Shri Vile Parle Kelavani Mandal's

MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India,

Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: Bachelor of Science

Course: Microbiology (USMAMB)

Semester V & VI

Choice Based Credit System (CBCS) with effect from the Academic year 2020-21

A.C. No: 7

Agenda No: Supplementary 4.6 (ii)

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the B.Sc - Microbiology, the learners should be enriched with knowledge and be able to-

PSO1: Articulate and communicate in the specialized terminology pertaining to microbiology.

PSO2: Define and explain the theories and practices of the various fields/ disciplines in microbiology.

PSO3: Explain the technologies and methods commonly used in microbiology.

PSO4: Acquire the requisite skills applicable to microbiological analysis.

PSO5: Describe the genetic and ecological relationships between microorganisms.

PSO6: Discuss the applications of microorganisms in the various areas of biotechnology.

Preamble

The grant of autonomy along with DBT Star funding has provided a platform for designing a curriculum that is dynamic and meets the need of the hour. The inherent freedom under autonomy provides for a multisensory learning experience.

The syllabus is as per the Credit Based Semester and Grading System (CBSGS) and continuous evaluation consisting of components of Internal Assessment and External Assessment. The changes introduced conform to the learning objectives.

Keeping in tune with the progression of the syllabus and maintaining continuity of flow of information from F.Y.B.Sc. and S.Y.B.Sc., the T.Y.B.Sc syllabus has been devised. Several changes are introduced in the year 2019-20 syllabus of the T.Y.B.Sc under autonomy to keep the students up to date with latest developments in the field of Microbiology. Some of the modules of the University syllabus dealing with fundamentals of Microbiology have been retained whilst other modules have been restructured as per the need of learning objectives. In semesters V and VI the learner will learn Advanced Genetics, Virology, Medical Microbiology, Immunology, Microbial Biochemistry and Bioprocess Technology. Some of the interdisciplinary modules such as bioinformatics, recombinant biotechnology, and bioinstrumentation will help the learner to understand the subject from a broader perspective.

All the 8 courses of theory and practicals (Semester-V and Semester-VI together) are compulsory to the students offering microbiology as a single major subject (6 units pattern of the old course). These courses are

1. USMAMB501 and USMAMB601
2. USMAMB502 and USMAMB602
3. USMAMB503 and USMAMB603
4. USMAMB504 and USMAMB604

The syllabus was framed with the critical in-puts from the Board of Study members and the faculty of the Microbiology department.

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Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) **Details of Continuous Assessment (CA)**

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Assignment	15 marks
Component 2 (CA-2)	Class Test	10 marks

b) **Details of Semester End Examination**

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
1	Question 1 will be based on module I, question 2 on Module II, question 3 on module III and question 4 on module IV. Each question will be subdivided into two sub-questions "A" and "B". Sub-question "A" will have two questions (of 10 marks each) out of which any one will be attempted. Total marks allotted to sub-question "A" will be 10 marks. Sub-question "B" will be compulsory for 5 marks without internal choice.	A (10 x 1) = 10 marks B = 5 marks	15
2		A (10 x 1) = 10 marks B = 5 marks	15
3		A ((10 x 1) = 10 marks B = 5 marks	15
4		A (10 x 1) = 10 marks B = 5 marks	15
5	It will have questions from all Four modules of the course. It will have 4 questions (of 5 marks each), one from each module, out of which any 3 will be attempted.	3 x 5 = 15 marks	15
		Total Marks	**75**

Dr. Geeta Narayan
HOD

Dr. Meenakshi Vaidya
Approved by Vice –Principal

Dr. Krutika Desai
Approved by Principal

HOD Approved by Vice –Principal Approved by Principal

Program: B.Sc.			**Semester: V**	
Course: MICROBIAL GENETICS			**Course Code: USMAMB501**	
Teaching Scheme			**Evaluation Scheme**	
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:
Microbial Genetics is an undergraduate T.Y.B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing and understanding biological genetic information. The course involves an understanding of Cell biology, DNA replication, genetic exchange and recombination, mutation and DNA repair. It gives an overview of the branches of genetics and model organisms. Additionally, the learner will be exposed to details of plasmids, transposable elements, basic and advanced virology and basic bioinformatics.

Course Outcomes:
After completion of the course, learners would be able to:
CO1: Describe the mechanism involved in DNA replication
CO2: Explain regulation of cell cycle, cell signaling and apoptosis
CO3: Apply knowledge about horizontal gene transfer mechanisms for mapping of genes in prokaryotes
CO4: Compare homologous recombination and site-specific recombination among prokaryotes
CO5: Describe the types and causes of mutations in DNA and mechanisms involved in DNA repair

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**DNA REPLICATION**	**15**
2	**CELL BIOLOGY**	**15**
3	**GENE TRANSFER MECHANISMS IN BACTERIA AND HOMOLOGOUS RECOMBINATION**	**15**
4	**MUTATION AND REPAIR**	**15**
	Total	**60**
PRACTICALS		**60**

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USMAMB501: Detailed Syllabus			
Unit	**Topic and Description**	**No. of lectures 48 minutes/lecture**	**No. of Credits**
Module I	**DNA REPLICATION** **Historical perspective**— conservative, dispersive, semi-conservative, Bidirectional and semi-discontinuous **Prokaryotic DNA replication** – Details of molecular mechanism involved in Initiation, Elongation and Termination **Enzymes and proteins associated with DNA replication**- primase, helicase, topoisomerase, SSB, DNA polymerases, ligases, Ter and Tus proteins **Eukaryotic DNA replication--** Molecular details of DNA synthesis, replicating the ends of the chromosomes **Rolling circle mode of replication**	**15 Lectures** **02** **05** **05** **02** **01**	**2.5**
Module II	**CELL BIOLOGY** **Structure of eukaryotic cell** **Cell cycle** **Mitosis and meiosis** **Cell signaling** **Apoptosis**	**15 Lectures** **01** **04** **03** **03** **04**	

Module III	**GENE TRANSFER MECHANISMS IN BACTERIA AND HOMOLOGOUS RECOMBINATION**	**15 Lectures**	
	Transformation Introduction and History Types of transformation in prokaryotes-- Natural transformation in *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Bacillus subtilis* Mapping of bacterial genes using transformation. Problems based on transformation.	**04**	
	Conjugation Discovery of conjugation in bacteria Properties of F plasmid/Sex factor The conjugation machinery Hfr strains, their formation and mechanism of conjugation F' factor, origin and behavior of F' strains, Sexduction. Mapping of bacterial genes using conjugation (Wolman and Jacob experiment). Problems based on conjugation	**05**	
	Transduction Introduction and discovery Generalised transduction Use of Generalised transduction for mapping genes Specialised transduction Problems based on transduction	**03**	
	Recombination in bacteria General/Homologous recombination Molecular mechanism Holliday model of recombination Site-specific recombination	**03**	

Module IV	**MUTATION AND REPAIR** **Mutation** **Terminology:** alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes. **Types of mutations:** Point mutation, reverse mutation, suppressor mutation, frameshift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutations. **Causes and mechanisms of mutation:** Natural/spontaneous mutation & Induced mutation. Replication error, depurination, deamination. Chemical mutagens- base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. Physical mutagens. Biological mutagen (only examples). Ames test Detection of mutants Fluctuation test. **DNA Repair** Mismatch repair Light repair Repair of alkylation damage Base excision repair Nucleotide excision repair SOS repair	**15 Lectures** **01** **04** **05** **05**	
	Total	**60**	**2.5**

RECOMMENDED READING:

ESSENTIAL READING:

1. B. A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., W. H. Freeman and company.
2. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th ed., Pearson Education International.
3. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton Prescott's Microbiology 7th Edition McGraw Hill International Edition.
4. R. Weaver Molecular Biology 3rd Edition McGraw Hill International Edition
5. N. Turn and J. Trempy Fundamental Bacterial Genetics 2004 Blackwell Publishing
6. H.K. Das Textbook of Biotechnology 4th Edition. Wiley dream Tech India Pvt. Ltd.
7. Gerald Karp Cell and Molecular Biology- Concepts and Experiments 3rd Edition John Wiley and Sons, New York
8. Geoffrey M. Cooper and Robert E. Hausman The Cell-A Molecular Approach 5th

SUPPLEMENTARY READING:

1. P. J. Russell (2006), "Genetics-A molecular approach", 2nded.
2. D.Nelson and M.Cox, (2005), "Lehninger's Principles of biochemistry", 4th ed., Macmillan worth Publishers.
3. B.Lewin, "Genes IX", , Jones and Bartlett publishers.
4. JD Watson, "Molecular biology of the gene", 5th edition, 2004 Pearson.
5. S. Simmons, "Principles of genetics", 3rdedn. John Wiley and sons, Inc.
6. E.D.P. De Robertis and E.M.F. De Robertis, Jr., 8th edition, Cell and molecular biology, Wolters Kluver.
7. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
8. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
9. Any other reference sources as recommended by the course instructor.

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Program: B.Sc.				**Semester: V**
Course: MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-I				**Course Code: USMAMB502**
Teaching Scheme			**Evaluation Scheme**	
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:

This course will provide an in-depth exploration of the fields of medical microbiology and immunology that are inexorably linked with each other. The course encompasses the aetiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases that are enlisted in the syllabus. It will also enable the students to appreciate the interplay between the virulence factors of pathogens and the host defence mechanisms.

Students of T.Y.B.Sc. Microbiology have had an introductory course on Immunology in S.Y.B.Sc. The present course encompasses efforts to understand how multicellular organisms have evolved to survive a variety of challenges to homeostasis, including infection by pathogens

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Summarize the virulence factors expressed by pathogenic organisms
CO2: Explain general and specific mechanisms by which an infectious agent causes disease.
CO3: Review common infectious agents and the diseases that they cause.
CO4: Evaluate methods used to identify infectious agents in the clinical microbiology lab.
CO5: Identify the cellular and molecular basis of immune responsiveness
CO6: Elaborate upon the types of immunoglobulins and the reactions mediated by them
CO7: Explain the mechanisms of activation of the complement cascade
CO8: Describe the role of the lymphocytes in the immune response

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**BACTERIAL STRATEGIES FOR EVASION AND STUDY OF A FEW DISEASES- I**	**15**
2	**STUDY OF A FEW INFECTIOUS DISEASES - II**	**15**
3	**BASIC IMMUNOLOGY-I**	**15**
4	**BASIC IMMUNOLOGY-II**	**15**
	Total	**60**
PRACTICALS		**60**

USMAMB502: Detailed Syllabus

Unit	Topic and Description	No. of Lectures	No. of Credits
Module I	**BACTERIAL STRATEGIES FOR EVASION AND STUDY OF A FEW DISEASES - I** **Study of virulence mechanisms in bacteria** **Identifying bacteria that cause disease** **Genomics and bacterial pathogenicity** The clonal nature of bacterial pathogens Mobile genetic elements Pathogenicity islands **Bacterial virulence factors** Adherence factors Invasion of host cells and tissues Toxins Exotoxins Exotoxins associated with diarrhoeal diseases and food poisoning LPS of gram-negative bacteria Enzymes Tissue degrading enzymes IgA1 proteases Antiphagocytic factors Intracellular pathogenicity Antigenic heterogeneity The requirement for iron The role of biofilms	**15 Lectures** **01** **01** **03**	**2.5**
	Study of A Few Infectious Diseases - I Urinary Tract – system & infections Leptospirosis Tabular form of other infectious agents causing UTI Respiratory tract system & infections *S. pyogenes* infections Diphtheria	**02** **08**	

	Tuberculosis Pneumonia caused by *K .pneumoniae* Tabular form of other respiratory tract infections		
Module II	**STUDY OF A FEW INFECTIOUS DISEASES - II** **Skin – structure & infections** Leprosy Fungal infections- Oral Thrush Pyogenic skin infections - *Pseudomonas* & *S. aureus.* **Gastrointestinal tract – system & infections** Enteric fever- *Salmonella* Shigellosis Rotavirus - diarrhoea Dysentery - *Entamoeba histolytica* Infections - Enteropathogenic *E. coli* strains Tabular form of other gastrointestinal tract infections **Vector-borne diseases**	**15 Lectures** **05** **08** **02**	
Module III	**BASIC IMMUNOLOGY- I** **Antigen presenting cells** Antigen presentation- professional and non-professional cells Processing pathways, (Cytosolic and Endocytic pathway) **The Complement System** The functions of complement The components of complement Complement activation Classical pathway Alternative pathway Lectin pathway Membrane attack complex Regulation of the complement system Biological consequences of complement	**15 Lectures** **03** **05**	

	activation **Immunoglobulins** Immunoglobulins – basic and fine structure Immunoglobulin classes and biological activities Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes Immunoglobulin Superfamily Monoclonal antibodies, Production and applications	**07**	
Module IV	**BASIC IMMUNOLOGY- II** **Antigens** Immunogenicity versus antigenicity Factors that influence immunogenicity Epitopes / antigen determinants (only concepts) Haptens and antigenicity Immunogenicity of some natural substances Types of antigens **T cells** Receptors, structure (alpha-beta, gamma- delta TcR) TcR-CD3 complex structure and functions. Accessory molecules. Subsets of T cells (Th (Th1, Th2, T reg) T cell activation, Costimulatory molecules, T cell differentiation (memory and effector cell) **B cells** Receptors ---------- structure and organization B cell activation and differentiation – Thymus dependent and independent antigens, B cell activating signals, Role of Th cells in Humoral response, formation of T – B conjugates, CD40 / CD40L interaction, T_H cell cytokine signals.	**15 Lectures** **05** **05** **05**	
	Total	**60**	**2.5**

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Program: B.Sc.			**Semester: V**	
Course: Practicals			**Course Code: USMAMBP512**	
Teaching Scheme			**Evaluation Scheme**	
Practicals (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
6.4	-	3	25	75

PRACTICALS	**No. of lectures 120**
1. UV survival curve – determination of exposure time leading to 90% reduction 2. Isolation of mutants using UV mutagenesis 3. Replica plate technique for selection and characterization of mutants – auxotroph and antibiotic resistant 4. Isolation and detection of plasmid DNA [Group Experiment] 5. Preparation of competent cells and transformationIllustration of the role of plasmids in antibiotic resistance through curing of the plasmid. 6. Study of iron sequestration- siderophore production in *Pseudomonas* spp.[Group experiment] 7. Acid fast staining of *M. tuberculosis*. *8.* To determine SLO and SLS activity of *S .pyogenes* 9. Identification of isolates obtained from nasal swabs, skin swab, pus, sputum, stool and urine by morphological, cultural and biochemical properties. 10. Antigen Preparation: O and H antigen preparation of *Salmonella*. Confirmation by slide agglutination [Group Experiment] 11. Biochemical test for identification of pathogens	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester.

RECOMMENDED READING:

ESSENTIAL READING:

1. S. Riedel, J. A. Hobden, S. Miller, S. A. Morse, T. A. Mietzner, B. Detrick, T. G. Mitchell, J. A. Sakanari, P. Hotez. R. Meija Jawetz, Melnick and Adelberg's Medical Microbiology 26thy Edition 2013 lange Publication.
2. Arti Kapil (Ed) Ananthnarayan and Panicker's Textbook of Microbiology 9th edition Orient Blackswan.
3. Brenda A. Wilson, Aligail A. Salyers, Dixie D. Whitt, Whitt, Malcolm, E. Winkler Bacterial Pathogenesis - A Molecular Approach 2nd Editionn 2002 ASM Press
4. Baron Samuel Medical Microbiology 4th Edition
5. Judith A Owen, Jenni Punt, Sharon A. Stranford, Patricia P Jones, Janis Kuby Immunology, 7th Edition 2013 W H Freeman and Company.

SUPPLEMENTARY READING:

1. Judith A Owen, Jenni Punt, Sharon A. Stranford, Patricia P Jones, Janis Kuby Immunology, 6th Edition 2013 W H Freeman and Company.
2. S. Pathak and U. Palan Immunology: Essential and Fundamental 1st and 3rd edition Capital Publishing Company
3. Fahim Khan. The Elements of Immunology 1st Edition
4. Any other reference sources as recommended by the course instructor.

Program: B.Sc.				**Semester: V**
Course: MICROBIAL BIOCHEMISTRY: PART-I				**Course Code: USMAMB503**
Teaching Scheme				**Evaluation Scheme**
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:

This course is designed for T.Y.B.Sc. Microbiology students as an extension of course on introduction to biochemistry in S.Y.B.Sc. With basic information on laws of thermodynamics, its relevance to biological systems, energy transformation and concept of metabolism. In this semester Students are introduced with mechanisms of transport of nutrients & solutes and further in detail catabolism of nutrients in various nutritional categories of microorganisms.

They will learn catabolism of simple and complex carbohydrates via different central metabolic pathways. Students will learn detailed mechanism of generation of ATP by substrate level phosphorylation, oxidative and photophosphorylation. Students also learn metabolism of inorganic carbon nitrogen and sulphur.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Summarize the process of solute transport across the cell.
CO2: Describe and explain the electron transport chains in prokaryotes and mitochondria as well as the mechanism of ATP synthesis.
CO3: Explain the mechanism of bioluminescence, its significance and applications.
CO4: Elaborate upon the mechanism of photosynthesis in prokaryotes.
CO5: Discuss utilization of simple and complex carbohydrates by central metabolic pathways.
CO6: Apply the concepts of energetics to the catabolism of carbohydrates.
CO7: Review utilization of inorganic nitrogen and Sulphur.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**BIOLOGICAL MEMBRANES & TRANSPORT**	**15**
2	**BIOENERGETICS AND BIOLUMINESCENCE**	**15**
3	**PROKARYOTIC PHOTOSYNTHESIS & INORGANIC METABOLISM**	**15**
4	**METABOLISM OF CARBOHYDRATES-I**	**15**
	Total	**60**
PRACTICALS		**60**

USMAMB503: Detailed Syllabus

Unit	Topic and Description	No. of lectures	No. of Credits
Module I	**BIOLOGICAL MEMBRANES & TRANSPORT**	**15 Lectures**	**2.5**
	Composition and architecture of membrane	**01**	
	Role of cell wall and membrane in transport of molecules	**02**	
	Methods of studying solute transport Using whole cells Using Liposomes Using Proteoliposome	**02**	
	Solute transport across membrane Facilitated / passive transport Superfamilies' of transporter Kinetics of solute transport Active transport Co transport across plasma membrane (Uniport, Antiport, Symport) Energy use in Active transport –proton motive force, e.g. lactose transport ATPases and transport e.g. Na-K ATPases ABC transporters e.g. Histidine transport Shock sensitive system – Role of binding proteins e.g. Maltose uptake Potassium transport in bacteria Phosphotransferase system Schematic representation of various Membrane transport mechanisms in *E. coli*	**07**	
	Other examples of solute transport Iron transport : A special problem Bacterial protein export Bacterial membrane fusion central to many biological processes	**03**	

Module II	**BIOENERGETICS AND BIOLUMINESCENCE**	**15 Lectures**	
	Biochemical mechanism of generating ATP- Substrate level, Oxidative, and Photo Phosphorylation	**01**	
	Electron transport chain (ETC) in eukaryotes and prokaryotes Components of electron transport chain. Carriers in ETC Electron transport chain in chemolithotrophs, facultative heterotrophs and aerobes(one representative example with their Carriers of ETC) Oxidative phosphorylation P/O ratio proton motive force redox potential	**07**	
	ATP synthesis Free energy released during electron transfer from NADH to O_2. Chemiosmotic coupling hypothesis ATP synthase- structure and mechanism of ATP synthesis	**03**	
	Bacteriorhodopsin Definition, Significance, Function as proton pump.	**01**	
	Bioluminescence Importance, mechanism and application	**03**	

Module III	**PROKARYOTIC PHOTOSYNTHESIS &** **INORGANIC METABOLISM**	**15 Lectures**	
	Prokaryotic photosynthesis Phototrophic prokaryotes Oxygenic Anoxygenic phototrophs Hill reaction Light and dark reactions Component of photophosphorylation , Light reactions in oxygenic and Anoxygenic bacteria Carbon dioxide fixation in photosynthetic bacteria	**07**	
	Dark reaction-Carbon dioxide fixation Calvin Benson cycle Reductive TCA	**03**	
	Inorganic Metabolism Metabolism of Sulphur and nitrogen by bacteria	**03**	
	Lithotrophy 'N' and 'S' oxidisers. Mechanism of oxidation. Examples of other lithotrophs	**02**	

Module IV	**Metabolism of carbohydrates-I**	**15 Lectures**	
	Catabolism of Carbohydrates Breakdown of polysaccharides – glycogen, starch, cellulose. Breakdown of oligosaccharides– lactose, maltose, sucrose, cellobiose. Utilization of monosaccharides – fructose, Galactose	**02**	
	Major pathways Glycolysis (EMP) HMP Pathway & Significance of the pathway ED pathway TCA cycle & Significance of the cycle Anaplerotic reactions Glyoxylate bypass Incomplete TCA in anaerobic bacteria	**08**	
	Amphibolic role of EMP and TCA cycle	**01**	
	Methods to study metabolism Mutation pulse labelling, radio respirometry	**03**	
	Energetics of Glycolysis, ED and TCA pathway – Balance sheet only (No efficiency calculation	**01**	
	Total	**60**	**2.5**

RECOMMENDED READING:

Essential reading:

1. Mathews, C.K., K.E. van Holde, D.R. Appling, S,J, Anthony-Cahill (2012) Biochemistry, 4thedn. Pearson
2. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
3. Stanier, R.Y., M.Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
4. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edition, Springer
5. Keith Wilson and John Walker Principles and Techniques of Biochemistry and Molecular Biology 7th edition 2010, Cambridge University press.

Supplementary Reading:

1. Rose, A.H. (1976) Chemical Microbiology, 3rdednButterworth-Heinemann
2. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edition, Springer
3. Conn, E.E., P.K.Stumpf, G.Bruening and R.Y.Doi. 1987. Outlines of Biochemistry, 5th edition, 1987. John Wiley &Sons. New York.
4. Nelson, D. L. and M.M. Cox(2005), Lehninger, Principles of biochemistry. 4th edition, W. H. Freeman and Company
5. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
6. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
7. Any other reference sources as recommended by the course instructor.

Program: B.Sc.				**Semester: V**
Course: BIOPROCESS TECHNOLOGY				**Course Code: USMAMB504**
Teaching Scheme				**Evaluation Scheme**
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:

This course on Bioprocess Technology is designed to develop the learner's ability to study the techniques used in the different phases of industrial microbiology such as strain improvement, basic fermentation equipment and its sterilization aspects. It gives an in-depth focus of the different types of fermenters used in the industry for the production of different biomolecules and also emphasizes its process parameters. It includes the principles and describes the main steps and processes in the industrial production of beverages, antibiotics, vitamins, organic acid and enzymes.

This course aims to enable graduates to enter industry with an appropriate level of understanding of the need for the requisite science and business aspects to make a viable product and enhance their entrepreneurial skills.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Apply newer approaches for screening various microbial metabolites

CO2: Describe the mechanisms of strain improvement and their applications in Industrial Microbiology

CO3: Describe the design of bioreactors for different applications and its process parameters

CO4: Design media, growth conditions and techniques for producing and recovering different types of microbial products of commercial value

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**SCREENING AND IMPROVEMENT OF INDUSTRIALLY IMPORTANT STRAINS**	**15**
2	**UPSTREAM PROCESSING**	**15**
3	**FERMENTER EQUIPMENT AND CONTROL**	**15**
4	**INDUSTRIAL FERMENTATIONS: PART-I**	**15**
	Total	**60**
PRACTICALS		**60**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

USMAMB504: Detailed Syllabus			
Unit	**Topic and Description**	**No. of Lectures**	**No. of Credits**
Module I	**SCREENING AND IMPROVEMENT OF INDUSTRIALLY IMPORTANT STRAINS** **Newer approaches for screening microbial metabolites** **Strain Improvement of industrial microorganisms** Selection of induced mutants Selection of mutants with altered permeability Isolation of mutants not producing Feed Back Inhibitors or Feed Back repressors (All Methods –Only one example) Use of auxotrophs for production of primary metabolites. Example aspartate family. Isolation of mutants that do not recognize the presence of inhibitors and repressors with example(Gradient plate –Lysine) Isolation of auxotrophic mutants example- (Penicillin-Davies technique and Miniaturized tech) Isolation of induced mutants for secondary metabolites. Isolation of resistant mutants Isolation of revertant mutants.	**15 Lectures** **05** **10**	**2.5**
Module II	**UPSTREAM PROCESSING** **Inoculum development** **Sterilization** Introduction. Media sterilization (Concept of nabla factor) Design of batch sterilization. Methods of batch sterilization- Design of continuous sterilization, Methods– Heat exchanger continuous injector flash cooling Sterilization of fermenter, feeds, liquid waste. Filter sterilization of media. Air sterilization with Absolute filters. **Solid substrate fermentation** Definition Types of substrates used Characteristics of SSF Types of fermenters used for SSF Advantages and disadvantages of SSF	**15 Lectures** **05** **05** **05**	

Module III	**FERMENTER EQUIPMENT AND CONTROL** **Design of fermenter** Scale Up Basic functions of fermenter,- Aseptic operation and containment, Body construction Aeration and agitation: Agitators, Stirrer glands and bearing, Mechanical seals (Names and Functions), Magnetic Drive, Baffles, Sparger: porous, orifice; nozzle; combined. Achievement and maintenance of aseptic condition. Valves / Steam traps – function in general and examples. Types of fermenters: Acetator, Cavitator, Tower fermenter, Cylindro conical, Air lift – outer loop / inner loop, Deep jet, Packed tower (generator), Bubble cap, Rotating disc. **Instrumentation and Control of variables** Introduction Types of sensors Sensing and Control of- pH, temp, Dissolved oxygen, Flow measurement and control, Pressure, Inlet / Exit gas analysis, Foam sensing, Oxygen	**15 Lectures** **10** **05**	
Module IV	**INDUSTRIAL FERMENTATIONS: PART- I** **Beer –Ale and Lager** **Wine –Red and white and Champagne** **Vinegar (Acetator and Generator)** **Alcohol from molasses** **Baker's yeast** **Fungal amylase by solid substrate fermentation**	**15 Lectures** **03** **03** **03** **02** **02** **02**	
	Total	**60**	**2.5**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc.			**Semester: V**	
Course: Practicals			**Course Code: USMAMBP534**	
Teaching Scheme			**Evaluation Scheme**	
Practicals (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
6.4	-	3	25	75

PRACTICALS	**No. of lectures 120**
1. Isolation and study of Bioluminescent organisms 2. Study of oxidative and fermentative metabolism 3. Qualitative and Quantitative assay of Phosphatase 4. Isolation and detection of Mitochondria 5. Isolation and detection of chloroplast 6. Estimation of Glucose in growth medium by GOD/POD 7. Galactose transport in yeasts 8. Ammonia and nitrite oxidation by chemolithotrophs 9. Gradient plate technique for analogue resistant mutants. 10. Alcohol tolerance of yeast. 11. Sugar tolerance of yeast. 12. Alcohol fermentation- Efficiency of fermentation 13. Chemical estimation –Sugar by Cole's 14. Chemical estimation –Alcohol 15. Production of amylase- shake flask and solid substrate cultivation and detection.	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

ESSENTIAL READING:

1. Stanbury P. F., Whitaker A. and HaII S. J., (2016), "Principles of Fermentation Technology", 3rd Edition, Aditya Books Pvt. Ltd, New Delhi.
2. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International(P) Ltd, Publishers, New Delhi
3. H. A. Modi, (2009). ''Fermentation Technology'' Vols 1 and 2, Pointer Publications, India
4. S.N.Jogdand (2012) Advances in Biotechnology, Himalaya publishing House.

SUPPLEMENTARY READING:

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 and 2, Academic Press
2. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
3. Okafor Nakuda (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
4. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th Edition, McMillan Publishers
5. Manual of Industrial Microbiology and Biotechnology (2010) Richard H. Balts, Julian E Davies, Arnold L. Demain , ASM press.
6. Any other resources suggested by the course instructor.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc.				**Semester: VI**
Course: rDNA TECHNOLOGY, BIOINFORMATICS AND VIROLOGY				**Course Code: USMAMB601**
Teaching Scheme				**Evaluation Scheme**
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:

Microbial Genetics is an undergraduate T.Y.B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing and understanding biological genetic information. The course involves an understanding of Cell biology, DNA replication, genetic exchange and recombination, mutation and DNA repair. It gives an overview of the branches of genetics and model organisms. Additionally the learner will be exposed to details of plasmids, transposable elements, basic and advanced virology and basic bioinformatics

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Describe the basic concepts and techniques of recombinant DNA technology

CO2: Explain the characteristics of model organisms

CO3: Describe different types of plasmids; the nature of the transposable elements and mechanism of transposition in prokaryotic cells.

CO4: Have acquired hands on skills of isolation of plasmid DNA from bacterial cells and its visualization by performing agarose gel electrophoresis.

CO5: Explain the basic concepts of Bioinformatics.

CO6: Describe the basic structure, classification, enumeration, cultivation and life cycle of viruses

CO7: Categorize various methods used for visualization of viruses

CO8: Explain the role of viruses in cancer and diseases caused by prions and viroids

CO9: Discuss regulation of lambda phage life cycle

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**EXTRACHROMOSOMAL DNA AND BIOINFORMATICS**	**15**
2	**RECOMBINANT DNA TECHNOLOGYAND ITS APPLICATIONS**	**15**
3	**BASIC VIROLOGY**	**15**
4	**ADVANCED VIROLOGY**	**15**
	Total	**60**
PRACTICALS		**60**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

USMAMB601: Detailed Syllabus			
Unit	**Topic and Description**	**No. of Lectures**	**No. of Credits**
Module I	**EXTRACHROMOSOMAL DNA AND** **BIOINFORMATICS** **Branches of Genetics** Transmission genetics Molecular genetics Population genetics Quantitative genetics **Model Organisms** Characteristics of a model organism Examples of model organisms used in study Examples of studies undertaken using prokaryotic and eukaryotic model organisms **PCR-** basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR) **Plasmids** Physical nature Detection and isolation of plasmids Plasmid incompatibility and Plasmid curing Cell to cell transfer of plasmids Types of plasmids Resistance Plasmids, Plasmids encoding toxins and other virulence characteristics Col factor	**15 Lectures** **01** **01** **02** **04**	**2.5**

	Degradative plasmids **Transposable Elements in Prokaryotes** Insertion sequences Transposons Types Structure and properties Mechanism of transposition Transposon mutagenesis Integrons **Bioinformatics** Introduction Definition, aims, tasks and applications of Bioinformatics. Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, Genomics, Proteomics, Database, tools and their uses**,** Importance, Types and classification of databases**.** Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.Protein structure databases- SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG.	**04** **03**	
Module II	**rDNA TECHNOLOGY AND ITS APPLICATIONS** **Basic steps in Gene Cloning.** **Cutting and joining DNA molecules** Restriction and modification systems, restriction endonucleases, DNA ligases	**15 Lectures** **01** **02**	

	Vectors Plasmids as cloning vectors. The plasmid vectors, pBR322 vector Cloning genes into pBR322 Phage as cloning vectors, cloning genes into phage vector Cosmids Shuttle vectors YAC BAC **Methods of transformation** **Screening and selection methods for identification and isolation of recombinant cells** **Applications of recombinant DNA technology:** Site specific mutagenesis of DNA, Uses of DNA polymorphism, STRS and VNTRS, DNA molecular testing for human genetic diseases (Only RFLP), DNA typing, gene therapy, Genetic engineering of plants and animals.	**04** **02** **03** **03**	
Module III	**BASIC VIROLOGY** **Viral architecture-** Capsid, viral genome and envelope Structure of TMV, T4, Influenza virus, HIV. **Viral classification** **The viral replication cycle**- attachment, penetration, uncoating, types of viral genome and their replication, assembly, maturation and release. **Cultivation of viruses**- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue	**15 Lectures** **04** **02** **04** **05**	

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Module IV	**ADVANCED VIROLOGY**	**15 Lectures**	
	Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail	**05**	
	Visualization and enumeration of virus particles Measurement of infectious units Plaque assay Fluorescent focus assay Infectious center assay Transformation assay Endpoint dilution assay. Measurement of virus particles and their components Electron microscopy Atomic force microscopy Haemagglutination Measurement of viral enzyme activity.	**03**	
	Regulation of lytic and lysogenic pathway of lambda phage	**03**	
	Role of viruses in cancer: Important Definitions, characteristics of cancer cell, cancer multi step process, Human DNA tumor viruses- EBV, Kaposi's sarcoma virus, Hepatitis B and C virus, Papilloma Virus	**02**	
	Prions and viroids	**02**	
	Total	**60**	**2.5**

RECOMMENDED READING

ESSENTIAL READING:

1. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., W. H. Freeman and company.
2. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th ed., Pearson Education International.
3. Edward Wagner and Martinez Hewlett, (2005) "Basic Virology", 2nd edition, Blackwell Publishing
4. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd Edition, Oxford University Press
5. Snustad, Simmons, "Principles of genetics", 3rdedn. John Wiley AND sons, Inc.

SUPPLEMENTARY READING:

1. Peter J. Russell (2006), "Genetics-A molecular approach", 2nd edition.
2. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
3. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
4. Benjamin Lewin, (9th edition), "Genes IX", Jones and Bartlett publishers.
5. JD Watson, "Molecular biology of the gene", 5thedn.
6. Teri Shors, (2009) , "Understanding viruses", Jones and Bartlett publishers.
7. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6thed, Blackwell Publishing
8. T. K. Attwood AND D. J. Parry-Smith, (2003), "Introduction to bioinformatics", Pearson education
9. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2ndedn. ASM press.
10. Any other reference sources recommended by the course instructor.

Program: B.Sc,				**Semester: VI**
Course: MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART-II				**Course Code: USMAMB602**
Teaching Scheme				**Evaluation Scheme**
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (SEE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:

This course will provide an in-depth exploration of the fields of medical microbiology and immunology that are inexorably linked with each other. The course encompasses the aetiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases that are enlisted in the syllabus. It will also enable the students to appreciate the interplay between the virulence factors of pathogens and the host defense mechanisms.

Students of T.Y.B.Sc. Microbiology have had an introductory course on Immunology in S.Y.B.Sc. The present course encompasses efforts to understand how multicellular organisms have evolved to survive a variety of challenges to homeostasis, including infection by pathogens.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Identify some common infectious agents and the diseases that they cause.
CO2: Evaluate methods used for antimicrobial testing in the clinical microbiology lab
CO3: Describe the modes of action of representative antibiotics
CO4: Review the means by which resistance to antibiotics are acquired by pathogens.
CO5: Appraise the immunological response and how it is triggered and regulated
CO6: Explain the cellular and molecular aspects of lymphocyte activation
CO7: Define the cellular/molecular pathways of humoral/ cell-mediated adaptive responses
CO8: Describe the mechanisms of antigen-antibody reactions and their relevance in disease diagnosis
CO9: Explore strategies for vaccine development

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**CARDIOVASCULAR SYSTEM & STUDY OF A FEW INFECTIOUS DISEASES - III**	**15**
2	**CHEMOTHERAPY OF INFECTIOUS AGENTS**	**15**
3	**THE WORKING OF THE IMMUNE SYSTEM**	**15**
4	**ANTIGEN-ANTIBODY REACTIONS AND VACCINES**	**15**
	Total	**60**

PRACTICALS	**60**

USMAMB602: Detailed Syllabus			
Unit	**Topic and Description**	**No. of Lectures**	**No. of Credits**
Module I	**STUDY OF A FEW INFECTIOUS DISEASES - III**	**15 Lectures**	**2.5**
	Cardiovascular system & systemic infections	**03**	
	Septicemia Bacterimia Toxemia Tabulation to include bacterial, viral and helminthic infections		
	Reproductive system & sexually transmitted diseases Syphilis Gonorrhea	**05**	
	AIDS	**03**	
	CNS & its infections meningococcal meningitis	**04**	
	tetanus poliomyelitis Tabulation of the remaining diseases		

Module II	**CHEMOTHERAPY OF INFECTIOUS AGENTS** **Introduction to chemotherapeutic agents** Attributes of an ideal chemotherapeutic agent and related definitions Testing of antibiotics for bacterial isolates by Kirby-Bauer method **Mode of action of antibiotics on:** Cell wall (Beta-lactams- Penicillin and Cephalosporins, Carbapenems) Cell Membrane (Polymyxin and Imidazole) Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol) Nucleic acid (Quinolones, Nalidixic acid, Rifamyicn) Enzyme inhibitors (Sulfa drugs, Trimethoprim) **List of common antibiotics used for treating viral, fungal and parasitic diseases.** **Mechanisms of drug resistance- Its evolution, pathways and origin**	**15 Lectures** **02** **09** **01** **03**	
Module III	**THE WORKING OF THE IMMUNE SYSTEM** **MHC complex and MHC molecules** Structure of class I, and class II molecules; class III molecules Peptide – MHC interaction **Cytokines** Properties and functions Cytokines secreted by T_{H1} and T_{H2} cells **Humoral Response** Induction of Humoral response, Primary and secondary responses Germinal centers and antigen induced B cell differentiation Generation of plasma cells and memory cells **Cell mediated effector response** Generation and target destruction by Cytotoxic T cells. Killing mechanism of NK cells. Antibody dependent cell cytotoxicity (ADCC)	**15 Lectures** **03** **02** **05** **05**	

Module IV	**ANTIGEN-ANTIBODY REACTIONS AND VACCINES** **Antigen-Antibody reactions** Precipitation Agglutination, passive agglutination agglutination inhibition Radioimmunoassay (RIA) Enzyme immunoassays (EIA) Immunofluorescence, Western blot technique **Vaccines** Active and passive immunization Types of vaccines Use of adjuvants in vaccine New vaccine strategies Ideal vaccine Route of vaccine administration Vaccination schedule Failures in vaccination	**15 Lectures** **07** **08**	
	Total	**60**	**2.5**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc.			**Semester: VI**	
Course: Practicals			**Course Code: USMAMBP612**	
Teaching Scheme			**Evaluation Scheme**	
Practicals (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
6.4	-	3	25	75

PRACTICALS	**No. of Lectures 120**
1. Isolation of genomic DNA of E. coli and measurement of its concentration by UV-VIS spectrophotometry. 2. Enrichment of coliphages, phage assay (pilot AND proper). 3. Restriction digestion of lambda phage /any plasmid DNA (Demonstration) 4. Amplification of DNA by PCR and confirmation of it by gel electrophoresis (Demonstration) 5. Western Blot. [Demonstration] 6. Bioinformatics practical a. On Line Practical b. Visiting NCBI and EMBL websites and list services available, software tools available and databases maintained c. Visiting AND exploring various databases mentioned in syllabus and d. Using BLAST and FASTA for sequence analysis e. Fish out homologs for given specific sequences (by teacher – decide sequence of some relevance to their syllabus and related to some biological problem e.g., evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology) f. Restriction analysis of given nucleotide sequence g. Pair-wise alignment and multiple alignment of a given protein sequences 7. Animal cell culture [Demonstration] 8. Acid fast staining of *M.leprae* 9. Identification of Candida species using the germ tube test and growth on CHROM agar 10. Demonstration of malarial parasite in blood films (Demonstration) 11. Selection and testing of antibiotics using the Kirby-Bauer method 12. Determination of MBC of an antibiotic. 13. Blood grouping – Direct and Reverse typing 14. Coomb's Direct test 15. Determination of Isoagglutinin titer 16. Demonstration experiments- Widal, VDRL	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

ESSENTIAL READING:

1. S. Riedel, J. A. Hobden, S. Miller, S. A. Morse, T. A. Mietzner, B. Detrick, T. G. Mitchell, J. A. Sakanari, P. Hotez. R. Meija Jawetz, Melnick and Adelberg's Medical Microbiology 26thy Edition 2013 lange Publication.
2. Arti Kapil (Ed) Ananthnarayan and Panicker's Textbook of Microbiology 9th edition Orient Blackswan.
3. Brenda A. Wilson, Aligail A. Salyers, Dixie D. Whitt, Whitt, Malcolm, E. Winkler Bacterial Pathogenesis - A Molecular Approach 2nd Editionn 2002 ASM Press
4. Baron Samuel Medical Microbiology 4th Edition
5. Judith A Owen, Jenni Punt, Sharon A. Stranford, Patricia P Jones, Janis Kuby Immunology, 7th Edition 2013 W H Freeman and Company.

SUPPLEMENTARY READING:

1. S. Pathak and U. Palan Immunology: Essential and Fundamental 1st and 3rd edition Capital Publishing Company
2. Fahim Khan. The Elements of Immunology 1st Edition
3. Any other reference sources as recommended by the course instructor.

Program: B.Sc.				**Semester: VI**
Course: MICROBIAL BIOCHEMISTRY: PART-II				**Course Code: USMAMB603**
Teaching Scheme				**Evaluation Scheme**
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:

In semester V students learn utilization of carbohydrates via central metabolic pathways, microorganisms have ability to utilize carbohydrate by fermentation. This semester learner will learn various fermentation mechanism and formation of various fermentation end products by different groups of microorganisms. This knowledge will help the learners understand industrial fermentation products. Carbohydrates are important constituents of cell structures. In this semester learners will learn synthesis of capsule, cell wall which have carbohydrates as major components. In addition to the carbohydrates there are a large number of macromolecules such as lipids, proteins and nucleic acids. which are catabolized by the living cells. Cells also synthesize these macromolecules. With the basic understanding regarding these macromolecules' learner will learn mechanism of catabolism and synthesis of cellular macromolecules. To maintain cell homeostasis all cellular processes are regulated at various level. The learner must be made aware the mechanism of regulation at various level in the living cell. This will not only help in understanding the network of metabolism but also help the learners in process biotechnology.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Recall microbial physiology including metabolism

CO2: Describe different types of fermentative metabolism of carbohydrates and will be able to apply this knowledge in process biotechnology

CO3: Illustrate synthesis of glucose from non-carbohydrate molecules in cell.

CO4: Elaborate upon biosynthesis of capsule and cell wall.

CO5: Discuss the metabolism of lipids, aliphatic hydrocarbons, proteins and nucleic acids.

CO6: Assess regulation of metabolism in bacteria at various levels.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**FERMENTATIVE PATHWAYS & ANABOLISM OF CARBOHYDRATES**	**15**
2	**LIPID METABOLISM & CATABOLISM OF HYDROCARBONS**	**15**
3	**METABOLISM OF PROTEINS AND NUCLEIC ACIDS**	**15**
4	**METABOLIC REGULATION**	**15**
	Total	**60**

PRACTICALS	60

USMAMB603: Detailed Syllabus			
Unit	**Topic and Description**	**No. of hours**	**No. of Credits**
Module I	**FERMENTATIVE PATHWAY& ANABOLISM OF CARBOHYDRATES**	**15 Lectures**	
	Fermentative pathways Lactic acid fermentation Homofermentors Heterofermentors Bifidobacterium pathway (Schematic) Alcohol fermentation ED pathway in bacteria EMP in yeasts	**05**	
	Other modes of fermentations in microorganisms Mixed acid Butanediol Butyric acid Butanol-acetone Propionic acid	**05**	
	Anabolism of Carbohydrates General pattern of metabolism leading to synthesis of a cell from Glucose Gluconeogenesis in bacteria Biosynthesis of capsule and cell wall	**05**	

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Module II	**LIPID METABOLISM & CATABOLISM OF HYDROCARBONS**	**15 Lectures**	
	General introduction to Lipids Lipids in bacteria Lipid as cell reserve. (PHB granules)	**01**	
	Catabolism of Lipids Oxidation of even number saturated fatty acid - β oxidation pathway Oxidation of old number of saturated fatty acid Oxidation of propionic acid Energetics of β oxidation of Palmitic acid Degradation of PHB granules	**06**	
	Anabolism of Lipids Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) Biosynthesis of unsaturated fatty acid in bacteria Biosynthesis of phosphoglycerides in bacteria Biosynthesis of PHB	**06**	
	Catabolism of aliphatic hydrocarbons Oxidation of saturated aliphatic hydrocarbon (n-alkane)- Omega oxidation	**02**	

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Module III	**METABOLISM OF PROTEINS AND NUCLEIC ACIDS**	**15 Lectures**	
	Protein catabolism Enzymatic degradation of proteins Metabolic fate of amino acids Metabolism of single amino acids Deamination reactions Decarboxylation Transamination Fermentation of single amino acid Fermentation of pair of amino acids -Stickland reaction	**05**	
	Anabolism of Proteins Schematic representation of amino acid families Synthesis of amino acids of aspartate family	**04**	
	Nucleic acid Catabolism Degradation of purine nucleotides in microorganisms Recycling of purine and pyrimidine nucleotides by salvage pathway	**03**	
	Anabolism of Nucleic Acids Metabolic origin of atoms in purine and pyrimidine ring. Biosynthesis of pyrimidine nucleotides. Biosynthesis of purine nucleotides. Formation of deoxyribonucleotides. Synthesis of nucleotide diphosphates and triphosphates	**03**	

Module IV	**METABOLIC REGULATION**	**15 Lectures**	
	Overview and major modes of regulation	**01**	
	Examples of cellular control mechanism acting at various levels of metabolism (tabulation only)		
	Regulation of gene expression (Transcription)	**06**	
	Introduction to operon model Common patterns of regulation of transcription -General concept of positive and negative regulation of operons Lac operon - Mechanism of regulation – Induction, Catabolite repression Trp operon - End Product Repression, Attenuation. Regulation of gene expression Multiple Sigma Factors Riboswitches		
	Regulation of enzyme activity (Post translational regulation)	**04**	
	End-Product Inhibition and Mechanism of End Product Inhibition in branched pathways with examples Isofunctional enzymes Concerted feedback inhibition Sequential feedback inhibition Cumulative Feedback inhibition Combined activation and inhibition Covalent modification of enzymes General examples Monocyclic cascade & interconvertable enzyme definition Glutamine synthetase system of *E.coli*		
	Regulation by proteolytic cleavage **Regulation of EMP and TCA**	**01** **01**	
	Total	**60**	**2.5**

RECOMMENDED READING:

ESSENTIAL READING:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
2. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5th edition, 1987. John Wiley & Sons. New York.
3. Salle, A.J. Fundamental Principles of Bacteriology, 7thedn McGraw Hill Book Co.
4. Madigan, M.T. and J.M. Martinko 2006. 11th edition, Brock Biology of Microorganisms. Pearson Prentice Hall.
5. Cohen, G.N. (2011). Microbial Biochemistry. 2ndedn, Springer

SUPPLEMENTARY READING:

1. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
2. Gottschalk, G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
3. Nelson, D. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry. 5th edition, W. H. Freeman and Company.
4. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown Publishers

Program: B.Sc.				**Semester: VI**
Course: APPLIED AND INDUSTRIAL MICROBIOLOGY				**Course Code: USMAMB604**
Teaching Scheme				**Evaluation Scheme**
Lecture (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
3.2	-	2.5	25	75

Learning Objectives:

Bioprocess Technology course is designed to develop the learner's ability to study the techniques used in the different phases of industrial microbiology such as strain improvement, basic fermentation equipment and its sterilization aspects. It gives an in-depth focus of the different types of fermenters used in industry for production of different products, and also emphasizes its process parameters. It includes the principles and describes the main steps and processes in the industrial production of beverages, antibiotics, vitamins, organic acid and enzymes.

The learner is expected to learn the need for quality management and regulatory bodies as the products need to fulfill these requirements. Thus, this paper readies the learner to understand and apply the knowledge of fermentation technology and related products.

This course aims to enable graduates to enter industry with an appropriate level of understanding of the need for the requisite science and business aspects to make a viable product and enhance their entrepreneurial skills.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: Explain the various steps involved in downstream processing and effluent treatment

CO2: Design an industrial process keeping in view various guidelines for product recovery and disposal of industrial effluent

CO3: Appreciate the importance of carbon credits

CO4: Enlist the applications of enzymes in various fields

CO5: Design media, growth conditions and techniques for producing and recovering different types of microbial products of commercial value

CO6: Categorize the different IPs

CO7: Outline the steps involved in patent application

CO8: Enlist the salient features of quality management and regulatory procedures

CO9: Describe the working of important instruments used in biochemical analysis

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Lectures**
1	**DOWNSTREAM PROCESSING AND ENVIRONMENTAL ASPECTS**	**15**
2	**INDUSTRIAL FERMENTATIONS – PART 2**	**15**
3	**QUALITY ASSURANCE AND REGULATORY PRACTICES**	**15**

4	**BIOINSTRUMENTATION**	**15**
	Total	**60**
PRACTICALS		**60**

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

USMAMB604: Detailed Syllabus			
Unit	**Topic and Description**	**No. of hours**	**No. of Credits**
Module I	**DOWNSTREAM PROCESSING AND ENVIRONMENTAL ASPECTS** **Downstream processing** Recovery and Purification of fermentation products Introduction, Precipitation, Filtration - theory, filter-aids, batch filters(Plate and frame filters), continuous filters.(Rotary vacuum),Centrifugation: flocculating agent, range of centrifuges - Basket, tubular bowl. Cell disruption: Physico-chemical. Liquid – Liquid extraction, Solvent recovery Chromatography –Ion exchange and Adsorption Membrane processes – Ultrafiltration, reverse osmosis, liquid membranes Drying, Crystallization Whole broth processing **Environmental aspects** Effluent treatment Introduction to carbon credits	**15 Lectures** **11** **04**	
Module II	**INDUSTRIAL FERMENTATIONS : PART-2** **Production of**: **Penicillin and Semisynthetic Penicillin** **Vitamin B12** from *Propionibacterium* and *Pseudomonas* **Glutamic Acid (direct)** **Citric acid** **Mushroom** **Enzyme Technology** Enzyme Immobilization methods, Applications in therapeutic uses, Analytical uses and Industrial uses	**15 Lectures** **03** **03** **02** **02** **02** **03**	

Module III	**QUALITY ASSURANCE AND REGULATORY PRACTICES** **Intellectual Property Rights:** Introduction to Intellectual Property Genesis of IPR - GATT, WTO, TRIPS, The World Intellectual Property Rights Organization (WIPO) Types of Intellectual Property – Patents, Copyright, Trademark, Trade secret Plant varieties protection act, Designs, Geographical Indications Indian Patent office site- http://www.ipindia.nic.in/ **QA,QC,GMP :** Definitions- Manufacture, Quality, Quality Control, In-Process Control, Quality Assurance, Good Manufacturing Practices. Chemicals, Pharmaceuticals, Chemicals and Pharmaceutical production The five variables, In process Items, Finished Products, Labels and Labeling, Packaging materials Documentation,Regulations,Control of Microbial contamination during manufacture, Premises and contamination control ,Manufacture of sterile products,Clean and Aseptic Area Important publications related to QA **Sterilization Control and SterilityAssurance:** Bio-burden determinations Environmental monitoring Sterilization Monitors – Physical, Chemical and Biological indicators, Sterility Testing	**15 lectures** **06** **05** **04**	
Module IV	**BIOINSTRUMENTATION** **Bioinstrumentation – Principles, working and applications of:** Spectrophotometry (I. R) Atomic absorption (AAS) AND Atomic Emission (Flame photometry) Radioisotopes and autoradiography Microbiological Assays Mass Spectrometry ESR NMR	**15 lectures**	

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: B.Sc.			**Semester: VI**	
Course: Practicals			**Course Code: USMAMBP634**	
Teaching Scheme			**Evaluation Scheme**	
Practicals (Hours per week)	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Percentage)**	**End Semester Examinations (ESE) (Percentage)**
6.4	-	3	25	75

PRACTICALS	**No. of Lectures 120**
1. β-galactosidase assay 2. To study catabolite repression by diauxic growth curve 3. Study of Home and Heterofermentation 4. Detection of organic acids by TLC 5. Qualitative and Quantitative assay of Protease 6. Qualitative and Quantitative assay of Lipase 7. Study of breakdown of amino acids –decarboxylase and Deaminase activity of any one amino acid 8. Bioassay of an antibiotic (Ampicillin / Penicillin) 9. Bioassay of Cyanocobalamin. 10. Immobilization of yeast cells for invertase activity- making of beads, Determination of activity and count by haemocytometer. 11. Sterility testing of injectible or vaccine. 12. Chemical estimation of Penicillin	

To develop scientific temper and interest by exposure through industrial visits and study/educational tours is recommended in each semester

RECOMMENDED READING:

ESSENTIAL READING:

1. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International (P) Ltd, Publishers, New Delhi
2. Stanbury P. F., Whitaker A. and HaII--S. J., 1997, "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. H. A. Modi, 2009. ''Fermentation Technology'' Vol: 1 and 2, Pointer Publications, India
4. Wilson and Walker, 2010. "Principles and Techniques of Biochemistry and Molecular Biology" 7thedn. Cambridge University Press.

SUPPLEMENTARY READING:

1. Environmental degradation : issues and challenges by Shitole and Sable, Global research publication (2012)
2. Crueger W. and Crueger A. 2000 "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
3. Prescott and Dunn's ''Industrial Microbiology''(1982) 4th Edition, McMillan Publishers
4. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 AND 2, Academic Press.
5. Any other reference sources as recommended by the course instructor.

Shri Vile ParleKelavaniMandal's

MMITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS

(AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India,

Best College(2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: Bachelor of Science

Course: Microbiology- Applied Component

Semester V& VI

Choice Based Credit System (CBCS) with effect from the Academic year 2020-21

A.C. No. 7

Agenda No. Supplementary 4.6 (iii)

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the B.Sc, the learners should be enriched with knowledge and be able to-

PSO1: Articulate and communicate in the specialized terminology pertaining to microbiology.
PSO2: Define and explain the theories and practices of the various fields/ disciplines in microbiology.
PSO3: Explain the technologies and methods commonly used in microbiology.
PSO4: Acquire the requisite skills applicable to microbiological analysis.
PSO5: Describe the genetic and ecological relationships between microorganisms.
PSO6: Discuss the applications of microorganisms in the various areas of biotechnology.

Preamble

The grant of autonomy along with DBT star funding has provided a platform for designing a curriculum that is dynamic and meets the need of the hour. The inherent freedom under autonomy provides for a multisensory learning experience.
The syllabusis as per CreditBased Semester and Grading System(CBSGS)and continuous evaluation consisting of components of Internal Assessment and External Assessment. The changes introduced conform to the Learning Objectives.
A major advantage of receiving autonomy is freedom to design a need-based curriculum for the learners. An applied component was introduced at the T.Y.B.Sc. level with a view to enhance the skillsandfor the holistic development of the learner. Keeping this goal in view, the syllabus for 2020-21 has been redrafted to suit the specific requirements of the learners of Mithibai College, Autonomous.
Each semester (Semester V and VI) will consist of one theory and one practical course of 100 marks each.

The course is as follows:

Semester V: USMAACMB5: Concepts in Biotechnology

Semester VI: USMAACMB6: Applied Biotechnology

I profusely thank all the committee members for their efforts in drafting the syllabus.

N.B. - (i) The duration of each theory lecture will be of 48 minutes. A course consists of 4 modules. For each module the number of hours allotted are 15. The total number of lectures for each course will thus be 60.

(ii) There will be one practical per batch for each course. The duration of each practical will be 4 lectures. For practical component the value of one credit is equal to 30 learning hours.

(iii) Thus, in a week, a student will study 3.2 hours of theory and 3.2 hours of practicals.

Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) **Details of Continuous Assessment (CA)**
25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Assignment on topics related to but not included in the course	15 marks
Component 2 (CA-2)	Class test based on the course content	10 marks

b) **Details of Semester End Examination**
75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
1	Subjective questions based on module 1	3 questions of 7 marks each to be attempted out of 4 questions	21
2	Subjective questions based on module 2	3 questions of 7 marks each to be attempted out of 4 questions	21
3	Subjective questions based on modules 3	3 questions of 7 marks each to be attempted out of 4 questions.	21
4	Objective questions based on modules 1 to 3	4 sub-questions of 3 marks each to be attempted out of 4 questions	12
		Total Marks	**75**

Dr. Geeta Narayan
HOD

Dr. Meenakshi Vaidya
Approved by Vice –Principal

Dr. Krutika Desai
Approved by Principal

Program: B.Sc. (2020-21)				**Semester: V**	
Course: Applied Component -- Concepts in Biotechnology				**Course Code: USMAACMB5**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation(CAE) (Percentage)**	**End Semester End Examinations (ESE) (Percentage)**
2	4	NA	4 (Theory &practical sare 2 creditseach	25	75

Learning Objectives: Concepts in Biotechnology is an undergraduate T.Y.B.Sc. Microbiology course that deals with both conceptual and practical tools for generating, processing and understanding biotechnological information. The course involves an understanding of tools and techniques in biotechnology. In addition, learners will develop life skills required for them to thrive while simultaneously becoming contributing members of society.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: List the basic tools and techniques used in biotechnology while simultaneously summarize the concepts behind thesame.

CO2: Appreciate the alternatives to chemically harmful fertilizers and pesticides, which include biofertilizers and biopesticides. The learner will also be introduced to Plant Tissue Culture.

CO3: Be introduced to a wide array of applications of Environmental Biotechnology which includes bioremediation methods and the study of biofuels which have a massive implication for today'ssociety.

CO4: Develop holistically and become contributing members of society.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Tools and techniques in Biotechnology – Part I	15
2	Introduction to Plant and Agricultural Biotechnology	15
3	Environmental Biotechnology	15
4	Life skills – PartI	15
	Total	**60**
PRACTICALS		

Module	Topic	No. of Hours/Credits 60hrs/2.5credits
Module 1	**Tools and techniques in Biotechnology – Part I**	**15 Lectures**
	Electrophoresis: SDS-PAGE, Native PAGE and 2D gel electrophoresis. Agarose gel electrophoresis &Pulse Field Gel Electrophoresis (PFGE).	**07**
	PCR: Factors affecting PCR, Applications of PCR. Basic PCR and variants of PCR (Reverse Transcriptase PCR, Real Time PCR, Nested PCR, Inverse PCR and Hot start PCR).	**08**
Module 2	**Introduction to Plant and Agricultural Biotechnology**	**15 Lectures**
	Biofertilizers: Characteristics and applications for Bacterial, fungal & algal biofertilizers.	**03**
	Biopesticides: Biological control of plant pathogens, insects and weeds.	**04**
	Plant single cell, tissue, organ, meristem, callus and protoplast culture- regeneration of plants, plant breeding – recombinant and non-recombinant approaches and germ plasmbank.	**08**
Module 3	**Environmental Biotechnology**	**15 Lectures**
	Biologicals fuels: ethanol, methane and hydrogen production. Petroleum prospecting and Microbially Enhanced Oil Recovery (MEOR) Genetically modified organisms in environment**.**	**06** **01**
	Bioremediation: Overview of the *in-situ* &*ex-situ* methods (should include biofiltration, bioaugmentation and vermicomposting). Bioremediation of xenobiotics, heavy metals, dyes, waste from paper and pulpindustry.	**07**
	Bioleaching.	**01**
Module 4	**Life Skills – Part I** 1. Mental well-being.	**15 Lectures**

	2. Managing accounts. 3. Failure management. 4. Effective communication & Presentation skills. 5. Team building and interpersonal skills. 6. Courtesy and Empathy. 7. Personality Development and Personal grooming. 8. Resisting and/or Managing peerpressure. 9. Creative thinking. 10. Positive attitude. 11. Motivational skills. 12. Analytical and logical thinking. 13. Listening skills. 14. Self-supervision. 15. Criticizing and praising.	
	Total	**60**

	Practical USMAACMBP5	
	Practical **(Hours per week)**	**Credit**
	4	**2**
1	Isolation and cultivationof: *a) Azotobacter* *b) Rhizobium* c) Phosphatesolubilizers	
2	Preparation of biofertilizer: mass production and method of seed application	
3	Production of Biopesticides (*Bacillus thuringiensis*).	
4	Vermicomposting/ visit to vermicomposting facility	
5	Isolation of genomic DNA (bacterial /yeast). a) Measurement of DNA by UV-Vis spectrophotometry. b) Gel electrophoresis of DNA.	
6	Amplification of DNA by PCR and confirmation by gel electrophoresis (Demonstration).	
7	PAGE for protein.	

Essential Reading:

1. Bernard R.Glick and Jack J. Pasternak(2002).Molecular Biotechnology:Principles and Applications of recombinant DNA. 4th Edition.
2. B. D. Singh. Biotechnology. KalyaniPublishers.
3. S. N. Jogdand. Advances in Biotechnology. 2005. 5thEdition.
4. S. B. Primrose. Modern Biotechnology 1989. Blackwell ScientificPubl.
5. Primrose and others. Principles of Gene manipulation. 6thedition. 2004 BlackwellScience.
6. Aluizio Borem Fabricio R. Santos and David E. Bowen. Understanding Biotechnology. 2004 PearsonEducation.
7. James Watson and Others.Recombinant DNA.2001.Scientific AmericanBooks.
8. S. N Jogdand. Gene Biotechnology. 2008, Himalaya Pub.House.
9. Purohit, S. S. Biotechnology – Fundamentals and applications. 4thedition, 2005. Agrobios(India).
10. Jogdand, S. N. Medical Biotechnology, 2008. Himalaya Pub. House(Ebrary)

Supplementary Reading:

1. Das, H.K. Textbook of Biotechnology, 2nd edition, 2005. Wiley Dreamtech India Pvt.Ltd.
2. R.C.Dubey.ATextbookofBiotechnology.2006S.ChandandCompanyLtd.

Any other reference sources as recommended by the course instructor.

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Program: B.Sc. (2020-21)				**Semester: VI**	
Course: Applied Component – Applied Biotechnology				**Course Code: USMAACMB6**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation(CAE) (Percentage)**	**End Semester End Examinations (ESE) (Percentage)**
2	4	NA	4 (Theory &practical are 2 credits each	25	75

Learning Objectives: Applied Biotechnology is an undergraduate T.Y.B.Sc. Microbiology course that deals with applications of Biotechnology. The course involves an understanding of advanced tools and techniques in biotechnology, animal biotechnology and the role of biotechnology in society and its applications with respect to Medicine. In addition, the learner will be exposed to more advanced life skills which include financial literacy, which is essential for them to thrive both as individuals as well as contributing members of society.

Course Outcomes:

After completion of the course, learners would be able to:

CO1: List the advanced tools and techniques used in biotechnology while simultaneously summarize the concepts behind thesame.

CO2: Discuss the legal, social and ethical aspects involved in biotechnology.

CO3: Develop a basic understanding of finance along with his/her holisticdevelopment.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	Tools and techniques in Biotechnology – Part II	15
2	Introduction to Animal Biotechnology	15
3	Role of biotechnology in society	15
4	Life skills – PartII	15
	Total	**60**
PRACTICALS		

Module 1	**Tools and techniques in Biotechnology– Part II**	**15 Lectures**
	DNA sequencing methods: Maxam & Gilbert, Chain termination and automatedsequencing.	**03**
	Probes: Significance and methods for probe synthesis and labeling.	**05**
	Blotting Techniques: Southern, Northern and Western blotting.	**03**
	In situ Hybridization and FISH.	**02**
	Microarray: Introduction.	**02**
Module 2	**Introduction to Animal Biotechnology**	**15 Lectures**
	Animal cell culture: Principles of mammalian cell culture. Establishment of cell lines (Continuous cell lines). Media and equipment for animal cellculture.	**06**
	Transfection methods, embryonic stem cell transfer, cloning livestock by nuclear transfer, *In vitro* fertilization and embryo transfer, targeted gene transfer, detection oftransgenes.	**06**
	Application of transgenic animals, animalbioreactors.	**03**
Module 3	**Role of biotechnology in society**	**15 Lectures**
	Social and ethical aspects of Biotechnology: Bioethics, and Bioterrorism. GMOs in the environment.	**08**
	Biotechnology in Medicine:	**03**
	Disease Diagnosis: monoclonal antibodies and detection of genetic diseases.	
	Disease treatment: Products from non-recombinant and recombinant organisms, interferons, growth factors, monoclonal antibodies. artificial tissue / organ, gene	**04**

	therapy, and blood products, drug designing, delivery and targeting.	
Module 4	**Life skills – Part-II** 1. Savings and investment. 2. Insurance. 3. Coping with stress and workpressures. 4. It's okay to say'NO'. 5. Time management. 6. Critical thinking. 7. Conflict resolution. 8. Managing emotions and coping withanger. 9. Psycho-sociodevelopment. 10. Self-awareness. 11. Decisionmaking. 12. Assertiveness. 13. Emergency situation response. 14. Self-confidence and Assertiveness. 15. Workplace skills.	**15 Lectures**
	Total	**60**

	Practical USMAACMBP6	
	Practical **(Hours per week)**	**Credit**
	4	**2**
1	Analysis DNA sequencing chromatogram: a) Sanger'smethod b) Maxam & Gilbert'smethod c) Automated sequencing method	
2	Western BlottingTechnique.	
3	Case studies for ethical issues in Biotechnology	
4	Animal cell culture (Demonstration).	
5	Visit to a Tissue Culturefacility.	
6	Visit to a biotechnology research institute	

Essential Readings:

1. *Bernard* R.Glick and Jack J. Pasternak(2002). Molecular Biotechnology: Principles and Applications of recombinant DNA. 4th Edition.
2. B. D. Singh. Biotechnology. Kalyani Publishers.
3. S. N. Jogdand. Advances in Biotechnology. 2005. 5th Edition.
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6. Aluizio Borem, Fabricio R. Santos and David E.Bowen Understanding Biotechnology.2004 Pearson Education.
7. James Watson and Others.Recombinant DNA.2001. Scientific American Books.
8. S. N . Jogdand. Gene Biotechnology. 2008, Himalaya Pub.House.
9. Purohit, S. S. Biotechnology – Fundamentals and applications. 4th edition, 2005. Agrobios (India).
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