



**Vivekanand Education Society's  
College of Arts, Science and Commerce  
(Autonomous)**

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

*Accredited by NAAC "A Grade" in 3<sup>rd</sup> Cycle - 2017*  
*Best College Award – Urban Area, University of Mumbai (2012-13)*  
*Recipient of FIST Grant (DST) and STAR College Grant (DBT)*

Affiliated to the  
**University of Mumbai**

*Syllabus for*

**Program: B.Sc. (Biotechnology)**

**(Program code: VESUSBT)**

**As per Choice Based Credit System (CBCS)  
with effect from Academic Year 2022 - 2023**

## **Program Outcomes (PO):**

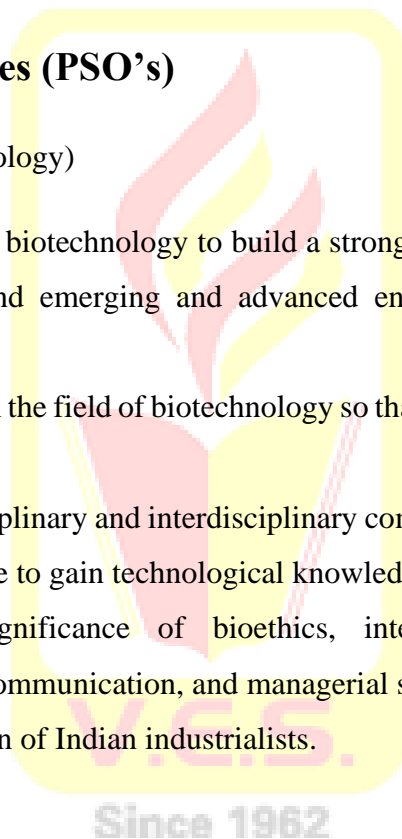
A learner completing B.Sc. (Biotechnology) will be able to:

- PO1 Demonstrate analytical skills in applying appropriate science principles and methodologies to solve a wide range of problems.
- PO2 Design, carry out experiments and analyze results by accounting uncertainties in different quantities measured using various scientific instruments.
- PO3 Acquire the ability to correlate and draw various inferences.
- PO4 Be able to apply the learnings in the academic course to an industrial setup

## **Program Specific Outcomes (PSO's)**

On completion of B.Sc. (Biotechnology)

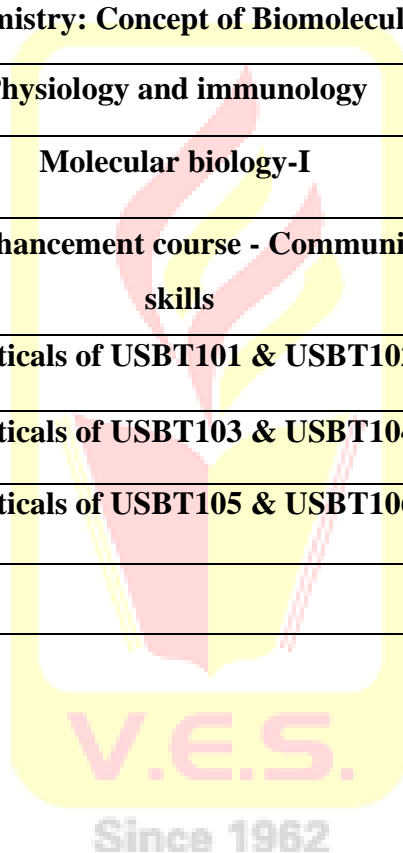
- PSO1 Apply the basics of biotechnology to build a strong foundation that will allow them to comprehend emerging and advanced engineering concepts in life sciences.
- PSO2 Acquire expertise in the field of biotechnology so that it may be used in industry and research.
- PSO3 By integrating disciplinary and interdisciplinary components of biotechnology, students will be able to gain technological knowledge.
- PSO4 Recognize the significance of bioethics, intellectual property rights, entrepreneurship, communication, and managerial skills in the development of the future generation of Indian industrialists.



## **F.Y.B.Sc. (BIOTECHNOLOGY)**

### **(SEMESTER I)**

<b>Course code</b>	<b>Title</b>	<b>Credits</b>	<b>No. of Lectures /week</b>
<b>VESUSBT101</b>	<b>Fundamentals of biotechnology-I</b>	<b>2</b>	<b>3</b>
<b>VESUSBT102</b>	<b>Microbiology-I</b>	<b>2</b>	<b>3</b>
<b>VESUSBT103</b>	<b>Basic Chemistry-I</b>	<b>2</b>	<b>3</b>
<b>VESUSBT104</b>	<b>Biochemistry: Concept of Biomolecules-I</b>	<b>2</b>	<b>3</b>
<b>VESUSBT105</b>	<b>Physiology and immunology</b>	<b>2</b>	<b>3</b>
<b>VESUSBT106</b>	<b>Molecular biology-I</b>	<b>2</b>	<b>3</b>
<b>VESUSBT107</b>	<b>Ability enhancement course - Communication skills</b>	<b>2</b>	<b>3</b>
<b>VESUSBTP101</b>	<b>Practicals of USBT101 &amp; USBT102</b>	<b>2</b>	<b>3</b>
<b>VESUSBTP102</b>	<b>Practicals of USBT103 &amp; USBT104</b>	<b>2</b>	<b>3</b>
<b>VESUSBTP103</b>	<b>Practicals of USBT105 &amp; USBT106</b>	<b>2</b>	<b>3</b>
		<b>20</b>	



# F.Y.B.Sc. BIOTECHNOLOGY

## (SEMESTER II)

Course code	Title	Credits	No. of Lectures /week
VESUSBT201	Fundamentals of Biotechnology-II	2	3
VESUSBT202	Cell biology and Microbiology-II	2	3
VESUSBT203	Basic Chemistry-II	2	3
VESUSBT204	Biochemistry: Concept of Biomolecules-II and Basic analytical techniques	2	3
VESUSBT205	Genetics	2	3
VESUSBT206	Basic Computers and Biostatistics	2	3
VESUSBT207	Ability enhancement course - Sustainable development and Environmental biotechnology	2	3
VESUSBTP201	Practicals of USBT201 & USBT202	2	3
VESUSBTP202	Practicals of USBT203 & USBT204	2	3
VESUSBTP203	Practicals of USBT205 & USBT206	2	3
		20	

V.E.S.

Since 1962

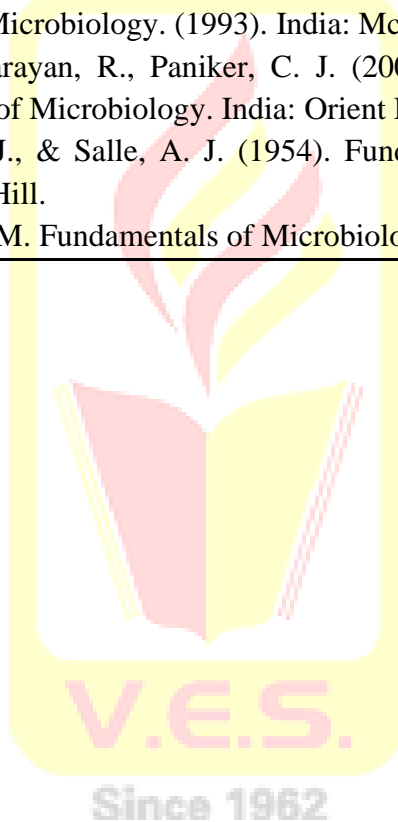
# SEMESTER I

Course Code	Title	Credits	No of lectures
<b>VESUSBT101</b>	<b>Fundamentals of biotechnology-1</b>	<b>02</b>	
<p><b>Course Objectives:</b> To familiarize the students with the potential and different applications of biotechnology</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of developments in various fields of Biotechnology</li> <li>• Be able to relate to applications and benefits of Biotechnology in the fields of agriculture, livestock, human health and environment</li> <li>• Discuss the basics of fermentation</li> </ul>			
<b>Unit I</b> <b>Introduction and scope of biotechnology</b>	<p><b>What is biotechnology?</b> Biotechnology –an interdisciplinary biological science; Biotechnology – definition; History &amp; Introduction to Biotechnology; Traditional and Modern Biotechnology; Scope and importance of biotechnology;</p> <p><b>World of Biotechnology-</b> Pharmaceutical Biotechnology, Plant Biotechnology, Industrial Biotechnology, Marine Biotechnology, Animal Biotechnology, Medical biotechnology, Environmental Biotechnology.</p> <p><b>Biotechnology in India –</b> Bio-business in India, booming biotech market, success story of biotech market, policy initiatives; and global trends; Biotechnology research in India;</p> <p><b>Potential of modern biotechnology;</b> Achievement of biotechnology; Prevention of misuse of biotechnology; Biotechnology Institutions in India (Public and Private Sector); Public Perception of Biotechnology.</p> <p><b>Case study: Serum Institute of India and its products</b></p>		<b>15</b>
<b>Unit II</b> <b>Applications of biotechnology</b>	<p><b>Applications of biotechnology: -</b></p> <p><b>Agriculture:</b> GM fruits- GM papaya, GM tomato, Insect resistant transgenic plants – Bt cotton, Bt brinjal, Modifications in nutrient quality – starch, oilseed protein, golden rice</p> <p><b>Livestock:</b> Growth, disease resistance, product quality,</p>		<b>15</b>

	<p>pharmaceuticals and nutritional supplements, industrial applications</p> <p><b>Human welfare:</b></p> <p>Cloned genes for production of -Insulin; recombinant vaccine for Hepatitis B virus. Molecular farming, Edible vaccines and their advantages</p> <p><b>Environment-</b></p> <p>Pollution abatement through GMOs</p> <p><b>Bioethics</b></p> <p><b>Case study:</b> Genetically modified microbes for bioremediation of oil spills in marine environment</p>		
<p><b>Unit III</b> <b>Fermentation technology</b></p>	<p><b>Introduction to fermentation processes:</b></p> <p>Microbial biomass, Microbial enzymes, Microbial metabolites, recombinant products, transformation processes. Development of fermentation Industry</p> <p><b>Component parts of fermentation process Screening:</b></p> <p>Definition, Primary screening and its methods, Secondary screening and its methods</p> <p><b>Fermenter design:</b></p> <p>Definition of a fermenter, aerated stirred tank batch fermenter-Typical design, Construction materials used, aeration and agitation</p> <p><b>Basic introduction to process parameters:</b> Temperature control, Foam production and control pH measurement and control, CO<sub>2</sub> and O<sub>2</sub> control</p> <p><b>Fermentation medium:</b></p> <p>Basic requirements of industrial media, Criteria for use of raw materials in media, Examples of raw materials used, Growth factors, Water, Carbohydrate sources, Protein sources</p> <p><b>Product: A typical process of Ethanol production and Antibiotic production</b></p>		15
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Dubey, R. C. (1993). A textbook of Biotechnology. S. Chand Publishing.</li> <li>2. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing.</li> <li>3. Singh, B. D., &amp; Singh, B. D. (2007). Biotechnology expanding horizons. Kalyani publishers.</li> <li>4. Stanbury, P. F., Whitaker, A., &amp; Hall, S. J. (2013). Principles of fermentation technology. Elsevier.</li> <li>5. Casida, L. E. (1968). Industrial microbiology. Industrial microbiology.</li> <li>6. Okafor, N., &amp; Okeke, B. C. (2017). Modern industrial microbiology and biotechnology. CRC Press.</li> </ol>		

Course Code	Title	Credits	No of lectures
VESUSBT102	Microbiology-1	02	
<p><b>Course Objectives:</b> To build firm foundation in microbiology, sterilization techniques and staining.</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of cultivation of microorganisms.</li> <li>• Develop skills towards use of microscopy and staining techniques</li> <li>• Understand the role of sterilization and disinfection in the field of microbiology</li> </ul>			
<p><b>Unit I</b> <b>Introduction to microbiology</b></p>	<p><b>Fundamentals, History and Evolution of Microbiology:</b> Discovery of Microorganisms, Conflict over spontaneous generation. Role of microorganisms in disease</p> <p><b>Classification:</b> The place of Microorganisms in the living world, Classification Whittaker's five kingdom classification, Introduction to Bergey's Manual, Groups of Microorganisms, Applications of microbiology in various fields</p> <p><b>Nutrition, Cultivation and Maintenance of microorganisms:</b> Nutritional categories of microorganisms, Design and Types of Culture Media, methods of isolation.</p>		15
<p><b>Unit II</b> <b>Sterilization techniques</b></p>	<p><b>Introduction:</b> Definition and concept of Sterilization and Disinfection.</p> <p><b>Types and Applications:</b> Dry Heat, Steam under pressure Gases, Radiation and Filtration</p> <p><b>Chemical Agents and their Mode of Action:</b> Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents.</p> <p><b>Disinfectant:</b> Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant</p>		15
<p><b>Unit III</b> <b>Microscopy and stains</b></p>	<p><b>Simple and Compound Microscope:</b> General principles of optics; various parts and their functions - objectives – numerical aperture, resolving power, depth of focus, working distance, aberrations; oculars; condensers.</p> <p><b>Dark Field Microscope; Phase Contrast Microscope</b></p>		15

	<p><b>and Fluorescent Microscope, TEM, SEM</b>  <b>Applications of microscopes</b></p> <p><b>Stains and Staining Solutions-</b>  Definition of Dye and Chromogen; acidic and basic dyes; functions and types of chromophore and auxochrome groups. Theories to explain staining.  Definition and function of stain; mordant, intensifiers and fixative.</p> <p><b>Natural and Synthetic Dyes</b>  <b>Simple Staining, Differential Staining</b> – Gram staining and Acid Fast Staining with specific examples</p>		
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Prescott, L. M. (2002). Microbiology 5th Edition.</li> <li>2. Pelczar., Microbiology. (1993). India: McGraw-Hill Education.</li> <li>3. Ananthanarayan, R., Paniker, C. J. (2006). Ananthanarayan and Paniker's Textbook of Microbiology. India: Orient Longman.</li> <li>4. Salle, A. J., &amp; Salle, A. J. (1954). Fundamental principles of bacteriology McGraw-Hill.</li> <li>5. Frobisher M. Fundamentals of Microbiology (9th Ed)</li> </ol>		





Course Code	Title	Credits	No of lectures
VESUSBT103	Basic Chemistry-1	02	
<p><b>Course Objectives:</b> To acquaint the students with basic concepts of Chemistry like nomenclature, chemical bonds, titrimetric, gravimetry, stereochemistry etc.</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of chemical bonds.</li> <li>• Develop skills towards use of titrimetric and gravimetric analysis</li> <li>• Be able to differentiate between chiral and achiral molecules and different enantiomers</li> </ul>			
<p><b>Unit I</b> <b>Nomenclature and Chemical bonds</b></p>	<p><b>Classification and Systematic Nomenclature of organic compounds</b> (few examples)</p> <p><b>Chemical Bonds:</b> Types and transition between the main types of bonding.</p> <p><b>Ionic Bond:</b> Nature of Ionic Bond, factors influencing the formation of Ionic Bond. Structure of NaCl and CsCl.</p> <p><b>Covalent Bond:</b> Nature of Covalent Bond, Types of covalent bond (Polar and Coordinate covalent bonds). Structure of CH<sub>4</sub>, NH<sub>3</sub>, H<sub>2</sub>O, Shapes of BeCl<sub>2</sub>, BF<sub>3</sub>.</p> <p><b>Hydrogen Bond:</b> Theory of Hydrogen Bonding and Types of Hydrogen Bonding (with examples of RCOOH, ROH, Salicylaldehyde, Amides and Polyamides).</p>		15
<p><b>Unit II</b> <b>Titrimetric and gravimetry</b></p>	<p><b>Titrimetric Analysis:</b> 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.</p> <p><b>Gravimetric Analysis:</b> 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</p>		15

	Ignition of Precipitate.		
<b>Unit III Stereochemistry</b>	<p><b>Isomerism:</b> Types of Isomerism: Constitutional Isomerism (Chain, Position and Functional) and Stereoisomerism, Chirality.</p> <p><b>Geometric Isomerism and Optical Isomerism:</b> 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)</p> <p><b>Conformation:</b> Conformations of Ethane. Difference between Configuration and Conformation.</p> <p><b>Configuration:</b> Asymmetric Carbon Atom, Stereogenic/ Chiral Centers, Chirality Representation of Configuration by —Flying Wedge Formula</p> <p><b>Projection formulae:</b> Fischer, Newman and Sawhorse. The Interconversion of the Formulae.</p>		<b>15</b>
<b>References</b>	<ol style="list-style-type: none"> <li>1. Bahl, B. S., &amp; Bahl, A. (2017). A textbook of organic chemistry. S. Chand Publishing.</li> <li>2. Lee, J. D. (2008). Concise inorganic chemistry. John Wiley &amp; Sons.</li> <li>3. Skoog, D. A., West, D. M., Holler, F. J., &amp; Crouch, S. R. (2013). Fundamentals of analytical chemistry. Cengage learning.</li> <li>4. Vogel, A. I., &amp; Jeffery, G. H. (1989). Vogel's textbook of quantitative chemical analysis. Wiley.</li> <li>5. Mosher, M. (1992). Organic Chemistry. (Morrison, Robert Thornton; Boyd, Robert Neilson).</li> </ol>		

Course Code	Title	Credits	No of lectures
VESUSBT104	Biochemistry: Concept of Biomolecules-1	02	
<p><b>Course Objectives:</b> To acquaint the students with different concepts of biomolecules</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop skills towards preparation of standard solutions in the laboratory.</li> <li>• Understand the role of buffers</li> <li>• Discuss the basics of carbohydrate and lipid biochemistry.</li> </ul>			
<p><b>Unit I</b></p> <p><b>Water, Standard solutions and Buffers</b></p>	<p><b>Structure, Properties and functions:</b> Water</p> <p><b>Preparation of standard Solutions:</b> Concept and significance of Chemical and Biological 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.</p> <p><b>Concept of pH:</b> Buffer solutions –Concept of Buffers, Derivation of Henderson -Hasselbach equation for Acidic and Basic buffers. Buffering capacity</p> <p><b>Biological buffers:</b> Significance of biological buffers. pH of body fluids like blood and saliva. Blood buffer systems: E.g.: Carbonate, Acetate and Phosphate buffers, Protein buffers (Introduction) Significance of TRIS buffers (Introduction)</p>		15
<p><b>Unit II</b></p> <p><b>Basics of Carbohydrate Chemistry</b></p>	<p><b>Carbohydrates:</b> Introduction, definition and general formula. <b>Classification of carbohydrates: Monosaccharides:</b> Two Families of Monosaccharides. Aldo series and keto series; (Triose - Glyceraldehyde and Dihydroxyacetone, Tetrose- Erythrose and Erythrulose, Pentose- Xylose, Xylulose, Ribose, Ribulose, Hexose- Glucose, Galactose, Mannose, Heptose- sedoheptose and Sedoheptulose (structures to be taught) Concept of Enantiomers, Mutarotation, Anomeric carbon and Epimers of glucose.</p> <p><b>Biologically important Derivatives of Hexoses:</b> Glucosamine, Gluconic acid, uronic acid, NAGA, NAMA</p> <p><b>Chemical reactions of monosaccharides Concept of glycosidic bond.</b></p>		15

	<p><b>Disaccharides:</b> Maltose, Lactose, Sucrose, Cellobiose (structures to be taught, biological significance, structure and bond type)</p> <p><b>Polysaccharides:</b> Homopolysaccharides and Heteropolysaccharides; Structural and Storage Polysaccharides. E.g., of polysaccharides -: starch (amylose and amylopectin), Glycogen, Peptidoglycan, Cellulose, chitin (structure and bond type)</p> <p><b>Examples of Reducing and nonreducing carbohydrates. Industrial applications of carbohydrates:</b> Fermentation, Pharmaceutical and Food industry.</p>		
<p><b>Unit III</b> <b>Basics of Lipid Chemistry</b></p>	<p><b>Introduction to Lipid Chemistry:</b> Definition and Biological functions of fats and Lipids. Definition of Fatty acids. <b>Classification of Fatty acids:</b> <b>Saturated Fatty Acids:</b> C2- C20 (Examples with trivial name, Biochemical names and Structures) <b>Unsaturated Fatty Acids:</b> Definition of MUFA and PUFA. C16- C20. Palmitolic, Oleic, Linoleic, Lenolenic, Arachidonic acid (Structures expected) <b>Storage Lipids:</b> AcylGlycerols (Simple and Mixed) Mono, Di and Triacylglycerols. (Structures expected) <b>Properties of Triacylglycerols:</b> Hydrolysis, Saponification, Antioxidant, Rancidity, Acid number, RM number, Action of lipase. <b>Structural lipids:</b> Phosphatidic acid and Membrane Phospholipids E.g.: Phosphatidylethanolamine, Phosphatidylserine, Phosphatidylcholine, Cardiolipin <b>Action of Phospholipase</b> <b>Steroids:</b> Definition and functions Eg: Cholesterol</p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Cox, M. M., &amp; Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.</li> <li>2. Conn, E., &amp; Stumpf, P. (2009). Outlines of biochemistry. John Wiley &amp; Sons.</li> <li>3. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.</li> </ol> <p>Mu, P., &amp; Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.</p>		

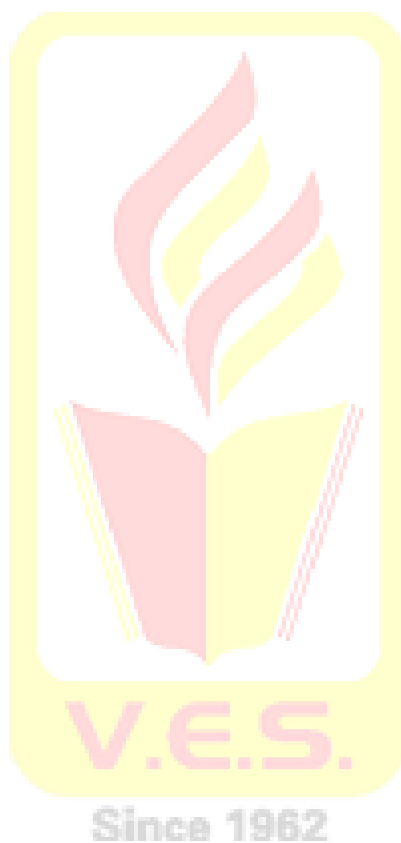
Course Code	Title	Credits	No of lectures
VESUSBT105	Physiology and immunology	02	
<p><b>Course Objectives:</b> To provide an insight in to the different physiological processes of plants and animals.</p> <p><b>Learning Outcomes</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>● Gain insights into the Physiological Processes of Plants and functions of plant growth regulators.</li> <li>● Develop a comprehensive and deep understanding of the vital physiological processes of animals.</li> <li>● Understand the concept of immunity and role of antigens and immunoglobulins in the immune system.</li> </ul>			
<p><b>Unit I</b> <b>Plant Physiology</b></p>	<p><b>Photosynthesis:</b> Hill's Reaction and its Significance, Light Reactions, Cyclic and Non-Cyclic Photoinduced Electron Flow, Energetics of Photosynthesis, Dark Phase of Photosynthesis, Calvin Cycle, C-3, C-4, CAM pathways, Rubisco oxygenase activity</p> <p><b>Plant hormones:</b> Auxin, Gibberellins, Cytokinins, Ethylene, Abscisic acid</p> <p><b>Introduction to Secondary Metabolites</b></p>		15
<p><b>Unit II</b> <b>Animal Physiology</b></p>	<p><b>Introduction to physiology:</b> Concept of homeostasis.</p> <p><b>Body fluids:</b> Major types of Body fluid.</p> <p><b>Blood:</b> Functions of blood, general properties of blood, Composition of blood. Thrombocytes or Platelets. Coagulation of blood. Theories of Coagulation. Hemolysis.</p> <p><b>Respiratory system:</b> Phases of Respiration, Principle of gases exchange, Mechanism of breathing.</p> <p><b>Digestion and absorption:</b> Mode of nutrition, Digestion: Digestion of foodstuffs, Digestion in humans. Absorption.</p> <p><b>Excretion:</b> Organs of excretion. Types of excretory products. Excretion in vertebrates - Human</p> <p><b>Kidney:</b> Structure of kidney, Structure of nephron. Function of kidney. Urine formation. Dialysis</p>		15

<p><b>Unit III</b> <b>Immunology</b></p>	<p><b>Introduction to Immunology:</b> Overview of Immune Systems, Innate Immunity, Mechanisms of innate immunity, Acquired Immunity, Local and Herd Immunity, Humoral and Cellular Immunity - Factors Influencing and Mechanisms of each. <b>Antigens:</b> Immunogenicity Versus Antigenicity, Factors That Influence Immunogenicity, Epitopes, Haptens, Superantigens <b>Antibodies:</b> Basic Structure of Antibodies, Antibody-Mediated Effector Functions, Antibody Classes and Biological Activities, Antigenic Determinants on Immunoglobulins.</p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Cox, M. M., &amp; Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.</li> <li>2. Verma, S. K., Verma, M. (2008). A Textbook of Plant Physiology, Biochemistry and Biotechnology. India: S. Chand Limited.</li> <li>3. Gujral, S. K., Kochhar, S. L. (2020). Plant Physiology: Theory and Applications. United States: Cambridge University Press.</li> <li>4. Rastogi, S. C. (2007). Essentials of Animal Physiology. India: New Age International (P) Limited, Publishers.</li> <li>5. Reddy, B. (2014). Text Book of Animal Pyhysiology. Andra Paresh, IMRF</li> </ol> <p><b>Publication</b></p> <ol style="list-style-type: none"> <li>1. Sembulingam, K. (2008). Essentials of Medical Physiology. India: Juta, Limited.</li> <li>2. Sherwood, L. (2012). Introduction to Human Physiology. United States: Brooks/Cole.</li> <li>3. Goldsby, U. R. A., Kuby, J., Kindt, T. J., Goldsby, R. A., Osborne, B. A., Marcus, D. A. (2003). Immunology. United Kingdom: W. H. Freeman.</li> <li>4. Textbook Of Microbiology (7th Edition). (2006). India: Orient BlackSwan. Rao, C. V. (2017). Immunology. United Kingdom: Alpha Science International, Limited.</li> <li>5. Murphy, K. M., Weaver, C. (2017). Janeway's Immunobiology. United Kingdom: Garland Science/Taylor &amp; Francis Group, LLC.</li> </ol>		

Course Code	Title	Credits	No of lectures
VESUSBT106	Molecular biology-1	02	
<p><b>Course Objectives:</b> To build a firm foundation of molecular biology</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of structure and organization of the hereditary material</li> <li>• Discuss the different processes involved in replication of DNA</li> <li>• Understand the relevance of physical, chemical and biological factors in mutations</li> </ul>			
<b>Unit I Chromosome structure, composition and packing</b>	<p><b>The Composition and structure of DNA and RNA:</b> Nucleotide and Nucleoside, Structure of nucleotides. Structure of DNA. DNA double helix – Watson and Crick’s Model. Structure of RNA. Types of RNA.</p> <p><b>Organization of DNA in chromosome:</b> Viral and Prokaryotic Chromosomes. Eukaryotic Chromosomes. Histone and Non-histone proteins. Nucleosome Structure. Packaging of DNA into chromosomes. Euchromatin and Heterochromatin. Centromeres and Telomeres</p> <p><b>Chromosome Banding Techniques. Karyotype and Idiogram</b></p>		<b>15</b>
<b>Unit II DNA replication</b>	<p><b>Models of DNA Replication</b> Evidence of Semi-conservative DNA replication- Meselson and Stahl’s experiment DNA Polymerases and its role,</p> <p><b>DNA Replication in Prokaryotes:</b> <i>E.coli</i> Chromosome Replication, Semi-discontinuous replication Bidirectional Replication of Circular DNA molecules. Rolling Circle Replication,</p> <p><b>DNA Replication in Eukaryotes</b> <b>Enzymes and proteins involved in DNA replication</b></p>		<b>15</b>
<b>Unit III- Mutation and repair</b>	<p><b>Definition and concept of Mutations:</b> Classification of mutations Types of Point Mutations, Types of Spontaneous and induced mutations Mutagenesis and types of Mutagens. (Examples of Physical, Chemical and Biological Mutagens)</p> <p><b>DNA repair:</b> Photo reversal, Base Excision Repair, Nucleotide Excision Repair, Mismatch Repair, SOS Repair.</p>		<b>15</b>

**References**

1. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.
2. Russell, P. J., & Gordey, K. (2002). IGenetics ,San Francisco: Benjamin Cummings.
3. Simmons, M. J., & Snustad, D. P. (2006). Principles of genetics. John Wiley & Sons.
4. Russell, P. J. (2000). Fundamentals of genetics. Longman Publishing Group.
5. Karp, G. (2009). Cell and molecular biology: concepts and experiments. John Wiley & Sons.
6. Strickberger M., Genetics. (1995). Australia: Deakin University





Course Code	Title	Credits	No of lectures
VESUSBT107	Ability Enhancement Course-Communication skills	02	
<p><b>Course Objectives:</b> To acquaint the students with different aspects of communication skills.</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of communication skills required to excel in real work environment and corporate life.</li> <li>• Gain insight into technical and non-technical qualities in career planning</li> <li>• Learn about Leadership, team building, decision making and stress management</li> </ul>			
<p><b>Unit I</b> <b>Academic skills</b></p>	<p><b>Essentials of Grammar:</b> Parts of speech, Articles, Modals, Sentences and their types., Punctuation marks</p> <p><b>Employment Communication:</b> Introduction, Resume, Curriculum Vitae, Scannable Resume, Developing an Impressive Resume, Formats of Resume, Job Application or Cover Letter. Email Writing</p> <p><b>Professional Presentation:</b> Nature of Oral Presentation, planning a Presentation, Preparing the Presentation, Delivering the Presentation</p> <p><b>Job Interviews:</b> Introduction, Importance of Resume, Definition of Interview, Background Information, Types of Interviews, Preparatory Steps for Job Interviews, Interview Skill Tips, Changes in the Interview Process, FAQ During Interviews</p> <p><b>Group Discussion:</b> Introduction, Ambience/Seating Arrangement for Group Discussion, Importance of Group Discussions, Difference between Group Discussion, Panel Discussion and Debate, Traits, Types of Group Discussions, topic based and Case based Group Discussion, Individual Traits</p>		15
<p><b>Unit II</b> <b>Soft skills</b></p>	<p>Introduction to Soft Skills and Hard Skills</p> <p><b>Personality Development:</b> Knowing Yourself, Positive Thinking, Johari's Window, Communication Skills, Non-verbal Communication, Physical Fitness</p> <p><b>Emotional Intelligence:</b> Meaning and Definition, Need for Emotional Intelligence, Intelligence Quotient versus Emotional Intelligence Quotient, Components of Emotional Intelligence, Competencies of Emotional Intelligence, Skills to Develop Emotional Intelligence</p> <p><b>Etiquette and Mannerism:</b> Introduction, Professional Etiquette, Technology Etiquette</p> <p><b>Communication Today:</b> Significance of Communication, GSC's 3M Model of Communication, Vitality of the Communication Process, Virtues of Listening, Fundamentals of Good Listening, Nature of Non- Verbal Communication, Need for Intercultural Communication, Communicating Digital World</p>		15

<p><b>Unit III</b> <b>Professional skills</b></p>	<p><b>Creativity at Workplace:</b> Introduction, Current Workplaces, Creativity, Motivation, Nurturing Hobbies at Work, The Six Thinking Hat Method</p> <p><b>Ethical Values:</b> Ethics and Society, Theories of Ethics, Correlation between Values and behavior, Nurturing Ethics, Importance of Work Ethics, Problems in the Absence of Work Ethics</p> <p><b>Capacity Building:</b> Need and Importance of Capacity Building Elements of Capacity Building Zones of Learning Ideas for Learning Strategies for Capacity Building</p> <p><b>Leadership and Team Building:</b> Leader and Leadership, Leadership Traits, Culture and Leadership, Leadership Styles and Trends, Team Building, Types of Teams</p> <p><b>Decision Making and Negotiation:</b> Introduction to Decision Making, Steps for Decision Making, Decision Making Techniques, Negotiation Fundamentals, Negotiation Styles, Major Negotiation Concepts</p> <p><b>Stress and Time Management:</b> Stress, Sources of Stress, Ways to Cope with Stress</p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Kumar, Sanjay, and Lata, Pushp. Communication Skills, Second Edition. India, Oxford University Press, 2015.</li> <li>2. Chauhan, G. S., Sharma, S. (2016). Soft Skills: An Intergrated Approach to Maximise Personality. India: Wiley.</li> <li>3. Mitra, B. K. (2011). Personality development and soft skills (Vol. 156). Oxford University Press.</li> <li>4. Guffey, M. E., &amp; Loewy, D. (2012). Essentials of business communication. Cengage Learning.</li> <li>5. Rao, M. S. (2010). Soft skills-enhancing employability: connecting campus with corporate. IK International Pvt Ltd.</li> <li>6. Sherfield, R. M. (2009). Cornerstone: Developing Soft Skills. Pearson Education India.</li> </ol>		

Course Code	Title	Credits	Notional hours
VESUSBTP101	<b>Practicals of Fundamentals of Biotechnology-I and Microbiology-I</b>	2	45
<ol style="list-style-type: none"> <li>Analyse a case-study and write a report on any one recent application of Biotechnology (In last 5 years)</li> <li>Study of Microscope – Compound Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescent Microscope, TEM, SEM. (Including ray diagrams)</li> <li>Monochrome staining using any suitable material. (Bacteria/Plant/Animal tissue)</li> <li>Differential staining – Gram staining, Acid fast staining, Romanowsky staining.</li> <li>Special staining – cell wall, capsule, spores, negative staining.</li> <li>Preparation of media- Nutrient broth and Agar, MacConkey Agar, Sabouraud's Agar</li> <li>Sterilization of Laboratory Glassware and Media using Autoclave</li> <li>Isolation techniques: T-streak, polygon method &amp; Colony Characteristics of Microorganisms.</li> <li>Use of Bergey's manual to help identify any one isolate</li> <li>Isolation of Yeasts from natural environment. &amp; Study of morphology and colony characteristics of yeasts. Fungal staining – wet mount (Lactophenol cotton blue/Methylene Blue)</li> </ol>			

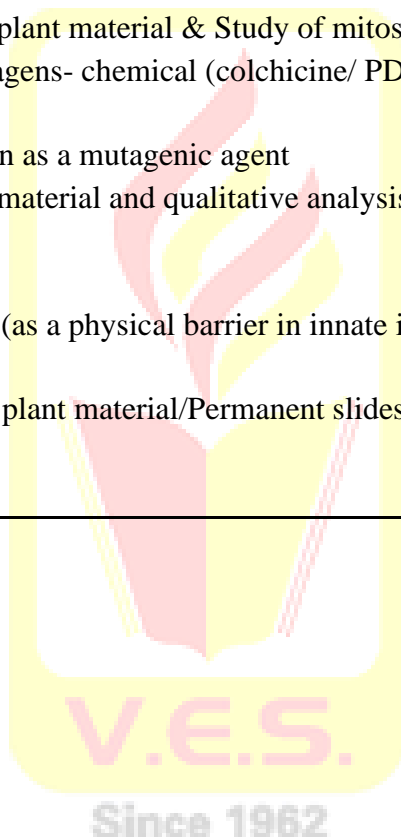
Course Code	Title	Credits	Notional hours
VESUSBTP102	<b>Practicals of Basic Chemistry-I and Biochemistry: Concept of -I</b>	2	45
<ol style="list-style-type: none"> <li>Preparation of Normal, Molar, Molal, Percent, PPM and PPB solutions</li> <li>Demonstration of pH meter and digital Balance</li> <li>Preparation of Acetate buffer pH 4.6, Carbonate buffer pH 6.8, Tris buffer pH 8.3</li> <li>Structures of Aldo series and Keto series of Monosaccharides, disaccharides and Polysaccharides &amp; Qualitative tests for carbohydrates; Molisch test, Benedict's test, Iodine test, Osazone formation</li> <li>Quantitative Estimation of carbohydrates by DNSA method</li> <li>Qualitative tests for lipids.</li> <li>Determine the rate constant for the saponification reaction between ethyl acetate and NaOH by back titration method</li> <li>Determination of Acetic acid in Vinegar by Titrimetric Method.</li> <li>Determination of the amount of Fe (II) present in the given solution Titrimetrically.</li> <li>Determination of amount of NaHCO<sub>3</sub> + Na<sub>2</sub>CO<sub>3</sub> in the given solid mixture Titrimetrically.</li> <li>Determination of the amount of Mg (II) present in the given solution complexometrically.</li> <li>Determination of percent composition of BaSO<sub>4</sub> and NH<sub>4</sub>Cl in the given mixture Gravimetrically.</li> </ol>			

Course Code	Title	Credits	Notional hours
VESUSBTP103	Practicals of Physiology, Immunology and Molecular biology-I	2	45

1. Verification of Beer and Lambert's Law and Determination of absorption maxima of CuSO<sub>4</sub>/K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>.
2. Study of Hill's reaction.
3. Solvent extraction of plant pigments and study the absorption spectra of pigments
4. Qualitative detection of plant secondary metabolites using standard tests - e.g. Tests for tannins, flavonoids, alkaloids, terpenoids, saponins, steroids.
5. Study of human blood count (RBC and WBC) using Haemocytometer
6. Estimation of Haemoglobin in human blood.
7. Analysis of Urine.
8. Study of mitosis from suitable plant material & Study of mitosis using pre-treated root tips of *Allium cepa* to study the effect of mutagens- chemical (colchicine/ PDB) on mitosis
9. Study the effect of UV radiation as a mutagenic agent
10. Extraction of DNA from plant material and qualitative analysis of DNA

**Do it yourself:**

11. Study of bacterial flora of skin (as a physical barrier in innate immunity) by swab method/Hand imprint method.
12. Study of meiosis from suitable plant material/Permanent slides/Photographs



## SEMESTER II

Course Code	Title	Credits	No of lectures
VESUSBT201	Fundamentals of Biotechnology-II	02	
<p><b>Course Objectives:</b> To acquaint students with the applications of biotechnology in the field of food, medicine and fermentation</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>● Develop an understanding of the application of biotechnology in the food industry.</li> <li>● Gain insight into details of genetic engineering.</li> <li>● Discuss tools and techniques used in medical biotechnology</li> </ul>			
<p><b>Unit I</b> <b>Food Biotechnology</b></p>	<p><b>Introduction to food biotechnology:</b> History of microorganisms in food science and key developments, Applications of biotechnology in fermented food products</p> <p><b>Introduction to Unit Operations and Processes:</b> Basic unit operations, food processing &amp; packaging (canning &amp; bottling), Production of cultures</p> <p><b>Fermented food products:</b> Bread, Vinegar, Sauerkraut, Single Cell Protein (SCP), Probiotics</p> <p><b>Food spoilage, food deterioration, food contamination and Food Adulteration</b></p> <p><b>Methods of food preservation</b></p> <p><b>Indicators of Food Microbial Quality &amp; Safety:</b> HACCP, FSSAI &amp; FDA</p>		<b>15</b>
<p><b>Unit II</b> <b>Medical biotechnology</b></p>	<p><b>Introduction to Medical Biotechnology and its applications</b></p> <p><b>Vaccines</b> Types of vaccines General vaccine production Large scale production of vaccine Trends in Vaccines Research Issues related to vaccine research <b>Synthetic peptides as vaccine</b></p> <p><b>Antibody Production</b></p> <p><b>Gene therapy</b></p> <p><b>Organ transplant cloning</b></p> <p><b>Stem cells -Sources and applications</b></p>		<b>15</b>

<p><b>Unit III</b></p> <p><b>Genetic engineering</b></p>	<p><b>What is Genetic engineering:</b>  Definition and developments  What is gene cloning?  Strategy for cloning  How to clone a gene?  How to construct rDNA?</p> <p>Source DNA [insert], Isolation of DNA from bacterial cell, Introducing insert into cloning vector</p> <p><b>Enzymes in genetic engineering:</b>  Restriction endonuclease; DNA ligase; Enzymes to modify ends of DNA molecules - exonuclease; endonuclease; S1 nuclease; alkaline phosphatase; polynucleotide kinase; DNA polymerase and klenow fragment; reverse transcriptase; terminal deoxynucleotidyl transferase</p> <p><b>Vectors:</b>  Role as agents of transfer  Features of plasmid vectors, Plasmid vectors - pBR322, pUC  BAC  Plant virus vectors and Animal virus vectors  Shuttle vector; Expression vector</p> <p><b>Host cells:</b>  <i>E. coli</i>; <i>Bacillus subtilis</i>; <i>Saccharomyces cerevisiae</i>; <i>Xenopus</i> oocytes; Mammalian fertilized egg cell</p> <p><b>Introducing vector into host:</b>  Prokaryote  Eukaryote</p> <p><b>Identification of recombinant clones.</b></p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Frazier, W. C., &amp; Westhoff, D. C. (1983). Food microbiology 5th Ed.</li> <li>2. Lee, B. H. (2014). Fundamentals of food biotechnology. John Wiley &amp; Sons.</li> <li>3. Jay, J. M., Loessner, M. J., &amp; Golden, D. A. (2008). Modern food microbiology. Springer Science &amp; Business Media.</li> <li>4. Woolverton, C. J., Sherwood, L., Willey, J. (2014). Prescott's Microbiology. India: McGraw-Hill Education.</li> <li>5. Patel, A. H. (1984). Industrial Microbiology. Macmillan India.</li> <li>6. Khan, F. A. (2011). Biotechnology fundamentals. CRC Press.</li> <li>7. Nicholl, D. S. T. (2002). An Introduction to Genetic Engineering (Studies in Biology). India: Cambridge University Press.</li> <li>8. Brown, T. A. (2013). Gene Cloning and DNA Analysis: An Introduction. Germany: Wiley.</li> <li>9. Genetic Engineering: Principles and Practice. (n.d.). India: McGraw-Hill Education.</li> <li>10. A Textbook of Biotechnology by R C Dubey 4th Ed</li> <li>11. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing</li> </ol>		

Course Code	Title	Credits	No of lectures
VESUSBT202	Cell biology and Microbiology-II	02	
<p><b>Course Objectives:</b> To build a firm foundation of concepts related to cell biology and microbiology</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Discuss the ultrastructure, function and location of organelles in prokaryotic and eukaryotic cells.</li> <li>• Develop an understanding of microbial growth and enumeration</li> <li>• Gain insight in to the basics of virology</li> </ul>			
<p><b>Unit I</b> <b>Ultrastructure of prokaryotic and eukaryotic cell</b></p>	<p><b>Ultrastructure of Prokaryotic Cell:</b> Concept of Cell shape, size and arrangement <b>Bacterial structures external to cell wall:</b> Flagella, Pili, Fimbriae, Capsule, Slime Layer, Sheath <b>Cell Wall</b> (Gram Positive and Negative) <b>Structures internal to cell wall:</b> Cell Membrane, nucleoid, Cytoplasm and cytoplasmic inclusion bodies and vacuoles, Genetic Material spores and cysts <b>Ultrastructure of Eukaryotic Cell:</b> Cell wall; Plasma membrane, Cytoplasmic Matrix, Nucleus –Nuclear Structure, nuclear envelope, nucleoplasm, Nucleolus; cytoplasmic structures – cytoplasmic inclusions, cytoplasmic organelles - Endoplasmic Reticulum; Golgi Apparatus; Mitochondria; Chloroplasts; Ribosomes; Lysosome - Endocytosis, Phagocytosis, Autophagy; Peroxisomes. <b>External Cell Coverings:</b> Cilia and Flagella <b>Comparison of Prokaryotic and Eukaryotic Cells</b></p>		15
<p><b>Unit II</b> <b>Microbiology</b></p>	<p><b>Microbial Growth</b> Definition of Growth Mathematical and expression of growth Growth curve Measurement of growth Efficiency of growth yield Synchronous growth Effect of nutrient on growth rate Continuous Culture of microorganisms Chemostat and Turbidostat <b>Enumeration of Microorganisms-</b> Direct and Indirect Methods <b>Preservation and Maintenance of cultures</b></p>		15

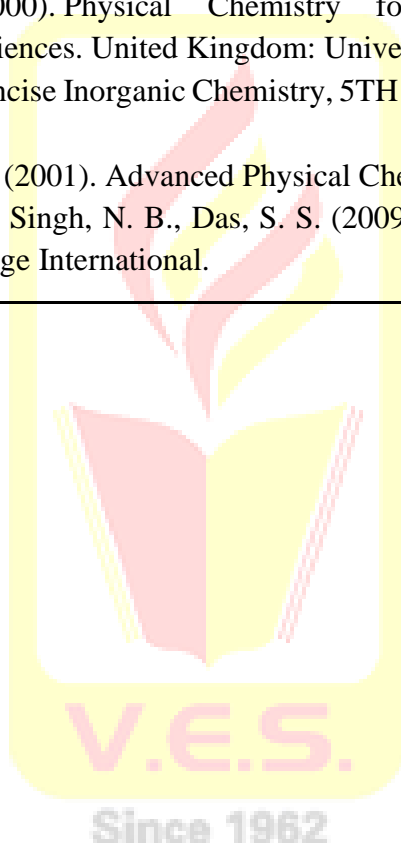
<p><b>Unit III Virology</b></p>	<p><b>Introduction to virology:</b> Historical perspective, <b>General Characteristics of Viruses:</b> Host Range</p> <p>Viral Structure- Nucleic Acid, Capsid and Envelope General Morphology- Helical, Polyhedral, Enveloped, Complex.</p> <p><b>Taxonomy of Viruses Viral Multiplication:</b> Multiplication of Bacteriophages and Animal Viruses <b>Isolation, Cultivation, and Identification of Viruses:</b> Growing Bacteriophages and animal viruses in the Laboratory, Viral Identification <b>Case studies-</b> TMV, Influenza COVID-19 (Self learning)</p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Pelczar., Microbiology. (1993). India: McGraw-Hill Education.</li> <li>2. Verma, P. S., &amp; Agarwal, V. K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology. S. Chand Publishing.</li> <li>3. Dubey, R. C. (2014). Advanced biotechnology. S. Chand Publishing</li> <li>4. Cooper, G. M., Hausman, R. E., &amp; Hausman, R. E. (2007). The cell: a molecular approach (Vol. 4). Washington, DC: ASM press.</li> <li>5. Stanier, R. Y. (1987). General Microbiology. Hong Kong: Macmillan.</li> <li>6. Funke, B. R., Case, C. L., Tortora, G. J. (2013). Microbiology: An Introduction. United Kingdom: Pearson.</li> <li>7. Woolverton, C. J., Sherwood, L., Willey, J. (2014). Prescott's Microbiology. India: McGraw-Hill Education</li> </ol>		





Course Code	Title	Credits	No of lectures
VESUSBT203	Basic Chemistry-II	02	
<p><b>Course Objectives:</b> To acquaint the students with some core aspects of physical chemistry</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of thermodynamics</li> <li>• Learn about reaction kinetics and order of reaction</li> <li>• Gain insight in to the details of oxidation and reduction reactions</li> </ul>			
<p><b>Unit I</b> <b>Thermodynamics</b></p>	<p><b>Thermodynamics:</b> System, Surrounding, Boundaries Sign Conventions, State Functions, Internal Energy and Enthalpy: Significance, examples, (Numerical problem expected.)</p> <p><b>Laws of Thermodynamics and its Limitations:</b> Mathematical expression. Qualitative discussion of Carnot Cycle for ideal Gas and Mechanical Efficiency. Laws of Thermodynamics as applied to Biochemical Systems.</p> <p><b>Concept of Entropy, Entropy for Isobaric, Isochoric and Isothermal Processes.</b></p>		15
<p><b>Unit II</b> <b>Chemical Kinetics</b></p>	<p><b>Reaction Kinetics:</b> Rate of Reaction, Rate Constant, Measurement of Reaction Rates Order &amp; Molecularity of Reaction, Integrated Rate Equation of First and Second order reactions (with equal initial concentration of reactants). (Numericals expected)</p> <p><b>Determination of Order of Reaction:</b> a) Integration Method b) Graphical Method c) Ostwald's Isolation Method Half Time Method. (Numericals expected).</p>		15

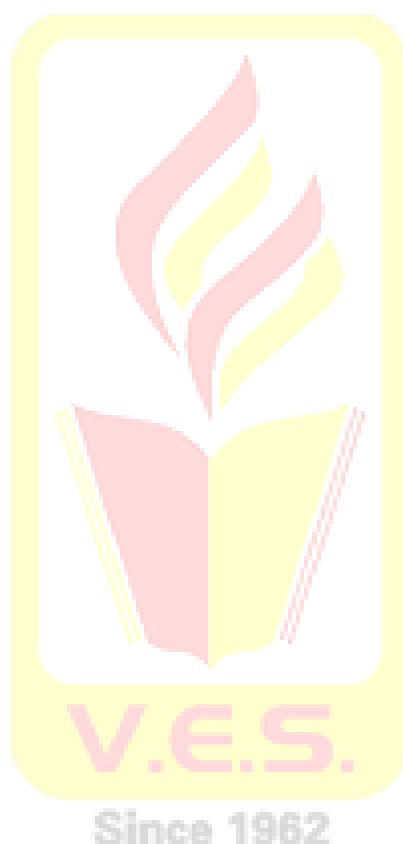
<p><b>Unit III</b> <b>Oxidation</b> <b>Reduction</b> <b>reactions</b></p>	<p><b>Principles of Oxidation &amp; Reduction Reactions:</b> Oxidising and Reducing Agents Oxidation Number, Rules to assign Oxidation Numbers with examples Ions like Oxalate, Permanganate and Dichromate. <b>Balancing Redox Reactions:</b> Ion Electron Method Oxidation, Reduction, Addition and Substitution &amp; Elimination Reactions.</p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Rao, C. N. R. (1973). University General Chemistry : An Introduction To Chemical Science. India: Macmillan India Limited.</li> <li>2. Chang, R. (2000). Physical Chemistry for the Chemical and Biological Sciences. United Kingdom: University Science Books.</li> <li>3. Lee, J.D., Concise Inorganic Chemistry, 5TH ED. (2008). India: Wiley India Pvt. Limited.</li> <li>4. Bajpai, D. N. (2001). Advanced Physical Chemistry. India: S. Chand, Limited.</li> <li>5. Singh, A. K., Singh, N. B., Das, S. S. (2009). Physical Chemistry: Volume II. India: New Age International.</li> </ol>		



Course Code	Title	Credits	No of lectures
VESUSBT204	<b>Biochemistry: Concept of Biomolecules-II and Basic analytical techniques</b>	02	
<p><b>Course Objectives:</b> To build a firm foundation on the fundamentals of biochemistry and analytical techniques</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>● Learn about fundamental structures and functions of amino acids &amp; proteins.</li> <li>● Develop an understanding of protein biochemistry and enzymology.</li> <li>● Develop skills towards the principle, working and applications of different analytical techniques.</li> </ul>			
<p><b>Unit I</b> <b>Proteins and amino acids</b></p>	<p><b>Amino acids:</b> General introduction, Classification and structures, properties (physical &amp; chemical) Amino Acids as drugs. Titration Curve of Amino Acids. Concept of Isoelectric pH, Zwitterion <b>Reactions of Amino Acids:</b> Sorenson's Titration, Ninhydrin Test</p> <p><b>Proteins:</b> Introduction, definition and functional classification.</p> <p><b>Classification of Proteins:</b> Simple- Fibrous and Globular Conjugated- Nucleoprotein, Lipoprotein, Glycoprotein, Phosphoprotein, Chromoprotein, Metalloprotein Derived- Primary and Secondary</p> <p><b>Peptide bond:</b> Features Example of Dipeptide, tripeptide, Nonapeptide e.g., Oxytocin, Vasopressin Amino acid composition of Bovine Cytochrome C and Bovine Chymotrypsinogen</p> <p><b>Three-dimensional Structure of proteins:</b> Concept of Monomeric, dimeric and multimeric proteins Primary structure - Peptide linkage, Native Secondary structure - Alpha Pleat and Beta fold; Spatial arrangements of adjacent amino acid residues Tertiary structure - Three-Dimensional arrangement Quaternary structure Di and Multimeric proteins E.g., structure of human Insulin</p> <p><b>Properties of proteins:</b> Solubility, Molecular weight, Shape, Iso electric pH, Salting out of proteins for purification</p> <p><b>Protein Denaturation and folding:</b> Denaturing agents and properties of denatured proteins</p>		15

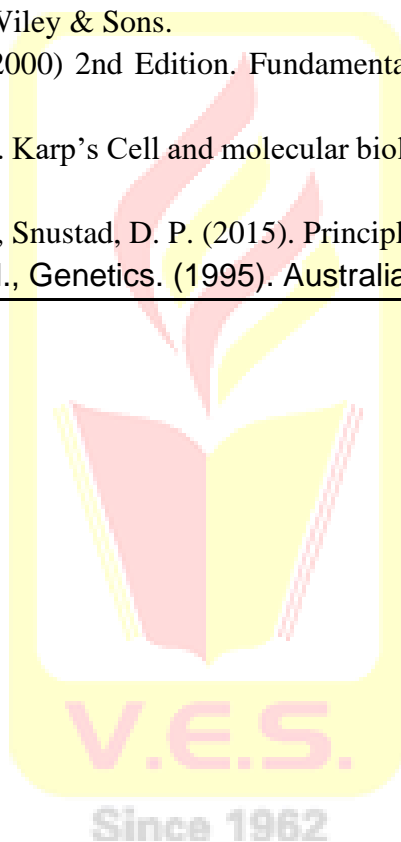
<p><b>Unit II</b> <b>Enzymes</b></p>	<p><b>Introduction to biocatalysis:</b> Properties of Enzymes Substrate, Optimum conditions, Co-substrate, Coenzyme, Cofactors <b>Classification and Nomenclature</b> ( one reaction per class) Mechanism of Enzyme Action, Active Sites, Enzyme Specificity, <b>Factors affecting enzyme activity</b> (Effect of pH, Temperature, Substrate Concentration, Enzyme concentration) <b>Enzyme Kinetics:</b> Derivation of Michaelis-Menten Equation, Lineweaver-Burk plot, Concept of <math>k_m</math> <b>Types of Enzyme Inhibitions:</b> Irreversible &amp; Reversible (Competitive, Uncompetitive, Non-Competitive) <b>Isoenzymes</b> (LDH, Alkaline Phosphatase, Creatine Phosphokinase) Allosteric Modulators, Co-Factors, Zymogens, Enzyme units Enzymes as Biomarkers and diagnostic tools. (SGPT, SGOT, LDH, CPK) <b>Industrial Applications of Enzymes</b></p>		<p><b>15</b></p>
<p><b>Unit III</b> <b>Basics of Analytical techniques</b></p>	<p><b>Methods of Separation:</b> Precipitation, Filtration, Distillation and Solvent Extraction <b>Analytical Techniques Chromatography:</b> Definition, Principles, Chromatographic performance parameters, Types Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Principle and Applications) <b>Spectroscopy - Colorimetry:</b> Properties of electromagnetic radiation, interaction with matter, lasers Colorimetric assays - Principle, Beer-Lambert's Law, Measurement of Extinction, Derivation of <math>E = kcl</math>, Limitations of Beer-Lambert's Law, Filter Selection Examples of colorimetric and UV absorption assays <b>Electrophoresis:</b> General principles, Factors affecting electrophoresis, Types of support media used, Types of electrophoresis (Agarose gel electrophoresis, PAGE)</p>		<p><b>15</b></p>

<b>References</b>	<ol style="list-style-type: none"><li>1. Cox, M. M., &amp; Nelson, D. L. (2008). Lehninger principles of biochemistry (Vol. 5). New York: Wh Freeman.</li><li>2. Conn, E., &amp; Stumpf, P. (2009). Outlines of biochemistry. John Wiley &amp; Sons.</li><li>3. Satyanarayana U. and Chakrapani U. (2007). Biochemistry. 3rd Edition. Books and Allied (P) Ltd.</li><li>4. Jain, J. L. (2004). Fundamentals of Biochemistry. India: S. Chand Limited.</li><li>5. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R. (2014). Fundamentals of Analytical Chemistry. India: Brooks/Cole, Cengage Learning.</li><li>6. Principles and Techniques of Biochemistry and Molecular Biology. (2010). United States: Cambridge University Press.</li></ol>
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Course Code	Title	Credits	No of lectures
VESUSBT205	Genetics	2	
<p><b>Course Objectives:</b> To provide insight to students on fundamental concepts of mendelian genetics, microbial genetics and population genetics</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of fundamental concepts of mendelian genetics</li> <li>• Discuss the different processes in microbial genetics and their role in mapping genes</li> <li>• Understand the relevance of population genetics</li> </ul>			
<p><b>Unit I</b> <b>Genetics fundamentals</b></p>	<p><b>Introduction to genetic and sub-disciplines of genetics:</b> Transmission genetics, Molecular genetics, Population genetics and Quantitative genetics.</p> <p><b>Basic Terminologies in genetics Mendelian Genetics:</b> Monohybrid Crosses and Mendel's Principle of Segregation. Representing crosses with a Branch Diagram. Confirming the principle of Segregation: The use of Test crosses. Dihybrid crosses and Mendel's Principle of Independent Assortment.</p> <p><b>Extensions of and Deviations from Mendelian Genetic Principles:</b> Multiple Alleles - ABO Blood groups Modifications of Dominance Relationships: Incomplete Dominance and Codominance. Essential Genes and Lethal Alleles. Effects of the environment on Gene expression.</p> <p><b>Gene Interactions and Modified Mendelian Ratios:</b> Epistatic and non-epistatic interactions.</p>		15
<p><b>Unit II</b> <b>Microbial genetics</b></p>	<p><b>Genetic analysis in Bacteria:</b> Prototrophs, Auxotrophs.</p> <p><b>Genetic Mapping in Bacteria by Conjugation:</b> Discovery of Conjugation in <i>E.coli</i>. The sex factor F, High-Frequency Recombination Strains of <i>E.coli</i>. F' Factors. Using conjugation to map bacterial genes- Interrupted-mating</p> <p><b>Genetic mapping in bacteria by Transformation Genetic mapping in Bacteria by Transduction:</b> Bacteriophages - Lytic and Lysogenic pathway. Transduction Mapping of Bacterial Chromosomes - Generalized Transduction and Specialized Transduction.</p>		15

<p><b>Unit III Population genetics</b></p>	<p><b>Genetic Structure of Populations:</b> Genotypic Frequencies and Allelic Frequencies, Hardy-Weinberg Law and its Assumptions, Genetic Variations in Populations. <b>Forces responsible for change in gene frequencies in population:</b> Natural Selection., Genetic Drift, Migration, <b>Speciation</b> <b>Role of Population Genetics in Conservation Biology</b></p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Russell, P. J. (2013). IGenetics: Pearson New International Edition PDF EBook: A Molecular Approach. United Kingdom: Pearson Education.</li> <li>2. Agarwal, V. K., Verma, P. S. (2018). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. India: S. Chand Limited.</li> <li>3. Gardner, E. J., Simmons, M. J., &amp; Snustad, D. P. (2006) 8th Edition. Principles of genetics. John Wiley &amp; Sons.</li> <li>4. Russell, P. J. (2000) 2nd Edition. Fundamentals of genetics. Longman Publishing Group.</li> <li>5. Karp, G. (2016). Karp's Cell and molecular biology: concepts and experiments. John Wiley &amp; Sons.</li> <li>6. Simmons, M. J., Snustad, D. P. (2015). Principles of Genetics. India: Wiley.</li> <li>7. Strickberger M., Genetics. (1995). Australia: Deakin University.</li> </ol>		



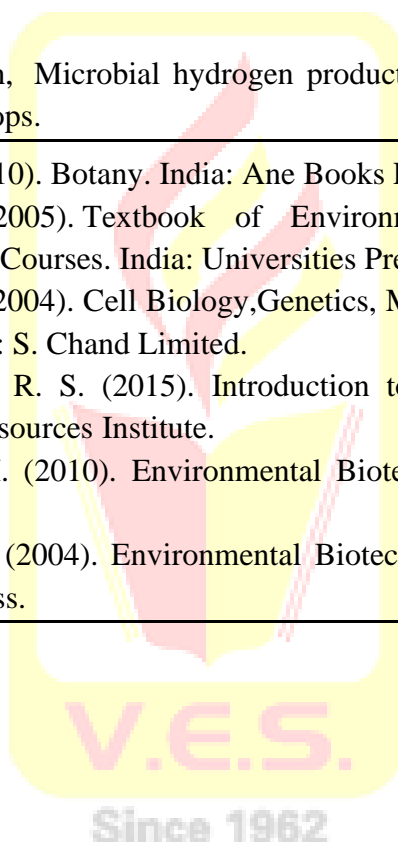
Course Code	Title	Credits	No of lectures
VESUSBT206	Basic Computers and Biostatistics	02	
<p><b>Course Objectives:</b> To develop the students' understanding of computer and biostatistics</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of computer networking and internet</li> <li>• Develop skills to use word processing, spreadsheet, presentation software.</li> <li>• Gain insights about the use of statistics in the field of biotechnology</li> </ul>			
<p><b>Unit I</b> <b>Introduction to computers</b></p>	<p><b>Introduction to computers:</b> Overview and functions of a computer system, Input and output devices, Storage devices. Modern computers: The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer &amp; The Super Computer</p> <p><b>Introduction to operating systems:</b> Operating System concept, Windows, Unix/Linux &amp; servers</p> <p><b>Word Processing:</b> Basic Operations, Creating and Editing documents, Formatting documents.</p> <p><b>Spreadsheet:</b> Creating and editing workbook, Organizing and formatting worksheets; Data analysis and management; Using formulas and functions</p> <p><b>Presentation Graphics:</b> Creating and Editing Presentations, Designing and Enhancing Presentation, Delivering Presentation, Advanced Presentation Graphics.</p>		15
<p><b>Unit II</b> <b>Computer networking</b></p>	<p><b>Introduction to networking:</b> Various terminologies Associated hardware devices, gadgets (Router, Switch) tools, services, and resources Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls</p> <p><b>Computer viruses:</b> An overview of Computer viruses: What is a virus? Virus signs, how do they get transmitted? What are the dangers? General Precautions</p> <p><b>The Internet and Internet Services:</b> Introduction, History of Internet, Internetworking Protocol, The Internet Architecture, Managing the Internet, Connecting to Internet, Internet Connections: Dial-up Access, Leased Line, Integrated Services Digital Network (ISDN), Digital Subscriber Line (DSL), Cable, Modem</p>		15



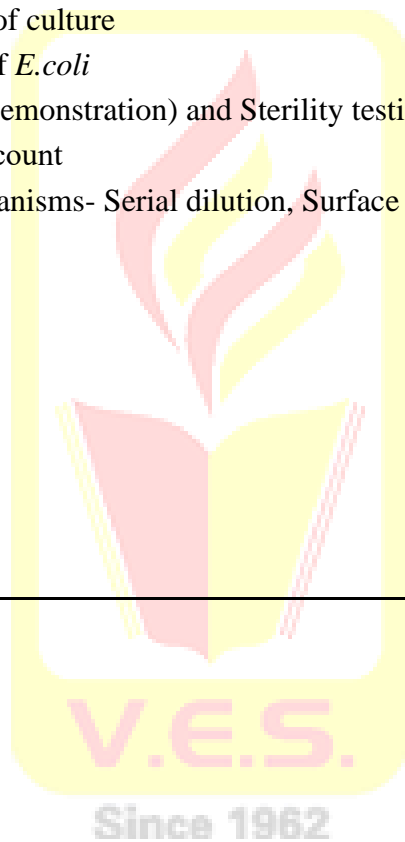
	<p>Internet Address  Internet Services: World Wide Web (WWW), Web Browser, Uniform Resource Locator (URL)  Internet Search Engines, WWW Development Languages, Uses of Internet  <b>Electronic Mail:</b>  E-mail Address, E-mail Message Format, E-mail Services, How E-mail Works File Transfer Protocol (FTP), How FTP Works, Terminal Network (Telnet), News, Internet Relay Chat (IRC), MS Outlook.</p>		
<p><b>Unit III  Biostatistics</b></p>	<p><b>Introduction to Biostatistics:</b>  Definition &amp; Importance of Statistics in Biology Variables, Types of variables (Quantitative &amp; Qualitative) <b>Types of Data and data visualization:</b>  Concept of Data, Sources of data, Types of data (Quantitative &amp; Qualitative), Representation of Data and Graphs (Bar Diagrams, Pie Charts and Frequency distribution, Histogram, Polygon and Curve)  <b>Sampling strategies:</b>  Population and Sample, Significance of using samples, Sample size, Random variation, Sampling techniques (Simple random sampling, Systematic sampling, Stratified sampling, Cluster sampling, Multiphase sampling) and Non- probability sampling  <b>Types of Statistics:</b>  Introduction to Descriptive &amp; Inferential statistics  <b>Descriptive statistics:</b>  <b>Measures of central tendency:</b>  Mean, Mode, Median (Ungrouped &amp; Grouped data)  <b>Measures of dispersion:</b>  Range, Variance, Standard deviation (Ungrouped &amp; Grouped data), Coefficient of variation  <b>Measures of location:</b>  Percentiles, Interquartile range (Box-Whisker plot)  <b>Normal/Gaussian distribution, Standard normal deviate, Sampling variation, Standard error of mean</b></p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Sinha, P. K., Sinha, P. (2004). Computer Fundamentals. India: BPB Publications.</li> <li>2. Goel, A. (2010). Computer Fundamentals. India: Pearson Education.</li> <li>3. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley.</li> <li>4. Tanenbaum, A. S., Wetherall, D. (2014). Computer Networks. United Kingdom: Pearson Education.</li> <li>5. Khanal, A. B. (2015). Mahajan's Methods in Biostatistics For Medical Students and Research Workers. India: Jaypee Brothers, Medical Publishers Pvt. Limited.</li> <li>6. Cross, C. L., Daniel, W. W. (2018). Biostatistics: A Foundation for Analysis in the Health Sciences. United Kingdom: Wiley.</li> <li>7. Arora, P. N., Malhan, P. K. (2009). Biostatistics. India: Himalaya Publishing House</li> </ol>		

Course Code	Title	Credits	No of lectures
VESUSBT207	Ability Enhancement Course- Sustainable development and Environmental biotechnology	02	
<p><b>Course Objectives:</b> To sensitize and create awareness about Ecology, renewable energy and different Environmental Issues.</p> <p><b>Learning Outcomes:</b> By the end of the course the student will:</p> <ul style="list-style-type: none"> <li>• Develop an understanding of the structure and functioning of the ecosystems.</li> <li>• Gain insights about the concept of pollution, climate change and sustainable development</li> <li>• Understand the relevance of renewable energy sources and conservation of biodiversity</li> </ul>			
<p><b>Unit I</b> <b>Ecological interactions and Biodiversity</b></p>	<p><b>Concept of Ecosystems:</b> Definition and Components- Structure and function of ecosystem aspects of ecosystems Food Chain and Food Web, Ecological Pyramids (Energy, Biomass and Number) Aquatic and Terrestrial Ecosystems, Different Abiotic Factors of ecosystem and adaptations to different abiotic factors</p> <p><b>Ecological Interactions:</b> Commensalism, Mutualism, Predation and Antibiosis, Parasitism, competition</p> <p><b>Biodiversity and its conservation:</b> Introduction – definition: genetic, species, ecosystem diversity, biogeographic classification of India, value of biodiversity, biodiversity at global, national and local levels, India as a mega diversity nation, Hotspots of biodiversity, threats to biodiversity, conservation of biodiversity</p>		15
<p><b>Unit II</b> <b>Pollution and climate change</b></p>	<p><b>Environmental Pollution:</b> Definition, Cause, effects and control measures of- Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, nuclear hazards. Role of an individual in prevention of pollution. Pollution case studies.</p> <p><b>Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Sustainable development:</b> Concept, basic principles of sustainable development, post- brundtland world, roots of sustainability, Indicators, paradigm towards new discipline- sustainability science.</p>		15

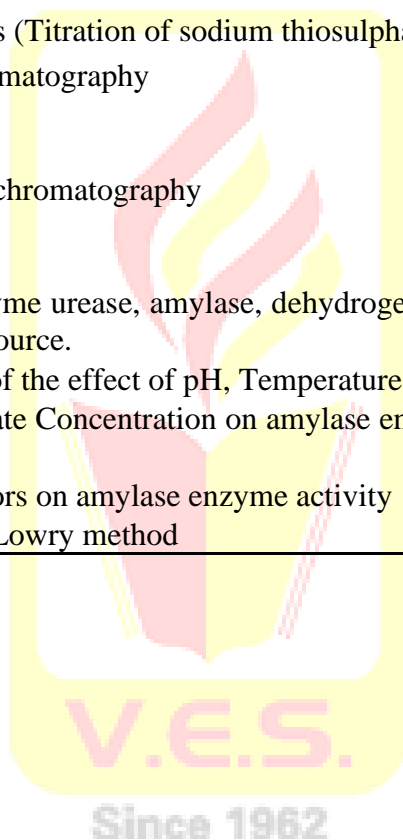
<p><b>Unit III</b> <b>Renewable sources of energy</b></p>	<p><b>Introduction:</b> Renewable and Non-renewable resources. The need for a sustainable lifestyle.</p> <p><b>Energy resources:</b> Types of energy Nonrenewable energy - Oil, coal and its environmental impacts.</p> <p><b>Renewable energy:</b> Hydroelectric power, Solar energy, Biomass energy, Biogas, Wind power and Geothermal energy.</p> <p><b>Biogas technology:</b> Biogas plant &amp; types, biodigester. Biogas-composition, production and factors affecting production and uses.</p> <p><b>Biofuels:</b> Ethanol production, Microbial hydrogen production, Biodiesel, Petrocrops.</p>		<p><b>15</b></p>
<p><b>References</b></p>	<ol style="list-style-type: none"> <li>1. Verma, V. (2010). Botany. India: Ane Books Pvt Ltd.</li> <li>2. Bharucha, E. (2005). Textbook of Environmental Studies for Undergraduate Courses. India: Universities Press (India) Pvt. Limited.</li> <li>3. Verma, P. S. (2004). Cell Biology, Genetics, Molecular Biology: Evolution and Ecology. India: S. Chand Limited.</li> <li>4. Khoiyangbam, R. S. (2015). Introduction to Environmental Sciences. India: Energy and Resources Institute.</li> <li>5. Fulekar, M. H. (2010). Environmental Biotechnology. United Kingdom: CRC Press.</li> <li>6. Scragg, A. H. (2004). Environmental Biotechnology. United Kingdom: Oxford University Press.</li> </ol>		



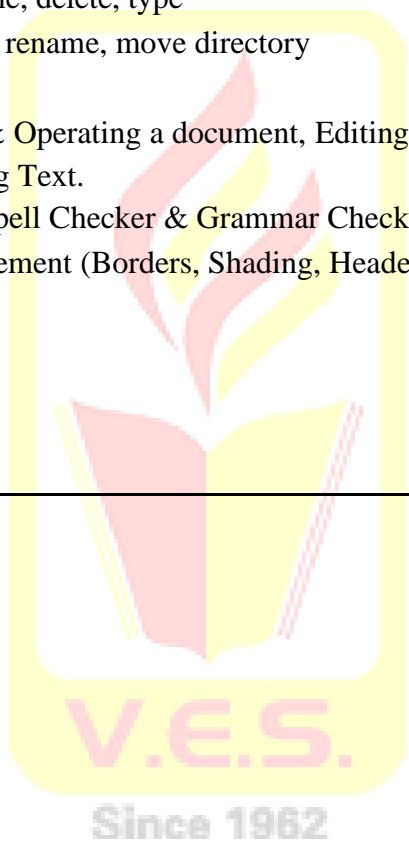
Course Code	Title	Credits
VESUSBTP201	<b>Practicals of Fundamentals of Biotechnology- II and Cell biology and Microbiology-II</b>	<b>02</b>
<ol style="list-style-type: none"> <li>1. Assignment - Write a report on a case study on any one food product developed at CFTRI.</li> <li>2. Isolation and characterization of organisms causing Food Spoilage (Using Bergey's Manual). Microbial examination of food and detection of Pathogenic Bacteria from Food Samples</li> <li>3. Determination of food preservative concentration (salt &amp; sugar) using MIC.</li> <li>4. Detection of Food adulterants in food samples</li> <li>5. Isolation of chromosomal DNA from <i>E. coli</i> and Agarose gel electrophoresis of the chromosomal DNA</li> <li>6. Motility by hanging drop method/stab culture</li> <li>7. Methods of preservation of culture</li> <li>8. Study of Growth Curve of <i>E.coli</i></li> <li>9. Preparation of vaccine (Demonstration) and Sterility testing of Vaccine</li> <li>10. Enumeration by Breed's count</li> <li>11. Enumeration of microorganisms- Serial dilution, Surface spread method, Pour plate method.</li> </ol>		



Course Code	Title	Credits
VESUSBTP202	<b>Practicals of Basic Chemistry-II and Biochemistry: Concept of Biomolecules-II and Basic analytical techniques</b>	<b>02</b>
<ol style="list-style-type: none"> <li>1. To determine enthalpy of dissolution of salt like <math>\text{KNO}_3</math></li> <li>2. Determine the rate constant for hydrolysis of ester using <math>\text{HCl}</math> as a catalyst</li> <li>3. Study the kinetics of reaction between Thiosulphate ion and <math>\text{HCl}</math></li> <li>4. Study reaction between potassium Persulphate and Potassium Iodide kinetically and hence to determine order of reaction</li> <li>5. Study the reaction between <math>\text{NaHSO}_3</math> and <math>\text{KMnO}_4</math> and balancing the reaction in acidic, alkaline and neutral medium</li> <li>6. Study transfer of electrons (Titration of sodium thiosulphate with potassium dichromate)</li> <li>7. Separation by Paper Chromatography <ol style="list-style-type: none"> <li>i) Amino acids</li> <li>ii) Sugars</li> </ol> </li> <li>8. Separation by Thin layer chromatography <ol style="list-style-type: none"> <li>i) Plants Pigments</li> <li>ii) Fatty acids</li> </ol> </li> <li>9. Qualitative Assay of enzyme urease, amylase, dehydrogenase, catalase and protease from Plant/Animal/Microbial source.</li> <li>10. Enzyme Kinetics: Study of the effect of pH, Temperature on activity of Amylase</li> <li>11. Study of Effect of Substrate Concentration on amylase enzyme activity and determination of <math>V_{\text{max}}</math> and <math>K_m</math></li> <li>12. Study of Effect of inhibitors on amylase enzyme activity</li> <li>13. Estimation of Protein by Lowry method</li> </ol>		



Course Code	Title	Credits
VESUSBTP203	Practicals of Genetics and Basic Computers and Biostatistics	2
<ol style="list-style-type: none"> <li>1. Study of mitosis from suitable plant material. Study of mitosis using pre-treated root tips of <i>Allium cepa</i> to study the effect of mutagens- chemical (colchicine/ PDB) on mitosis</li> <li>2. Study of meiosis from suitable plant material/Permanent slides/Photographs</li> <li>3. Study the effect of UV radiation as a mutagenic agent</li> <li>4. Extraction of DNA from plant material.&amp;Qualitative analysis of DNA</li> <li>5. Identification of types of point mutations from given DNA sequences</li> <li>6. Isolation of antibiotic/ dye resistant mutants using replica plate technique.</li> <li>7. Study of Karyotype - Normal male and female</li> <li>8. File handling: copy, rename, delete, type</li> <li>9. Directory structure: make, rename, move directory</li> <li>10. Word Processing: <ol style="list-style-type: none"> <li>a. Creating, Saving &amp; Operating a document, Editing, Inserting, Deleting, Formatting, Moving &amp; Copying Text.</li> <li>b. Find &amp; Replace, Spell Checker &amp; Grammar Checker,</li> <li>c. Document Enhancement (Borders, Shading, Header, Footer)</li> </ol> </li> </ol>		



### Modality of assessment

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 25% marks in the first part & by conducting the Semester End Examinations with 75% marks in the second part. Practical Examination will consist of End Sem examination.

**Student will have to score 40% of marks in Internal assessment as well as End Sem examination to pass the course.**

The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:

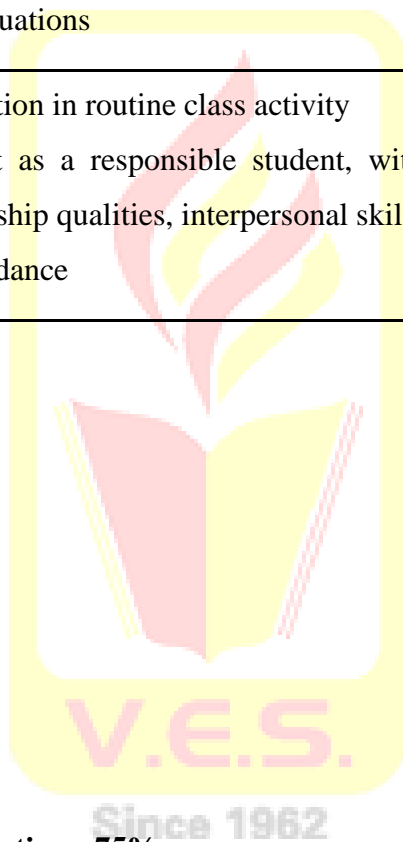
**Internal Assessment:** It is defined as the assessment of the learners on the basis of internal evaluation as envisaged in the Credit & Choice based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

**Semester End Assessment:** It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.

**A. Theory - Internal assessment 25%**

**25 marks**

Sr No	Evaluation type	Marks
1.	<ul style="list-style-type: none"> <li>- Tests, Assignments,</li> <li>- Project based learning activities (Group Research/ Case studies/ Reports / Assignments / Presentations / Skit / Poster / etc.),</li> <li>- Class Test (multiple choice questions / objective)</li> <li>- Best of two evaluations</li> </ul>	20
2.	<ul style="list-style-type: none"> <li>- Active participation in routine class activity</li> <li>- Overall conduct as a responsible student, with respect to good behavior, leadership qualities, interpersonal skills etc.</li> <li>- Activities/Attendance</li> </ul>	05



**B. Theory - External examination - 75%**

**75 marks**

**Semester End Theory Assessment**

Duration - Each paper shall be of 2.5 hour duration.

1. Theory question paper pattern:

- a. There shall be three compulsory questions, one based on each unit and one from all units
- b. Each question shall carry 25 marks each.
- c. Each question shall be subdivided into three sub questions a and b with internal choice in each
  - i. Sub-question 'a' shall consist of 4 questions of 5 marks each
  - ii. Sub-question 'b' shall consist of 5 questions of 2 marks each
  - iii. Sub-question 'c' shall consist of 5 questions of 1 mark each

Question no.	Details	Marks
<b>Q1.</b>	<b>Based on Unit 1</b>	<b>25</b>
	a. Attempt the following (Any two of four)	10
	b. Attempt the following (any five out of seven)	10
	c. Attempt the following (any five out of seven)	5
<b>Q2.</b>	<b>Based on Unit 2</b>	<b>25</b>
	a. Attempt the following (Any two of four)	10
	b. Attempt the following (any five out of seven)	10
	c. Attempt the following (any five out of seven)	5
<b>Q3.</b>	<b>Based on Unit 3</b>	<b>25</b>
	a. Attempt the following (Any two of four)	10
	b. Attempt the following (any five out of seven)	10
	c. Attempt the following (any five out of seven)	5



**C. Semester End Practical Assessment**

**50 marks**

	<b>Section 1 Based on Paper 1</b>	<b>50 Marks</b>
A	Technique 1	20
B	Technique 2	10
C	Spots/Quiz	10
D	Viva	05
E	Journal	05

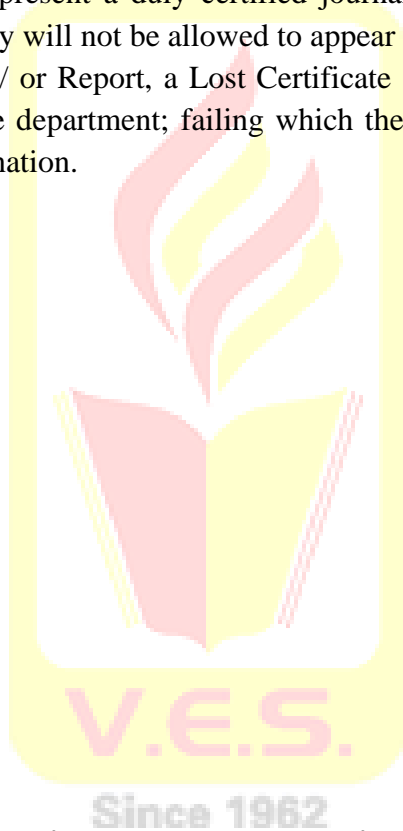


	<b>Section 2 Based on Paper 2</b>	<b>50 Marks</b>
A	Technique 1	20
B	Technique 2	10
C	Spots/Quiz	10
D	Viva	05
E	Journal	05

### **PRACTICAL BOOK/JOURNAL**

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.



## **Overall Examination and Marks Distribution Pattern**

### **SEMESTER I**

<b>Course</b>	<b>Marks</b>	
<b>VESUSBT101</b>	<b>100</b>	<b>Theory 700</b>
<b>VESUSBT102</b>	<b>100</b>	
<b>VESUSBT103</b>	<b>100</b>	
<b>VESUSBT104</b>	<b>100</b>	
<b>VESUSBT105</b>	<b>100</b>	
<b>VESUSBT106</b>	<b>100</b>	
<b>VESUSBT107</b>	<b>100</b>	

<b>VESUSBTP101</b>	<b>100</b>	<b>Practical 300</b>
<b>VESUSBT102</b>	<b>100</b>	
<b>VESUSBT103</b>	<b>100</b>	
<b>Total</b>		<b>1000</b>

### SEMESTER II

<b>Course</b>	<b>Marks</b>	
<b>VESUSBT201</b>	<b>100</b>	<b>Theory 700</b>
<b>VESUSBT202</b>	<b>100</b>	
<b>VESUSBT203</b>	<b>100</b>	
<b>VESUSBT204</b>	<b>100</b>	
<b>VESUSBT205</b>	<b>100</b>	
<b>VESUSBT206</b>	<b>100</b>	
<b>VESUSBT207</b>	<b>100</b>	
<b>VESUSBTP201</b>	<b>100</b>	<b>Practical 300</b>
<b>VESUSBTP202</b>	<b>100</b>	
<b>VESUSBTP203</b>	<b>100</b>	
<b>Total</b>		<b>1000</b>

