Academic Council dated 20th May, 2021 as per Item Number: 2.03

DOMBIVLI SHIKSHAN PRASARAK MANDAL'S,

K.V. PENDHARKAR COLLEGE OF ARTS, SCIENCE AND COMMERCE, (AUTONOMOUS) DOMBIVLI (EAST), DIST. THANE

(Affiliated to University of Mumbai)

Faculty of Science

DEPARTMENT OF BIOTECHNOLOGY

(Programme: Bachelor of Science, B.Sc.)

SYLLABUS FOR

F. Y. B.Sc. – Biotechnology (Semester I and II)

Choice Based Credit System (CBCS)

(with effect from the Academic Year: 2021-2022)

Semester – I				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/ Week**
PUSBTI21-171	Core Subject	Basic Chemistry-I	2	3
PUSBTI21-172	Core Subject	Bioorganic Chemistry	2	3
PUSBTI21-173	Core Subject	Biodiversity and Cell Biology	2	3
PUSBTI21-174	Core Subject	Microbial Techniques	2	3
PUSBTI21-175	Core Subject	Introduction to Biotechnology	2	3
PUSBTI21-176	Core Subject	Molecular Biology	2	3
PUAFCI21-141	Ability Enhancement Course 1 (FC I)	Foundation Course I	2	3
PUSBTI21-P1 PUSBTI21-P2 PUSBTI21-P3	Core Subject Practicals	Practicals of PUSBTI21-171 and PUSBTI21-172 PUSBTI21-173 and PUSBTI21-174 PUSBTI21-175 and PUSBTI21-176	6	18
Semester –II				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/ Week**
PUSBTII21-271	Core Subject	Basic Chemistry-II	2	3
PUSBTII21-272	Core Subject	Physical Chemistry	2	3
PUSBTII21-273	Core Subject	Physiology and Ecology	2	3
PUSBTII21-274	Core Subject	Genetics	2	3
PUSBTII21-275	Core Subject	Tissue Culture & Dairy Technology	2	3

PUSBTII21-276	Core Subject	Enzymology, Immunology and Biostatistics	2	3
PUAFCII21-242	Ability Enhancement Course 2 (FC II)	Foundation Course II	2	3
PUSBTII21-P1 PUSBTII21-P2 PUSBTII21-P3	Core Subject Practicals	Practicals of PUSBTII21-271 and PUSBTII21-272 PUSBTII21-273 and PUSBTII21-274 PUSBTII21-275 and PUSBTII21-276	6	18

SEMESTER – I

THEORY

SEMESTER I

Basic chemistry – I

COURSE CODE	TITLE	CREDITS
PUSBTI21-171	**Basic Chemistry I**	**2**

Course Objective: To acquaint the students with basic concepts of Chemistry.

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

- Classify and name inorganic and organic compounds based on IUPAC system.
- Understand concepts on various chemical bonds & their role in biological compounds.
- Learn the role of water in biology & preparation of buffers of different pH.

Unit I **Nomenclature and Classification**	Nomenclature and Classification of Inorganic Compounds: Oxides, Salts, Acids, Bases, Ionic, Molecular and Coordination Compounds Nomenclature and Classification of Organic Compounds: Alkanes, Alkenes, Alkynes, Cyclic Hydrocarbons, Aromatic Compounds, Alcohols and Ethers, Aldehydes and Ketones, Carboxylic Acids and its derivatives, Amines, Amides, Alkyl Halides and Heterocyclic Compounds	15 Lectures
Unit II **Chemical Bonds**	Ionic Bond**:** Nature and Structure of Ionic Bond, Factors influencing the formation of Ionic Bond. Covalent Bond: Nature and Structure of Covalent Bond Coordinate Bond: Nature of Coordinate Bond Van Der Waals forces: dipole - dipole, dipole-induced dipole, ion-dipole interaction. Hydrogen Bond: Theory of Hydrogen Bonding and its types.	15 Lectures

Unit III **Water and Buffers**	**Chemistry of Water:** Properties of Water and its interaction with Solutes (Polar, Non-Polar, Charged) Non-Polar Compounds in Water – Change in its Structure and the Hydrophobic Effect, Role of Water in Biomolecular Structure and Function and Water as a Medium for Life. **Solutions**: Normality, Molarity, Molality, Mole fraction, Mole concept, Solubility, Weight ratio, Volume ratio, Weight to Volume ratio, ppb, ppm, millimoles, milliequivalents (Numericals expected). **Primary and Secondary Standards**: Preparation of Standard Solutions, Principle of Volumetric Analysis. **Acids and Bases:** Lowry-Bronsted and Lewis Concepts. Strong and Weak Acids and Bases - Ionic Product of Water - *pH,pKa, pKb*. Hydrolysis of Salts. **Buffer solutions** –Concept of Buffers, Types of Buffers, Derivation of Henderson equation for Acidic and Basic buffers, Buffer action, Buffer capacity (Numericals expected.) pH of Buffer Solution.	15 lectures

Learning space

Natural sources of organic compounds, Industrial importance of buffers.

Reference Books

1. Concise Inorganic Chemistry. 5th edition (2008), Author: J. D. Lee, John Wiley & Sons, USA.
2. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Inorganic chemistry, Shriver & Atkins

5. Inorganic Chemistrv, Third Edition, GARY L. MIESSLER DONALD A. TARR
6. Organic Chemistry, 6th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)
7. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry, Oxford, 1970
8. Modern inorganic chemistry, An intermediate text, C. CHAMBERS, A. K. HOLLIDAY
9. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf; John Wiley and Sons, USA
10. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
11. Vogels' TextBook of Quantitative Chemical Analysis, G H Jeffery, J Bassett, J Mendham, R C Denney.

ICT Backup

1. https://youtu.be/1A-M1zA0uL0
2. https://youtu.be/JO8w_BnX-w4
3. https://www.khanacademy.org/science/chemistry/chemical-bonds
4. https://www.britannica.com/science/water
5. https://www.npsd.k12.nj.us/cms/lib/NJ01001216/Centricity/Domain/472/Molarity%20Molality%20Normality%20and%20Mass%20Percent%20Worksheet%20II.pdf
6. https://www.khanacademy.org/science/chemistry/acids-and-bases-topic

SEMESTER I

Bioorganic Chemistry

COURSE CODE	TITLE	CREDITS
PUSBTI21-172	Bioorganic Chemistry	2

Course Objectives: To acquaint students with Bioorganic Molecules.

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

- Describe the Classification, Structure and Functions of various Carbohydrates & Lipids.
- Understand Amino acids & their role, Protein structure and conformation.
- Understand the Structure, Properties, Types and importance of nucleic acids.

Unit I **Biomolecules: Carbohydrates and Lipids**	**Carbohydrates**: General functions of Carbohydrates Nomenclature: Classification based on simple sugars (mono, oligo, poly) Classification based on carbonyl function (aldose, ketose) Structure, Physical and Chemical properties of Monosaccharides Stereoisomers of monosaccharides. Complex Carbohydrates: Structure and Types of Oligosaccharides and Polysaccharides Chemical Reactions for Detection of Mono., Di and Polysaccharides **Lipids:** General functions of Lipids, Classification of Lipids Structure and Characteristics of Fatty acids Structure and Functions: Triacylglycerol, Phospholipids, Glycolipids and Lipoproteins Steroids: Structure and Function of Cholesterol Amphipathic lipids	15 lectures

Unit II **Biomolecules: Proteins and Amino Acids**	Amino acids: Properties, Structure, Function and classification Chemical tests, Ionization and Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitter ion. Proteins: Classification based on Structure and Functions. Denaturation of protein.	15 lectures
Unit III **Biomolecules: Nucleic Acids**	Structure of Nitrogenous Bases, Nucleosides, Nucleotides, Polynucleotides. Hydrogen Bonding between Nitrogenous Bases in DNA. Properties, Types and Functions of DNA and RNA. Differences between DNA and RNA.	15 lectures

Learning space

Extraction of biomolecules of industrial significance from natural sources.

Reference Books

1. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
2. Biochemistry by U. Satynarayana and U. Chakrapani. 3rd edition.
3. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf; John Wiley and Sons, USA

ICT Backup

1. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P000991/M016859/ET/1467781230Module17.pdf
2. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P000991/M016863/ET/1467781981module21Phospholipids.pdf
3. https://microbenotes.com/carbohydrates-structure-properties-classification-and-functions/
4. https://www.khanacademy.org/science/biology/macromolecules/proteins-and-amino-acids/a/introduction-to-proteins-and-amino-acids
5. https://www.khanacademy.org/science/biology/macromolecules/proteins-and-amino-

acids/a/orders-of-protein-structure

6. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P000991/M020196/ET/1495017622Module-2-Etext.pdf

SEMESTER I

Biodiversity and Cell Biology

COURSE CODE	TITLE	CREDITS
PUSBTI21-173	**Biodiversity and Cell Biology**	**2**

Course Objectives: To acquaint students with concept of diversity in Biology, particularly in relation to plant, animal, and microbial diversity & to introduce the various types of experimental models used in Biological Sciences.

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

- The process of origin of life and concept of diversity in biology.
- The basic structure and functions of prokaryotic cells.
- The ultrastructure and functions of sub cellular organelles of eukaryotic cells and cell cycle.
- Some popularly used model organisms and their role in understanding biological processes.

Unit I **Origin of Life and Ultra Structure of Prokaryotic cell**	Origin of Life (Chemical and Biological Evolution, Origin of Eukaryotic Cell) **Ultrastructure of Prokaryotic Cell:** Concept of Cell Shape and Size. Detail Structure of Slime Layer, Capsule, Flagella, Pilli, Cell Wall (Gram Positive and Negative), Cell Membrane, Cytoplasm and Genetic Material Storage Bodies and Spores.	15Lectures
Unit II **Ultrastructure of Eukaryotic cell**	**Ultrastructure of Eukaryotic Cell:** Plasma membrane, Cytoplasmic Matrix, Microfilaments, Intermediate Filaments, and Microtubules. Organelles of the Biosynthetic- Endoplasmic Reticulum & Golgi Apparatus. Lysosome, Endocytosis, Phagocytosis, Autophagy, Proteasome. Eukaryotic Ribosomes, Mitochondria and Chloroplasts. Nucleus –Nuclear Structure, Nucleolus.	15Lectures

	External Cell Coverings: Cilia and Flagella. Comparison of Prokaryotic and Eukaryotic Cells	
Unit III **Biodiversity and its conservation**	Concept of Biodiversity (Taxonomical, Ecological and Genetic Diversity & its Significance) **Introduction to Microbial Diversity:** Habitats, Examples and Applications of Archaebacteria, Eubacteria, Blue-green Algae, Actinomycetes, Eumycota, Viruses. **Overview of Plant and Animal diversity** Experimental model organism-*Escherichia coli, Arabidopsis thaliana, Drosophila melanogaster and Mus musculus.* Biotechnology in Biodiversity conservation-Gene banks & its types-Seed banks, pollen banks, DNA banks, Cryobiology	15 Lectures

Learning space

Field visits to understand biodiversity, collaboration with NGOs or enthusiastic naturalists groups, contribution of different model organisms in research.

Reference Books

1. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology by P.S.Verma & V.K.Agrawal (2005**),** S. Chand & Company Ltd
2. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGrawHill Companies Inc. NY
3. Prescott, Harley, and Klein's Microbiology-7th edition, McGraw Hill
4. iGenetics, A Molecular Approach -3rd edition, Peter J. Russel

ICT Backup

1. https://youtu.be/STy21PvUvuc

2. https://youtu.be/VTo1GEpg5Z0
3. https://youtu.be/URUJD5NEXC8
4. https://www.khanacademy.org/science/ap-biology/natural-selection/origins-of-life-on-earth/v/origins-of-life
5. https://ncert.nic.in/textbook/pdf/lebo115.pdf
6. https://onlinelibrary.wiley.com/doi/full/10.1038/npg.els.0000814

SEMESTER - I

Microbial Techniques

COURSE CODE	TITLE	CREDITS
PUSBTI21-174	**Microbial Techniques**	**2**

Course Objectives: To acquaint students with basic techniques in Microbial nutrition, Enumeration and Asepsis.

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

- To provide a basic understanding of the significance and methods of sterilization.
- To impart skill in handling and culture of Microorganisms.
- To reinforce the use of microscope and study the various types of stains and staining methods to be used for visualization of specimens.

Unit I **Microscopy and Stains**	Microscope- Simple and Compound: Principle. Parts, Functions and Applications. Chromatic and achromatic aberrations. Dark Field and Phase Contrast Microscope Stains and Staining Solutions- Definition of Dye and Chromogen. Structure of Dye and Chromophore. Functions of Mordant and Fixative. Natural and Synthetic Dyes. Simple Staining, Differential Staining and Acid Fast Staining with specific examples	15 lectures
Unit II **Sterilization Techniques**	Sterilization and Disinfection Types and Applications: Dry Heat, Moist Heat, Gases, Radiation and Filtration Chemical Agents and their Mode of Action-Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents Characteristics of Ideal Disinfectants and its evaluation	15 lectures

Unit III **Nutrition, Cultivation and** **Enumeration of Microorganisms**	Nutrition and Cultivation of Microorganisms: Nutritional Requirements and Classification of Different Nutritional Types of Organisms. Design and Types of Culture Media Concept of Isolation and its Method Growth and Enumeration: Growth kinetics and Growth Yield, Measurement of Growth & Enumeration of microorganisms, Continuous and synchronous growth.	15 lectures

Learning space

Development of own microscope using lenses, project on isolation of microorganisms from various sources.

Reference Books

1. Fundamental Principles of Bacteriology - A. J. Salle McGraw Hill
2. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
3. Fundamentals of Microbiology by Frobisher, Thomson Learning; 9th edition
4. Prescott's Microbiology, 8thedition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M, Sherwood, Christopher J Woolverton, Chris Woolverton, McGraw Hill Science Engineering, USA.
5. General Principles of Microbiology-Stanier 5th edition.

ICT Backup

1. https://www.britannica.com/technology/microscope
2. https://nios.ac.in/media/documents/dmlt/Microbiology/Lesson-02.pdf
3. https://nios.ac.in/media/documents/dmlt/Microbiology/Lesson-04.pdf
4. https://nios.ac.in/media/documents/dmlt/Microbiology/Lesson-03.pdf
5. https://www.uwyo.edu/virtual_edge/lab05/nutritional.htm
6. https://www.uwyo.edu/virtual_edge/lab05/enumeration.htm

SEMESTER I

Introduction to Biotechnology

COURSE CODE	TITLE	CREDITS
PUSBTI21-175	**Introduction to Biotechnology**	**2**

Course Objectives: To acquaint students with the various fields in Biotechnology, different applications of Biotechnology & an understanding of Agriculture, Food & Fermentation Biotechnology.

Learning Outcome: At the end of this course the student would have a good understanding of:

- The field of Biotechnology, its scope and applications.
- Well familiar with a very important aspect of Agriculture biotechnology.
- Basic of Food biotechnology with food processing technology & Fermentation Techniques with industrial application and scope.

Unit I **Scope and Introduction to Biotechnology**	History, Introduction and Scope of Biotechnology Branches of Biotechnology Biotechnology Institutions in India (Public and Private Sector), Biotechnology Research in India, Biotech Success Stories, Biotechnology in context of Developing World, Public Perception of Biotechnology, Ethics in Biotechnology	15 lectures
Unit II **Agricultural Biotechnology**	Genetically Modified Crops GM Technology for Improved Nutritional quality: GM Tomato, Golden rice GM Technology for Biotic stress: Pest and Virus resistant plant GM Technology for Abiotic stress: Salt, cold and drought resistant plant Molecular Pharming in plants, Plant Based Vaccines	15 lectures

Unit III **Food and Fermentation Biotechnology**	**Food Biotechnology:** Biotechnological applications in enhancement of Food Quality Unit Operation in Food Processing Quality Factors in Pre-processed Food Food Deterioration and its Control Microbial role in food products Modern Biotechnological Regulatory Aspects in Food Industries. **Fermentation Technology:** Definition, Applications of Fermentation Technology **Overview of Microbial Fermentations:** Acetic Acid, Citric Acid, Antibiotics, Enzymes and Beverages	15 lectures

Learning space

Collecting information on Biotechnology industries in India and abroad, interviewing an entrepreneur in biotechnology sector, developing model of genetically modified organism.

Reference Books

1. Advanced Biotechnology, 1st edition by R.C. Dubey, S Chand publications
2. Biotechnology: Fundamentals and Applications by S. S. Purohit, 1 January 2005, Agrobios (India)
3. Industrial Microbiology- L. E. Casida- John Wiley &Sons
4. Industrial Microbiology- A. H. Patel, 1st edition 2008 MacMillan publication.
5. Food Microbiology-Frazier, W.C publication 1978.

ICT Backup

1. https://www.encyclopedia.com/medicine/medical-magazines/biotechnology-ethical-issues
2. https://www.biologydiscussion.com/biotechnology/biotechnology-introduction-scope-and-

applications-of-biotechnology/11608

3. https://the-gist.org/2011/03/molecular-farming-%E2%80%93-how-plants-produce-the-vaccines-of-tomorrow/
4. https://embryo.asu.edu/pages/golden-rice
5. https://ejbpc.springeropen.com/articles/10.1186/s41938-018-0051-2
6. http://www.ijetsr.com/images/short_pdf/1512892504_300-306-chd967_ijetsr.pdf
7. https://www.fmi.org/docs/default-source/food-safety/biotechnology-backgrounder.pdf?sfvrsn=0
8. https://www.biotechnologynotes.com/industrial-biotechnology/fermentation-process/fermentation-process-introduction-progress-and-process-industries-biotechnology/13639

SEMESTER - I

Molecular Biology

COURSE CODE	TITLE	CREDITS
PUSBTI21-176	Molecular Biology	2

Course Objectives: To acquaint students with DNA replication, recombination, mutation and repair & Tools in Genetic Engineering.

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

- Learn the molecular details of DNA replication.
- Understand the reasons for DNA mutations and mechanism of DNA repair & recombination.
- Understand concepts of cloning vectors & enzymes used in genetic engineering.

Unit I **Replication**	**DNA Replication in Prokaryotes and Eukaryotes:** Semi-conservative DNA replication DNA Polymerases and its role E. coli Chromosome Replication, Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication, DNA Replication in Eukaryotes **DNA Recombination:** Holliday Model for Recombination	15 lectures
Unit II **Mutation and DNA Repair**	Definition and Types of Mutations. Mutagenesis and Mutagens. (Examples of Physical, Chemical and Biological Mutagens) Types of Point Mutations, DNA repair Photoreversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair.	15 lectures

Unit III **Introduction to Genetic Engineering**	Basics of Genetic Engineering (Recombinant DNA Technology) History of Genetic Material. Molecular Cloning and Cloning Vectors-Plasmids, Cosmids and Lambda bacteriophage Enzymes- DNA Polymerases, Restriction Endonucleases and its types, Ligases, Reverse transcriptases, Nucleases, Terminal Transferases, Phosphatases & Kinases, Topoisomerases. Evolution in Enzymology: KLenow Polymerases, Taq DNA polymerases, T7 DNA polymerases	15 lectures

Learning space

Preparing working model of replication, project on effect of mutagens.

Reference Books

1. iGenetics, A Molecular Approach-3rd edition, Peter J. Russell
2. Biotechnology: Fundamentals and Applications, S.S. Purohit-4th edition, Agrobios (India) 2005.
3. Biotechnology, B. D. Singh, G. G. Publication, 2003
4. Genetic Engineering: Principles and Practice, Sandhya Mitra (Author)

ICT Backup

1. https://www.youtube.com/watch?v=TNKWgcFPHqw
2. https://www.youtube.com/watch?v=mCaFgwWH61o
3. https://www.youtube.com/watch?v=KSlmkkN5ipE
4. https://www.khanacademy.org/test-prep/mcat/biomolecules/genetic-mutations/v/the-different-types-of-mutations
5. https://www.khanacademy.org/test-prep/mcat/biomolecules/genetic-mutations/v/the-causes-of-genetic-mutations
6. https://www.khanacademy.org/test-prep/mcat/biomolecules/genetic-mutations/v/mutagens-and-carcinogens

7. https://www.news-medical.net/life-sciences/Mechanisms-of-DNA-Repair.aspx
8. https://www.khanacademy.org/science/biology/biotech-dna-technology/dna-cloning-tutorial/a/restriction-enzymes-dna-ligase.
9. https://www.yourgenome.org/facts/what-is-genetic-engineering
10. https://microbenotes.com/cloning-vectors/

SEMESTER – I

Practical

SEMESTER – I

Practical

COURSE CODE	TITLE	CREDITS
PUSBTI21-P1	Practicals in PUSBTI21-171 and PUSBTI21-172	**2**

1. Pre-practical discussion (Safety measures, Hazards identification, MS-DS data sheet)
2. Safety Measures and Practices in Chemistry Laboratory, Working and use of a Digital Balance, Functioning and Standardization of *pH* Meter, Optical Activity of a Chemical Compounds by Polarimeter
3. Preparation of Standard (Molar, Molal and Normal solutions) and Buffer Solutions. Determination of strength of HCl in commercial sample.
4. Qualitative Analysis of Inorganic Compounds - Three experiments
5. Characterization of Organic Compounds containing only C, H, O elements (no element test) - Compounds belonging to the following classes: Carboxylic Acid, Phenol, Aldehyde/Ketone, Ester, Alcohol, Hydrocarbon and Characterization of Organic Compounds containing C, H, O, N, S, Halogen Elements (element tests to be done) Compounds belonging to the following classes: Amine, Amide, Nitro Compounds, Thiamide, Haloalkane, Haloarene.
6. Spot test for Carbohydrates, Fats and Proteins and Amino Acids and Nucleic Acids.
7. Standardization of Colorimeter and Estimation of Reducing sugar by DNSA method.
8. Estimation of Protein by Biuret method and Lowry method.
9. Saponification of Fats, Saponification Value of Oil or Fat, Iodine value of Oil and determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method.

SEMESTER –I

Practical

COURSE CODE	TITLE	CREDITS
PUSBTI21-P2	Practicals in PUSBTI21-173 and PUSBTI21-174	**2**

1. Components and working of Simple, Compound, Dark Field, Fluorescent and Phase Contrast Microscope.
2. Staining of Plant and Animal Tissues using Single and Double Staining Techniques.
3. Special Staining Technique for Cell Wall, Capsule and Endospores and Fungal Staining.
4. Monochrome Staining, Differential Staining, Gram Staining, and Acid Fast Staining and Romanowsky Staining.
5. Study of Photomicrographs of Cell Organelles.
6. Sterilization of Laboratory Glassware and Media using Autoclave.
7. Preparation of Media- Nutrient broth and Agar, MacConkey Agar, Sabourauds Agar.
8. Isolation of Organisms: T-streak, Polygon method.
9. Enumeration of microorganisms by Serial Dilution, Pour Plate, Spread Plate Method.
10. Colony Characteristics of Microorganisms, Enumeration by Breed's count.
11. Growth Curve of *E. coli*.

SEMESTER – I

Practical

COURSE CODE	TITLE	CREDITS
PUSBTI21-P3	Practicals in PUSBTI21-175 and PUSBTI21-176	**2**

1. Assignment- Study of any branch of biotechnology and its applications.
2. Microbial examination of food and detection of Pathogenic Bacteria from Food Samples.
3. Isolation of organisms causing Food Spoilage.
4. Microscopic determination of Microbial flora from Yoghurt and Lactic Acid Determination.
5. Extraction of Casein from Milk.
6. Meat Tenderization using Papain.
7. Fermentative production of Alcohol.
8. Determination of Alcohol content.
9. Extraction of genomic DNA from plant material.

MOOC Details (FY Biotechnology)

Semester I

Sr. No.	Paper & Unit	Details of the course	Link for reference
1	PUSBTI21-176 Unit III Genetic Engineering	**Swayam** **Genetic engineering: Theory and Applications** Duration: 12 weeks Start date: 26 July Free enrolment, Paid certificate	https://onlinecourses.nptel.ac.in/noc19_bt15/preview
2	PUSBTI21-176 Unit I Replication	**Alison** **Biomolecules: DNA replication and sequencing** Duration: 4-5 Hrs. Free enrolment, Self-paced. Publisher: NPTEL	https://alison.com/course/biomolecules-dna-replication-and-sequencing
3	PUSBTI21-175 Unit I Scope and Introduction to Biotechnology	**Coursera** **Industrial Biotechnology** Beginner level Manchester Institute of Biotechnology Duration: 6 Weeks Free enrolment, Paid certificate	https://www.coursera.org/learn/industrial-biotech
4	PUSBTI21-172 Unit II Proteins and Amino acids	**Coursera** **Amino acids to Proteins** Princeton University Duration: 8 Weeks Free enrolment, Paid certificate	https://www.coursera.org/lecture/life-on-other-planets/amino-acids-to-proteins-2J7GY

SEMESTER II

Theory

SEMESTER II

Basic chemistry-II

COURSE CODE	TITLE	CREDITS
PUSBTII21-271	Basic Chemistry II	2

Course Objective: To acquaint students with concepts of Stereochemistry, Titrimetry & Gravimetry and Analytical separation techniques.

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

- Describe the role of isomerism, conformation & configuration of molecules.
- Understand the concepts of Titrimetry & Gravimetry analysis, role of titrations, pH and buffers
- Separate molecules using the apt techniques relevant to the specific molecule e.g. chromatography & colorimeter.

Unit I Stereochemistry	**Isomerism** – Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality. **Geometric Isomerism and Optical Isomerism:** Enantiomers, Diastereomers, and Racemic mixtures Cis-Trans, Threo, Erythro and Meso isomers. Diastereomerism (Cis-Trans Isomerism) in Alkenes and Cycloalkanes (3 and 4 membered ring) **Conformation**: Conformations of Ethane. Difference between Configuration and Conformation. **Configuration**, Asymmetric Carbon Atom, Stereogenic/ ChiralCenters, Chirality, Representation of Configuration by — "Flying Wedge Formula" **Projection formulae** – Fischer, Newman and Sawhorse. The Interconversion of the Formulae. **Racemization and Resolution: Methods of Racemization Resolutions of Racemic mixture**	15 Lectures

Unit II Analytical chemistry: Titrimetry and Gravimetry	**Measurement of Mass and Volume:** Distinction between mass and weight; Types of analytical balances, Sources of errors in weighing and their elimination. Units of volume, effect of temperature on volume measurement. Apparatus for precise measurement of volume; pipette, burette and volumetric flask. **Titrimetric Analysis**: Titration, Titrant, Titrand, End Point, Equivalence Point, Titration Error, Indicator, Primary and Secondary Standards, Characteristics and examples Types of Titrations – Acid-Base, Redox, Precipitation, Complexometric Titration. Acid-Base Titration, Strong Acid *Vs* Strong Base. Theoretical aspects of Titration Curve and End Point Evaluation. Theory of Acid –Base Indicators, Choice and Suitability of Indicators. **Gravimetric Analysis:** Solubility and Precipitation, Factors affecting Solubility, Nucleation, Particle Size, Crystal Growth, Colloidal State, Ageing/Digestion of Precipitate. Co-Precipitation and Post-Precipitation. Washing, Drying and Ignition of Precipitate. (Numericals Expected).	15 Lectures
Unit III Analytical reactions and Techniques	**Scope of analytical reactions:** Scope and applications of analytical chemistry. Chemical equilibria, quantitative reactions and solution chemistry. Coordination, complex formation and chelating. Selectivity, masking. **Methods of Separation** Precipitation, Filtration, Distillation and Solvent Extraction. **Analytical Techniques Chromatography:** Definition, Principles, Types	15 Lectures

	Introduction to Paper Chromatography, Thin Layer Chromatography, Column Chromatography and its Applications. **Colorimetry:** Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of E = kcl, Limitations of Beer-Lambert's Law, Filter Selection	

Learning space

To explore the relatedness of stereochemistry and analytical techniques in the biology field.

Reference Books

1. University General Chemistry, 1st edition (2000), C.N. R. Rao
2. Physical Chemistry University for biological sciences,1stedition, Chang R.
3. Essentials of Physical Chemistry, 24th edition, (2000), B S Bahl, G D Tuli, Arun Bahl.
4. Concise Inorganic Chemistry .5th edition (2008), Author: J. D. Lee
5. Organic Chemistry, 6th edition, (1992), Morrison Robert Thornton
6. Fundamentals of Analytical chemistry, Skoog, West, Holler, Crouch
7. Vogels' TextBook of Quantitative Chemical Analysis, G H Jeffery, J Bassett, J Mendham, R C Denney
8. Analytical Biochemistry, 3 edition, (1998), David Holmes, H. Peck, Prentice Hall, UK.
9. Modern Analytical Chemistry, David Harvey
10. Principles and Practice of Analytical Chemistry Fifth Edition, F.W. Fifieldand D. Kealey

ICT Backup

1. https://www.britannica.com/science/isomerism
2. https://www.toppr.com/guides/chemistry/coordination-compounds/geometric-and-optical-isomerism/
3. https://www.youtube.com/watch?v=_obE4YAVJS4
4. https://www.toppr.com/guides/chemistry/solutions/titration-types-examples-procedure/
5. https://paramedicsworld.com/biochemistry-practicals/demonstration-of-colorimeter-principle-components-working-uses-applications/medical-paramedical-studynotes
6. https://amrita.olabs.edu.in/?brch=2&cnt=1&sim=96&sub=73
7. https://chemdictionary.org/chromatography/

SEMESTER II

Physical chemistry

COURSE CODE	TITLE	CREDITS
PUSBTII21-272	Physical chemistry	2

Course Objectives: To acquaint students with concepts in Thermodynamics, Kinetics and Redox Reactions.

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

- Describe the thermodynamics of chemical reactions.
- Understand the kinetics of chemical reactions.
- Understand the principles of redox reactions.

Unit I **Thermodynamics**	**Thermodynamics**: System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numericals expected). Laws of Thermodynamics and its Limitations, Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency. Laws of Thermodynamics as applied to Biochemical Systems. Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.	15 lectures
Unit II **Chemical Kinetics**	**Reaction Kinetics:** Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order & Molecularity of Reaction, Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected) Determination of Order of Reaction by a) Integration Method b) Graphical Method c) Ostwald's Isolation Method d) Half Time Method. (Numericals expected).	15 lectures

Unit III **Oxidation Reduction reactions**	**Principles of Oxidation & Reduction Reactions**– Oxidizing and Reducing Agents, Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate. Balancing Redox Reactions by Ion Electron Method Oxidation, Reduction, Addition, Substitution & Elimination Reactions.	15 lectures

Learning space

To learn redox reactions in daily life.

Reference Books

1. Physical Chemistry Thermodynamics, SAMUEL GLASSTONE
2. Concise Physical chemistry, DONALD W. ROGERS
3. Physical chemistry, Ninth Edition, Peter Atkins Julio de Paula.
4. Physical Chemistry, W. J. MOORE
5. Chemical Kinetics and Reaction Dynamics, Santosh K. Upadhyay
6. Physical Chemistry, SAMUEL GLASSTONE
7. Vogels' TextBook of Quantitative Chemical Analysis, G H Jeffery, J Bassett, J Mendham, R C Denne
8. Fundamentals of Analytical chemistry, Skoog, West, Holler, Crouch
9. Inorganic chemistry, Shriver & Atkins
10. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012

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2. https://www.khanacademy.org/science/biology/energy-and-enzymes/the-laws-of-thermodynamics/v/introduction-to-entropy
3. https://www.youtube.com/watch?v=YM-uykVfq_E
4. https://www.youtube.com/watch?v=0ZVtMEhY4oM
5. https://www.khanacademy.org/science/chemistry/oxidation-reduction/redox-oxidation-reduction/v/oxidizing-and-reducing-agents-1
6. https://www.youtube.com/watch?v=j0hI-a6EWWo
7. https://www.khanacademy.org/science/organic-chemistry/organic-structures/oxidation-reduction-review/v/organic-oxidation-reduction-reactions

SEMESTER II

Physiology and Ecology

COURSE CODE	TITLE	CREDITS
PUSBTII21-273	Physiology and Ecology	2

Course Objectives: To acquaint students with physiological processes in plants and animals and knowledge of ecosystem.

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

- Understand the chemical basis of photosynthesis and mechanism of light reactions.
- Understand the physiology of various systems in animals.
- Understand functioning of ecosystem and interactions.

Unit I **Plant Physiology**	**Plant water relations:** Physical aspects of water absorption – Diffusion, Imbibition, Osmosis. Mechanism of water absorption, Concept of water potential, transpiration and guttation. Photosynthesis, Intracellular Organization of Photosynthetic System. Fundamental Reactions of Photosynthesis Photosynthetic Pigments, Role of Light, Hill Reaction and its Significance. Light Reactions, Cyclic and Non-Cyclic Photo Induced Electron Flow, Energetics of Photosynthesis, Photorespiration.	15 lectures
Unit II **Animal Physiology**	**Physiology of Digestion:** Movement of Food and Absorption, Secretary functions of Alimentary Canal, Digestion and Absorption, assimilation in Gut of Mammals **Physiology of Respiration:** Mechanism of Respiration, Principles of Gaseous Exchange in the Blood and Body Fluids **Physiology of Circulation:** Blood Composition, Structure and Function of its Constituents	15 lectures

	Regulation of the Circulation Mechanism and working of Heart in Human. **Physiology of Excretion:** Anatomy of Mammalian Kidney, Structure of Nephron, Urine Formation and Role of Kidney in Excretion and Osmoregulation	
Unit III Ecosystem and Interactions	Ecosystems, Components, Structure and Function of Ecosystems, Trophic Levels, Food Chain and Food Web, Ecological Pyramids (Energy, Biomass and Number) Ecological interactions: Interactions, Commensalism, Mutualism, Predation and Antibiosis, Parasitism.	15 lectures

Learning space

Preparing working model of plant and animal physiology processes, reading and collecting science articles on environment.

Reference Books

1. A Textbook of Plant Physiology- Verma V., Ane Books India, 4th edition, 2007
2. Plant physiology - Zeiger, E., Taiz L., United Kingdom: Sinauer Associates. 2010.
3. Plant Biotechnology- K. G. Ramavat S.Chand Publications
4. Devlin R.M. (1983) - Fundamentals of Plant Physiology (Mac. Millan, New York)
5. Applegate anatomy and physiology Learning systems – Guyton
6. Human anatomy and Physiology by Marieb,6th edition
7. Cell biology, Genetics, Molecular biology, Evolution and Ecology by Verma and Agarwal,2005

ICT Backup

1. https://www.britannica.com/science/photosynthesis
2. https://untamedscience.com/biology/plants/plant-growth-hormones/
3. https://www.britannica.com/science/human-digestive-system
4. https://www.youtube.com/watch?v=QsSdAXv5BEM&t=7s
5. https://www.youtube.com/watch?v=PlNEabFZ5Qk
6. https://www.youtube.com/watch?v=_qmNCJxpsr0&t=17s
7. http://ncert.nic.in/ncerts/l/lebo114.pdf
8. https://www.youtube.com/watch?v=nqPhY1-4f_0

SEMESTER – II

Genetics

COURSE CODE	TITLE	CREDITS
PUSBTII21-274	**Genetics**	**2**

Course Objectives: To acquaint students with concepts in Genetics.

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

- Understand fundamentals of Mendelian genetics.
- Understand methods of gene exchange in bacteria.
- Understand the concepts of Population Genetics.

Unit I **Genetics Fundamentals**	**Mendel's Laws of Heredity** - Monohybrid Cross: Principle of Dominance and Segregation. Dihybrid Cross: Principle of Independent Assortment. **Allelic Interactions**: Incomplete Dominance, Co-dominance, Multiple Alleles, Lethal alleles, Penetrance and expressivity. **Gene Interaction**: Epistasis.	15 lectures
Unit II **Microbial Genetics**	Genetic analysis in Bacteria- Prototrophs, Auxotrophs. Bacteriophages: Lytic and Lysogenic cycle Mechanism of Genetic Exchange in Bacteria: Conjugation; Transformation; Transduction; (Generalized Transduction, Specialized Transduction) Bacterial Transposable Elements.	15 lectures
Unit III **Population Genetics**	Introduction to basics of population genetics & terminologies. **Genetic Structure of Populations:** Genotype Frequencies & Allele Frequencies **The Hardy–Weinberg Law:** Assumptions, mathematical expression, problems. **Genetic Variation in Natural Populations:** Measuring Genetic Variation at the Protein Level & Measuring Genetic Variation at the DNA Level	15 lectures

	Effects of Evolutionary Forces on the Genetic Structure of a Population: Mutation, Migration, Natural selection, Genetic drift & Speciation. Role of Population Genetics in Conservation Biology	

Learning space

Data collection of human traits and its inheritance pattern, reading advance reference books and research papers.

Reference Books

1. iGenetics- Mendelian approach by Peter Russell
2. Microbiology by Pelczar (5th edition)
3. Genetics-Mendelian approach by Peter Russell (5th edition)

ICT Backup

1. https://www.khanacademy.org/science/high-school-biology/hs-classical-genetics/hs-introduction-to-heredity/a/hs-introduction-to-heredity-review
2. https://youtu.be/3CQqFpKiRhw
3. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1392256/
4. https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/mutations-ap/a/genetic-variation-in-prokaryotes#:~:text=In%20transformation%2C%20a%20bacterium%20takes,through%20a%20tube%20between%20cells.
5. https://biologydictionary.net/lytic-cycle/
6. https://www.khanacademy.org/science/ap-biology/natural-selection/hardy-weinberg-equilibrium/v/hardy-weinberg

SEMESTER II

Tissue Culture & Dairy Technology

COURSE CODE	TITLE	CREDITS
PUSBTII21-275	**Tissue Culture & Dairy Technology**	**2**

Course Objectives: To acquaint students with Techniques of Plant and Animal Tissue Culture & Dairy microbiology.

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

- Understand the basic culturing techniques of animal cell culture.
- Understand aseptic techniques involved in plant tissue culturing and perform culturing under sterile conditions.
- Understand the concept of culturing and preservation techniques in dairy technology related to various dairy products.

Unit I **Plant Tissue Culture**	Concept of Totipotency, Organization of Plant Tissue Culture Laboratory, Equipments and Instruments Aseptic Techniques: Washing of Glassware, Media Sterilization, Aseptic Workstation, Precautions to maintain Aseptic Conditions. Culture Medium: Nutritional requirements of the explants, PGR's and their *in-vitro* roles Media Preparation Callus Culture Technique: Introduction, Principle and Protocols Organogenesis, Somatic embryogenesis and synthetic seeds	15 lectures
Unit II **Animal Tissue Culture**	**Basics of Animal Tissue Culture** Introduction to Animal Tissue culture, Types of Cell Culture Techniques. Laboratory Organization and Layout for Animal Tissue Culture Laboratory, Equipment, Sterilization Methodology.	15 lectures

	Introduction to Animal Cell Culture media: Nutritional and Physiological factors, Growth Factors and Growth Parameters. Growth Kinetics Primary Cell Cultures: Establishment and Maintenance of Primary Cell Culture, Application of Cell Cultures	
Unit III **Dairy Technology**	Milk - Normal flora, changes in raw milk. Enumeration Factors affecting bacteriological quality, Preservation methods, Pasteurization, Starter cultures, Fermented products- Production process and spoilage of cheese: Swiss and Cheddar, Butter, Yoghurt and Buttermilk.	15 lectures

Learning space

Industry visits, literature survey-based project, experimental project on nutritional and microbiological quality of milk and milk products.

Reference Books

1. Plant Biotechnology- K. G. Ramavat S.Chand Publications
2. Plant Tissue Culture by Kalyan Kumar De
3. Experiments in Plant tissue culture- Dodds and Roberts- Cambridge University Press
4. Culture of Animal cells- Ian Freshney -- John Wiley &Sons
5. Principles and Practice of Animal Tissue culture- Sudha Gangal–University Press
6. Applied Dairy Microbiology Elmer H Marth and James L Steele, Mercel Dekker Inc New York, 2nd edition
7. Microbial Technology Peppler, H.J and Perlman, D 2nd Academic Press Practicals
8. Industrial Microbiology Prescott and Dunn CBS publishers
9. Dairy Technology by Yadav and Grower

ICT Backup

1. https://phytotechlab.com/media/documents/TechnicalLiterature/ComponentsOfTissueCultureMedia.pdf
2. https://www.biologydiscussion.com/plant-tissues/callus-culture/callus-culture-history-principles-and-significance-plant-tissue-culture/14597#:~:text=If%20a%20bit%20of%20tissue,of%20medicinal%20plants%20in%20nature.
3. https://www.biologydiscussion.com/plant-tissues/totipotency/totipotency-meaning-expression-and-importance-plant-tissue-culture/14641
4. https://www.intechopen.com/books/biomedical-tissue-culture/culture-conditions-and-types-of-growth-media-for-mammalian-cells
5. https://www.biologydiscussion.com/biotechnology/animal-biotechnology/culture-media-for-animal-cells-an-overview/10499
6. https://iopscience.iop.org/book/978-0-7503-1347-6/chapter/bk978-0-7503-1347-6ch1
7. https://www.biologydiscussion.com/industrial-microbiology-2/cheese/how-is-cheese-made-step-by-step-principles-production-and-process/86647
8. http://www.madehow.com/Volume-4/Yogurt.html
9. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=5303
10. http://ecoursesonline.iasri.res.in/mod/resource/view.php?id=5761

SEMESTER - II

Enzymology, Immunology and Biostatistics

COURSE CODE	TITLE	CREDITS
PUSBTII21-276	**Enzymology, Immunology and Biostatistics**	**2**

Course Objectives: To acquaint students with concepts in Enzymology, Immunology and Biostatistics.

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

- Classify enzymes and understand the kinetics of enzyme catalyzed reactions
- Differentiate between innate and acquired immunity, understand the different functional units of immunity in the body.
- Apply statistical tools in data analysis.

Unit I **Enzymology**	Definition, Classification, Nomenclature, Chemical Nature, Properties of Enzymes, Mechanism of Enzyme Action, Active Sites. Enzyme Specificity, Effect of pH, Temperature, Substrate Concentration on Enzyme Activity, Enzyme Kinetics, Michaelis-Menten Equation, Lineweaver Burk plot Types of Enzyme Inhibitions-Competitive, Uncompetitive, Non-Competitive Allosteric Modulators Co-Factors, Zymogens. Industrial applications of enzymes	15 lectures
Unit II **Immunology**	**Overview of Immune Systems:** Cell and Organs involved in immunity: T and B cells. Innate Immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each. **Antigens and Antibodies:** Types of Antigens, General Properties of Antigens, Haptens and Superantigens.	15 lectures

	Discovery and Structure of Antibodies: (Framework region) Classes of Immunoglobulins, Antigenic Determinants. Antigen-Antibody Interactions.	
Unit III **Biostatistics**	Definition, Importance & applications of Statistics in Biology Types of Data, Normal and Frequency Distribution Representation of Data and Graphs: Bar Diagrams, Pie Charts and Histogram, Polygon and Curve. Measures of Central Tendency: (For Raw, Ungroup & Group Data), Mean, Median, Mode. Measures of Dispersion Range, Variance, Coefficient of Variance. Standard Derivation. Standard Error.	15 lectures

Learning space

Extraction of enzymes for industrial use, Data collection and analysis by statistical approach, learning computer software for statistical analysis.

Reference Books

1. Outlines of Biochemistry: 5thEdition, (2009), Erice Conn & Paul Stumpf; John Wiley and Sons, USA
2. Lehninger, Principles of Biochemistry. 5thEdition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
3. Kuby immunology, Judy Owen, Jenni Punt, SharonStranford.,7th edition (2002) edition (2012), Freeman and Co., NY
4. Introduction to Immunology- C. V Rao- Narosa Publishing House
5. Methods in Biostatistics- B. K. Mahajan –Jaypee Brothers
6. Biochemistry - U Satyanarayana, 4th edition (2004). Elsevier Health Sciences.
7. Biostatistics- PN Arora & PK Malhan, (2010) Himalaya Publishing House

ICT Backup

1. https://www.britannica.com/science/enzyme
2. https://youtu.be/gtst3GZ7kjw
3. https://teachmephysiology.com/biochemistry/molecules-and-signalling/enzyme-inhibition/
4. https://www.britannica.com/science/antigen
5. https://youtu.be/8PWF5OeB7Ec
6. https://youtu.be/PzunOgYHeyg
7. https://youtu.be/9r0xzlpNjTw
8. https://www.dentalcare.com/en-us/professional-education/ce-courses/ce1/five-classes-subclasses-of-immunoglobulins
9. https://youtu.be/I64HjpsLnZg
10. https://youtu.be/U7E7rAw--DA

SEMESTER – II

Practical

SEMESTER – II

Practical

COURSE CODE	TITLE	CREDITS
PUSBTII21-P1	Practicals in PUSBTII21-271 and PUSBTII21-272	**2**

1. To determine enthalpy of dissolution of salt like KNO3.
2. Determine the rate constant for hydrolysis of ester using HCl as a catalyst.
3. Study the kinetics of reaction between Thiosulphate ion and HCl.
4. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction.
5. Study the reaction between NaHSO3 and KMnO4 and balancing the reaction in acidic, alkaline and neutral medium.
6. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate)
7. Determination of the volume strength of hydrogen peroxide solution by titration with standardized potassium permanganate solution.
8. Determination of amount of K oxalate and oxalic acid in the given solution titrimetrically.
9. Standardize commercial samples of NaOH using KHP (Potassium hydrogen phthalate) and sample of HCl using borax.
10. Dissociation Constant of Weak Acids by Incomplete Titration Method using *pH* Meter and determination of Acetic acid in Vinegar by Titrimetric Method.
11. Determination of the amount of Fe (II) present in the given solution Titrimetrically.
12. Determination of amount of NaHCO3 + Na2CO3 in the given solid mixture Titrimetrcially.
13. Determination of the amount of Mg (II) present in the given solution complexometrically.
14. Determination of percent composition of BaSO4 and NH4Cl in the given mixture Gravimetrically.

SEMESTER – II

Practical

COURSE CODE	TITLE	CREDITS
PUSBTII21-P2	Practicals in PUSBTII21-273 and PUSBTII21-274	**2**

1. Study of Hill's reaction.
2. Colorimetric study of Absorption Spectrum of Photosynthetic Pigments.
3. Analysis of Urine.
4. Study of Mammalian Blood, Blood count using Haemocytometer.
5. Estimation of Haemoglobin in Mammalian Blood.
6. Study of Human Blood Groups.
7. Problems in Mendelian Genetics.
8. Study of Mitosis and Meiosis.
9. Study of Karyotypes – Normal Male and Normal Female.
10. Study of Interactions- Commensalism, Mutualism, Predation and Antibiosis, Parasitism.

SEMESTER – II

Practical

COURSE CODE	TITLE	CREDITS
PUSBTII21-P3	Practicals in PUSBTII21-275 and PUSBTII21-276	**2**

1. Working and use of various Instruments used in Biotechnology Laboratory (Autoclave, Hot air Oven, Centrifuge, Incubator, Rotary Shaker, Filter Assembly, LAF, *pH* meter and Colorimeter).
2. Preparation of Stock Solutions and Preparation of Media for PTC.
3. Aseptic Transfer Technique, Surface Sterilization and Inoculation for Callus Culture.
4. Preparation of synthetic seeds.
5. Working and use of various Instruments and glasswares used in ATC Laboratory.
6. Trypsinization of Animal Tissue and Viability Count.
7. Analysis of Milk- Methylene Blue, Resazurin Test, Phosphatase Test.
8. Estimation of milk protein by Pyne's method.
9. Enzyme Kinetics : Study of the effect of *pH*, Temperature on activity of Enzyme, inhibitor Study of Effect of Substrate Concentration on enzyme activity and determination of Vmax and Km.
10. Study of antigen antibody interaction by Ouchterlony method.
11. Biometric Analysis for Mean, Median, Mode and Standard Deviation.
12. Data representation using frequency Polygon, Histogram and Pie Diagram.

MOOC Details (FY Biotechnology)

Semester II

Sr. No.	Paper & Unit	Details of the course	Link for reference
1	PUSBTI21-276 Unit II Immunology	**Coursera** **Fundamentals of Immunology specialization** University of Rice Duration: 6 Weeks Free enrolment, Paid certificate	**https://www.coursera.org/specializations/immunology**
2	PUSBTI21-273 Unit II Animal Physiology	**Coursera** **Vital Signs: Understanding what the body is telling us** University of Pennsylvania Duration: 6 Weeks Free enrolment, Paid certificate	**https://www.coursera.org/learn/vital-signs**
3	PUSBTI21-274 Unit III Population genetics	**Coursera** **From Disease to Genes and Back** Novosibirsk State University Duration: 6 Weeks Free enrolment, Paid certificate	**https://www.coursera.org/learn/disease-genes**
4	PUSBTI21-275 Unit III Dairy technology	**Swayam** **Food preservation technology** Department of microbiology, Mysore Duration: 12 weeks	**https://onlinecourses.swayam2.ac.in/cec20_ag07/preview**

EVALUATION

1. **Core Courses:** The College will conduct all the semester examinations of 100 marks per Theory Paper in the prescribed pattern of 40 marks of internal assessment/Project work and 60 marks for semester end examination. **The student will have to secure a minimum of 40% marks in internal assessment as well as semester end examination per theory paper, for all the above theory papers.**
2. The student will have to secure a minimum of 40% marks in internal assessment as well as semester end examination in the theory paper and practical exam.
3. In each semester, the student will have to submit Project/Assignment/Journal for theory papers in the College before appearing for the Semester End Examination. The last date of submission of the Project will be officially declared by the College.
4. The Project work will be carried out by the student with the guidance of the concerned Faculty Member who will be allotted to the student as the Guide for the Project.
5. The College will conduct all the semester examinations of 100 marks per Practical Paper at the end of each semester. **The student will have to secure a minimum of 40% marks in the examination per practical paper, for all the above practical papers.**

EVALUATION PATTERN
FOR F.Y.B.SC. (THEORY)

1.	**INTERNAL ASSESSMENT**		**40 Marks**
1.1	**Internal 1**: Assignment/Tutorial/Seminar/Participation in conference, etc		15Marks
1.2	**Internal 2**: MCQ Test/ Project		20Marks
1.3	Active Participation, Overall performance		05 Marks
2.	**EXTERNAL ASSESSMENT (Semester End Examination)**		**60 Marks**
	N.B. 1. All questions are compulsory 2. All questions carry equal marks.		
	Q.1.	Based on Unit-I, II & III Multiple choice questions/Fill in the blanks /Match the column/Give one word/Name the following/Give an example/Explain the term/Define	**12**
	Q.2.	Unit-I Long Answer Question Short Answer Question	**12** 12/08/06 04/02
	Q.3.	Unit-II Long Answer Question Short Answer Question	**12** 12/08/06 04/02
	Q.4.	Unit-III Long Answer Question Short Answer Question	**12** 12/08/06 04/02

	Q.5. Short Notes based on Unit I, II and III (Solve any three out of six) a b c d e f	**12**

EVALUATION PATTERN

F.Y.B.Sc . (PRACTICAL)

2.	EXTERNAL ASSESSMENT	100 Marks
	Experiment –1 (Major technique)	25
	Experiment –2 (Major technique)	25
	Experiment -3 (Minor technique)	15
	Experiment -4 (Minor technique)	15
	Viva/Identification/Spots	10
	Journal	10
	TOTAL MARKS	100

Students will have to perform and report experiments in journal.

Semester – I and II

Ability Enhancement Course 1 (FC I)

Ability Enhancement Course 2 (FC I)

DSPM's K. V. Pendharkar Autonomous College, Dombivli

Revised Syllabus for

F.Y.B.A./B.Sc./F.Y.BCom/FYBAF/FYBMS/FYMAMMC/FYBIOTECH/FYBBI

(Semester I and II)

Course Title: Foundation Course

1. Syllabus as per Credit Based Semester & Grading System.

i) Name of the Programme - Foundation Course F.Y.B.A. /B.Sc./B.Com

ii) Course Code - PUAFCI21-141 and PUAFCII21-242

iii) Course Title - Foundation Course - I

iv) Semester wise Course Contents - Enclosed the copy of syllabus

v) References and additional references – Enclosed in the Syllabus

vi) Credit structure - 2 Credits per Semester.

vii) No. of lectures per Unit - 11, 11, 12, 11 and 12, 11, 11, 11 (45 lectures per Semester)

viii) No. of Lectures per Semester - 45 + 45 (Total 90)

viii) No. of lectures per week - 03

2. Scheme of Examination - 40 marks for Internal and 60 marks for External Exam

Revised Syllabus for Foundation Course for F.Y.B.A./B. Sc./ B. Com

Semester I

Internal marks: 40 **External marks: 60** **Total Marks: 100**

Objectives :

1. To acquaint students with multi-cultural diversity of Indian society.
2. To understand the concept of disparity as arising out of stratification and inequality.
3. To analyze the inequalities and its manifestation in inter-group conflicts.
4. To understand the philosophy and basic features of the Indian Constitution.
5. To develop students' abilities to think role of youth in promoting tolerance, peace and communal harmony.
6. To acquaint the student with the basic understanding of various growing social problems in India.

Learning Outcome:

1) Learners will acquire a deeper and more inclusive understanding of Indian society, its nature, social problems, role of Indian Constitution and youth in maintaining the social fabric of Indian society.

2) They will know the concept of disparity as arising out of social stratification and inequality

3) They will understand evolution and Salient features of the Indian Constitution

CREDIT 2 Lectures: 45

Module 1- Overview of Indian Society (11 hours)

a) Multi-cultural nature of Indian society with its demographic composition: population distribution according to religion, caste, and gender

b) The linguistic diversity in India

c) Regional variations in the context of rural, urban and tribal demography

d) The unity in diversity

Module 2- Concept of Disparity - I (11 hours)

a) The concept of disparity as arising out of social stratification and inequality

b) The issues faced by the Minorities and elderly population

c) The inequalities faced by persons with disabilities and to know about various welfare schemes available to them

d) Role of NGO's in addressing the problems of elderly and persons with disabilities

Module 3 - Concept of Disparity - II (12 hours)

a) The inequalities manifested due to the caste system and inter-group conflicts arising thereof

b) The causes and effects of conflicts arising out of regionalism and linguistic differences

c) Inter-group conflicts arising out of communalism

d) Role of youth in promoting tolerance, peace and communal harmony as crucial values in strengthening the social fabric of Indian society.

Module 4 - The Indian Constitution (11 hours)

a) Evolution of the Indian Constitution

b) Philosophy of the Constitution as set out in the Preamble

c) Salient features of the Indian Constitution

d) Fundamental Duties of the Indian Citizens

Topics for Assignments - Growing Social Problems in India

1. Substance abuse- impact on youth & challenges for the future

2. HIV/AIDS- awareness, prevention, treatment and services

3. Issue of child labour- magnitude, causes, effects and response

4. Child abuse- effects and ways to prevent

5. Trafficking of women- causes, effects and response

6. Local self-government in urban and rural areas

7. Panchayati Raj and significance of 73rd and 74th Constitutional Amendment and their implications for inclusive politics

8. Participation of women in Indian politics/Organized and Unorganized sectors

9. Social Evils and Remedies: Problems faced by youth community (Addiction to social medias, Ragging, Drug addiction, smoking, Drinking, Depression etc.) and remedial measures to overcome them.

10. References of various organizations and institutes , NGOs providing treatment, support and counseling

11. Information of various social institutes working locally and globally with introduction of some dedicated social workers with the information of the work done by them for better living

12. Disaster Management in natural calamities and in manmade created situations.

13. Concept of Disaster & Types of Disaster

14. Disaster Management: Concept & Significance

15. Educating Masses

16. Role of Youth

Revised Syllabus for F.Y.B.A./B.Sc./F.Y.BCom

Semester II

Internal marks: 40 **External marks: 60** **Total Marks: 100**

Objectives :

1. To acquaint students with the concepts of globalization, liberalization and privatization
2. To make students aware of the origin and evolution of the concept of Human Rights
3. To make students understand the importance of the concepts of ecology and environmental and its impact on human life
4. To create awareness about the importance of sustainable development among students
5. To highlight the causes and impact of stress and conflicts arising in the society
6. To equip students with some coping and management techniques to deal with stress and conflicts.

Learning Outcome:

1) Learners will acquire a deeper and more inclusive understanding of the role of globalization, liberalization and privatization in the Indian society along with the understanding of the origin and evolution of Human Rights.

2) An awareness about the environmental problems will be created along with the introduction of the concept of sustainable development.

3) The course will enable students to understand the different stressors in their life as well as it will equip them with some techniques of coping and management of stress and conflicts.

CREDIT 2 Lectures: 45

Module 1 – Globalization and Indian Society (12 hours)

a) Understanding the concepts of liberalization, privatization and globalization

b) Growth of Information technology and communication and its impact on everyday life

c) Impact of globalization on industry; changes in employment and increasing migration

d) Changes in agrarian sector due to globalization; rise in corporate farming and increase in farmers' suicides

Module 2 – Human Rights (11 hours)

a) Concept of Human Rights – Its origin and evolution

b) The Universal Declaration of Human Rights

c) Human Rights constituents with special reference to Fundamental Rights and stated in the Indian constitution

d) Directive Principles of the State Policy enshrined in Indian Constitution

Module 3 – Ecology (11 hours)

a) Concept of Ecology and Environment

b) Environmental degradation – Its causes and impact on human life

c) Sustainable development – concept and components

d) Role of an Indian individuals and organizations in environment protection movements

Module 4 – Understanding stress and conflicts – Its management (11 hours)

a) Agents of socialization and their role in development of the individual

b) Stress: Causes, impact and coping Mechanism

c) Conflict: Meaning, Types and Ways of Resolutions

d) Abraham Maslow's Theory of Self-Actualization

Topics for Assignments – Contemporary Societal changes

1. Impact of Globalization on marginalized groups
2. Increasing urbanization, problems of housing, health and sanitation
3. Changing lifestyle and its impact on culture
4. Impact of consumerism and materialism in today's society
5. Farmers' Suicide and agrarian distress
6. Land acquisition and change of land use
7. Debate regarding genetically modified crops
8. Development projects and human rights violations
9. Increasing crime among youth and impact on society
10. Increasing suicides among youth and impact on society
11. Impact of social media on stress and leading to conflict
12. Significance of values, ethics, prejudices in development of individual
13. Steriotypes and prejudices as cause of conflict in society.
14. Aggression and violence: causes, impact and remedial measures
15. Self-Actualization
16. From Unsustainable to Sustainable development
17. Water conservation, rain water harvesting, watershed management.
18. Climate change, global warming, ozone layer depletion,
19. Environment protection Act
20. Wildlife Protection Act
21. Forest Conservation Act
22. Population explosion, impact on environment
23. Women and Child Welfare Value Education
24. Role of Information Technology in Environment and human health

References :

1. Asthana, D. K., and Asthana, Meera, *Environmental Problems and Solutions*, S. Chand, New Delhi, 2012.

2. Bakshi, P.M., *Indian Constitution*,

3. Baron, R. A., & Kalsher, M. J. (2008). Psychology: From Science to Practice.(2nd ed) Pearson Education inc., Allyn and Bacon Basu, D.D., *An Introduction to the Indian Constitution*,

4. Lahey, B. B. (2007). Psychology: An Introduction. (9th ed.). McGraw- Hill Publications, New York

5. Mohapatra, Gaur Krishna Das, *Environmental Ecology*, Vikas, Noida, 2008.

6. Motilal, Shashi, and Nanda, Bijoy Lakshmi, *Human Rights: Gender and Environment*, Allied Publishers, New Delhi, 2007.

7. Sharma, P.D., *Ecology and Environment*, Rastogi Publications, 2015.

8. Shiva, Vandana *Ecology and the Politics of Survival: Conflict over Natural Resources in Indi*a, Sage Publications, California, 1991.

Learners Space

In addition to the assigned curriculum, there will be innovative ways for students with a special interest in social, economic, constitutional or political aspects. The subject foundation course is very wide and its scope is enlarged. The students can do various things along-with the prescribed things in curriculum. In addition to the syllabus presented, they will be informed about various references.to develop this attitude the use of following things are recommended.

1) Watch a television programme based on subject matter of foundation course and mark out its different perspectives

2) Prepare a survey based report on the primary sources available in your village or town and throw light on social and economic challenges faced by the people.

3) Work with NGO or any serving organization to help challenged and destitute section in the society.

Recommended ITC BACK UP

It is commended to orient the students about social discourse in india with the help of teaching-aid and photos, documentaries, movies, charts, PPT and other available ICT tools along with youtube channels offering history information.

Referred other Autonomous colleges

1) Ramnarain Ruia Autonomous College, Matunga

2) B. K. Birla College of arts, science and commerce (Autonomous), Kalyan

3) St. Xavier's College (Autonomous), Mumbai

Foundation Course- Pedagogy

The Foundation course subject students of FYBA, FYBCOM and FYBSC class will study Overview of Indian Society, Concept of Disparity and Indian Constitution. Learners will also acquire a deeper and more inclusive understanding of the role of globalization, liberalization and privatization in the Indian society along with the understanding of the origin and evolution of Human Rights. As this paper is largely associated with current events and problem the reading of newspapers, magazines and watching news is recommended for the students.

The students need to develop association with the society or the social components and first-hand experience of reality. There are various topics for the projects regarding the characteristics of the Indian society, issues and challenges and the economic, ecological transformation. The Students are expected to participate in project work to find the real glimpse of the society and to develop humanitarian perspectives to all the communities in India. It has been suggested to break up the group of students in the class and distribute the topics to them and organize singing discussions in it so that the skills of expressing ideas will be developed in the students.

Multi-perspective attitude will be more useful and will makes teaching more dynamic, challenging, and motivating for students and has the long-term consequence of educating generations for peace, tolerance, and democracy. Along with classroom teachings. It is commended to orient the students about social discourse with the help of teaching-aid and photos, documentaries, movies, charts, PPT and other available ICT tools. This will enhance their grasping abilities ns understanding of the subject and make it more interesting.

Mr. P. B. Kusmude

Convenor

Assessment:

Workload: 3 lectures per week.

Marks: For 60 marks 4 questions of 15 marks with options are allotted for external assessment.

40 marks out of 100 will be allotted to internal assessment. A minimum of 16 out of 40 (Internal) 24 out of 60 (external/term end) marks must be scored by the student. The student should get an aggregate 40 marks out of 100 per semester to pass in the course.

Internal Assessment – 40 marks (Semester I & II)

Sr. No.	Particulars	Marks	Time
1	One periodical class tests including two shorts notes (10), Fill in the blanks (5), and Answer in one line (5)	20	30 Minutes
2	One assignment based on curriculum (10), Group/individual discussion and Active participation in class (10)	20	-

Projects / Assignments (for Internal Assessment)

i. Projects/Assignments topics can be taken from any of the four modules.

ii. Students should be given a list of possible topics - at least 3 from each Module at the beginning of the semester.

iii. The Project/Assignment can be done in form of Street-Plays/Power-Point Presentations/Poster Exhibitions and any other similar mode appropriate to the topic.

iv. Students can work in groups (not more than 6 students in a group).

v. Students must submit a hard/soft copy of the Project/Assignment before appearing for the semester end examination.

F.Y.B.A./B.Sc. – Foundation Course - I

Question Paper Pattern for Semester I & II

Time -2 hours **Total Marks - 60**

NB: Answer the following questions (15 Marks Each)

Q.1. Based on Module I

OR

Q.1. Based on Module I

Q.2. Based on Module II

OR

Q.2. Based on Module II

Q.3. Based on Module III

OR

Q.3. Based on Module III

Q.4. Based on Module IV

OR

Q.4. Based on Module IV

Pedagogy

Biotechnology – key technology of 21st century- refers to applications or manipulations of techniques on living things to produce goods and services. Due to ever expanding scope of biotechnology, the role of teachers is becoming challenging. The syllabus of First Year Biotechnology is designed to impart fundamental concepts of basic chemistry, life science, genetics, molecular biology, applications of biotechnology, etc. The student will gradually be directed further towards specific knowledge related to the field of biotechnology. The teacher must be competent enough to not only impart knowledge but to develop a student as a keen observer, hard worker, goal setter and independent thinker.

The teaching and learning process underlying this course is student centric to create an environment which interests, challenges and develops confidence among students. Although the primary method of teaching would be interactive lectures and practical sessions to facilitate learning, various pedagogical approaches to be followed to enhance effective learning process. It may include various methods as below:

- Co-curricular activities like poster making, model making, presentations, etc.
- Audio- video based lectures, animated presentations, science fiction movies, cartoon programmes, etc. will help in cognitive learning of important concepts.
- Laboratory based learning; experimental teaching learning has to be major component of teaching to help students acquire practical skills in the area.
- Use of models, charts, simulations, virtual labs will help students understand basic subject concepts.
- Collaborative approaches like Seminars, Group discussions, Role plays, Field work and Group projects will facilitate overall personality development of students.
- The evaluation process may involve formative and summative assessment approach involving assignment, objective tests, presentations, seminars, projects, quizzes, etc.
- Through industrial visits and excursions students can understand practical utility and scope of the subject.

Above all students should be inculcated with positive attitude, preparedness, creativity and compassionate learning with personal touch in the subject.

Academic Council dated 10th February, 2022 as per Item Number: 3.03

DOMBIVLI SHIKSHAN PRASARAK MANDAL'S,

K.V. PENDHARKAR COLLEGE OF ARTS, SCIENCE AND COMMERCE, (AUTONOMOUS) DOMBIVLI (EAST), DIST. THANE

(Affiliated to University of Mumbai)

Faculty of Science

DEPARTMENT OF BIOTECHNOLOGY

(Programme: Bachelor of Science, B.Sc.)

SYLLABUS FOR

S. Y. B.Sc. – Biotechnology (Semester III and IV)

Choice Based Credit System (CBCS)

(With effect from the Academic Year: 2022-2023)

SEMESTER- III				
Course code	**Course type**	**Course Title**	**Credits**	**Lectures/ Week**
PUSBTIII22-371	Core Subject	Biophysics	2	3
PUSBTIII22-372	Core subject	Applied Chemistry- I	2	3
PUSBTIII22-373	Core Subject	Immunology	2	3
PUSBTIII22-374	Core Subject	Cell Biology and Cytogenetics	2	3
PUSBTIII22-375	Core Subject	Molecular Biology	2	3
PUSBTIII22-376	Skill enhancement elective	Bioprocess Technology	2	3
PUSBTIII22-377	General Elective	Entrepreneurship development	2	3
PUSBTIII22-P1	Core subject Practical	Practical of **PUSBTIII22-371** and **PUSBTIII22-372**	2	6
PUSBTIII22-P2	Core subject Practical	Practical of **PUSBTIII22-373** and **PUSBTIII22-374**	2	6
PUSBTIII22-P3	Core Subject and Skill enhancement elective Practical	Practical of **PUSBTIII22-375** and **PUSBTIII22-376**	2	6
SEMESTER-IV				
Course code	**Course type**	**Course Title**	**Credits**	**Lectures/ Week**
PUSBTIV22-471	Core Subject	Biochemistry	2	3
PUSBTIV22-472	Core subject	Applied Chemistry- II	2	3
PUSBTIV22-473	Core Subject	Medical Microbiology	2	3
PUSBTIV22-474	Skill enhancement	Molecular Diagnostics	2	3

	elective			
PUSBTIV22-475	Core Subject	Biostatistics and Bioinformatics	2	3
PUSBTIV22-476	Core Subject	Environmental Biotechnology	2	3
PUSBTIV22-477	General Elective	Research methodology	2	3
PUSBTIV22-P1	Core subject Practical	Practical of **PUSBTIV22-471** and **PUSBTIV22-472**	2	6
PUSBTIV22-P2	Core Subject and Skill enhancement elective Practical	Practical of **PUSBTIV22-473** and **PUSBTIV22-474**	2	6
PUSBTIV22-P3	Core subject Practical	Practical of **PUSBTIV22-475** and **PUSBTIV22-476**	2	6

SEMESTER III

Course Code	Title	Credits	No. of Lectures
PUSBTIII22-371	**BIOPHYSICS**	**2**	

Course objectives:-

The objective of this course is to have a firm foundation in the fundamentals and applications of current biophysical theories.

Learning outcomes:-By the end of the course the student will:

- Develop an understanding of the different aspects of classical physics.
- Be able to relate principles of physics to applications and techniques in the field of biology such as microscopy, spectroscopy and electrophoresis.

UNIT I **Optics and Electromagnetic Radiations**	**Introduction to Optics and Lasers:** ***Optics*:** Properties of Light - Reflection, Refraction, Dispersion, Interference. ***Lasers*:** Properties of Lasers, Stimulated Emissions, Laser Action; Applications of Laser. **Electromagnetic Radiations:** Introduction to Electromagnetic Radiation. **Spectroscopy:** Types and Properties of Spectra; Basic Laws of Light Absorption. Spectrophotometer:-Principle, Instrumentation and Applications; UV-Vis Spectrophotometer, Single and Dual Beam Spectrophotometer. **Microscopy:** Types of Microscopy; Electron Optics; Electron Microscopy- Preparation of Specimen, SEM, TEM and Immuno-Electron Microscopy. Fluorescence Microscopy.		15

UNIT II **Heat, Sound, Magnetism and Fluid Dynamics**	**Heat:** Concept of Temperature; Modes of Heat Transfer; Measuring Temperature; Platinum Resistance Thermometer; Thermocouple and Thermistors. **Sound:** Types of Sound Waves - Audible, Ultrasonic and Infrasonic Waves; Doppler Effect; Applications of Ultrasonic Waves. **Magnetism:** Magnetic Field; Magnetism of Earth; Paramagnetism, Diamagnetism, Ferromagnetism. Nuclear Magnetism and Biomagnetism. **Fluid Dynamics :** ***Viscosity*:** Definition Flow of Liquids through Capillaries; Stokes' Law; Terminal Velocity. Determination of 'η' by Falling Sphere Method; Viscosity Estimation by Oswald's Viscometer. ***Surface Tension*:** Definition - Surface Tension and Surface Energy; Capillary Action; Angle of Contact; Wettability; Temperature Dependence of Surface Tension. Applications in Biology.		15
UNIT III **Electrophoretic Techniques**	**Electrophoresis:** Introduction, Principle of Electrophoresis Migration of Ions in an applied electric field; Factors affecting Electrophoretic Mobility; **Types & Techniques of electrophoresis:** Free Electrophoresis: Moving Boundary Electrophoresis; Zone Electrophoresis : Supporting Matrix Paper electrophoresis; AGE; Native and SDS PAGE (reducing and non-reducing, continuous and discontinuous); **Specialized Electrophoretic techniques:** Discontinuous Gel Electrophoresis, Isoelectric focusing and 2D PAGE. Staining and Detection methods; Gel-Documentation. Applications in Biology.		15

Learner's space:
Applications of Optics in Medical field/Space Science, etc. Use of Electrophoresis in Advance Molecular Biological techniques like PCR/RAPD/RFLP/AFLP etc.

MOOC:

1. https://www.classcentral.com/course/swayam-fundamentals-of-optical-and-scanning-electron-microscopy-5334
2. https://www.classcentral.com/course/swayam-experimental-biotechnology-19863

Pedagogy: Group discussion, Models, Animated YouTube Videos, Online worksheets, Virtual Labs.

Reference books:

1. Essential Biophysics, Narayanan, New Age Publications
2. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley
3. Biophysical Chemistry: Principles & Techniques by Upadhyay, Upadhyay,Nath. (Himalaya Publishing House)
4. Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, Cambridge University Press
5. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications

ICT backup:

1. https://www.britannica.com/technology/laser
2. https://www.va.gov/DIAGNOSTICEM/What_Is_Electron_Microscopy_and_How_Does_It_Work.asp
3. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P001354/M021523/ET/1501757741ET.pdf
4. http://www.dspmuranchi.ac.in/pdf/Blog/electrophoresis.pdf
5. https://ncert.nic.in/ncerts/l/iesc112.pdf
6. https://ncert.nic.in/textbook/pdf/leph105.pdf

Course Code	Title	Credits	No. of Lectures
PUSBTIII22-372	**APPLIED CHEMISTRY – I**	**2**	

Course objectives:-

The objective of this course is to have a firm foundation in the fundamentals and applications of organic and green chemistry.

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

- Develop an understanding of the different aspects of organic and green chemistry.
- Discuss the role of organic compounds in biology and synthesis of organic compounds.
- Discuss the role of green chemistry and its application in industry.

UNIT I Organic Chemistry	**Introduction to Types of Organic Reactions:** Addition, Elimination and Substitution Reactions. Rearrangement reactions **Metal Coordination in Biological Systems:** Essential and Non-essential Elements in Biological Systems. Role of Metal Ions in Biological Systems Enzymes, Apoenzymes and Coenzymes. Biological Role of Metalloenzymes with respect to Myoglobin, Haemoglobin. Biological Role of Carboxypeptidases, Catalases and Peroxidases. **Structure and Function:** Dioxygen Binding, Transfer and Utilization; Metal Complexes in Medicines.		15
UNIT II Synthesis of Organic Compounds	**Synthesis of Organic Compounds :** Criteria for Ideal Synthesis; Selectivity and Yield. Linear and Convergent Synthesis and Multicomponent Reactions. Microwave Assisted Organic Synthesis, Ultrasound in Synthesis and Polymer supported Synthesis. Retrosynthesis.		15

UNIT III **Green Chemistry and Synthesis**	Introduction to Green Chemistry; Need and Relevance of Green Chemistry; Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry. **Principles of Green Chemistry.** Green Synthesis in Industry: Green Materials, Green Reagents, Green Solvents and Green Catalysts. **Future Trends in Green Chemistry:** Green chemistry in sustainable development.		15

Learner's space:

Biological role of different enzymes, isoenzymes and coenzymes, organic synthesis of active pharmaceutical compounds and the significance of green chemistry for sustainable development can be studied.

MOOC:

Enzymology - https://onlinecourses.swayam2.ac.in/cec20_bt20/preview Swayam, Credit point - 4, Duration - 12 weeks, UG level

Pedagogy: Animated Videos, Group discussion, Models, Google classrooms.

Reference books:

1. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhatacharjee, 7th Edition, Pearson Education (2011).
2. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)
3. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
4. Fundamentals of Organic Chemistry, G. Marc Loudon, 4th Edition Oxford
5. Biochemistry - Satyanarayan and Chakrapani 4th edition
6. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
7. V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
8. M.C. Cann& M.E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).

ICT backup:

1. https://www.rgpv.ac.in/campus/PY/enzymes_ppt.pdf
2. https://www.vedantu.com/chemistry/types-of-organic-reactions
3. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/synth2.htm
4. https://www.iqvia.com/blogs/2019/11/importance-and-impact-of-organic-synthesis-and-retrosynthesis-in-the-field-of-chemistry
5. https://www.epa.gov/greenchemistry/basics-green-chemistry

Course Code	Title	Credits	No. of lectures
PUSBTIII22-373	**IMMUNOLOGY**	**2**	

Course objectives:-
The objective of this course is to familiarize students with the immune effector mechanisms and various immunotechniques.

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

- Understand the role of complements in immune response and different immune cell receptors involved in immune reaction.
- Understand the principles underlying various immunotechniques.

UNIT I **Effectors of Immune Response**	**Complement System-** Classical, Alternate and Lectin pathways; Regulation and Biological Effects of Complement System; Deficiencies of Complement System **MHC Classes -** General Organization and Inheritance; Structures and Peptide Interactions; Class I and II Diversity and Polymorphism; Antigen Presentation through Endocytic and Exocytic Pathways; MHC Restriction.		15
UNIT II **Cell Receptors**	**T-cell Receptor Complex:** Structure and Activation. **B-cell Receptor:** Structure, Maturation and Activation **Toll like receptors** **B-T cell interaction (B-T cell cooperation)** **Cell cytotoxic responses as the effector mechanism.**		15
UNIT III **Immuno Techniques**	**Precipitation Reactions :** Immunoprecipitation, Immunoelectrophoresis, CIEP, Rocket Electrophoresis and 2-D Immunoelectrophoresis **Agglutination Reactions :** Passive, Reverse Passive, Agglutination Inhibition. Coomb's Test; Complement Fixation Tests, RIA, ELISA, ELISPOT,		15

	Chemiluminescence, Western Blot, Immunofluorescence, Flow Cytometry. **Alternatives to Antigen-Antibody Reactions.**		

Learner's space:
Application of immunology concepts and techniques in commercial kits used to diagnose the infections.

MOOC:

1. Fundamentals of Immunology: Innate Immunity and B-Cell Function
   https://www.coursera.org/learn/immunologyfundamentalsimmunitybcells?specialization=immunology, Coursera, Duration - 12 weeks, UG level
2. Immunology - Course (swayam2.ac.in) Swayam, Credit point – 4, Duration - 12 weeks, UG level.

Pedagogy: YouTube videos, PPT**,** Group discussion, Models, Practical techniques, Animated videos, Virtual labs.

Reference books:

1. Immunology, Richard Goldsby, Thomas Kindt, Barbara Osborne, JenisKuby; 5th edition.
2. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and ShubhangiSontakke, University Press, India
3. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA.
4. Introduction to Immunology- C V Rao- Narosa Publishing House

ICT backup:

1. https://www.physio-pedia.com/Complement_System
2. https://courses.lumenlearning.com/microbiology/chapter/major-histocompatibility-complexes-and-antigen-presenting-cells/
3. https://youtu.be/3W67OH3v2lU
4. https://youtu.be/RRbuz3VQ100

Course Code	Title	Credits	No. of lectures
PUSBTIII22-374	**CELL BIOLOGY AND CYTOGENETICS**	**2**	

Course objectives:-

The objective of this course is to have a firm foundation in the fundamentals of cell biology and cytogenetics.

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

- Develop an understanding of the cytoskeleton and transport mechanism across cell membranes.
- Discuss the structure of chromosomes and types of chromosomal aberrations, linkage and mapping.

UNIT I **Cytoskeleton**	Overview of the Major Functions of Cytoskeleton. **Microtubules:** Structure and Composition, MAPs, Functions of Microtubules. Motor Proteins: Kinesin, Dynein MTOCs, Dynamic Properties of Microtubules Microtubules in Cilia and Flagella **Intermediate Filaments:** Structure and Composition Assembly and Disassembly Types and Functions **Microfilaments:** Structure and Composition, Assembly and Disassembly Motor Protein: Myosin Role of Microfilaments in Muscle Contractility Actin Binding Proteins Examples of Nonmuscle Motility and Contractility		15

UNIT II **Cellular Transport and Cellular Interactions**	Concept of Cell Permeability Uptake of Nutrients by cells **Principles of Membrane Transport-** Transporters and Channels Active Transport, Passive Transport **Types of Transporters:** ATP Driven Pumps - Na+ K+ Pump, Ca2+ pump **Cell Junctions and its Classification,** Microvilli **Cell Adhesion:** Role of cadherins and integrins **Extracellular Matrix** Cell Coat and Cell Recognition. Cellular Interactions.		15
UNIT III **Cytogenetics**	**Genome organization in Viruses, Prokaryotes and Eukaryotes** **Extrachromosomal Inheritance** Mitochondrial DNA, Chloroplast DNA Kappa particles in Paramoecium **Structural organization and Significance** of Polytene chromosome, Lampbrush Chromosome **Variation in Chromosomal Structure and Number :** Deletion, Duplication, Inversion, Translocation, Aneuploidy, Euploidy and Polyploidy and Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy 21, Trisomy 18 and Trisomy 13. Karyotyping and its importance **Genetic Linkage, Crossing Over and Chromosomal Mapping :** Two-point Cross; Three point Cross **Pedigree Analysis**.		15

Learner's space:

Insight into Cytoskeletal Abnormalities, cellular processes like Endocytosis and Literature search of human genetic disorders through OMIM.

MOOC:

1. Essential Human Biology: Cells and Tissues: Duration: 5 weeks (2–3 hours per week) Self-paced, Free (Optional upgrade available)https://www.edx.org/course/essential-human-biology-cells-and-tissues.
2. General Biology II: The World of the Cellhttps://www.udemy.com/course/general-biology-ii-the-world-of-the-cell/
3. https://www.classcentral.com/course/swayam-human-molecular-genetics-5803

Pedagogy: Posters, PowerPoint presentation, animated videos, Models, Case study (Genetic counselling), Preparing pedigree charts for inheritance of some human traits, Flipped classroom.

Reference books:

1. Cell and Molecular Biology- Concepts and Experiments, 6th edition (2010)—Gerald Karp – Wiley International
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 and Molecular Biology – De Robertis- Lippincott Williams & Wilkins
4. Prescott, Harley and Klein's Microbiology, McGraw Hill Higher Education, Joanne M. Willey, Linda Sherwood, Lansing M.Prescott, Christopher J. Woolverton 7th edition 2008
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons
6. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co
8. Fundamentals of Genetics. B.D Singh
9. Textbook of Cell Biology, Genetics, molecular biology , Ecology and Evolution.: P.S. Verma and V.K Agarwal (2001)

ICT backup:

1. https://www.cureffi.org/2013/03/30/cell-biology-07-microtubules-and-cell-division/
2. https://organismalbio.biosci.gatech.edu/chemical-and-electrical-signals/effectors-and-movement/
3. http://www.vivo.colostate.edu/hbooks/pathphys/topics/sodium_pump.html
4. https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/cell-communication/a/cell-cell-junctions
5. http://www2.csudh.edu/nsturm/CHEMXL153/GenomeOrganization.htm
6. https://www.lecturio.com/magazine/human-genetics-chromosomal-aberrations/
7. https://www2.kumc.edu/genetics/lab/

Course Code	Title	Credits	No. of Lectures
PUSBTIII22-375	**MOLECULAR BIOLOGY**	**2**	

Course objectives:-

The objective of this course is to have an insight into the mechanism of gene expression and regulation.

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

- Examine the steps involved in the transcription of Prokaryotes & Eukaryotes.
- Discuss the mechanisms associated with gene expression at the level of translation.
- Discuss the mechanisms associated with regulation of gene expression in prokaryotes and eukaryotes.

UNIT I **Gene Expression-Transcription**	**Gene Expression- an Overview.** **Transcription Process in Prokaryotes:** RNA Synthesis; Promoters and Enhancers; Initiation of Transcription at Promoters; Elongation and Termination of an RNA Chain. **Transcription in Eukaryotes:** Eukaryotic RNA Polymerases; Eukaryotic Promoters; Transcription of Protein Coding Genes by RNA Polymerase; Eukaryotic mRNA's; Transcription of other genes; Spliceosomes, RNA editing		15
UNIT II **Gene Expression-Translation**	**Nature of Genetic Code** (Deciphering the genetic code, Characteristics, Wobble Hypothesis) **Translation in Prokaryotes and Eukaryotes** Charging of t-RNA, Process of Protein Synthesis (Initiation, Elongation, Translocation, Termination) **Post Translational Modifications.** Glycosylation, Acetylation, Methylation **Protein sorting**		15

UNIT III **Regulation of Gene Expression**	**In Prokaryotes:** **In Bacteria:** *lac* Operon of *E.coli*; *trp* Operon of *E.coli*. **In Eukaryotes :** Operons in Eukaryotes; Control of Transcriptional Initiation; Gene Silencing and Genomic Imprinting; Post-Transcriptional Control; RNA Interference.		15

Learner's space:
Role of Antibiotics in Bacterial Transcription & Translation Inhibition. Use of Gene Silencing in Therapeutics & its challenges.

MOOC:

1. https://www.my-mooc.com/en/mooc/molecular-biology-part-2-transcription-mitx-7-28-2x-0/
2. https://www.edx.org/course/molecular-biology-part-3-rna-processing-and-transl?index=product&queryID=74a7f9fda239d84108dff3daf5d1e6cf&position=6
3. https://www.classcentral.com/course/epigenetics-486.

Pedagogy: Google Classroom, YouTube animated Videos, Concept Mapping, Group Discussion, Worksheet & Flow Sheet Preparation & Power point presentation.

Reference books:-

1. iGenetics(Molecular Approach), 3rd edition- Peter Russell -Pearson Education
2. Microbial Genetics- Freifelder –Narosa Publishing House
3. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett
4. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2005). Lehninger principles of biochemistry 4thedn. Macmillan. W.H. Freeman and Company, New York.

ICT backup:

1. https://www.youtube.com/watch?v=nXj2Hmd51l4
2. https://www.youtube.com/watch?v=CxxQ5i97YB0
3. https://www.youtube.com/watch?v=G8RYhV569xg
4. https://www.khanacademy.org/science/biology/gene-regulation

Course Code	Title	Credits	No. of Lectures
PUSBTIII22-376	**BIOPROCESS TECHNOLOGY**	**2**	

Course objectives:-

The objective of this course is to understand the basic skills applied in fermentation technology and build a foundation for more advanced studies in bioprocess technology.

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

- Develop an understanding of the various aspects of bioprocess technology.
- Develop skills associated with screening of industrially important strains.
- Understand principles underlying design of fermenter and fermentation process.

UNIT I **Microorganisms in Industrial Processes**	**Types of Microorganisms used in Industrial Processes:** Bacteria, Actinomycetes, Fungi and Algae. **Screening and maintenance of strains:** Primary Screening and Secondary Screening. Culture Collection centres. Strain improvement of microorganisms **Preservation of Industrially Important Microbial Strains** - Stab culture, Soil stock method, Lyophilisation & Cryopreservation		15
UNIT II **Fermenter and Fermentation Processes**	**Design of a fermenter:** Stirred Tank Fermenter- Basic Design; Parts of a Typical Industrial Fermenter. **Fermentation Media:** Components; Design and Optimization. **Sterilization:** Sterilization of Fermenter and Fermentation Media. **Process Parameters:** pH, Temperature, Aeration, Agitation, Foam, etc. **Types of Fermentation:** Surface and Submerged; Batch and Continuous, Aerobic and Anaerobic. **Product Isolation and Purification.** **Study of representative fermentation processes:** Outline of Penicillin and Ethanol Production by fermentation along with a flow-diagram.		15

UNIT III ***In-vivo* and *In-vitro* Assay of Industrial Products**	**Assay of Industrial Products:** *In vivo* Animal assays - Pyrogen and Endotoxin testing Chemical and Biological; Types and Subtypes; Kinetics. Advantages and Disadvantages. Bioavailability and Bioequivalence Studies		15

Learner's space:
To explore manufacturing details of various industrial products produced by microorganisms.

MOOC:

1. Phase- I Online Certificate Course on Fermentation Technology - Atal Bihari Vajpayee Vishwavidyalaya (e-atalgyansangum.ac.in).
2. Microbial fermentation processes and bioreactor design - Biochemical and Bioprocess Engineering | Coursera

Pedagogy: Google classroom & making crossword puzzle & group discussions, Production flow-sheet preparation, Industrial visits.

Reference books:

1. Food Microbiology- Frazier
2. Industrial Microbiology- A. H. Patel
3. Industrial Microbiology- L. E. Casida- John Wiley & Sons
4. Prescott & Dunn's Industrial Microbiology by Presscott, Samuel cate 1872-1962, Fourth edition, Western cott publication.

ICT backup:

1. https://youtu.be/xbdJUuHUXOE
2. Screening of Microorganisms: Primary and Secondary Techniques | Industrial Biotechnology (biotechnologynotes.com)
3. https://youtu.be/hASoAZ_QCHk
4. Pharmaceutical Bioavailability and Bioequivalence: Pharmaceutical Guidelines (pharmaguideline.com)

Course Code	Title	Credits	No. of Lectures
PUSBTIII22-377	**ENTREPRENEURSHIP DEVELOPMENT**	**2**	

Course objectives:-

To develop and systematically apply an entrepreneurial way of thinking that will allow identification and creation of business opportunities.

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

- Develop an understanding of the systematic process and to select and screen a business idea.
- Design strategies for successful implementation of ideas.
- Learn potential opportunities and ideas and career choices available to the entrepreneur.

UNIT I **Introduction to Entrepreneurship Development**	Concept of Entrepreneur & Entrepreneurship; Need and Importance; Factors Influencing Entrepreneurship; Essentials of a Successful Entrepreneur. Ethics &Social Responsibility of Entrepreneurs, Opportunities & Scope of Entrepreneurs, Entrepreneurs in India & Abroad; Woman as an Entrepreneur.		15
UNIT II **Setting-up of an Enterprise and Planning**	Location of Enterprise; Real Estate and Human Resource Planning, Financial Planning; Role of Government and Financial Institutions in Entrepreneurship Development; Raising Money from Venture Capitalists, Government Grants, Product Selection and Ideas; Project Planning and Formulation; Project Feasibility Assessment; Regulatory Affairs, Corporate Laws, Innovation, IPR generation and Protection, Preparation of a Business Plan, Characteristics and Importance of Planning		15
UNIT III **Marketing, Research and Opportunities in Biotechnology**	Marketing Plan for an Entrepreneur; Strategic Alliances, Marketing strategy, Advertising and Sales Promotion Market Assessment and Market Research, Need for International Market Research, Domestic vs. International Market Research, Cost and Methodology of Market Research, Desk and Field Research Entrepreneurship Opportunities in Biotechnology		15

Learner's space:
Learn mentorship programs in collaboration with government organizations, incubation centres, educational institutions and private organizations.

MOOC:

1. https://www.startupindia.gov.in/content/dam/invest-india/Templates/public/Action__Plan.pdf
2. The Science and Business of Biotechnology: Duration: 16 weeks (10–12 hours per week), Self-paced, Free (Optional upgrade available)
3. https://www.edx.org/course/the-science-and-business-of-biotechnology

Pedagogy: YouTube videos, Case studies, Group Discussion, Seminars, Case studies, Flipped Classroom.

Reference books:

1. Entrepreneurship - Kurup
2. Handbook of Entrepreneurship development - Basotia and Sharma
3. Jose Paul and Kumar Ajith N, "Entrepreneurship Development and Management", Himalaya Publishers, New Delhi, 2000.
4. Dollinger, "Entrepreneurship Strategies and Resources", Pearson Education, 2003.
5. Holt David H, "Entrepreneurship: New Venture Creation", Prentice Hall of India, 2000

ICT backup:

1. https://www.businessmanagementideas.com/entrepreneurship-2/women-entrepreneurs/21046
2. https://youtu.be/ol_VZfjgkME
3. https://youtu.be/YxfJPCXHAwA
4. https://www.labiotech.eu/expert-advice/beginners-guide-biotech-life-science-marketing/
5. https://www.process.st/business-plan-vs-business-proposal/

PRACTICAL

	SEMESTER III	
Course code	**Title**	**Credits**
PUSBTIII22-P1 (PRACTICAL based on PUSBTIII22-371 and PUSBTIII22-372)	1. Verification of Beer-Lambert's Law. 2. Study of Absorption Spectra of any one coloured compound ($CuSO_4$ /$CoCl_2$/ $KMnO_4$). 3. Plasmid Biology a) Extraction of Plasmid DNA and quantification using UV Spectrophotometry. b) Separation of plasmid DNA by Agarose Gel Electrophoresis. 4. Electrophoresis of Proteins by native PAGE and SDS-PAGE. 5. Electron Microscope, Fluorescence Microscope (Lab Visit). 6. Purification of any TWO Organic Compounds by Recrystallization Selecting Suitable Solvent. 7. Organic Estimations: Acetone, Amide, Benzoic Acid. 8. Organic Preparations: a) Acetylation of Primary Amine (Preparation of Acetanilide)	2
Course code	**Title**	**Credits**
PUSBTIII22-P2 (PRACTICAL based on PUSBTIII22-373 and PUSBTIII22-374)	1. Passive Agglutination- RA Factor Test. 2. Immunoelectrophoresis 3. ELISA (Kit-based) - HEPALISA. 4. DOT-ELISA. 5. Western Blotting - Demonstration. 6. Flow Cytometry - Lab Visit. 7. Study of Human chromosomal disorders - Trisomy 21 Trisomy 13 Trisomy 18, Klinefelter and Turner, Cri-du-Chat.(Preferably using online software) 9. Study of Polytene Chromosomes. 10. Mapping based on Three Point Cross.(Problems) 11. Pedigree Analysis- Autosomal and Sex-Linked. (Problems) 12. Karyotyping: Video demonstration	2

Course code	Title	Credits
PUSBTIII22-P3 (PRACTICAL based on PUSBTIII22-375 and PUSBTIII22-376)	1. Study of *E.coli* Diauxic Growth Curve- (Lactose and Glucose). 2. Study of *lac* Gene Expression using Blue-White Selection. 3. Expression of β-galactosidase and Measurement of Activity. 4. Screening for an Antibiotic Producing Strain of Microorganism. 5. Lab Scale Production of Penicillin (Static and shaker). 6. Purification of Penicillin from Broth Culture of *Penicillium spp.* by Solvent Extraction. 7. Estimation of Penicillin from Recovered Broth by Chemical (Iodometric) Method. 8. Estimation of Penicillin from Recovered Broth by Biological (Bioassay) Method.	2

SEMESTER-IV

Course Code	Title	Credits	No. of Lectures
PUSBTIV22-471	**BIOCHEMISTRY**	**2**	

Course objectives:-

The objective of this course is to gain an insight into the metabolic processes associated with catabolism of carbohydrates, amino acids, lipids and nucleotides.

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

- Understand the catabolic pathways of carbohydrates, amino acids, lipids and nucleotides.
- Explain the role of energy rich molecules in metabolism.

UNIT I **Carbohydrate Metabolism, ETS and Energy Rich Compounds**	**Carbohydrate Metabolism:** Glycolytic Pathway (Homolactic Fermentation; Alcoholic Fermentation) Citric Acid Cycle and its Regulation; Gluconeogenesis; Pentose Phosphate Pathway; Glyoxylate Pathway; Reductive TCA. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above pathways) **Electron Transport System:** Electron Transport and Oxidative Phosphorylation, Inhibitors of ETS. **Energy Rich Compounds:** ATP as Energy Currency, Structure of ATP, Hydrolysis, Other Energy Rich Compounds other than ATP like PEP, Creatine Phosphate, etc.		15
UNIT II **Amino Acid Metabolism**	**Protein digestion and absorption** Overview of Amino acid biosynthesis **Amino Acid Catabolism:** **Metabolic fate of amino groups:** Transamination, Deamination, Fate of Ammonia, Urea Cycle **Metabolic fate of carbon chain of amino acids:** Breakdown of Glucogenic and Ketogenic Amino Acids. **Amino Acids as Biosynthetic Precursors:** Biosynthesis of Epinephrine, Dopamine, Serotonin, GABA, Histamine, Glutathione, Creatine, Indoleacetic acid and Cinnamate		15

UNIT III **Lipid and Nucleotide Metabolism**	**Lipid Metabolism:** Digestion, Mobilization & Transport of Fatty Acids. Beta oxidation of Saturated Fatty Acids; Oxidation of Unsaturated Fatty Acids; Oxidation of Odd Chain Fatty Acids. Alpha and Omega Oxidation of Fatty acids. Ketone Body synthesis and breakdown. (Sequence of Reactions, Regulation, Energy Yield and Metabolic Disorders of the above pathways) **Nucleotide Metabolism:** Degradation of Purines and Pyrimidines.		15

Learner's space:

Anabolic pathways and Human genetic disorders affecting carbohydrates, amino acid, lipids and nucleotide metabolism can be studied.

MOOC: Biochemistry: The Molecules of Life, Duration: 3 weekshttps://www.futurelearn.com/courses/biochemistry.

Pedagogy: Flow-sheet preparation, metabolic pathway poster preparation, animated videos, Flipped classroom, Case study, Google classroom for E-notes.

Reference books:

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2005). Lehninger principles of biochemistry 4th edition. Macmillan. W.H. Freeman and Company, New York.
2. Biochemistry, 5th Edition by U Satyanarayana, U Chakrapani Elsevier Health Sciences, 25-Jun-2020
3. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet& Judith Voet , John Wiley and Sons, I. USA
4. Biochemistry: 7th Edition, (2012), Jeremy Berg, LubertStryer, W.H.Freeman and company, NY

ICT backup:

1. https://courses.lumenlearning.com/suny-ap2/chapter/carbohydrate-metabolism-no-content/
2. https://www.youtube.com/watch?v=ppqpUVaasNc
3. https://www.khanacademy.org/test-prep/mcat/biomolecules/fat-and-protein-metabolism/v/digestion-mobilization-and-transport-of-fats-part-i
4. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/urea-cycle
5. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6331359/
6. https://www.ncbi.nlm.nih.gov/books/NBK513323/
7. https://www.lecturio.com/magazine/metabolism-amino-acids/#transamination-of-amino-acids

Course Code	Title	Credits	No. of Lectures
PUSBTIV22-472	**APPLIED CHEMISTRY –II**	**2**	

Course objectives:-

The objective of this course is to have a firm foundation in the fundamentals and applications of current chemical theories for the physical world.

Learning outcomes:- By the end of the course the student will:

- Develop an understanding of the different aspects of analytical chemistry.
- Gain knowledge of natural product chemistry and related acquired skills.
- Gain an understanding of basic concepts in polymer chemistry and Nanomaterials.

UNIT I **Sampling and Separation Techniques**	**Sampling:** Importance of Sampling and Sampling Techniques Types of Sampling - Random and Non-Random Sampling of Solids, Liquids and Gases. **Separation Techniques:** Types of Separation Techniques - Filtration, Zone refining, Distillation, Vacuum Distillation. Solvent Extraction - Partition Coefficient and Distribution Ratio, Extraction Efficiency, Separation Factor, Role of Complexing Agents, Chelation, Ion pair Formation, Solvation, and Soxhlation. Centrifugation - Basic principles of sedimentation.		15
UNIT II **Natural Product Chemistry**	**Natural Product Chemistry:** Primary and Secondary Metabolites. Distribution and biogenetic origin of natural products **Natural products from Microorganisms and Fungi:** Antibiotics, non-antibiotic drugs from fungal and other microbial sources, microbial phytotoxins **Natural products from plants**: Glycosides & Saponins, Alkaloids, Steroids & triterpenoids, Flavonoids, Coumarins & Lignans, Essential oils		15

	Chromatographic Separation of Natural Products: Separation Techniques: Planar chromatography: HPTLC Column chromatography: HPLC, GC		
UNIT III **Polymers and Nanomaterials**	**Polymers:** Introduction to Polymers. Types of Polymers - Monomer, Polymer, Homopolymer, Copolymer, Thermoplastics and Thermosets, Addition and Condensation Polymers (Examples and Uses) Stereochemistry of Polymers. Biodegradable Polymers. **Nanomaterials:** Introduction to Nanomaterials. Forms of Nanomaterials: Nanoparticles, Nanofilms and Nanotubes Synthesis and Characterization of Nanomaterials. Applications of Nanomaterials.		15

Learners' space:
Industrial applications of Sampling and Separation techniques, Structure elucidation of Natural products, Examples of nanomaterial products.

Pedagogy: PPTs, Preparation of charts, Video based lectures

References books:

1. Chemistry of Natural Products, O. P. Agarwal, Goel Publishing House
2. Trease and Evans Pharmacognosy, William C. Evans, 16th edition
3. Principles and Techniques of Biochemistry and Molecular Biology, Keith Wilson and John Walker, Cambridge University Press
4. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhatacharjee, 7th Edition, Pearson Education (2011).
5. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)
6. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
7. Fundamentals of Organic Chemistry , G. Marc Loudon, 4th Edition Oxford
8. Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition,2008 7. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008
9. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition

10. Textbook of T.Y.B.Sc Analytical Chemistry Revised syllabus
11. Unit Operation of Chemical Engineering, 6th edition by Warren Mccabe
12. S.Y.B.Sc Analytical Chemistry Textbook- Sheth Publishers
13. Basic Concepts of Analytical Chemistry-S.M. Khopkar
14. Bioanalytical Techniques, M.L. Srivastava
15. Polymers-Textbook of Organic Chemistry,T.Y.B.Sc Himalaya Publishing House
16. Polymer Science-V.R. Gowariker, Viswanathan
17. Nanomaterials: B. Viswanathan

ICT backup:

1. https://www.researchgate.net/profile/Br-Rajeswara-Rao/post/What-is-the-most-efficient-method-for-extraction-of-phytochemicals-from-plants/attachment/59d6460ec49f478072eae357/AS%3A273831233556481%401442297861959/download/Natural+Products+Chemistry-Cooper%2C+Nicola.pdf
2. https://www.intechopen.com/books/secondary-metabolites-sources-and-applications/an-introductory-chapter-secondary-metabolites
3. https://www.frontiersin.org/articles/10.3389/fmicb.2019.00914/full

Course Code	Title	Credits	No. of lectures
PUSBTIV22-473	**MEDICAL MICROBIOLOGY**	**2**	

Course objectives:-

The objective of this course is to gain insight into disease factors and processes and diseases caused by microorganisms.

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

- List the factors playing a role in causing a disease gain.
- Discuss the various aspects of systemic infections including causative agents, symptoms and prophylaxis.
- Gain the technical capability of handling, isolating and identifying various bacteria.

UNIT I **Infectious Diseases**	**Host Parasite Relationship:** Normal Flora; Factors Affecting the Course of Infection and Disease; Mechanisms of Infection and Virulence Factors. **Infection:** Patterns of Infection; Types of Infections; Signs and Symptoms; Epidemiology and Epidemiological Markers. **Diseases:** Origin of Pathogens; Vectors; Acquisition of Infection; Koch's Postulates.		15
UNIT II **Medical microbiology- Causative Organisms- I**	**Skin:** *S. aureus, S. pyogenes.* **Respiratory Tract Infections:** *M.tuberculosis, S.pneumoniae* (Characteristics Transmission, Course of Infection, Lab Diagnosis, Management of TB, Prevention and Control, Immuno and Chemoprophylaxis, DOTS and MDR). **Urinary Tract Infections:** *E.coli*: Characteristics, Virulence, Clinical disease, and *E.coli* Infections. *Proteus*.		15
UNIT III **Medical microbiology - Causative Organisms- II**	**GI Tract Infections:** *Salmonella and Shigella spp.* (Characteristics, Virulence- Pathogenesis and Immunity, Clinical Disease, Carriers Lab Diagnosis, Phage Typing Prophylaxis		15

	and Treatment). **Sexually Transmitted Diseases:** Syphilis and Gonorrhoea. **Nosocomial Infections:** *Pseudomonas aeruginosa* **Collection & processing of Clinical samples**		

Learner's space:
To learn biochemical identification of other microorganisms of related infections using Bergey's Manual.

MOOC:

1. https://www.coursera.org/learn/epidemics#about
2. https://www.lecturio.com/medical-courses/respiratory-tract-infections-introduction.lecture
3. Bacteria and Chronic Infections | Coursera.

Pedagogy: Google classroom & making crossword puzzle & group discussions on examples, Practical techniques, PowerPoint presentation with pictures, E- journals, Virtual labs.

Reference Books:

1. Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. N.Y Presscott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda
2. Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Enginering, USA.
3. Text book of Medical Microbiology, Anantnarayan 7th Edition
4. Microbiology- Frobisher, 9th Edition
5. Microbiology, an introduction by Gerad Tortora, Berdell Funke & Christine Case, 9th Edition 2008, Pearson Education.

ICT backup:

1. https://www.mayoclinic.org/diseases-conditions/infectious-diseases/symptoms-causes/syc-20351173
2. https://www.healthline.com/health/klebsiella-oxytoca#symptoms
3. https://www.medicalnewstoday.com/articles/161858#medical-signs
4. Lesson-10.pmd (nios.ac.in) Isolation & identification of Organisms
5. https://youtu.be/3T7TpyCOpCo
6. Bacterial Infections of the Respiratory Tract | Microbiology: Health and Disease (lumenlearning.com)

Course Code	Title	Credits	No. of Lectures
PUSBTIV22-474	**MOLECULAR DIAGNOSTICS**	**2**	

Course objectives:-

The objective of this course is learning and understanding molecular techniques and utilizing these techniques in diagnosis.

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

- Gain an understanding of the basic principles used in molecular diagnosis.
- Gain critical thinking and analytical skills to understand new diagnostic methods.
- Apply the knowledge and skills gained in the course to be able to use in developing new diagnostic kits.

UNIT I **Basics of Molecular Diagnostics**	**Introduction to Molecular Diagnostics:** Overview of Molecular Diagnostics; History of Molecular Diagnostics; Molecular Diagnostics in post genomic era; Areas used in Molecular Diagnostics; Future prospects - Commercialising Molecular Diagnostics, personalized medicine, Theranostics. **Characterisation and analysis of Nucleic acids and Proteins:** Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and restriction enzyme mapping, RFLP. **Hybridisation techniques:** Southern, Northern, Western and FISH; Markers, probes and its Clinical applications.		15
UNIT II **Nucleic acid amplification Method**	**Target amplification:** PCR - General Principle; Components of a Typical PCR reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection. **PCR Types:** Reverse Transcriptase PCR, Real Time PCR, Multiplex PCR, Nested PCR Applications of PCR		15

UNIT III **Molecular Biology based Diagnostics**	**Disease identification and Genetic tests for following disorders**- Thalassemia, Sickle Cell anaemia, Alzheimer's disease. **Molecular Diagnostics for infectious diseases:** Molecular testing for *Neisseria*, Molecular diagnosis for HIV-1; **Genetic Counselling and Molecular Diagnosis** Genetic testing- Need and uses; genetic counselling. Case studies- Diagnostic testing for Cystic fibrosis; Fragile X diagnostic and Carrier testing. **Ethical, Social and legal issues to molecular genetic testing**		15

Learner's space:
Collect information about molecular therapeutics. Applications of PCR other than medical field.

MOOC:

1. https://onlinecourses.nptel.ac.in/noc21_bt36/preview.
2. https://www.mooc-list.com/tags/molecular-diagnosis
3. https://www.futurelearn.com/courses/molecular-techniques

Pedagogy: Activity, Videos, Virtual labs.

Reference books:

1. Applications Genomics, Proteomics. Rastogi 3rd edition and Drug discovery
2. Molecular diagnostics- Fundamentals, methods and clinical applications – Buckingham and Flaws F.A. Davis Company Philadelphia.
3. Molecular diagnostics for the clinical laboratorian by Coleman and Tsongalis, Humana Press publication

ICT backup:

1. https://www.khanacademy.org/science/ap-biology/gene-expression-and-regulation/biotechnology/a/polymerase-chain-reaction-pcr
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3768498/
3. https://academic.oup.com/femsre/article/43/1/88/5173038
4. https://www.aasv.org/jshap/issues/v7n3/v7n3p125.pdf

Course Code	Title	Credits	No. of Lectures
PUSBTIV22-475	**BIOINFORMATICS and BIOSTATISTICS**	**2**	

Course objectives:-

The objective of this course is learning and understanding basic concepts of Bioinformatics and Biostatistics.

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

- Gain an understanding of the basic concepts of Bioinformatics and Biostatistics.
- Understand the tools used in bioinformatics.
- Apply the various statistical tools for analysis of biological data.

UNIT I **Introduction to Computers and Biological Databases**	**Computer Basics:** Organization of a Computer; I/O Units; Computer Memory; Processor; Operating System.MS Word, Power point, Excel **Internet Basics:** Connecting to the Internet, E-mail, FTP, www, Difference between www and Internet. **Biological Databases:** Classification of Databases – General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite (KEGG), and Secondary (PIR). Structure databases (CATH & SCOP)		15
UNIT II **Sequence Alignments &Visualization**	Local alignment and Global alignment Pairwise alignment (BLAST and FASTA Algorithm) **BLAST and Sequence Alignment:** BLAST and its Types; Retrieving Sequence using BLAST. **Multiple Sequence Alignment:** Progressive Alignment Algorithm (ClustalW), Application of multiple sequence alignment. **Protein Structure Visualization Software** (RasMol). **Phylogenetic analysis:** Definition and description of phylogenetic trees, comparison		15

	of genetic sequences of organisms, Phylogenetic analysis tools**.**		
UNIT III Biostatistics	Theory and Problems based on- Coefficient of Correlation and Regression Analysis; Steps in Testing Statistical Hypothesis; Parametric Tests:- Z Test – Single Mean and Two Means, t- Test – Single Mean, Paired and Unpaired; Chi square Test.		15

Learner's space:
Use of bioinformatics tools in genomics and Proteomics. Application of Biostatistics in Pharmaceutical industry, Research & Development, Education & Commercial Industries.

MOOC:

1. https://www.my-mooc.com/en/mooc/bioinformatics-introduction-and-methods-sheng-wu-xin-xi-xue-dao-lun-yu-fang-fa/
2. https://www.coursera.org/learn/bioinformatics-methods-1
3. https://www.coursera.org/learn/introduction-to-computers-and-office-productivity-software.

Pedagogy: Google classroom, online bioinformatics software, YouTube videos, Online Worksheets.

Reference books:-

1. Bioinformatics- methods and Applications S.C.Rastogi, N. Mendiratta, Prentice Hall India Learning Private Limited
2. Introduction to Bioinformatics by Attwood & Parry-Smith
3. Biostatistics by Malhan & Arora
4. Biostatistics by B.K.Mahajan, 6th edition
5. Biostatistics by Veer Bala Rastogi

ICT backup:

1. https://www.ncbi.nlm.nih.gov/
2. https://www.ebi.ac.uk/
3. https://www.rcsb.org/
4. https://www.uniprot.org/
5. https://scope-international.online/biostatistics/
6. https://study.com/articles/How_to_Become_a_Research_and_Development_Biostatistician.html

Course Code	Title	Credits	No. of Lectures
PUSBTIV22-476	**ENVIRONMENTAL BIOTECHNOLOGY**	**2**	

Course objectives:-

The course is an introduction to environmental biotechnology and focuses on the utilization of microbial processes in waste and water treatment.

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

- Understand the application of available energy sources.
- Understand the current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments.

Unit I Renewable sources of Energy	**Energy sources renewable** – Solar energy, wind power, geothermal energy and hydropower, Biomass energy, **Biogas technology**- biogas plant & types, Bio digester. **Biogas**- composition, production and factors affecting production, uses. **Biofuels** – ethanol production. Microbial hydrogen production Biodiesel, Petrocrops.		15
Unit II Industrial effluent treatment	**Biological processes for industrial effluent treatment -** Aerobic biological treatment, Activated sludge process, CASP, Advanced activated sludge processes (any two) Biological filters, RBC, FBR Anaerobic biological treatment- Contact digesters, Packed bed reactors, Anaerobic baffled digesters, UASB. **Solid waste treatment** **Pollution indicators & biosensors** - Biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation. **Use of immobilized enzymes or microbial cells for treatment.**		15

Unit III **Waste water treatment**	**Wastewater treatment:** Introduction, Biological treatment, impact of pollutants on bio treatment, use of packaged organisms and genetically engineered organisms in waste treatment. **Heavy metal pollution:** Sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal. **Bioremediation**: Biosorption by bacteria, fungi and algae, factors affecting biosorption limitations of biosorption.		15

Learner's space:

Learn production of zero carbon (or carbon negative) renewable fuels; Artificial Photosynthesis. Commercial application of use of consortia of microorganisms in Bioremediation.

MOOC:

1. Wastewater Treatment and Recycling - Course (nptel.ac.in), Duration - 12 weeks, Credit points - 3.
2. Environmental Biotechnology - Course (nptel.ac.in)

Pedagogy: Animated videos, Google classroom for E- Notes, Presentations, Group Discussion, YouTube videos, Case study of examples, E- Journals.

Reference books:

1. Environmental Biotechnology Allan Scragg Oxford University press
2. Environmental Biotechnology Indu Shekhar Thakur IK International (Basic concepts and applications).
3. Environmental Biotechnology by M. H. Fulekar
4. Environmental Biotechnology (Industrial pollution management) S. N. Jogdand, Himalaya Publishing house.
5. Environmental Chemistry – A. K. De

ICT backup:

1. https://www.youtube.com/watch?v=3UafRz3QeO8
2. https://www.csir.res.in/achivement/csir-pride/energy
3. https://youtu.be/QERmaMtEtY8
4. https://youtu.be/67BvwMofkMU
5. https://youtu.be/uAyVcR17COs

Course Code	Title	Credits	No. of Lectures
PUSBTIV22-477	**RESEARCH METHODOLOGY**	**2**	

Course objectives:-

The objective of this course is to develop research aptitude, logical thinking and reasoning.

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

- Understand basic principles of research methodology and identify a research problem.
- Understand a general definition of research design.
- Identify the overall process of designing a research study from its inception to its report.

UNIT I **Introduction to Research Methodology and Research Problem**	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; Problems Encountered by Researchers in India; What is a Research Problem? Selecting the Problem; Necessity of Defining the Problem; Technique Involved in Defining a Problem		15
UNIT II **Research Design and Data Collection**	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; 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		15

UNIT III **Interpretation and Report Writing**	Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation - paraphrasing, 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 Bibliography (APA and MLA) Presenting Research: Oral and Poster Publication, Impact factor of Journals, H-Index, Plagiarism Research Organizations in Biological Sciences in India: DBT, DST, CCMB, NIV		15

Learner's space:

Use of data collection methods in Semester VI projects, conducting survey-based research project, Exploring online software's for statistical analysis of data

MOOC:

1. https://www.coursera.org/learn/research-methods,
2. https://www.coursera.org/specializations/data-collection
3. https://www.classcentral.com/course/swayam-academic-and-research-report-writing-20220

Pedagogy: Google classroom, E-journals, Discussion, PPTs

Reference books:

1. Research Methodology: Methods and Techniques, C. R. Kothari, New Age International Publishers
2. Research Methods for the Biosciences. Holmes, Moody & Dine. Oxford University Press

ICT backup:

1. https://gradcoach.com/what-is-research-methodology/
2. https://www.cusb.ac.in/images/cusb-files/2020/el/cbs/MCCOM2003C04%20(Business%20Research%20Methods)Research_Methodology_C_R_Kothari.pdf
3. https://eduvoice.in/types-research-methodology/
4. ttps://www.researchgate.net/publication/325546150_WRITING_RESEARCH_REPORT
5. https://eduvoice.in/types-research-report-writing/
6. https://www.ox.ac.uk/students/academic/guidance/skills/plagiarism#:~:text=Plagiarism%20is%20presenting%20someone%20else's,is%20covered%20under%20this%20definition.

PRACTICAL

	SEMESTER IV	
Course code	**Title**	**Credits**
PUSBTIV22-P1 (PRACTICAL based on **PUSBTIV22-471** and **PUSBTIV22-472**)	1. Determination of Lactate Dehydrogenase (LDH) Activity in Blood Serum. 2. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum). 3. Estimation of Uric acid and Creatinine in Urine. 4. Qualitative Detection of Ketone Body in Urine. 5. Isolation of Mitochondria and Demonstration of ETC using a Marker Enzyme. 6. Separation of Inorganic Binary (Solid-Solid) Mixture (Min 4 mixtures containing 2 cations and 2 anions). 7. Identification of Organic Compounds of Known Chemical Type (Min 4 Compounds). 8. Instrumentation - GC, HPLC, HPTLC analysis (Lab visit) 9. Qualitative detection of Secondary metabolites 10. Separation of any one secondary metabolite by TLC 11. Chemical andBiological Synthesis of Silver Nanoparticles and its characterisation by UV- Vis Spectrophotometer.	2
Course code	**Title**	**Credits**
PUSBTIV22-P2 (PRACTICAL based on **PUSBTIV22-473** and **PUSBTIV22-474**)	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 *Pseudomonas* - Isolation, Urease test, Oxidase Test, TSI Slant. 5. RPR Test (Kit Based). 6. Permanent Slide- *Mycobacterium*. 7. Isolation, Quantitative Analysis and AGE of Genomic DNA from Yeast. 8. Isolation and Quantification of RNA from Yeast. 9. Restriction Mapping Problems. 10. RFLP- Kit Based. 11. DNA Amplification – PCR.	2

Course code	Title	Credits
PUSBTIV22-P3 (PRACTICAL based on **PUSBTIV22-475** and **PUSBTIV22-476**)	1. MS Power point, MS Excel 2. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases. 3. Use of NCBI BLAST Tool. 4. Pairwise and Multiple Sequence Alignment and Phylogeny. 5. Classification of Proteins using CATH/SCOP. 6. Visualization PDB Molecules using Rasmol/Raswin. 7. Determination of Total solids from an effluent sample. 8. Study of physico-chemical parameters (pH, colour, turbidity, BOD, COD) of an industrial effluent sample. 9. Most Probable Number (MPN) – Presumptive, Confirmed and Completed tests. 10. Bioremediation of metal. 11. Visit to STP / CETP	2

Summer Training:

1. This should be taken up in the summer over a period of one month preferably in an immunology / veterinary / virology institute or a laboratory using recombinant DNA methods.
2. The students could also be assigned to assist a clinic (in a hospital), a fermentation plant, brewery or bakery and watch the various stages in brewing and baking and post-fermentation processing. Prior arrangement must be made on the mode of interaction of the educational institute with the clinic and the industry.

Evaluation pattern S.Y Biotechnology (Autonomous) 2022 -2023

1. **Core Courses:** The College will conduct all the Semester examinations of 100 marks per Theory Paper in the prescribed pattern of 40 marks of internal assessment/Project work and 60 marks for Semester end examination. **The student will have to secure a minimum of 40% marks in Internal assessment as well as Semester end examination per theory paper.**
2. In each semester, the student will have to submit a Project/Assignment/Journal for theory papers in the College before appearing for the Semester End Examination.
3. The Project work will be carried out by the student with the guidance of the concerned Faculty Member who will be allotted to the student as the Guide for the Project.
4. The College will conduct all the Semester examinations of 100 marks per Practical Paper at the end of each semester. **The student will have to secure a minimum of 40% marks in the examination per practical paper.**

Evaluation Pattern
For S.Y.B.Sc. Biotechnology (Theory)

1.	**INTERNAL ASSESSMENT**		**40 Marks**
1.1	One class test (Objectives/ Multiple Choice)		20 Marks
1.2	Assignment/ Project/ Presentation/Book or Research paper review report/Business proposal presentation/Case-study		15 Marks
1.3	Active Participation, Overall performance		05 Marks
2.	**EXTERNAL ASSESSMENT (Semester End Examination)**		**60 Marks**
	N.B. 1. All questions are compulsory 2. All questions carry equal marks.		
	Q.1.	**Based on Unit-I, II & III** Multiple choice questions/Fill in the blanks /Match the column/Give one word/Name the following/Give an example/Explain the term/Define/Give significance/State the role of	**12**
	Q.2.	**Unit-I** Long Answer Question Short Answer Question	**12** 12/08/06 04/02
	Q.3.	**Unit-II** Long Answer Question Short Answer Question	**12** 12/08/06 04/02

	Q.4.	**Unit-III** Long Answer Question Short Answer Question	**12** 12/08/06 04/02
	Q.5. Short Notes based on Unit I, II and III (Solve any three out of six)		**12**

Practical

EXTERNAL ASSESSMENT (Practical)	**100 Marks**
Experiment - 1(Major technique)	25
Experiment - 2 (Major technique)	25
Experiment - 3 (Minor technique)	15
Experiment - 4 (Minor technique)	15
Viva/Identification/Spots	10
Journal	10
TOTAL MARKS	100

UNIVERSITY OF MUMBAI

Revised Syllabus for T.Y.B.Sc.
Programme- B.Sc.
Course- Biotechnology (USBT)
(Third Year – Sem. V & VI)

(Credit Based Semester and Grading System with effect from the academic year 2018-2019)

TYBSC Biotechnology Course Structure

Semester V

Course code USBT	Title	Theory /Practical	Marks	Credits	Nos of Lectures & Practical
501	Cell biology	Theory	100	2.5	60
502	Medical Microbiology & Instrumentation	Theory	100	2.5	60
503	Genomes and Molecular Biology	Theory	100	2.5	60
504	Marine Biotechnology	Theory	100	2.5	60
P501+502	Cell biology+ Medical Microbiology & Instrumentation	Practical	100	3.0	72
P503+504	Genomes and Molecular Biology+ Marine Biotechnology	Practical	100	3.0	72
Applied Component	Biosafety	Theory	100	2.0	48
	Biosafety	Practical	100	2.0	48
	TOTAL		**800**	**20**	**480**

Semester VI

Course code USBT	Title	Theory/ Practical	Marks	Credits	Nos of Lectures & Practical
601	Biochemistry	Theory	100	2.5	60
602	Industrial Microbiology	Theory	100	2.5	60
603	Pharmacology and Neurochemistry	Theory	100	2.5	60
604	Environmental Biotechnology	Theory	100	2.5	60
P 601-P 602	Biochemistry& Industrial Microbiology	Practical	100	3	72
P 603-P 604	Pharmacology - Neurochemistry and Environmental Biotechnology (50M)+ Project work (50M)	Practical	100	3	72
Applied component	Agribiotechnology	Theory	100	2.0	48
Applied component	Agribiotechnology	Practical	100	2.0	48
	TOTAL		**800**	20	**480**

Teaching pattern:

One (01) Credit would be of thirty- forty (30-40) learning hours; of this more than fifty percent of the time will be spent on class room instructions including practical as prescribed by the University. Rest of the time spent invested for assignments, projects, journal writing, case studies, library work, industrial visits, attending seminars / workshops, preparations for examinations etc. would be considered as notional hours. The present syllabus considers (60L as class room teaching and 15 lectures as Notional hours/ paper). Each lecture duration would be for 48 min

The names of the reference books provided in the syllabus are for guidance purpose only. Students and faculty are encouraged to explore additional reference books, online lectures, videos, science journals for latest/ additional information.

Examination pattern for:

Theory:

- The question paper for the Term End Exam would be of **100 marks** consisting of 5 Questions (20M each), of which one question would be common for all units in the syllabus.

- The question paper would be set for 150 marks including internal options.

- There shall be no internal exam for any paper.

Practical:

- Would be conducted over a period of 3 days; 50M each paper.

- Each student to perform 2 major and 2 minor practical for Sem V and 2 major and project presentation for Sem VI ,

- Viva would be conducted during the practical during Sem V; Sem VI would have ONLY project presentation

- Journals would be uniform throughout all the centres; matter would be communicated to all the centres by the syllabus committee.

- Distribution of marks for the experiments carried out during the examination:

  Sem V (50M/ paper): Major: 20M; Minor: 10M; Viva: 10M; Journal 10M.
  Sem VI (50M/paper): Major (x2): 40M; Journal: 10M; Project 50M

  The report could be around 25-30 pages with appropriate referencing and formatting.
  Marks distribution for the project would be as follows:
  25M documentation, 15M presentation, 10 M viva and interactions;

- Students would undertake a project for 1-2 months during the last semester for 50 M. The project **should** include **either** of the following:

  1. One/ more major instrumentation OR
  2. One / more major technique/s required in the field of interest OR
  3. Bioinformatics OR
  4. Biostatistics

Semester V

Course code USBT	Title	Unit	Topics	Credit	No of Lectures
501	Cell Biology	I: Cell cycle	Cell cycle Introduction: Prokaryotic and Eukaryotic- **3 Lectures;** The Early Embryonic Cell Cycle and the Role of MPF-**4 Lectures;** Yeasts and the Molecular Genetics of Cell-Cycle Control – **4 Lectures;** Apoptosis, Cell-Division Controls in Multicellular Animals- **4 Lectures**	2.5	15
		II: Cell Signalling	Cell signalling and signal transduction:Introduction General Principles of Cell Signaling - **3 Lectures;** Signaling via G-Protein-linked Cell-Surface Receptors - **3 Lectures;** Signaling via Enzyme-linked Cell-Surface Receptors - **3 Lectures;** Target-Cell Adaptation, The Logic of Intracellular - **3 Lectures;** Signaling: Lessons from Computer-based "Neural Networks"- **3 Lectures**		15
		III: Developmental Biology	Overview of how the modern era of developmental biology emerged through multidisciplinary approaches - **5 Lectures;** Stages of development- zygote, blastula, gastrula, neurula cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation ,lineages of three germ layers, fate map - **6 Lectures;** Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation-- axis specification, positional identification (regional specification), Morphogenetic movements, Model organisms in Developmental biology - **4 Lectures**		15
		IV: Cancer Biology	Cancer: Introduction, Cancer as a Microevolutionary Process - **4 Lectures**; The Molecular Genetics of Cancer - **6 Lectures**; Cancer and Virus Cancer diagnosis and chemotherapy - **5 Lectures**		15
		Total			60

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

Course code USBT	Title	Unit	Topics	Credit	No of Lectures
502	**Medical Microbiology and Instrumentation**	I: Virology	Introduction to viruses-Position in biological spectrum; Virus properties - **2 Lectures**; General structure of viruses Baltimore Classification and Taxonomy(ICTV) - **2 Lectures**; Cultivation of viruses - **2 Lectures**; Reproduction of ds DNA phages Hepatitis /ss RNA (influenza), animal viruses and plant (TMV)virus - **4 Lectures;** Virus purification and assays - **2 Lectures;** Cytocidal infections and cell damage - **2 Lectures;** Viroids and Prions - **1 Lecture**	2.5	15
		II: Chemotherapeutic drugs	Discovery and Design of antimicrobial agents -**1 Lecture**; Classification of Antibacterial agents, Selective toxicity, MIC, MLC - **2 Lectures** Inhibition of cell wall synthesis (Mode of action for): Beta lactam antibiotics: Penicillin, Cephalosporins; Glycopeptides: Vancomycin; Polypeptides: Bacitracin -**2 Lectures** Injury to Plasma membrane: Polymyxin – **1 Lecture**; Inhibition of protein synthesis Aminoglycosides, Tetracyclines Chloramphenicol, Macrolides-Erythromycin- **2 Lectures**; Inhibition of Nucleic acid synthesis: Quinolones, Rifampicin, Metronidazole - **2 lectures**; Antimetabolites: Sulphonamides, Trimethoprim - **1 lecture**; Drug Resistance: Mechanism, Origin and transmission of drug resistance - **1 lecture**; Use and misuse of antimicrobial agents - **1 lecture**; Antifungal drugs, Antiviral drugs - **2 lectures**		15

		III: Spectroscopy	Principle, instrumentation, working and applications of: Fluorescence Spectroscopy - **3 Lectures** Luminometry - **3 Lectures** Light scattering spectroscopy - **3 Lectures** Infrared Spectroscopy - **3 Lectures** Atomic absorption Spectroscopy - **3 Lectures**		15
		IV: Bio-analytical techniques	Principle, working and applications of: Affinity chromatography - **2 Lectures** Ion-exchange chromatography - **2 Lectures** Molecular (size) exclusion chromatography - **2 Lectures;** HPLC - Method development and validation- **3 Lectures**; Isotopes in Biology: Nature of radioactivity - **1 Lecture**; Detection Techniques using GM counter, Scintillation counter, autoradiography - **4 Lectures**; Applications of Tracer techniques in Biology - **1 Lecture**		15
		Total			60

References:

1. Principles and techniques in biochemistry and molecular biology (2010), Keith Wilson and John Walker, 7th edition, Cambridge University Press
2. Biophysics (2002) Vasantha Pattabhi and N. Gautham, Kluwer Academic Publishers
3. Physical Biochemistry: principles and applications, 2nd edition (2009), David Sheehan , John Wiley & Sons Ltd
4. HPLC method validation for pharmaceuticals: a review (2013), Harshad V. Paithankar, International Journal of Universal Pharmacy and Bio Sciences 2(4): July-August.
5. Mim's Medical Microbiology 5th edition
6. Microbiology by Prescott Harley and Klein 5th edition Mc Graw Hill
7. Medical Microbiology Jawetz,E., Brooks,G.E, Melnick,J.L., Butel,J.S Adelberg E. A 18th edition
8. Medical Microbiology by Patrick Murray 5th edition
9. Foundations In Microbiology by Talaro and Talaro Third edition W.C Brown
10. Understanding Viruses by Teri Shors

PRACTICALS

USBT P 501-502 **3 credits** **72hrs**

1. Separation of components from a mixture using Affinity chromatography (Kit may be used)
2. Separation of components from a mixture using ion exchange chromatography (Kit may be used)
3. Separation of components from a mixture using Size exclusion chromatography (Kit may be used)
4. HPLC method validation.
5. MIC and MLC of any one antibiotic
6. Antibiotic sensitivity test using agar cup method
7. Antibiotic sensitivity test using paper disc method
8. Antibiotic sensitivity test using ditch method.
9. Cancer Biology: (Field visit and 2 page report in the journal)
10. Chick embryo candling and inoculation methods Demonstration experiment
11. Book review (Emperor of all Maladies)

Course Code USBT	Title	Unit	Topics	Credit	No of Lectures
503	**Genomics and Molecular Biology**	I: Genetic engineering of plants	Genetic engineering of plants; Methodology. Plant transformation with the Ti plasmid of *A.tumefaciens*, Ti plasmid derived vector system - **4 Lectures;** Transgenic plants: Physical methods of transferring genes to plants : electroporation, microprojectile bombardment, liposome mediated, protoplast fusion- **5 Lectures;** Vectors for plant cells - **4 Lectures;** Improvement of seed quality protein **- 2 Lectures**	2.5	15
		II: Transgenic Animals	Transgenic mice- methodology-retroviral method, DNA microinjection, ES method - **5 Lectures;** genetic manipulation with cre-loxP - **2 Lectures;** Vectors for animal cells - **2 Lectures;** Transgenic animals recombination system - **2 Lectures;** Cloning live stock by nuclear transfer - **2 Lectures;** Green Fluorescent Protein - **1 Lectures;** Transgenic fish – **1 Lectures**		15
		III: Tools in Molecular Biology	Cloning vectors-Plasmids (pUC series), Cosmids, phagemids M13, shuttle vectors, YAC vectors, expression vectors pET - **4 Lectures;** 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 - **3 Lectures;** Recombinant selection and screening methods: genetic, immunochemical, Southern and Western analysis, nucleic acid hybridization, HART,HRT- **2 Lectures;** Expression of cloned DNA molecules and maximization of expression - **2 Lectures;** Cloning strategies-genomic DNA libraries, cDNA libraries, chromosome walking and jumping - **4 Lectures**		15
		IV: Gene sequencing and editing	Maxam Gilbert's method, Sanger's dideoxy method, Automated DNA sequencing, Pyrosequencing - **6 Lectures;** Human genome mapping and it's implications in health and disease - **3 Lectures**; RNAi, ZNF(Zinc finger nucleases), TALENS(Transcription Activator Like Effector Nucleases), CRISPER/Cas system(Clustered Regularly Interspersed Repeats) - **6 Lectures**		15
		Total			60

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. Biotechnology B.D. Singh.
7. Gene Cloning and DNA Analysis 6th Edition T.A. Brown.
8. Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)

Course Code USBT	Title	Unit	Topics	Credit	No. of Lectures
504	**Marine Biotechnology**	I: Marine Biotechnology- Introduction & Bioprospecting	Introduction to Marine Biotechnology- **1 lecture;** The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal &deep sea ecosystems. Hydrothermal vents- **4 lectures;** Bioprospecting, Marine Microbial Habitats and Their Biotechnologically relevant Microorganisms- **2 lectures;** Methods for Microbial Bioprospecting in Marine Environments **- 2 lectures;** Biotechnological Potential of Marine Microbes **-1 lecture;** Bioactive compounds from other Marine Organisms: fungi, Microalgae, Seaweeds, Actinomycetes, sponges - **5 lectures**	2.5	15
		II: Marine Drugs and Enzymes	Drugs from Marine organisms: Pharmaceutical compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents - **4 lectures;** Approved Marine Drugs as Pharmaceuticals **- 2 lecture;** Marine Natural products and its Challenges **- 2 lectures;** Marine Microbial Enzymes- Marine Extremozymes and Their Significance, Current Use of Marine Microbial Enzymes - **7 lectures.**		15
		III: Marine Functional foods and Nutraceuticals	Marine Functional Foods: Marine Sources as Healthy Foods or Reservoirs of Functional Ingredients **-3 lectures;** Marine-Derived Ingredients with Biological Properties- **3 lectures;** Functional Foods Incorporating Marine-Derived Ingredients **-2 lectures;** Marine Nutraceuticals : Marine Bioactives as Potential Nutraceuticals, Functional Carbohydrates, Polyunsaturated Fatty Acids- **3 lectures;** Carotenoids, Soluble Calcium, Fish Collagen and Gelatin, Marine Probiotics **-4 lectures.**		15
		IV: Marine Bioresources and	Marine Bioresources, Marine Secondary Metabolites, Marine Proteins, Marine Lipids- **4 lectures;** Cosmetics from Marine Sources: Scenario of Marine Sources in the Cosmetic Industry, Cosmetics: Definition and Regulations,		15

		Cosmetics	Cosmeceuticals , Target Organs and Cosmetics Delivery Systems , Components of Cosmetics, Major Functions of Some Marine Components in Cosmetics and Cosmeceuticals , Treatments Based on Marine Resources , Products Based on Marine Resources **- 11 lectures.**		
		Total			60

References:

1. Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.
2. Nollet, Leo M. L- Marine microorganisms- extraction and analysis of bioactive compounds-CRC Press_Taylor& Francis (2017)
3. R. S. K. Barnes, R. N. Hughes(auth.)-An Introduction to Marine Ecology, Third Edition-Wiley-Blackwell (1999)
4. Blanca Hernández-Ledesma, Miguel Herrero-Bioactive Compounds from Marine Foods-Plant and Animal Sources-Wiley-Blackwell (2013)
5. Fabio Rindi, Anna Soler-Vila, Michael D. Guiry (auth.), Maria Hayes (eds.)-Marine Bioactive Compounds_ Sources, Characterization and Applications-Springer US (2012)
6. W. Evans-Trease and Evans Pharmacognosy 15 th ed.-Saunders (2010)

PRACTICALS

USBT P 503-504 **3 credits** **72hrs**

1. Transformation in *E.coli.*
2. Genomic DNA Extraction: Animal cells.
3. Restriction enzyme digestion and ligation (Kit may be used).
4. Phage titration: *Demonstration*
5. Polymerase chain reaction. *Demonstration*
6. Gradient plate technique
7. Bacterial gene expression (Kit may be used).
8. Study of any 5 marine bacteria and algae (Macro and micro)
9. DPPH assay for antioxidant extracted from marine algae
10. Extraction of carotenoids from marine algae/Bacteria/Fungi
11. Extraction and estimation of Gelatin / Collagen.
12. Extraction of alkaloids from marine organisms and their separation by TLC.

Course	Title	Unit	Topics	Credits	Lectures
Applied component	**Biosafety**	I: Introduction to biosafety	Introduction - **1 lecture** Biological Risk Assessment, Hazardous Characteristics of an Agent- **2 lectures;** Genetically modified agent hazards - **1 lecture**; Cell cultures - **1 lecture;** Hazardous Characteristics of Laboratory Procedures - **1 lecture;** Potential Hazards Associated with Work Practices – **2 lectures;** Safety Equipment and Facility Safeguards - **2 lectures**; Pathogenic risk and management - **2 lectures**	2.0	15
		II: GLP	Concept of GLP- **1 lectures;** Practicing GLP- **1 lecture**; Guidelines to GLP - **2 lectures;** Documentation of Laboratory work - **1 lectures;** Preparation of SOPs - **2 lectures**; Calibration records - **1 lectures;** Validation of methods - **1 lectures;** Documentation of results - **1 lecture**; Audits & Audit reports - **1 lecture.**		12
		III: Detection and testing of contaminants	Microbial Contamination in food and pharma product - **3 lectures**; Some common microbial contaminants **- 3 lectures;** Microbiological Assays for pharmaceutical products **- 4 lectures**; Regulatory Microbiological testing in pharmaceuticals - **3 lectures.**		12
		IV: Biosafety in Biotechnology	Concepts on biosafety in Biotechnology - **2 lectures;** Regulating rDNA technology -**2 lectures;** Regulating food and food ingredients -**3 lectures;** Genetically engineered crops, livestock Bioethics -**3 lectures;** Contemporary issues in Bioethics **- 2 lectures.**		12
		Total			**48**

References:

1. Pharmaceutical Microbiology - Hugo, W.B, Russell, A.D 6th edition Oxford Black Scientific Publishers.
2. 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.
3. Molecular Biotechnology –Principles and Applications of Recombinant DNA Glick, B.R, Pasternak, J.J Patten, C.L 3rd edition ASM press

PRACTICALS

Applied Component- Biosafety 2 Credits 48hours

1. Validation of micropipette, measuring cylinders, colorimeters
2. Calibration of pH meter and weighing balance
3. Vitamin B12 bioassay
4. Testing for adulterants in food; ex. Starch in milk
5. Making SOP for any 2 major laboratory instruments
6. Sterility of injectables

Semester VI

Course Code USBT	Title	Unit	Topics	Credits	Lectures
601	**Biochemistry**	I: Protein Biochemistry	Protein structure: Protein Tertiary and Quaternary Structures **-2 Lectures;** Protein Denaturation and Folding – **3 Lectures**; Protein Function: Reversible Binding of a Protein to a Ligand: Oxygen-Binding Proteins – **2 Lectures;** Complementary Interactions between Proteins and Ligands: Immunoglobulins – **1 Lecture**; Protein Interactions Modulated by Chemical Energy: Actin, Myosin, and Molecular Motors **-3 Lectures**; Protein purification – **4 Lectures.**	2.5	15
		II: Metabolism	Carbohydrate biosynthesis and its regulation: Peptidoglycan in Bacteria **-2 Lectures;** Starch and sucrose in Plants **-4 Lectures;** Glycogen in Animals **- 4 Lectures;** Biosynthesis and regulation of Cholesterol, Atherosclerosis – **5 Lectures.**		15
		III: Endocrinology	Mechanism of action of group I and II hormones- **1 Lecture;** Structure, storage, release, transport, biochemical functions and disorders associated with hormones secreted by Hypothalamus **-1 Lecture;** Anterior Pituitary gland - GH, stimulating hormones) **-1 Lecture;** Posterior Pituitary gland – oxcytocin and vasopressin **-1 Lecture;** Thyroid gland – Thyroxine, calcitonin **- 2 Lectures;** Parathyroid gland – PTH **-1 Lecture;** Adrenal medulla – epinephrine and norepinehprine **-1 Lecture;** Adrenal cortex – Glucocortocoids **- 1 Lecture;** Pancreas – insulin and glucagon **- 2 Lectures;** Female Gonads – estrogen and progesterone **- 2 Lectures;** Male gonads – testosterone**- 1 Lecture;** Placenta – hCG **- 1 Lecture.**		15
		IV:	Minerals and Vitamins;		

		Nutrition	Dietary sources, bioactive form, functions and disorders associated with fat soluble (A D E K) and water soluble vitamins- **7 Lectures;** Minerals - physiological and biochemical functions of principal and trace elements. - **7 Lectures;** Malnutrition – Over nutrition (obesity) and PEM (Kwashiorkor and Marasmus)- **1 Lecture.**		15
		Total			60

References:

1. Lehninger, principles of biochemistry, 4th edition (2005), David Nelson and Michael Cox *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.

Course Code USBT	Title	Unit	Topics	Credit	No. of Lectures
602	**Industrial Microbiology**	I: Dairy technology	Milk: Normal flora, changes in raw milk - **2 lectures;** Enumeration - **1 lecture**; Factors affecting bacteriological quality - **1 lecture**; Dairy technology Preservation methods - **2 lectures**; Pasteurization- **1 lecture**; Starter Cultures - **2 lectures;** Fermented products-Production process and spoilage of Cheese: Swiss and Cheddar - **2 lectures;** Butter - **2 lectures;** Yogurt - **1 lectures** and Buttermilk - **1 lecture.**	2.5	15
		II: Down-stream Processing (DSP)	Introduction of DSP - **2 lectures;** Foam separation - **1 lecture**; Types of Precipitation - **1 lecture**; Filtration **2 lectures**, Centrifugation - **1 lecture;** Chromatography in DSP - **2 lectures;** Cell disruption- physical and chemical methods - **2 lectures;** Solvent recovery, Membrane processes - **1 lecture;** Drying - **1 lecture**; Crystallization and Whole broth processing - **2 lectures**.		15
		III: Fermentation process	Introduction to Inoculum development - **2 lectures;** Bacterial and fungal inoculum development with one example each - **3 lectures**, scale up, scale down - **2 lectures**; Production of: Streptomycin - **1 lecture;** Protease - **1 lecture;** Mushroom - **1 lecture;** Glutamic acid - **1 lecture;** Lysine - **1 lecture,** ethanol production **1 lecture** Semi-synthetic Penicillin **1 lecture**, Biotransformation - **1 lecture.**		15
		IV: QA-QC	Concept of GMP- **1 Lectures;** Requirements of GMP implementation - **2 Lectures;** Documentation of GMP practices - **2 Lectures**; Regulatory certification of GMP - **2 Lectures;** Quality Control (QC): Concept of QC - **2 Lectures;** Requirements for implementing QC -		15

			2 Lectures; QA concepts: Concept of QA - **2 Lectures;** Requirements for implementing - **2 Lectures**.		
		Total			60

References:

1. Applied Dairy Microbiology Elmer H Marth and James L Steele Mercel Dekker Inc New York, 2nd edition
2. Microbial Technology Peppler,H.J and Perlman,D 2nd Academic Press Practicals
3. Industrial Microbiology Prescott and Dunn CBS publishers
4. Dairy technology by Yadav and Grower
5. Fermentation technology by Stanbury and Whittkar
6. Pharmaceutical Microbiology by Russel and Hugo

PRACTICALS

USBT P 601-602 **3 credits** **72hrs**

1. Estimation of Milk protein-Pynes method
2. Microbial analysis of Milk by MBRT and RRT
3. Phosphatase test in Milk
4. DMC of milk sample
5. Isolation of Normal flora from Milk and curd
6. Determination of blood glucose levels for detection of diabetes mellitus.
7. Determination of serum cholesterol (total, HDL and LDL ratio)
8. Estimation vitamin C by DCPIP method from food samples.

Course Code USBT	Title	Unit	Topics	Credits	No of Lectures
603	**Basic pharmacology and Neurochemistry**	I: General principles of Pharmacology	Mechanism of drug action - **2 Lectures;** drug receptors and biological responses - **2 Lectures;** second-messenger systems, the chemistry of drug–receptor binding - **2 Lectures;** dose–response relationship: therapeutic index - **3 Lectures;** ED, LD, - **2 Lectures;** Potency and Intrinsic Activity - **2 Lectures;** Drug antagonism - **2 Lectures.**	2.5	15
		II: Drug Absorption and Distribution	Absorption of drugs from the alimentary tract - **2 Lectures;** factors affecting rate of gastrointestinal absorption - **2 Lectures;** absorption of drugs from lungs - **1 Lecture;** skin - **1 Lecture;** absorption of drugs after parenteral administration factors influencing drug distribution - **2 Lectures;** binding of drugs to plasma proteins - **2 Lectures;** Physiological barriers to drug distribution - **3 Lectures.**		15
		III: Basic Toxicology and Regulatory Toxicology	Background Definitions - **1 Lectures;** Causation: degrees of certainty Classification - **1 Lectures;** Causes Allergy in response to drugs Effects of prolonged administration: chronic organ toxicity - **2 Lectures;** Adverse effects on reproduction - **1 Lecture;** <u>Poisons</u>: Deliberate and accidental self-poisoning Principles of treatment Poison-specific measures General measures - **2 Lectures;** Specific poisonings: cyanide, methanol, ethylene glycol, hydrocarbons, volatile solvents, heavy metals, - **3 Lectures;** herbicides and pesticides, - **2 Lectures;** biological substances (overdose of medicinal drugs is dealt with under individual agents**)** - **1 Lecture;** Incapacitating agents: drugs used for torture - **1 Lecture;** Nonmedical use of drugs - **1 Lecture.**		15
		IV: Neurochemistry	Anatomy and functioning of the brain - **2 Lectures;** Neuronal pathways - **2 Lectures;**		15

			Propogation of nerve impulses - **2 Lectures;** Neuronal excitation and inhibition - **3 Lectures;** Synapses and gap junctions - **3 Lectures;** Action of Neuro toxins and neurotransmitters - **3 Lectures.**		
		Total			60

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

Course Code USBT	Title	Unit	Topics	Credits	No of Lectures
604	**Environmental Biotechnology**	I: Renewable sources of energy	Energy sources renewable – solar energy, wind power, geothermal energy and hydropower, biomass energy - **5 Lectures;** Biogas technology- biogas plant & types, biodigester. Biogas- composition, production and factors affecting production, uses - **5 Lectures;** Biofuels – ethanol production. Microbial hydrogen production Biodiesel, Petrocrops - **5 Lectures;**	2.5	15
		II Industrial effluent treatment	Biological processes for industrial effluent treatment, aerobic biological treatment- activated sludge process, CASP, advanced activated sludge processes (any two) Biological filters, RBC, FBR - **5 Lectures;** Anaerobic biological treatment- contact digesters, packed bed reactors, anaerobic baffled digesters, UASB - **3 Lectures;** Solid waste treatment - **2 Lectures;** pollution indicators & biosensors - **2 Lectures;** biodegradation of xenobiotics- persistent compounds, chemical properties influencing biodegradability, microorganisms in biodegradation - **2 Lectures;** Use of immobilized enzymes or microbial cells for treatment - **1 Lecture.**		15
		III Wastewater treatment	Wastewater treatment- introduction, biological treatment, impact of pollutants on biotreatment, use of packaged organisms and genetically engineered organisms in waste treatment - **5 Lectures;** Heavy metal pollution – sources, microbial systems for heavy metal accumulation, techniques used for heavy metal removal - **5 Lectures;** biosorption by bacteria, fungi and algae, factors affecting biosorption limitations of biosorption - **5 Lectures.**		15
		IV Hazardous waste management	Biodegradation of waste from tanning industry - **2 Lectures;** petroleum industry - **2 Lectures;** paper & pulp industry - **2 Lectures;** Dairy - **2 Lectures;** Distillery - **2 Lectures;** Dye - **1 Lecture;** Antibiotic industry - **2 Lectures;** Removal of oil spillage & grease deposits - **2 Lectures.**		15
		Total			60

References:

1. Environmental Biotechnology Allan Scragg Oxford University press
2. Environmental Biotechnology (Basic concepts and applications) Indu Shekar Thakur IK International
3. Environmental Biotechnology (Industrial pollution management) S.D. Jogdand Himalaya Publishing House

PRACTICALS

USBT P 603-604 **3 credits** **72hrs**

1. LD 50, ED 50 evaluation using suitable models e.x daphnia
2. Study the effect of heavy metals on the growth of bacteria.
3. Determination of Total Solids from an effluent sample.
4. Study of physico-chemical (pH, color, turbidity, BOD, COD) parameters of any one industrial effluent sample
5. Estimation of chromium from Effluents (Demonstration)
6. Visit to ETP/ CETP

Course	Title	Unit	Topics	Credit	No. of Lectures
Applied component	**Agri Biotechnology**	I: Precision Agriculture and Agriculture systems	Introduction to Agriculture and Agriculture systems- **1 Lecture;** Green house Technology-- Types of green house, importance, functions and features of green house, Design criteria and calculation -**2 Lectures;** Construction material, covering material and its characteristics, growing media, green house irrigation system. nutrient management -**3 Lectures;** Greenhouse heating, cooling and shedding and ventilation system, Computer controlled environment - **3 Lectures**;, Phytotrons, fertigation and roof system -**1 Lecture;** Precision Cultivation- tools, sensors for information acquisition -**2 Lectures.**	2	12
		II: Plant stress biology	Abiotic stress –Physiological and molecular responses of plants to water stress, salinity stress, temperature stress – heat and cold, Photooxidative stress, stress perception and stress signaling pathways, Ionic and osmotic homeostasis, reactive oxygen species scavenging- **4 Lectures;** 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 - **8 Lectures.**		12
		III: Molecular Markers in Plant Breeding	Genetic markers in plant breeding-- Classical markers, DNA markers (RFLP, RAPD, AFLP, SSR, SNP)- **4 Lectures;** Application of Molecular Markers to Plant Breeding [quantitative trait locus (QTL) mapping] **- 4 Lectures;** Plant DNA Barcoding- Barcoding Markers (matK, rbcl, ITS, tmH-psbA), steps, recent advances, Benefits, Limitations - **4 Lectures.**		12

		IV: Biofertilizers and Biopesticides	Biofertilizer: Nitrogen-fixing Rhizobacteria - Symbiotic Nitrogen Fixers -**2 Lectures;** Nonsymbiotic Nitrogen Fixers Plant Growth Promoting Microorganisms-Phosphate-Solubilizing Microbes (PSM), Phytohormones and Cytokinins, Induced Systemic Resistance- **2 Lectures;** Plant Growth Promotion by Fungi--Mycorrhizae Arbuscular Mycorrhizae Ectomycorrhizae **-2 Lectures;** Microbial Inoculants -- Inocula, Carriers, and Applications, Monoculture and Co-culture Inoculant Formulations Biocontrol, Polymicrobial Inoculant Formulations-**3 Lectures;** Biopesticides – types, Bacillus thuringiensis, insect viruses and entomopathogenic fungi (characteristics, physiology, mechanism of action and application) **-3 Lectures.**		12

References:

1. M. Ajmal Ali, G. Gyulai, F. Al-Hemaid -Plant DNA Barcoding and Phylogenetics, LAP Lambert Academic Publishing (2015)
2. P. Parvatha Reddy (auth.)-Sustainable Crop Protection under Protected Cultivation-Springer Singapore (2016)
3. S.B. Anderson (ed.), Plant Breeding from Laboratories to Fields, InTech,2013
4. Henry Leung, Subhas Chandra Mukhopadhyay (eds.) - Intelligent Environmental Sensing (2015, Springer International Publishing)
5. Travis R. Glare, Maria E. Moran-Diez - Microbial-Based Biopesticides_ Methods and Protocols (2016, Humana Press)
6. Altieri, Miguel A.Farrell, John G-Agroecology- The Science Of Sustainable Agriculture, Second Edition-CRC Press (2018)
7. Arie Altman, Paul Michael Hasegawa-Plant Biotechnology and Agriculture_ Prospects for the 21st Century-Academic Press (2011)

PRACTICALS

Applied component-Agri-Biotechnology

USBT P 603-604 **2 credits** **48 hrs**

1. RAPD analysis demonstration experiment
2. Isolation of Rhizobium
3. Isolation of Azotobacter
4. Isolation of Phosphate solubilising bacteria
5. Study of effect of abiotic stress on plants.
6. Rapid screening tests for abiotic stress tolerance (drought, - PEG, Mannitol &salinity NaCl)
7. Estimation of antioxidants and antioxidant enzymes - Ascorbate, Catalase, and Peroxidase
8. Visit to green house facility and submission of field visit report.