizing practices across international markets to streamline regulatory approvals and enhance global drug development efforts.Regulatory Variability:

	Managing and navigating the diverse regulatory requirements across regions and countries poses challenges in ensuring consistent compliance and documentation standards.Multinational Operations: Coordinating drug development activities across multiple sites, each subject to different regulatory frameworks, requires effective communication, resource allocation, and harmonization of practices. Quality Assurance Standardization: Maintaining uniformity in quality control measures, analytical methods, and documentation practices throughout the drug development lifecycle is essential for meeting ICH guidelines and regulatory expectations.
2	Pharmaceutical Company XYZ, a leading player in the pharmaceutical industry, is committed to ensuring the safety, efficacy, and quality of its products. To streamline manufacturing processes, improve regulatory compliance, and elevate overall quality standards, the company has decided to implement Total Quality Management (TQM) principles throughout its operations. Challenges Faced: Stringent Regulatory Requirements: Meeting the stringent regulations imposed by regulatory bodies, such as the FDA, EMA, and other health authorities, requires meticulous documentation, compliance, and quality control measures.Product Variability: Managing the variability in raw materials, production processes, and packaging introduces challenges in maintaining consistent product quality and effectiveness. Continuous Improvement: Ensuring a culture of continuous improvement, proactive risk mitigation, and problem-solving is essential to address emerging challenges, enhance operational efficiency, and drive innovation.

PRACTICALS	
1	Validation of micropipette, measuring cylinder, colorimeter
2	Calibration of pH meter, balance
3	Testing of adulterants
4	Making SOP of lab instruments
5	Sterility of injectable
6	LAL test for endotoxin

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	V
Course Name	Marine Biotechnology
Course Code	PUSBT504
Type of Course	Discipline related course
Level of the Course	Medium
Total Credits for the Course	2

Course Objectives:

1. The objective of this course is to give an overview of marine environment and its living and non-living resources
2. To understand the potential applications of Marine Biotechnology

Unit No.	Name of Unit	Topic No.	Name of Topic	Hours
I	Introduction to Marine Biotechnology	1.1	Introduction to Marine Biotechnology-The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal &deep sea ecosystems. Hydrothermal vents	15
		1.2	Bioprospecting, Marine Microbial Habitats and their Biotechnologically relevant microorganisms, Methods for Microbial Bioprospecting in Marine Environments	
		1.3.	Marine Bioresources- Marine Secondary Metabolites, Marine Proteins, Marine Lipids	
		1.4	Biotechnological Potential of Marine Microbes	
II	Marine Functional foods and Nutraceuticals	2.1	Marine Functional Foods: Marine Sources as Healthy Foods or Reservoirs of Functional Ingredients ;Marine-Derived Ingredients with Biological Properties	15
		2.2	Functional Foods Incorporating Marine-Derived Ingredients	
		2.3	Marine Nutraceuticals :Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated Fatty Acids	
		2.4	Carotenoids, Soluble Calcium, Fish Collagen and Gelatin, Marine Probiotics	

III	Marine Drugs And Cosmetics	3.1	Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna – marinetoxins, antiviral and antimicrobial agents	15
		3.2	Approved Marine Drugs as Pharmaceuticals	
		3.3	Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry, Cosmetics: Definition and Regulations, Cosmeceuticals , Target Organs and Cosmetics Delivery Systems	
		3.4	Components of Cosmetics, Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals , Treatments Based on Marine Resources , Products Based on Marine Resources	
			TOTAL LECTURES	**45**

Course Outcomes: By the end of the course the student will have the knowledge of

1. Define the features of marine ecosystem - its functioning & describe the bioprospecting methods that will help to enumerate potential organism which are important sources of bioactive compounds
2. Explain the functional food and nutraceutical significance of compounds of marine origin.
3. Identify active compounds of pharmaceutical and industrial application from marine flora and fauna along with their significance and associated challenges.
4. Investigate the types and potential of marine bioresources for various applications.
5. Evaluate the cosmetic and therapeutic application of marine sources on target organs.
6. Create employability in food, pharma and cosmetic industries.

References:

1. Marine Communities by Paul Snelgrove
2. Encyclopedia of Life Sciences
3. Springer handbook of marine Biotechnology
4. R. S. K. Barnes, R. N. Hughes (auth.)-An Introduction to Marine Ecology, Third Edition-Wiley-Blackwell (1999)
5. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press_Taylor& Francis (2017).

	CASE STUDY
1	Over the last decades, the ocean has been identified as a sustained source for the requirements of human beings. The marine environment has an enormous biodiversity

	and is a source with huge potential for scientific applications.Among the potentials, the pharmaceutical perspective has been identified as having an important and substantial role for future therapeutic uses. With the huge diversity of marine organisms and exposure to extreme environmental conditions, there is an extraordinary potential for the discovery of various natural products. Marine-derived secondary metabolites have become a promising source for the design and development of drugs. Examples are marine derived-secondary metabolites, including halogenated terpenes, steroids and sterols, and polyphenols, with ample therapeutic potentials. Marine proteins and lipids are also targeted to speculate on their role in human health.
2	Cosmeceutical science is a new branch aimed at utilizing the resources of the natural environment to obtain efficient products. These products lie between cosmetics and pharmaceuticals and they are medium volume/ medium-value products that offer lower risk and a quicker potential return on investment than the high-risk high-reward pharmaceutical market. The value of the cosmeceutical market has been increasing, and it is likely that this trend will continue. Various sources, especially algae, are used for potent cosmeceutical applications. The products are classified in the cosmeceutical market into four major categories: nonbleaching agents, antioxidants, peptides, and growth factors. The cosmetic components vary depend on the nature of the product. Because of their unique position as neither cosmetics nor pharmaceuticals, no specific regulation exists for these products . Depending on the regulations of different countries, a group of products can be considered as cosmetic, therapeutic goods, or drug

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	V
Course Name	Computational Biotechnology
Course Code	PUSBT505
Type of Course	Skilled Enhancement Course
Level of the Course	Basic
Total Credits for the Course	2

Course Objectives:

1. Learning and understanding basic concepts of Bioinformatics.
2. To understand the omics concept.

Unit No.	Name of Unit	Topic No.	Name of Topic	Hours
I	Introduction to Computers and Biological Databases	1.1	Computer Basics : Organization of a Computer; I/O Units; Computer Memory; Processor; Binary Arithmetic; Logic Circuit; Architecture; Operating System. Internet Basics : Connecting to the Internet, E-mail, FTP, www, Difference between www and Internet.	15
		1.2	Biological Databases : Importance and Classification of Databases. Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL	
		1.3	Protein Structure Databases: PDB, NDB, PubChem Classification Databases (CATH/SCOP). Model Organism Databases: SGD, MGD, FlyBase, Wormbase Protein Databases based on Composition, Motifs and Patterns. Protein Structure Visualization Software .	
II	BLAST and Sequence Alignment	2.1	Pairwise Alignment: Identity, Similarity and Homology; **Scoring matrices:** basic concept of a scoring matrix, PAM and BLOSUM series **Pairwise sequence alignments:** basic concepts of sequence alignment (Global and Local Alignment), Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, gap penalties	15

		2.2	BLAST and Sequence Alignment : BLAST and its Types. FASTA.	
		2.3	Multiple Sequence Alignment: Goal of Multiple Sequence Alignment; Simultaneous Methods; Progressive Methods; Databases of Multiple Alignment; MSA and Phylogenetic Trees .	
III	Omics Concepts	3.1	Genomics, Proteomics, Metabolomics, transcriptomics, interactomics, Phenomics, localizomics	15
		3.2	Gene networks - Integration of Networks. Combination of omics approaches: data integration	
		3.3	Modeling; Synthetic biology	
			TOTAL LECTURES	**45**

Course outcomes: By the end of the course the student will be able to:

1. Identify the importance of bioinformatics in biological sciences
2. Apply existing software effectively to extract information from large databases.
3. Utilise online resources for basic analysis of Biological data
4. Critically think and research methods in Bioinformatics to understand computational and experimental data.
5. Use the newest OMICS techniques and systems biology approach to understand the basic of life.
6. Produce and present original research in Bioinformatics.

References:

1. Bioinformatics and Functional Genomics by Pevsner, J**.** A. John Wiley & Sons, Inc., USA(2009).
2. Bioinformatics: Methods and Applications. S. C. Rastogi, Namita Mendiratta, Parag Rastogi. PHI Learning Pvt Ltd.
3. Ideker et al. A new approach to decoding life: Systems Biology. Annual Review on Genomics and Human Genetics 2001, 2: 343-372.
4. Kitano, Systems Biology: A Brief Overview. Science, 2002, 295: 1662-1664.

BOS	Biotechnology
Class	T. Y. B. Sc. Biotechnology
Semester	V
Course Name	Basic Pharmacology and Neurochemistry
Course Code	PUSBT506 (A)
Type of Course	Skilled Enhancement Elective
Level of the Course	Moderate
Total Credits for the Course	2

Course Objectives:

1. Learn basic pharmacological principles.
2. Serve as a stepping stone to advanced level topics in PG.
3. Come to terms with toxicological aspects of substances.

Unit No.	Name of Unit	Topic No.	Name of Topic	Hours
I	General principles of Pharmacology	1.1	Drug Discovery Process, steps involved in new drug discovery, Overview of clinical trials Mechanism of drug action, drug receptors and biological responses; second-messenger systems, the chemistry of drug–receptor binding	15
		1.2	dose–response relationship: therapeutic index; ED, LD Potency and Intrinsic Activity Drug antagonism	
		1.3	Basic pharmacodynamics and pharmacokinetics concepts	
II	Drug Absorption and Distribution and ADR	2.1	Absorption of drugs from the alimentary tract**;** factors affecting rate of gastrointestinal absorption, absorption of drugs after parenteral administration factors influencing drug distribution	15
		2.2	binding of drugs to plasma proteins**;** Physiological barriers to drug	
		2.3	Adverse Drug Reactions: Allergy in response to drugs Effects of prolonged administration: chronic organ toxicity	
		2.4	Poisons: Deliberate and accidental self-poisoning, Principles of treatment Poison-specific measures General measures.	

III	Neurochemistry	3.1	Neuronal pathways; Propagation of nerve impulses; Neuronal excitation and inhibition; Synapses and gap junctions;	15
			Action of Neurotoxins and neurotransmitters	
		3.2	CNS Pharmacology – introduction, Neuropsychiatric disorders: anxiety, mood disorders, neurodegenerative disorders and drugs used for their treatment	
			TOTAL LECTURES	**45**

Course Outcomes:

1. Demonstrate the process of new drug discovery and development of drugs**.**
2. Describe the major behavioural and cognitive functions of the brain with their cellular and molecular basis and predict the consequences of damage to these systems.
3. Classify receptors and study the principles, site, mechanisms and factors modifying drug action.
4. Analyse adverse drug reactions and drug toxicity so that it can be minimised.
5. Determine the effect of Pharmacokinetic parameters on the biological effects of the drug
6. Apply critical thinking skills to formulate novel scientific questions in neuroscience and its role in addiction.

References:

1. Textbook of Medical Physiology Guyton, A.C and Hall 11th edition J.E Saunders.
2. Modern Pharmacology with clinical Applications Craig,C.R, Stitzel,R.E 5th edition.
3. Clinical Pharmacology Bennet,PN, Brown,M.J, Sharma,P 11th edition Elsevier.
4. Biochemistry Metzler, D.E Elsevier

	CASE STUDY
1	Mrs. Anderson, an 80-year-old female with a history of hypertension, osteoarthritis, and depression, presents to her primary care physician with complaints of dizziness, nausea, and confusion. Mrs. Anderson reports experiencing dizziness, nausea, and confusion over the past week, which have worsened in severity. She denies any recent changes in her medications, diet, or lifestyle. The primary care physician conducts a comprehensive review of Mrs. Anderson's medication list, including prescription medications, over-the-counter drugs, and supplements. A potential drug-drug interaction or adverse drug reaction is suspected, prompting further investigation. Blood tests, including electrolyte levels, renal function, and liver function tests, are ordered to assess for any metabolic abnormalities or organ dysfunction that may contribute to Mrs. Anderson's symptoms. A pharmacist is consulted to review Mrs. Anderson's medication regimen, identify potential drug interactions or adverse effects, and recommend appropriate interventions. The pharmacist identifies a potential drug interaction between sertraline and amlodipine, both of which Mrs. Anderson is

	currently taking. Concurrent use of sertraline, a selective serotonin reuptake inhibitor (SSRI), and amlodipine, a calcium channel blocker, may lead to an increased risk of hypotension and central nervous system depression.Genetic testing reveals that Mrs. Anderson metabolizes medications, including sertraline and amlodipine, at a slower rate due to genetic polymorphisms in drug-metabolizing enzymes. Reduced drug metabolism may result in higher drug concentrations and increased susceptibility to adverse effects.The primary care physician discontinues sertraline and switches Mrs. Anderson to an alternative antidepressant with a lower risk of drug-drug interactions, such as mirtazapine. Amlodipine dosage is reduced to minimize the risk of hypotension and central nervous system depression. Following medication adjustments and close monitoring, Mrs. Anderson's symptoms of dizziness, nausea, and confusion gradually resolve. Regular follow-up visits and pharmacovigilance efforts help ensure the safe and effective management of Mrs. Anderson's medication regimen, minimizing the risk of adverse drug reactions and optimizing her overall health and well-being.
2	Mrs. Johnson, a 75-year-old female, presents with progressive memory loss, disorientation, and difficulty performing daily tasks. Neurological examination and imaging studies reveal findings consistent with Alzheimer's disease pathology. Mrs. Johnson participates in a clinical trial testing monoclonal antibodies targeting beta-amyloid aggregates to promote their clearance from the brain. Immunotherapeutic approaches aim to reduce beta-amyloid burden and slow disease progression by targeting pathological protein aggregates. Investigational drugs targeting tau protein pathology, such as tau aggregation inhibitors or kinase inhibitors, are being evaluated in clinical trials for their potential to reduce tau pathology and improve cognitive outcomes. Mrs. Johnson is prescribed donepezil, an acetylcholinesterase inhibitor, to enhance cholinergic neurotransmission and alleviate cognitive symptoms associated with Alzheimer's disease. Donepezil increases acetylcholine levels in the brain, improving cognitive function and temporarily slowing disease progression. Mrs. Johnson shows modest improvement in cognitive function and daily living activities with donepezil therapy, experiencing temporary relief from memory loss and confusion. Ongoing clinical trials investigating anti-beta-amyloid and tau-targeted therapies hold promise for slowing disease progression and providing more effective treatments for Alzheimer's disease in the future

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	V
Course Name	Research Methodology & Scientific writing
Course Code	PUSBT506 (b)
Type of Course	skilled Enhancement Elective
Level of the Course	Medium
Total Credits for the Course	2

Course objectives:

1. To understand the general aspects of metabolic reactions associated with carbohydrates, lipids and amino acids
2. The course aims to provide in-depth knowledge of research design and methodology and to train the student in writing a study plan and critically reviewing scientific literature.

Unit No.	Name of Unit	Topic No.	Name of the topic	Hours
I	Introduction to Research Methodology and Research Problem	1.1	Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; Research Methods versus Methodology; Research Process; Criteria of Good Research;	15 lectures
		1.2	Research Questions and Hypothesis: characteristics of good Hypothesis. Research question and formulation of hypotheses- directional and non-directional hypotheses, Basis for hypotheses. Understanding the language of research – Concept, Construct, Definition, Variable. Research Process	
		1.3	What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem.	

II	Research Design and Data Collection	2.1	Meaning of Research Design; Need for Research Design; Features of a Good Design; Important Concepts Relating to Research Design; Different Research Designs; Basic Principles of Experimental Designs; , various methods of Research. Survey, Philosophical, Historical, Experimental, Causal Comparative, Genetic, Case Studies.	15 lectures
		2.2	Developing a Research Plan- Collection of Primary Data; Observation Method; Interview Method; Collection of Data. through Questionnaires; Collection of Data through Schedules; Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. Focus Group Discussion, Techniques of developing research tools, viz. Questionnaire and rating scales etc. Reliability and validity of Research tools.	
III	Interpretation, Report Writing and Scientific Writing	3.1	Meaning of Interpretation, Why Interpretation?, Technique of Interpretation, Precautions in Interpretation	15 lectures
		3.2	Types of research documents, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. writing and formatting of report, presentation, interpretation, art of oral presentation, format of publications in research journals; Journal Impact factor	
		3.3	Methods to search required information effectively, Bio-Ethics – Bioethical concerns; Plagiarism; Citation and acknowledgement.	
			Total Lectures	**45**

Course Outcomes: By the end of the course the student will be able to:

1. Explain and apply techniques for scientific writing and research methodology to prepare the writing of a scientific report.
2. Perform investigation using methods, explain and take position on the results as well as summarise related work.
3. Plan and design experiments to obtain statistically significant data.
4. Systematically analyze, provide meaningful interpretation, and present experimental data.
5. Implement the preparation of experimental research proposals theoretically and practically
6. Conceptualize scientific articles and present scientific presentations properly

References:

1. Bhattacharya, D. K. (2003): Research Methodology, Excel Books, New Delhi
2. Cenise F. Polit, J.B. Bemadette, P. Hungler (1984) Essential of Nursing
3. Research Methods Lippinott Company, U.K.
4. Carol T. Bush (1985): Nursing Research, Reston Publishing C. Reston,Kothari, C.R. Research Methodology (Methods and Techniques), New Age Publisher.
5. Power Analysis for Experimental research A Practical Guide for the Biological, Medical and social Sciences by R. Barker Bausell, Yi-Fang Li Cambridge University Press.
6. Design of Experience: Statistical Principles of Research Design and Analysis, by Robert O. Kuehl Brook

SEMESTER VI

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	VI
Course Name	RDNA technology and Genomics
Course Code	PUSBT601
Type of Course	Core
Level of the Course	Medium
Total Credits for the Course	3

Course Objectives:

1. To help the student to get information on the latest advances in genetic engineering and recombinant DNA technology, which is a powerful tool needed for modern biotechnology research.
2. To expand their understanding towards latest technologies in DNA sequencing.

Unit No.	Name of Unit	Topic No.	Name of Topic	Hours
I	rDNA Technology	1.1	Cloning vectors-Plasmids pBR322, (pUC series), Cosmids, phagemids M13, shuttle vectors, BAC vectors, YAC vectors, expression vectors pET**;**	15
		1.2	Gene cloning-Isolation and purification of DNA; Isolation of gene of interest: Restriction digestion, electrophoresis, blotting, cutting, and joining DNA, methods of gene transfer in prokaryotes and eukaryotes	
		1.3	Recombinant selection and screening methods: genetic, immunochemical, Southern and Western analysis, nucleic acid hybridization, HART, HRT**;**	
		1.4	Expression of cloned DNA molecules and maximization of expression**;** Cloning strategies-genomic DNA libraries, cDNA libraries, chromosome walking and jumping	
II	Applications of rDNA Technology	2.1	Gene knockouts and Gene Therapy: Creation of knockout mice, disease model, somatic and germ-line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting.	`

		2.2	Transposition: Mechanisms of transposition, Transposon-generated *invitro* mutagenesis.	
		2.3	Genome projects and their implications, Applications of rDNA technology in industry, medicine, agriculture and pharmacy. Social impact of recombinant DNA technology.	
III	Gene sequencing and editing	3.1	Maxam Gilbert's method, Sanger's dideoxy method, principle of automated DNA sequencing.	15
		3.2	Next Generation DNA sequencing Methods : (SOLiD, Ilumina, pyrosequencing and ion torrent), RNA sequencing, Chemical Synthesis of oligonucleotides.	
		3.3	RNAi, ZNF(Zinc finger nucleases), TALENS (Transcription Activator Like Effector Nucleases), CRISPER/Cas system(Clustered Regularly Interspersed Repeats)	
			TOTAL LECTURES	45

Course outcomes: By the end of the course the student will be able to:

1. Explain the concept of genetic engineering of plants and animals including the techniques, applications and limitations.
2. Demonstrate the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.
3. Describe the workflows in the different gene editing procedures and different NGS technologies in the market and imply human genome mapping in diseases.
4. Applying the knowledge of plant and animal genetic manipulations for commercial applications.
5. Discuss how genome editing works and describe and compare different techniques used to manipulate microbes, optimizing drops, combat cancer and other genetic disorders, etc.
6. Use and apply the knowledge of genetic engineering in problem solving and in practice

References:

1. iGenetics A Molecular Approach 3rd Edition Peter J. Russell.
2. Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 3rd Edition Glick B.R., Pasternak J.J., Patten C.L.
3. Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.
4. Biotechnology 3rd Edition S.S. Purohit.

5. Genomes 3rd Edition T.A. Brown.
6. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.
7. Biotechnology B.D. Singh.
8. Gene Cloning and DNA Analysis 6th Edition T.A. Brown.

	CASE STUDY
1	The clustered, regularly interspaced, short palindromic repeat associated endonuclease 9 (CRISPR/Cas9) system has emerged as a powerful approach for precision breeding to create plants with desirable traits. However, the CRISPR/Cas9 system relies heavily on an efficient plant transformation system that is usually time-consuming and costly. CRISPR-Cas9 vector is constructed with neomycin phosphotransferase II and green fluorescent protein (eGFP-NPTII), where the high expression of GFP during plant regeneration allowed us to minimize the positional effect on T-DNA expression and facilitate screening T-DNA-free mutants. Successful gene editing using CRISPR/Cas9 has been illustrated in different plant species, but an important aesthetic characteristic of leaf variegation remains unexplored. With the newly designed construct, we have targeted the variegation gene LsVAR2 in lettuce. Our results indicated that LsVAR2 is closely related to both AtFtsH2 and AtFtsH8, in which homozygous mutations lead to an albino phenotype while a variegated phenotype was induced by CRISPR/Cas9 de novo gene editing. In conclusion, the unique design of our CRISPR/Cas9 construct could efficiently edit the target gene and ease the screening of non-TDNA mutants through detecting GFP signals during plant regeneration and progeny segregation. Additionally, the success of gene-editing of LsVAR2 in lettuce demonstrates proof in this method to develop novel plant breeding materials for valuable horticultural plant species.
2	Clinically rare, multiple primary tumors are a growth or development of two or more neoplasms in the same individual. A 57-year-old woman with two primary cancers, namely, breast and gastric cancers, and a gastrointestinal stromal tumor was admitted. Next-generation sequencing (NGS) of the three tumors and blood was performed to determine their clonal origin and identify genetic cancer susceptibility. NGS identified that germline genetic variants potentially correlated with an individual risk of developing multiple cancers and that additional mutations are required to drive the formation of different tumors.

PRACTICALS	
1	Genomic DNA Extraction from Animal tissue (liver/spleen).
2	Agarose Gel Electrophoresis
3	Estimation of DNA by DPA method
4	Restriction enzyme digestion of pUC18 DNA

5	Ligation of DNA fragment with cloning vector transformation.
6	Gradient plate technique
7	Isolation of mutants using Replica Plating
8	Bacterial gene expression (Kit may be used)

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	VI
Course Name	Industrial Microbiology
Course Code	PUSBT602
Type of Course	Core
Level of the Course	Medium
Total Credits for the Course	3

Course Objectives:

1. Help in the understanding of dairy technology.
2. Will give an idea about the avenues of exploiting microbes and to study the downstream processes for product recovery in fermentation.

Unit No.	Name of Unit	Topic No.	Name of Topic	Hours
I	Dairy technology	1.1	Milk: Normal flora, changes in raw milk, Enumeration, Factors affecting quality of milk	15
		1.2	Dairy technology -Preservation methods, Pasteurization, Starter Cultures	
		1.3	Fermented products Production -Process and spoilage of Cheese: Swiss and Cheddar, Butter, Yogurt and Buttermilk	
II	Fermentation process	2.1	Antibiotic production- Streptomycin, Penicillin	15
		2.2	Production of Vitamin B12, β-Carotene	
		2.3	Organic acid production-Citric acid, Acetic acid	
		2.4	Amino acid production- Glutamic acid, L-lysine	
		2.5	Beverage production- Wine, Beer	
III	Down stream processing	3.1	Introduction of DSP, Foam separation, Types of Precipitation, Filtration, Centrifugation	15
		3.2	Cell disruption- physical and chemical methods, Chromatography in DSP	
		3.3	Solvent recovery, Two phase aqueous extraction, Membrane process, Drying Crystallization and Whole broth processing	

TOTAL LECTURE	45

Course outcomes: By the end of the course, the student will be able to:

1. Identify normal flora, sources of contamination and spoilage causing microbes of milk and describe the process of preservation of milk to prevent spoilage of dairy products.
2. Explain the role of microorganisms in the production of dairy products and its spoilage.
3. Develop skills with practical exposure to assess quality of milk and milk products.
4. Appreciate the different types of fermentation processes and understand the actual process involved in fermentations of important products.
5. Comprehend the techniques and the underlying principles in downstream processing
6. Design media, growth conditions and techniques for producing and recovering different types of products of commercial value.

References:

1. Applied Dairy Microbiology Elmer H Marth and James L Steele Mercel Dekker Inc
2. New York, 2nd edition
3. Industrial Microbiology Prescott and Dunn CBS publishers
4. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
5. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
6. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
7. H. A. Modi, (2009). ‘’Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
8. Okafor Nduka (2007) ‘’Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
9. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial
10. R. C. Dubey, 2005 A Textbook of ‘’Biotechnology'' S. Chand and Company, New Delhi.

	CASE STUDY
1	Mr. Hari is setting up an industry for citric acid production. He has tried various citrus fruit peel but he could not get yield which can compete with the existing market demand. He has given the task to his Research & Development department to isolate a suitable microbe for the production and optimize the conditions for the maximum production of citric acid. You can help Mr. Hari and his team by answering the following questions.
2	Mr. Ronak is setting up an industry for glutamic acid production. He has tried various fungal cultures but he could not get yield which can compete with the existing market demand. His team has noticed that most of the product is entrapped within the cell which also has reduced the yield. He has given the task to his Research & Development department to resolve the problem. He has asked to search for bacterial culture which can be used for the production. You can help Mr. Ronak and his team by answering the following questions.

PRACTICALS	
1	Isolation of Normal flora from Milk
2	DMC of milk sample
3	Extraction of casein
4	Estimation of Milk protein-Pynes method
5	Estimation of acetic acid in vinegar
6	Estimation of citric acid

BOS	Biotechnology
Class	T.Y.BSc
Semester	VI
Course Name	Agri Biotechnology
Course Code	PUSBT603
Type of Course	Discipline Related Course
Level of the Course	Medium
Total Credits for the Course	2

Course Objectives:

1. To study green house technology and precision agriculture.
2. To understand the effects of biotic and abiotic stress on plants.

Unit No.	Name of Unit	Topic No.	Name of Topic	Hours
I	Precision Agriculture and Agriculture systems	1.1	Introduction to Agriculture and Agriculture systems Greenhouse Technology- Types of greenhouse, importance, functions and features of greenhouse, Classification of greenhouses, Design criteria and calculation	15
		1.2	Construction material, covering material and its characteristics, growing media, greenhouse irrigation system. Nutrient management	
		1.3	Greenhouse heating, cooling and shedding and ventilation system, Computer controlled environment, Future thrusts Phytotrons, fertigation and roof system Precision Cultivation- tools, sensors for information acquisition.	
II	Plant stress biology	2.1	Abiotic stress –Physiological and molecular responses of plants to water stress, salinity stress, temperature stress – heat and cold, Photooxidative stress	15
		2.2	Ionic and osmotic homeostasis, reactive oxygen species scavenging	
		2.3	Biotic stress - plant interaction with bacterial, viral and fungal pathogens, plant responses to pathogen– biochemical and molecular basis of host-plant resistance , toxins of fungi and	

			bacteria systemic and induced resistance –pathogen derived resistance, signalling	
III	Biofertilizers and Biopesticides	3.1	Biofertilizer: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers Nonsymbiotic Nitrogen Fixers Plant Growth Promoting Microorganisms-Phosphate-Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance Plant Growth Promotion by Fungi-- Mycorrhizae Arbuscular Mycorrhizae Ectomycorrhizae	15
		3.2	Microbial Inoculants - Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations;	
		3.3.	Characteristics of *Azotobacter* and *Rhizobium*, Isolation and biofertilizer preparation	
		3.4.	Biopesticides – types, *Bacillus thuringiensis*, insect viruses and entomopathogenic fungi	
			TOTAL LECTURE	45

Course Outcomes: By the end of the course the student will be able to:

1. Describe the types and significance of plant growth promoting microorganisms and biopesticides.
2. Discuss types of Greenhouses and factors affecting greenhouse cultivation.
3. Identify impacts of biotic and abiotic stresses on plants.
4. Analyse the effects of biofertilizers/ biopesticides/ agriculture systems on crop growth and development.
5. Recommend suitable methods to alleviate stress in plants and to enhance plant growth and productivity.
6. Isolate, characterize and develop biofertilizer/ biopesticide formulation

REFERENCES

1. P. Parvatha Reddy (auth.)-Sustainable Crop Protection under Protected Cultivation- Springer Singapore (2016)
2. William Hopkins and Norman Huner – Introduction to plant physiology – 4th

Ed – John Wiley & Sons, Inc.
3. Arun Shanker and Chitra Shanker - Abiotic and Biotic Stress in Plants - Recent Advances and Future Perspectives – Intechopen – ISBN: 978-953-51-2250-0.
4. Henry Leung, Subhas Chandra Mukhopadhyay (eds.) - Intelligent Environmental Sensing (2015, Springer International Publishing)
5. Opender Koul and G. S. Dhaliwal – Microbial pesticides – Taylor and Francis, 2002.
6. Travis R. Glare, Maria E. Moran-Diez - Microbial-Based Biopesticides_ Methods andProtocols (2016, Humana Press)
7. Altieri, Miguel A.Farrell, John G-Agroecology- The Science Of Sustainable

	CASE STUDY
1	Reduced rainfall and intense heat has led to drought conditions in the farm. It was observed that the plant growth and productivity declined drastically. Also, the weakened plants were under attack by pathogenic microorganisms. Mr. Pradhan suggested application of a polymicrobial biofertilizer which will help plants survive the adverse conditions and boost growth and yield.
2	A biofertilizer formulation was developed by an agency for crop plants exposed to salt stress. Effective strains of a free living nitrogen fixer with a suitable carrier base were selected for preparing the biofertilizer formulation. Morphological studies of the isolates showed organisms to be Gram negative with cyst forming capability. A field study with the formulation was conducted with maize plants. Observations over a period of time showed that plants inoculated with the formulation exhibited better growth and yield. Similar field trials under salt stressed conditions also showed better survival of plants. The agency claims that their formulation can be used as a tool for sustainable agriculture.

PRACTICALS	
1	Isolation of Rhizobium
2	Isolation of Azotobacter
3	Isolation of Phosphate solubilising bacteria
4	Study of effect of abiotic stress on plants. salinity stress metal stress
5	Estimation of proline in stressed plants.
6	Isolation of IAA producers and quantification of IAA produced.
7	Estimation proteins in plants grown under stress and non stress conditions using Lowry's method
8	RAPD analysis demonstration experiment

BOS	Biotechnology
Class	T.Y.B.Sc Biotechnology
Semester	VI
Course Name	Environmental Biotechnology
Course Code	PUSBT604
Type of Course	Discipline Related Course
Level of the Course	Medium
Total Credits for the Course	2

Course Objectives:

1. The objective of this course is to gain awareness about different Types of Environmental Pollution, control and Related Issues.
2. To understand how to detoxify the harmful chemicals released in the environment by the use of microorganisms.

Unit No.	Name of Unit	Topic No.	Content	Hours
I	Bioremediation and Waste water treatment	1.1	Concept of Bioremediation. Microorganisms in Bioremediation, Mycoremediation and Phytoremediation.	15
		1.2	Biosorption by bacteria, fungi and algae, factors affecting biosorption, limitations of biosorption. Bioaugmentation and Biostimulation.	
		1.3	Modern Waste Water treatment: Primary, Secondary and Tertiary Treatment	
II	Industrial Effluent Treatment	2.1	Biological processes for industrial effluent treatment, aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR, Membrane Bioreactors; Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB	15

		2.2	Solid waste treatment; Biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation of xenobiotics	
		2.3	Use of immobilized enzymes or microbial cells for treatment**.** Pollution indicators & biosensors.	
III	Hazardous waste management	3.1	Heavy metal pollution – sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal	15
		3.2	Biodegradation of waste from tanning industry; petroleum industry; paper & pulp industry	
		3.3	Biodegradation of waste from Dairy industry; Distillery industry; Dye industry	
		3.4	Biodegradation of waste from Antibiotic industry	
Total Lectures				**45**

Course Outcome: By the end of the course the student will be able to:

1. Describe the concept of bioremediation and the various methods of waste water treatment.
2. Explain the technologies, tools and techniques in the field of environmental quality evaluation, monitoring and remediation of contaminated environments.
3. Demonstrate the use of biosensors and biomarker for monitoring of environment and environmental analysis.
4. Analyze the potential for biodegradation of xenobiotic organic pollutants, taking microbial and physical/chemical environments, as well as the chemical structure of the compound itself, into consideration.
5. Evaluate the functioning of technology involved in solid waste and waste water treatment using aerobic and anaerobic methods.
6. Develop strategies of environment management through bioremediation and phytoremediation for the decontamination of soil and water.

References

1. Environmental biotechnology – Indu shekhar thakur
2. Microbiology- Frobisher
3. Microbiology - 5th Edition- Pelczar

4. Fundamental of Bacteriology - 11th Edition- A. J. Salle
5. M.H Fulekar environmental biotechnology

	CASE STUDY
1	Rising heavy metals pollution in agricultural ecosystem has become a serious concern worldwide. Metal contamination in agricultural fields are due to anthropogenic activities like industrial waste disposal, faulty agriculture management practices, use of municipal solid waste and industrial effluents, etc. Sewage water contains heavy loads of organic matter, nutrient elements, heavy metals and other contaminants. These metals persist in nature for long time and happen to be toxic in plants, animals and humans when these surpass specific threshold concentration levels. Therefore, removal of metals from contaminated sites is inevitable for sustaining crop production. Although, there are many approaches followed to remediate contaminated sites, phytoremediation is considered farmers-friendly, cost effective, non destructive and eco-friendly plant based approach for metal remediation. Phytoremediation with mustard is a well known and regularly adopted practice for metal removal from contaminated areas. However, genetic potential of mustard cultivars may have much influence on phytoremediation potential of mustard
2	In Bangladesh, about 90% of tannery industries are engaged in the chrome tanning process because it is simple in operation and renders excellent properties to the leather. The research findings revealed that the tannery industry generates an unhygienic and toxic environment in the Hazaribag area. Most use outdated processing methods, and the tanneries dump 22,000 cubic liters of toxic waste each day into Dhaka's main river. Most use outdated processing methods, and the tanneries dump 22,000 cubic liters of toxic waste each day, including the cancer-causing toxin hexavalent chromium, into Dhaka's main river. International agencies have highlighted the issue and have recommended the degradation of tannery effluent before the release.

PRACTICALS	
1	Study the effect of heavy metals on the growth of bacteria.
2	Determination of Total Solids from an effluent sample.
3	Study of physical parameters (pH, color, turbidity of any one industrial effluent sample)
4	Determination of BOD of effluent sample
5	Determination of COD of effluent sample
6	Estimation of chromium from Effluents
7	Routine analysis of water

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	VI
Course Name	Nutrition and Endocrinology
Course Code	PUSBT605
Type of Course	Skilled Enhancement Course
Level of the Course	Basic
Total Credits for the Course	2

Course Objectives:

1. To understand pathways related to synthesis of important carbohydrates and lipids
2. To develop an understanding of mechanism of action of protein and steroid hormones
3. To gain insights regarding hierarchy, functions, disorders of hormone secretions

Unit No.	**Name of Unit**	**Topic No.**	**Name of Topic**	**Hours**
I	Nutrition: Minerals and Vitamins	1.1	Minerals and Vitamins; Dietary sources, bioactive form, functions and disorders associated with fat soluble (A D E K) and water soluble vitamins	15
		1.2	Minerals - physiological and biochemical functions of principal and trace elements	
		1.3	Malnutrition – Over nutrition (obesity) and PEM (Kwashiorkor and Marasmus).	
II	Hormones I	2.1	General introduction to Endocrinology. Chemical classification of hormones, Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine.	15
		2.2	Production of Hormones by DNA technology, Neurohormones as neural messengers, Mechanism of hormones production	
		2.3	Structure, storage, release, transport, biochemical functions and disorders associated with hormones secreted by Hypothalamus	
III	Hormones II	3.1	Structure, synthesis, physiology and biochemical actions and diseases of: **Pituitary gland Hormones** – oxcytocin and vasopressin**.** **Hormones of the Pancreas**: insulin and glucagon.	15

		3.2	**Thyroid gland:** T3 and T4, **Adrenal gland:** Aldosterone; Epinephrine and Norepinephrine; the Renin Angiotensin System.	
		3.3	Hormones of Female Gonads – estrogen and progesterone**;** Hormones of Male gonads – testosterone**;** Hormones of Placenta – hCG	
			TOTAL LECTURES	**45**

Course outcomes: By the end of the course the student will be able to:

1. Describe the importance and significance of Vitamins and minerals in diet and enlist the dietary source
2. Underline the health disorders due to deficiency in Vitamins and minerals and other nutrition related disorders
3. Classify hormones, their structure, source, functions and regulation and understand the role of endocrine system in homeostasis
4. Explain the use of biotechnology and the mechanism involved in hormone production
5. Explain the function and structure of various glands involved in hormone secretion
6. Enlist the biochemical actions and disorders associated with hormones

References:

1. Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and MichaelCox *W.H. Freeman* and Company, New York.
2. Biochemistry , 4th edition (2010), Voet and Voet, John Wiley and sons, USA
3. Harper's Illustrated Biochemistry, 27th edition, RK Murray, DK Granner, PA Mayes and VW Rodwell, McGraw Hills publication.
4. Biochemistry, 4nd edition (2017), Satyanarayana and Chakrapani, Books & Allied (P)Ltd
5. Nutrition Science, 6th edition (2017), Srilakshmi, new age international publishers.
6. Human Physiology, Vol. I & II, - C. C. Chatterjee – Medical Allied Agency – Calcutta.

BOS	Biotechnology
Class	T. Y. B. Sc Biotechnology
Semester	VI
Course Name	Clinical Studies and Data Management
Course Code	PUSBT606 (a)
Type of Course	Skill Enhancement Elective
Level of the Course	Moderate
Total Credits for the Course	2

Course Objectives:

1. To present critical concepts and practical methods to support planning, collection, storage, and dissemination of data in clinical research.
2. To provide theoretical knowledge on various essential CDM topics: Regulatory Guidelines, CDM workflow, Data Management Plan etc.

Unit No.	**Name of Unit**	**Topic No.**	**Name of Topic**	**Hours**
I	Pre-clinical Research and Clinical Trial	1.1	Responsibilities of Stakeholders: Sponsors, Investigators, CROs, Monitors.	15
		1.2	Number and types of experimental animals used for preclinical research, CPCSEA rules, recognition of animal house, food and diseases of experimental animals, Protocol for preclinical studies	
		1.3.	Clinical Trial Design. Clinical Trial Phase I, II, III and IV	
II	Data Management	2.1	Introduction to CDM, CRF Design, Clinical Data Entry. Electronic Data Capture, Data Validation, Discrepancy Management.	15
		2.2	Clinical Data Coding, SAE Reconciliation.	
		2.3	Quality Assurance& clinical Data Management, Guideline & Regulation in Clinical trial data.	
IV	Computer and Statistical Analytical System	3.1	Introduction to MS Office: Word, Excel, PowerPoint Internet search engines	15
		3.2	SAS Introduction, SAS syntax, SAS Dataset, Reading SAS Dataset, SAS Function.	

		3.3	Do Loop and Array Processing Using Excel for statistical Analysis, SPSS Introduction, Use of SPSS for statiscal analysis	
			TOTAL LECTURES	**45**

Course outcomes: By the end of the course the student will be able to:

1. Realise the importance of preclinical research and develop protocols as per the guidelines.
2. Understand various essential elements of Clinical Research and Clinical Data Management.
3. Perform CRF Designing, Data entry, Data Collection, AE Management.
4. Create Reports and make informed Consent.
5. Analyse clinical data using SAS and clinical Data management tools.
6. Execute the roles and responsibilities of CR and CDM personnel at various levels.

References:

1. Practical Guide to Clinical Data Management (3rd Ed) – Susanne Prokscha, CRC Press, Taylor & Francis Group
2. Introduction to Computers – Rimple Sanchla, Vipul Prakashan
3. Introduction to Computers – Shamal Parab & Saravanan Reddy, Sheth Publishers Pvt. Ltd.
4. Use of Laboratory animals in Biomedical and Behavioral Research, National Academy Press, Washington D. C. 1988
5. Laboratory Animals: Regulations and Recommendations for the Care and Use of Animals in Research, 2nd Edition, Javier Guillen, Academic Press, Elsevier, 2018.
6. The Selection and Use of Contract Research Organizations By Shayne C. Gad, Taylor & Francis Group, 2003

BOS	Biotechnology
Class	T. Y. B. Sc
Semester	VI
Course Name	Entrepreneurial Avenues in Biotechnology
Course Code	PUSBT606 (b)
Type of Course	Skill Enhancement Elective
Level of the Course	Medium
Total Credits for the Course	2

Course Objectives:

1. To encourage the students for Entrepreneurship in Biotechnology and give them some options.
2. Give the students basic idea to set up few Biotechnology startups like Mushroom cultivation, Hydroponics, Probiotic formulations.

Unit No.	Name of Unit	Topic No.	Name of Topic	Hours
I	Biotech start up Ecosystem	1.1	Extramural Grants for Ventures and Priming of the Ecosystem with Newer Initiatives; Scale-up Funding	15
		1.2	Overview of current landscape: Genesis of technology and regional clusters.	
		1.3	Areas of Innovation	
		1.4	Startups in India: Opportunities and Challenges.	
II	Mushroom Cultivation and Probiotic Formulation	2.1	Types of edible mushrooms, identifying features, Preparation of media (PDA and Oatmeal agar media) sterilization. Infra structure, Substrates (locally available) polythene bag, vessels, Inoculation hood – inoculation loop – low cost stove – sieves – Culturel rack mushroom unit (Thatched house) – Mushroom bed preparation – Paddy straw, sugarcane trash, maize straw, banana leaves. Preparation of inoculums, Spawn production, preparation of bed, inoculation, growth conditions, harvest.	15
		2.2	Classification and physiology of common probiotics: Lactic acid bacteria (LAB), Bifidobacterium and Propionibacterium. Probiotics in Pharmaceutics, Probiotics in animal nutrition and health. FAO and WHO Guidelines on Probiotics.	

III	Hydroponics and aquaponic	3.1	Commercial Aspects and Recent Advancements, Techniques in Hydroponics – Static solution culture, Continuous –flow Solution culture, NFT, Passive sub-irrigation, Ebb and flow, Dutchbucket, Deep water culture, Bubbleponics. Media used for Hydroponics. Aeroponics	15
		3.2	Introduction to aquaponics, Aquaponics system components, Grow bed designs and setup: Float System, Flood and Drain System, NFT system.	
			TOTAL LECTURES	45

Course Outcomes: By the end of the course, students will be able to

1. Develop a range of generic skills that are relevant to self-employment and entrepreneurship.
2. Develop understanding of current national and global scenario of Biotech startups
3. Develop skills with practical exposure to set up Biotechnology startups like Mushroom Cultivation and Probiotic Formulation
4. Realize the commercial and technical aspects for setting up an start up venture for Hydroponics and aquaponic
5. Identify potentially significant scientific advances which open up valuable opportunities.
6. Create value for the enterprise's stakeholders

References:

1. Nita Bahl (1988) Hand book of Mushrooms, II edition, Vol.I & II.
2. Paul Stamets, J.S. and Chilton, J.S. (2004). Mushroom Cultivator: A practical guide to growing mushrooms at home, Agarikon Press.
3. How to Hydroponics. Keith Roberto. 4th Edition. 2003. The Futuregarden Press
4. Complete Guide for Growing Plants Hydroponically. J. Benten Jones. Jr. CRC Press.
5. Probiotics and Prebiotics in Food, Nutrition and Health. Semih Otles. 1st Edition. CRC Press.
6. Biotech Startups in India - At the Cusp of Global Impact. Published by Confederation of Indian Industry (CII) and Sathguru Management Consultants.
7. Biotechnology Start up Ecosystem in India. 2019. Biotech Consortium India Limited (BCIL) New Delhi
8. The Indian startup ecosystem: Drivers, challenges and pillars of support. Sabrina Korreck. ORF Occasional Paper No. 210, September 2019, Observer Research Foundation.

BOS	Department of Skill Development & Entrepreneurship
Class	T. Y. B. Sc. Biotechnology
Semester	V
Course Name	Emotional Intelligence
Course Code	PUSBT607
Level of Course	Moderate
Type of the Course	Skill Enhancement Course
Total Credits for the Course	2

Course Objectives:

1. To learn how to lead with emotional intelligence
2. To study different aspects of self-management, building on the foundation of (i) self-awareness (ii) self-regulation (iii) Social skills and empathy and (iv) Relationship Management.

Unit No.	**Name of Unit**	**Topic No.**	**Name of Topic**	**Hours**
I	Introduction to Emotional Intelligence and Self awareness	1.1	Introduction to Emotional Intelligence. Dimensions of Emotional Intelligence. Difference between EQ v/s IQ.	10
		1.2	Emotional Competencies. Importance of EI. The concept of Emotional Hijacking	
		1.3	Meaning of Self-Awareness, benefits of Self-awareness, Self-Awareness Strategies, Self-Awareness Skills.	
II	Self-Regulation & Elements.	2.1	Introduction to Self-Regulation Self-regulation strategies.	10
		2.2	Self-Control, Meaning of Self-Control, Three Habits of Self-Control, Assessing your Self-Control, Developing Self-Control	
		2.3	Concepts of Trustworthiness, Conscientiousness & Adaptability.	
		2.4	Innovation and Innovation Skills	

III	Social Skills and empathy	3.1	Social Skills in EI, Meaning, Elements: Persuasion and Influencing Skills, Communication Skills, Conflict Management Skills, Leadership Skills, Change Management Skills, Building Bonds (Rapport), Collaboration and Cooperation Team-Working Skill	7
		3.2	Empathy: Meaning, Types, Elements, Tactics.	
IV	Relationship Management	4.1	Relationship Management in EI: Understanding Relationship management, Strategies, Relationship management Skills.	8
		4.2.	The competencies associated with relationship management, Influence, Leadership, Developing Communication, Change Catalyst. Four criteria for effective relationship management: Decision, interaction, Outcome, Needs.	
			TOTAL LECTURES	**45**

Course outcomes: By the end of the course the student will be able to:

1. Describe the value of emotional intelligence for professional success.
2. Relate the impact of impact of self-awareness & self-control on others.
3. Develop strategies for strengthening empathy.
4. Examine capabilities to demonstrate social awareness through empathy.
5. Justify actions to create connections and build relationships for greater professional effectiveness.
6. Construct methodology for managing emotions.

References:

Books:

1. Emotional Intelligence, Daniel Goleman, Bloomsbury Publishing
2. Emotional Intelligence: Why It Can Matter More Than IQ,Daniel Goleman, Bantam
3. Emotional Intelligence 2.0, by Travis Bradberry, Jean Greaves, Perseus Books Group

Web links:

1. https://www.skillsyouneed.com/ps/self-control.html
2. https://www.passingthebatonpodcast.com/relationship-management/
3. http://www.free-management-ebooks.com/faqpp/developing-05.htm
4. https://www.skillsyouneed.com/general/emotional-intelligence.